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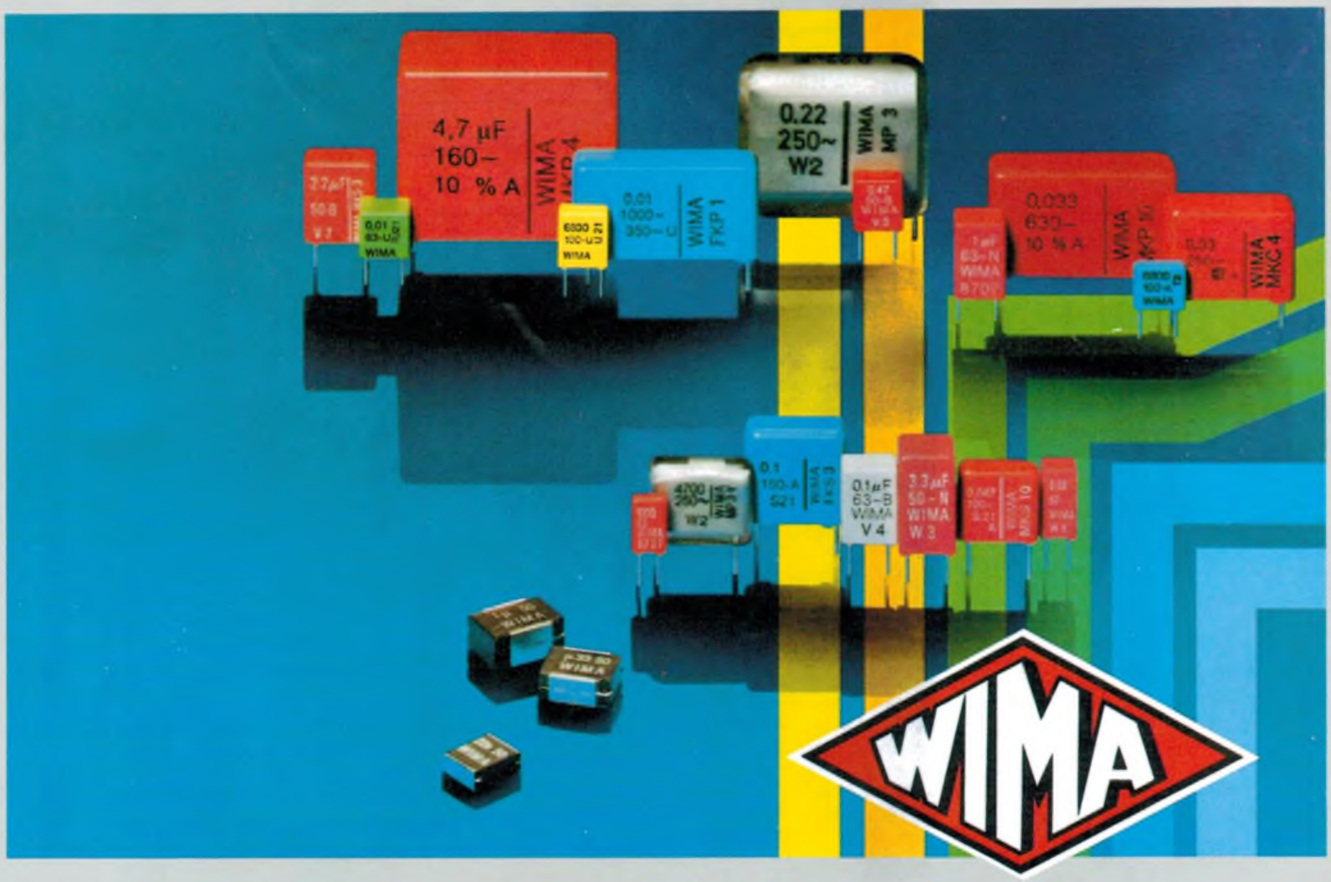

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191 Ramsgate Road,
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Electronics Australia

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AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Easy to build digital Amphometer

Here's a very neat and elegant design for a compact 4-digit amphometer. You can use it with a variety of sensors, for both full size and scale model vehicles. Find out more in our story starting on page 64...

Pioneer's new 'A-V Surround' amp

The new Pioneer VSA-1000 amplifier features an inbuilt digital surround sound processor, plus video signal selection circuitry and full remote control. See our review, starting on page 10.

On the cover

Dave Warren displays one of the aperture wheels for Protel's new Australian-designed photoplotter. See our feature story on its development, starting on page 14 (Picture by Tom Moffat). The picture of our new Amphometer is by Greg McBean.

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MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
NEWS EDITOR
Winifred Vincent, MSEE, MS.Phys
TECHNICAL EDITOR
Peter Phillips, B.Ed., Dip.Ed., ECC
PRODUCTION CO-ORDINATOR
Milli Godden
EDITORIAL STAFF
Rob Evans, CET (RMIT)
Dewald de Lange, B.Eng.
READER SERVICES
Allison Brown
ADVERTISING MANAGER
Selwyn Sayers
CONTRIBUTORS
Neville Williams, FIREE, VK2XV
Jim Lawler, MTETIA
DRAFTING
Karen Rowlands
GRAPHICS DESIGNER
Brian Jones
ART PRODUCTION
Alana Horak, Ray Eirth, Ron Farrell
PRODUCTION
Tracy Douglas
ADVERTISING PRODUCTION
Brett Baker, Inga Tettmann
CIRCULATION MANAGER
Michael Prior
DISTRIBUTION MANAGER
Helen Petersen
PUBLISHER
Michael Hannan
HEAD OFFICE, EDITORIAL & ADVERTISING
180 Bourke Road, Alexandria, NSW 2015
P.O. Box 227, Waterloo 2017.
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Fax number: (02) 693 6613
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INTERSTATE ADVERTISING OFFICES
Melbourne: 221a Bay Street, Port Melbourne, Vic 3207. Phone: (03) 646 3111
Fax No: (03) 646 5494, Nikki Roche
Brisbane: 26 Chermside Street, Newstead, Qld 4006. Phone: (07) 854 1119
Fax No: (07) 252 3692, Bernie Summers
Adelaide: 98 Jervois Street, Torrensville, SA 5031. Phone: (08) 352 8666
Fax No: (08) 352 6033, Mike Mullins
Perth: 118 Forrest Street, Cottesloe, WA 6011 Phone: (09) 385 3332, Fax (09) 385 3700, Estelle de San Miguel
New Zealand: 63-73 View Road, Auckland, Phone: (09) 443 0954.Fax No: (09) 443 1326 Gordon Marr
United Kingdom: John Fairfax & Sons (Aust) Ltd. 12 Norwich Street, London, EC4A 1BH. Phone: (01) 353 9321, Fax: (09) 593 0348
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LETTERS TO THE EDITOR

Fluoro omission

I appreciated the January 1990 article 'Understanding Fluorescent Lamps' because it filled in my sketchy knowledge on the subject, in most areas. There was, however, one serious error and one, possibly serious, omission.

The new, slimline, high-efficiency tubes are only electrically interchangeable with the old version in so far as they will actually work in the old fittings. Their life expectancy, though, is greatly reduced when they are used with the old 20 or 40 watt ballasts.

When stocks of the old tubes dried up and I had to sell slimline tubes to customers with older fittings, they started to complain that the tubes were only lasting for as little as six months, whereas previously they might have lasted for several years. After some searching I discovered that at least one wholesaler, A & L Distributors in Victoria, stocked the older tubes. This non-compatibility seems to be more widely known now, since even some supermarkets are again stocking the older tubes.

Incidentally, the 40 watt tubes I have been buying are 32mm in diameter, so there is another size.

The omission concerns the dangerous nature of the chemically active contents of the tube. I was always warned, when young, never to break a tube or allow the powder inside to contact broken skin. Was this warning too harsh, or does a definite danger exist in handling broken fluorescent tubes?

After the wealth of detail on operation it would have been good to see more information on the sections of power factor and electronic ballasts. I understand someone has also developed and patented, in Australia and overseas, a system for modifying fluorescent tube power consumption, with a view to vastly reducing power bills. Perhaps these are areas in which someone could report further.

Trevor Graetz,
Culcairns, NSW

Shorts Locator

I have just got my PCB Shorts Locator (February 1989) working, having purchased a kit some time ago. I found one problem with the design, and a potential problem with the parts list. You may want to advise other constructors of these problems.

Firstly the parts list problem. The parts list specifies the timer chip as a '555 timer,' and the text refers to the 'ubiquitous 555 timer'. It is quite likely that the real 'ubiquitous 555' would not work in this circuit, as this bipolar part has a specified minimum supply voltage of 4.5V, whereas the shorts locator runs it on 3V. What should have been specified here is the not-quite-so-ubiquitous CMOS version 555 timer, usually going under the part number of XXX7555, where XXX varies from one manufacturer to another. These CMOS versions are mostly specified to operate with a supply down to about 2V.

Fortunately, my kit had the right type of 555, an Hitachi HA17555, but it still didn't work.

A common problem with 555 circuits (both bipolar and CMOS) is internal and external feedback from the output pin (3) to the internal flipflops which trigger and terminate the timing cycle. This is particularly troublesome when the load is inductive (piezo beepers, relays, etc.) I have always found that a low-impedance 100nF capacitor (e.g., a ceramic by-pass type) across the output (pin 3 to pin 1) fixes this problem, and so it did with the shorts locator.

Without this low-pass filter on the output, the 7555 was oscillating at about 80kHz, regardless of the pin 5 control voltage. Unfortunately, my hearing doesn't extend quite that far!

Daniel Ford,
Beecroft, NSW

SOTA in PNG

I was very interested in the article on the School of the Air, in the December issue.

You may be interested to know that the SOTA does, or rather did have a parallel. This was in Papua New Guinea.

From the early 60's the Christian Radio Missionary Fellowship conducted a SOTA, mainly for Missionaries' children, and at its height there were over

60 children enrolled. We had two teachers and ran a one-hour morning session for prep to grade 2 and a one-hour afternoon session for grades 3-6. Our first teacher was in fact, trained by the Australian SOTA.

The teachers operated a library service for the children and also sent out musical instruments (records etc.) for the children to play over the radio. It was AM in those days.

The teachers also visited the students when time was available which of course, meant flying as all were very isolated. In the early days a SOTA camp was held at our Base on Rugli which gave the children contact with the others on the SOTA.

As we conducted a listening watch for medical and other urgent traffic, the SOTA was often interrupted and the children took keen interest in proceedings.

The CRMF SOTA was truly a multinational and ecumenical event as it brought together children from parents of many countries and many different Missionary Societies.

As Missionary Societies grew and began their own schools, the need for our SOTA decreased, resulting in its termination a couple of years ago. Running with the SOTA was a Radio Sunday School held weekly on Sunday afternoons and apart from a short break, the RSS continues today on a very similar basis to the SOTA.

Robin Cole,
Executive Director, CRMF,
Blackburn Sth, VIC

Disappointing fete

Thank you for publishing an editorial on the Electronics Stall for Hobbies at the Spastic Centre fete. As you mentioned in your article we raised $11,000 in 1988 but regrettably this last year we only raised $4000 on the day. This is very disappointing in that we had 25 of our staff people volunteer to set up the material, sell it and clear it away at the end of the day which was a lot of effort.

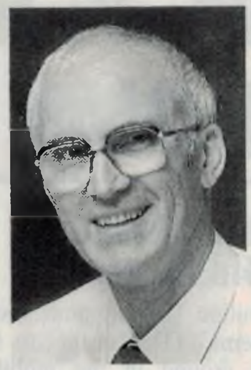
Perhaps it is a true reflection of the state of the economy as the overall fete takings were down 50% on the day.

Thank you once again for your generous support of our charity.

Alan Skinner, GM
Centre Industries,
Brookvale, NSW

Free free to send a letter to the Editor if there's something you believe that *EA's* readers should know. If we agree we'll publish it, but we do reserve the right to edit those that are too long, or potentially libelous.

EDITORIAL VIEWPOINT



Attracting more young people into science and electronics

Over the last few months a number of reports have been published both here and in overseas countries such as the UK, revealing a quite dramatic decline in the number of young people applying for enrolment in science and engineering courses – including those for electronics. So much so, in fact, that universities and colleges are having to lower their entry requirements in order to achieve even minimum enrolment levels.

On the other hand, the enrolments in courses for economics, commerce, law and medicine are as high as ever. The only other area where enrolments have fallen to a comparable extent is teacher training courses.

You don't need to be an Einstein to see that this fading interest in science, engineering and teaching is due to the current low status and average salary levels of these professions. When it's well known that a 30-year-old stockbroker or commercial lawyer can earn from three to five times as much as a typical scientist or engineer at the peak of their career, why would a young person want to enter science or engineering?

This is a particularly worrying trend for a country like Australia, because our neglect of science and engineering over past decades has already dragged us well behind in many important areas. That's why we import so many hi-tech products, not just from highly developed countries like Japan and the US, but also from so-called 'developing' countries like Taiwan and Korea.

If we're ever to remedy this situation, we're going to need all of the bright, creative and well-trained scientists and engineers we can get. Yet it looks like we're going to have not *more* of these people, but *less*. Frankly I can't think of a better recipe for ensuring that Australia does indeed become a third world 'banana republic' – can you?

But what's to be done? The politicians really don't seem to be very interested even now, despite their rhetoric. Presumably this is because they don't see many votes in science or technology, either way. And the firms and organisations involved in these areas have very little money to spend on lobbying or contributions to political parties. They're often too busy fighting for their survival.

Surely the key is to make many more people aware of the crucial importance of science and 'high' technologies such as electronics, to the future of our country and its economy. If enough people begin to realise this, not only will the status of our science and engineering rise again, but more money will be available to fund their growth.

In our own small way, *Electronics Australia* is trying to play its part in raising this consciousness. We're also trying to show young people how interesting and satisfying technology can be, not just as a career but also as a hobby.

Jim Rowe

What's New In HOME ELECTRONICS

'Auto answer' cellular phone

Philips Telecommunication and Data Systems (TDS) claims to have broken new ground in the mobile telephone market with the launch of a cellular phone which offers an auto-answer feature.

The Philips MCR-30 cellular mobile phone is the latest model to be designed and manufactured in Australia for both domestic and world markets. Its features are expected to lead to substantial export orders.

Users can pre-determine the number of rings before the MCR-30 automatically answers the call, leaving the driver to just speak instead of having to fiddle with a key or button.

A call accounting feature enables a charge rate to be set for calls, enabling accurate accumulation of charges, for example by client, to enable appropriate recharging.

Features of the MCR-30 include automatic redial for a preset number of times and a repeat interval, both of which can be set by the user, and being able to set periodic pips to monitor cost. It can also be adjusted to remotely operate an answering machine by recalling the appropriate tones from the memory.

For further information, contact Philips Mobile Radios, 23 Lakeside Drive, Tally-ho Technology Park, Burwood East 3151 or phone (03) 235 3666.

Low priced double cassette receiver

Aimed at the price point of around $100, packed with numerous features and operating from either AC or DC, the new AJW-228 portable is designed for both outdoor and indoor environments.

The radio section offers either AM or FM stereo with FM stereo indicator and telescopic antenna. The tape section offers a double cassette facility with two speed dubbing, auto stop mechanism to protect both the tape and the tape mechanism, and a one-way continuous play.

The audio section offers 16 watts PMPO and a 3-band graphic equaliser, driving two full range speakers.

The AJW-228 portable cassette receiver is available in black and can be purchased at selected department stores and Akai dealers, at a recommended retail price of $109.

More VHS, S-VHS camcorders from JVC

JVC has now introduced a total of four 'VideoMovie' compact camcorders: the GR-A1EA, GR-60EA, GR-S77EA and GR-S707EA. The first two are in regular VHS-C configuration while the latter two are in Super VHS-C.

Features of the GR-A1EA include automated focusing at any distance, a 'two age' insertion function to document important personal events, a tiltable view finder, a retake recording-mode search function and an electronic tracking control.

The GR-60EA has a flying erase head, retake, insert editing and audio dubbing functions. Additionally, it is capable of creating animated video programmes via an optional remote control unit.

The existing GR-S77EA is claimed to represent Super VHS in its most compact form, while providing quality pictures. It has all the features of regular VHS, which should make it a popular model.

The GR-S707EA combines picture quality with HiFi VHS Stereo sound and is a semi-professional level camcorder with a shoulder-mould design. Specialised audio components such as microphones and mixers may be connected via the unit's line-level audio input for advanced applications.

The GR-S707EA has the flexibility of manual control for all camera functions. Its other capabilities include truly variable time-lapse, self-timer, animation and a complete array of editing functions. It has in fact over 40 major features.

For further information, contact JVC (Hagemeyer A'sia), 13 Garema Circuit, Kingsgrove 2208 or phone (02) 750 4188.

Budget fax machines

Voca Commmunications' new M900 facsimile machine has many standard features, yet is available to price-conscious facsimile machine users, at just $1299.

Despite its low pricing, the M900 comes equipped with an integral handset, copying function and many of the features until now only available on more expensive machines. The new machine, which simply plugs into an ordinary telephone line extension, is therefore ideal for small or home business operators or for company executives who require a personal fax.

There is no need to dedicate a telephone line to the M900 as the manual answer mode allows the unit to double as a telephone. In manual mode the operator answers the telephone as normal and by simply pressing the start button, can begin to receive a facsimile if the fax tones are heard, while in automatic mode the M900 operates as an automatic facsimile receiving machine.

With the 'voice prompt' feature activated, incoming calls are greeted by a courteous pre-recorded voice which informs them they have contacted the M900, and that if they wish to do so they may begin their fax transmission.

The 'switch-to-fax' facility is available when the M900 is connected to a pulse telephone line, with a second handset connected via a mode 3 adaptor. Calls answered on the second telephone can be switched through to the fax machine if the fax tone is heard. Professionals who are often on the move can use a cordless handset as the second telephone, retaining cordless telephone mobility as well as the 'switch-to-fax' capability from remote locations. Alternatively, a conventional telephone answering system may be connected to the M900 to record telephone messages when an office is unattended.

For further information, contact Voca Communications, 11-29 Eastern Road, South Melbourne 3205 or phone (03) 697 7000.

HiFi VCR has multi-language display

Akai has introduced a new VHS hifi stereo VCR with an interactive monitor system that can display prompt instructions in any of eight languages.

Incorporating a hifi stereo tuner with sound quality comparable to digital audio equipment, the VS-965 will not only indicate a stereo transmission or pre-recorded stereo tape, but also whether the transmission or tape is in full hifi sound.

The 'next function mode' menu allows the user to programme the VCR for play, rewind, quick index, eject, and turn off in a desired sequence. Further programming is accomplished by easy to read prompt and programming instructions that appear in any of eight selectable languages on screen, allowing TV shows to be programmed for up to a year in advance.

The VS-965 uses Akai's DX3 (3-head) video system, which is claimed to produce extremely high picture clarity. The HQ system further enhances image quality and a 'twin digital auto tracking' feature automatically optimises head alignment.

The VS-965 is available at selected department stores and Akai dealers, is covered by a one year national warranty on parts and labour and has a recommended retail price of $999.

Laser plays old records

US company Finial Technology announced in January 1985, that by 1986 it would start selling a laser turntable to play conventional vinyl gramophone records, for US$2500. Because of the non-contact nature of the laser beam as opposed to a conventional mechanical stylus, the records, some of which are now museum pieces, would not suffer wear and tear. But the years passed, and even by 1989 Finial could not produce a working model.

In 1989 a Japanese company, Carillon Technology bought the design and hired the engineers who worked for Finial. Now Carillon has come up with a gramophone that plays both vinyl LP records and 78rpm shellac discs using a laser beam – but selling at a price of US$32,000. The cost and time delay are indicative of the difficulty experienced in developing the technology.

The V-shaped groove of the record carries left and right channel information on the left and right walls. Two separate laser light sources and sensors are used to read undulations down to around 0.2um. As the disc spins, the undulations on the grooved wall behave like a continually changing curved mirror, from which information is extracted.

Sony develops CD recorder/player

Sony, in conjunction with Taiyo Yuden has developed a prototype magneto-optic recording/erasing CD machine. The machine has a recording time of 74 minutes and the rewritable discs are said to be recordable for up to a million cycles.

The machine can play ordinary compact discs, but the discs it records apparently cannot be played on conventional CD players because of the special wavelength and intensity of the light used to make the imprint on the iron-cobalt substrate material. Apart from the compatibility with other machines, price will no doubt be a major factor in determining its eventual market success.

Hifi loudspeakers

JBL Australia is introducing its 'XPL' series of loudspeakers, which use materials first used by US aerospace industry. Each product is equipped with 25mm titanium dome high frequency drivers and composite low frequency drivers featuring Symmetrical Field Geometry (SFG) magnetic structures.

The titanium dome is cooled with Ferrofluid, a magnetic oil which helps prevent heat build-up and power compression.

The cones are combinations of polypropylene, fibre substrates with copolymer, or Aquaplas treatments to control mass, stiffness, damping and break-up.

The baffle is a multiple layer structure of fibreboard covered with a shell of Reaction Moulded Foam (RMF). In addition to providing strength and acoustic damping, a stepped baffle also improves the speakers' imaging and spatial qualities.

For further information, contact JBL Australia, 578 Princes Highway, St Peters 2044 or phone (02) 516 3622.

Teletext programming for video recorder

JVC (Victor Company of Japan) has introduced a new system for timer programming that lets users automatically programme their VCRs with teletext information.

Modern teletext services offer a wide variety of benefits including instant access to news, weather, and sports reports, television broadcast schedules, notices of local events and entertainment, and much more. This information is available at any time to the viewer and can be called to the screen simply by inputting the appropriate page number.

The first of JVC's teletext-compatible VCRs is the high performance HR-D830EA Hifi VHS VCR. Besides boasting powerful stereo sound with a dynamic range of more than 90dB, the HR-D830EA offers exciting new performance features like automatic digital AV tracking, to ensure optimum tracking of both the hifi audio and video tracks at all times, noiseless special effects thanks to the DA-3 head system, and duet editing for simplified simultaneous control of two JVC decks in editing.

All teletext operations are controlled via an attractive new ergonomically designed remote control which, besides its teletext capabilities with colour coded teletext control buttons, features an LCD with built-in clock for independent pre-programming.

For further information, contact JVC dealers or Hagenmeyer, 13 Garema Circuit, Kingsgrove 2208 or phone (02) 750 4188.

Hifi Equipment Review:

Pioneer's VSA-1000 A-V 'surround' amp

The new VSA-1000 amplifier from Pioneer provides a built-in digital surround sound processor (with Dolby Pro Logic decoding), plus no less than *five* power amplifier channels. It also boasts a very flexible video signal selection system, with S-connector facilities, and a programmable multi-function remote control.

Nowadays the average Australian lounge or living room is tending to acquire quite a collection of audio and video gear. As well as the hifi amplifier with its collection of audio sources such as CD player, AM/FM tuner and cassette tape deck, and perhaps things like a graphic equaliser, there's generally also a TV set and a VCR. If you're keen on surround sound, there will probably also be a surround sound decoder and one or more additional power amplifiers.

Before long, the collection may well be joined by a DAT machine, an S-VHS or hi-band 8mm VCR and possibly things like a video disc player, HDTV monitor and satellite TV receiver.

Achieving flexible and convenient control of this overall 'entertainment system' can be rather tricky. Most reasonably modern amplifiers provide for selection of audio signals for both listening and recording, but when it comes to video signal routing you're generally on your own.

There are a few small video switching boxes around, but they're rather limited in terms of capabilities. Few if any can cope with the new S-connector system, for example, with its separate luminance and chrominance signals – as used for S-VHS, and effectively the other 'enhanced' video systems like hi-band Video-8.

It's basically this situation of growing domestic complexity that Pioneer's new high-performance VSA-1000 amplifier seems to have been designed to help sort out. Because it's by no means just a hifi amplifier; it also combines a digital surround sound decoder/simulator, the additional power amplifiers for both 'rear' and 'middle' surround channels, and a video control/routing system which works in parallel with the audio side. The video side caters not only for conventional composite video signals, but for the S-connector system as well.

As a bonus, the VSA-1000 also offers the convenience of a very comprehensive remote control facility – whose functions include control over master volume, surround sound mode and delay time, balancing between front/rear and left/right, selection of various preset bass/treble tonal characteristics and sound field 'recipes'. The remote control can even 'learn' the command codes used to operate your TV, VCR, CD player and so on, so that it can be used to control your complete system.

In short, it's a very interesting attempt to come to grips with this grow-

ing problem – and one for which Pioneer is to be congratulated, I believe. But let's take a closer look at those functions and facilities, before we go any further.

In more detail

The VSA-1000 is a rather larger and heavier beast than many hifi amplifiers; it measures 420 x 162 x 421mm, and weighs a hefty 12.5kg – or over 27.5 pounds, in old money. So you wouldn't really want to carry it around much.

The front panel also looks rather more impressive than most amplifiers, with some 50 different pushbuttons and a fluorescent display panel in addition to the large volume control knob. There's also a headphone jack, and video/audio inputs for the 'Video 2' input source – to allow convenient connection to a video camera.

The rest of the connections to the VSA-1000 are at the rear, and it's here that you really start to become aware of the unit's greater complexity. In fact the rear panel looks a little reminiscent of a Boeing 747 cockpit, with some 60 RCA connectors, 14 loudspeaker connection terminals, an impedance selector switch for the front (main channel) speakers, six video S-connector sockets, four 2-pin AC outlets for accessories (three switched, total 300W), a 5-pin video/audio outlet socket for an optional RF modulator, an input balance control for setting up the Dolby Pro Logic surround circuit, and a functional earth terminal. Whew!

It's a bit bewildering initially, but everything is explained quite well in the manual and it really doesn't take long to work out where everything goes.

The same applies to the front panel, really – at least for the basic functions. It's only for the VSA-1000's more esoteric facilities that you need to refer to the manual; the rest of it is fairly logical and intuitive.

Essentially the audio side of the system comprises two main stereo channels, with power amplifiers rated at 100W continuous average (RMS) power output into 8-ohm loads. These channels are fairly conventional in terms of control facilities, except that the tone control circuitry is digital – with memories – and the input signal/recording signal selection system is rather more elaborate than usual. For example any of 13 different inputs may be selected for listening: phono, CD, tuner, tape 1, tape 2/DAT, line, VCR1, VCR2, VCR3, VDP (video disk player), TV, video 1 or video 2. The last-named pair are from either video cameras or a satellite TV receiver, etc.

The recording selection system is just as flexible, with the ability to select either the signal to which you're currently listening, or some four other signal you might want to record from 'in parallel'. The recording signal can also be routed to VCR1, VCR2, VCR3 or tape 1, or more than one of these.

There are other little niceties too, like a switchable noise filter for the sound inputs from VCR1/VCR2, switches for alternative sets of main speakers, and linked front end output/power amp input sockets so that you can break the connections and re-route the signals for special purposes.

Along with this very flexible 'basic' stereo amplifier system there is the digital surround sound processor, with a choice of 'studio' or 'stadium' acoustic recipes, the full Dolby 'Pro Logic' surround sound system with automatic emphasis of the dominant signal component, or surround sound simulation for mono signals. The processor also provides the ability to vary the surround sound delay time (15-20-30ms) and the relative levels of the rear and centre speaker channels compared with the main front channels.

Complementing the sound processor are three further amplifier channels, to drive the additional rear and centre speakers. Each of these three additional channel amplifiers is rated at 30W RMS output into 8 ohms, so that the total rated output of the VSA-1000 is a very husky 260 watts.

On the video side, the VSA-1000 is basically a switcher/router – divided into two separate sections, one dealing with composite video and the other with S-connector separate luminance (Y) and chrominance (C) signals.

The composite video section operates to a large extent in parallel with the audio input signal and recording signal selection circuitry. It selects the video from VCRs 1, 2 and 3; a VDP; the TV receiver; or the Video 1 and Video 2 inputs, routing them via a distribution amplifier to the video monitors, an optional RF modulator and/or any of the VCRs. In addition the signals from VCR2, VCR3, the VDP, and video inputs 1 and 2 can be routed separately to VCR1, for parallel background recording.

The S-connector video section is a little more modest, allowing selection of signals from two S-connector VCRs and a VDP, routing them to an S-terminal monitor and/or S-VCR2. However S-VCR1 can also be fed with signals separately, from either S-VCR2 or the S-VDP.

Quite apart from these video switching and routing facilities the VSA-1000

Pioneer VSA-1000

also contains an internal video generator, capable of displaying its functions, modes and command menus up on either the composite monitor screens, the TV screen or the S-monitor screen. However this internal video generator is designed only for the NTSC system, and can't be used with Australian PAL system video gear. At this stage Pioneer apparently has no plans to produce a PAL version.

Inside the case of the VSA-1000, things are fairly crowded. There are a total of four main PC boards, with a few smaller boards as well.

A vertical PCB behind the front panel carries the display panel and much of the control circuitry, with the main large power transformer behind it to the left. Alongside the transformer and running across the rest of the case is a large fabricated heatsink radiator, made from 5mm aluminium plate with some 15 deep 'U' shaped fins rivetted to it. This appears to carry most of the audio output transistors, for all five channels.

Behind the heatsink and transformer are the three main PCBs, stacked one above the other. The largest and lowest board appears to carry the front amplifier channels and the power supply circuitry, with the other two used for the secondary audio channels and the video circuitry. Most of the interconnections are made via ribbon cable and PCB connectors, with wire-wrapping used for the leads carrying heavy current.

An interesting feature of the amplifier's 'works' is the small DC motor and gearbox system used to actuate the master volume control, via the remote control unit. The motor itself is quite tiny – about 15mm diameter by 25mm long – but is coupled to the triple volume control pot via an equally compact gearbox and clutch. The nett result is a very smooth and quiet remote volume control facility, with visual feedback via a small LED imbedded in the knob.

The VSA-1000's IR remote control unit is almost as impressive as the amplifier unit itself. It carries no less than 72 control buttons and three slider switches!

As with the main unit, however, the functions of these buttons are clearly marked, and largely intuitive. They're grouped into various sections, used for audio functions and mode selection, input signal selection, volume and muting, TV/tuner/VCR channel selection, Tape/VCR function control and CD/VDP player function control.

There are some 140 system commands for Pioneer's own audio and video components programmed into remote unit's memory at the factory, but these can be replaced with the user's own choices if desired.

How it went

We first checked out the performance of the sample VSA-1000 in the lab, and it gave a pretty good account of itself.

The continuous RMS power output from each of the main front channels, with both channels driven, measured 115W into 8 ohm loads in the '8-ohm' switch position. With the switch in the '4- to 8-ohms' position, we measured 70W into 8-ohm loads and 50W into 4-ohm loads. The corresponding IHF pulsed power figures turned out to be 166W into 8 ohms and 144W into 4 ohms, showing that the VSA-1000 would give rather more output under typical music conditions.

At 100W RMS continuous into 8 ohms the THD of these channels measured 0.01%, falling to 0.009% for 50W into 4 ohms. The corresponding intermodulation distortion figures were 0.027% and 0.016% respectively. These figures were measured using the CD inputs.

Noise level for the line level and CD inputs measured –105dB below 100W into 8 ohms, with a figure of –85dB for the phono input relative to 25mV input. Line level input sensitivity measured 180mV, while the phono input sensitivity was 3.5mV with an overload level of 140mV.

Frequency/power response from the CD inputs (for 100W into 8 ohms) measured 10Hz – 20kHz within 0.5dB. The digitally controlled bass and treble tone controls gave a total range of +/–12dB at 50Hz (adjustable in 3dB steps), and +/–10dB at 15kHz (adjustable in 2.5dB steps).

The two rear channel amplifiers and the front centre channel amplifier all appear to be identical in performance, and to share a common power supply. With any two driven continuously, they each produced a measured output of 50W RMS into 8 ohms, for 0.009% THD, or 30W RMS into 4 ohms, for 0.012% THD. These figures were measured using the direct amplifier inputs; slightly higher distortion figures were obtained via the surround sound processing circuitry, as you might expect.

In short, these figures are all quite commendable and reveal the VSA-1000 as a very solid and clean performer. But how did it sound?

We tried it out in a fairly typical domestic listening room, with a pair of fairly large reflex enclosures for the two main channels, a medium-sized reflex system for the centre channel and a pair of compact sealed enclosures for the rear channels. The signal sources were a medium-range CD player, AM/FM tuner and turntable with magnetic cartridge. Then we settled down for quite a few hours of careful listening, much of the time to a set of high-quality and familiar CD recordings that we often use for this type of test.

It turned out to be a very pleasant experience. Not only did the VSA-1000 sound very clean and unforced, even at high listening levels, but it was a rare pleasure to be able to spend most of the time seated comfortably in an armchair – making whatever adjustments that were necessary using the remote control unit.

Considering just how many adjustments have to be made, both to set up a system of this complexity and to try out various modes and functions, this was really quite impressive. You can turn any of the channels on or off, adjust relative balancing from right to left, front to back, and sides to centre, adjust bass and treble, select surround sound decoding mode, adjust reverb delay time, select input signals, and of course adjust master volume – all via remote control!

We weren't able to test the video side of the VSA-1000 to any significant extent, due to a difficulty in getting hold of the necessary equipment in the time available. However judging from the audio side, the switching/routing functions are all likely to match the specs. It's a pity that the video superimpose circuitry won't work with Australian PAL gear, though.

Summarising, then, the new Pioneer VSA-1000 is not only a very clean and impressive performer as a multi-channel amplifier, but also a flexible and convenient audio-visual control system with the added bonus of a built-in digital surround sound processor. This should make it an excellent choice as the core of a complete home audio-visual entertainment system – all controlled from your armchair.

At the quoted price of $1499 it also seems good value for money, considering what it contains and the functions it provides.

We're assured that you should be able to find the VSA-1000 at your nearest Pioneer stockist. However in case of any difficulty, you can always contact Pioneer Electronics Australia, at 178-184 Boundary Road, Braeside 3195 or phone (03) 580 9911. (R.E. and J.R.)

Success for Aussie hi-tech product:

Protel's new Photoplotter

Designers at a Tasmanian company have developed a new high performance photoplotter that will sell at less than half the price of the overseas competition. The Protel company is probably best known for its popular line of PCB design software, but its engineers have been quietly working away on the new plotter, which is planned to be the perfect mate for their software.

by TOM MOFFAT

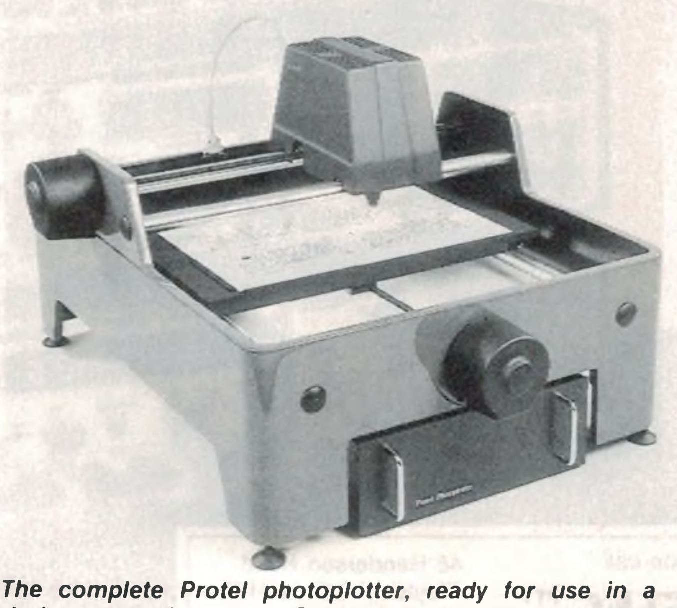
PCB design programs, and most other CAD programs as well, produce as their final output some kind of drawing. In the case of PCB design, the drawing is a photographic transparency used as a 'negative' for etching printed circuit boards. Other CAD packages may produce drawings of some machine part, or a building, or a new road. But regardless of the type of drawing required, the ultimate aim is the highest quality and accuracy possible.

There are many ways to produce hard-copy images from a computer. Perhaps the cheapest and nastiest method is to send the image to a dot-matrix printer, which produces black dots in the desired pattern using the same print wires it uses to produce written text. This can be improved upon considerably if a laser printer is used, but seldom is the output considered 'reproduction quality'.

The next step up the ladder is a proper 'pen and ink' X-Y plotter that uses motors to move a pen across a piece of paper, leaving a line behind it wherever it goes. The plotter is driven by a computer, which tells it the X-Y co-ordinates of the point it should start from, which point it should go to, and whether or not it should leave a line (the pen is raised from the paper for changing positions, and lowered for drawing).

It is possible to change pens – some plotters do this automatically – so you can have lines of different widths, and even different colours. Plotters of this type sell from a couple of thousand dollars up, and are capable of producing very high quality artwork. Pen-and-ink plotters are probably the most common type for run-of-the-mill work; for architectural drawings and routine PCB jobs. But in the case of really complicated PCB's, and things like designing integrated circuits, the utmost accuracy is essential. Here's where *photoplotters* enter the picture.

In PCB work, a pen-and-ink plotter will usually draw its image on a piece of



The complete Protel photoplotter, ready for use in a darkroom environment. One stepper motor moves the photo-head, while the other moves the film table.

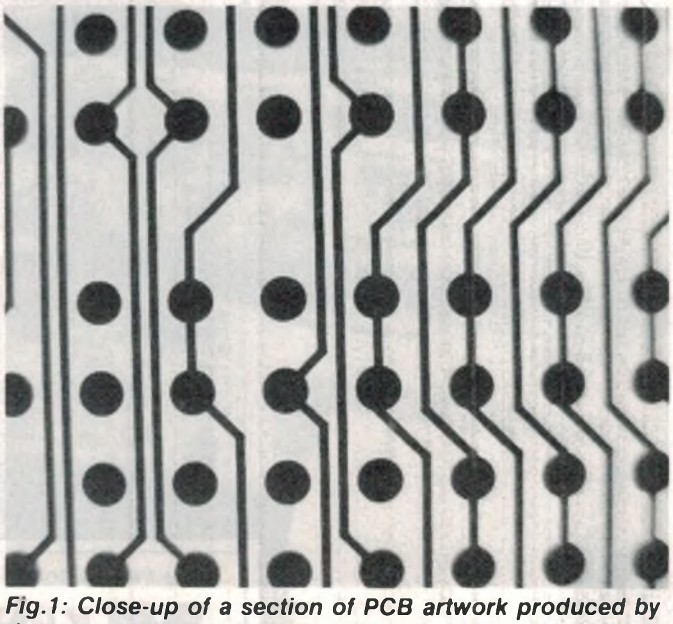


Fig.1: Close-up of a section of PCB artwork produced by the new photoplotter. Note the very sharp and smooth edges.

white translucent plastic film, which is then back-lit and photographed by a large camera to produce the actual 'negative' for etching the PCB (the negative may in fact be a positive). It is common to draw the plot double-sized in each direction, and then photo-reduce it by a factor of two each way to improve accuracy.

The photoplotter cuts out the 'middle man' (the white translucent plastic) and draws directly onto a piece of photographic film. It does this by projecting a very fine beam of light onto the film, and then physically moving the 'projector' around to leave a trail of exposed film where the light has been. If the 'projector's' optics are good, and the positioning is accurate enough, the photoplotter can overcome any defocussing and image distortion that would have been caused by the camera. Every camera has some distortion, no matter how well it is made.

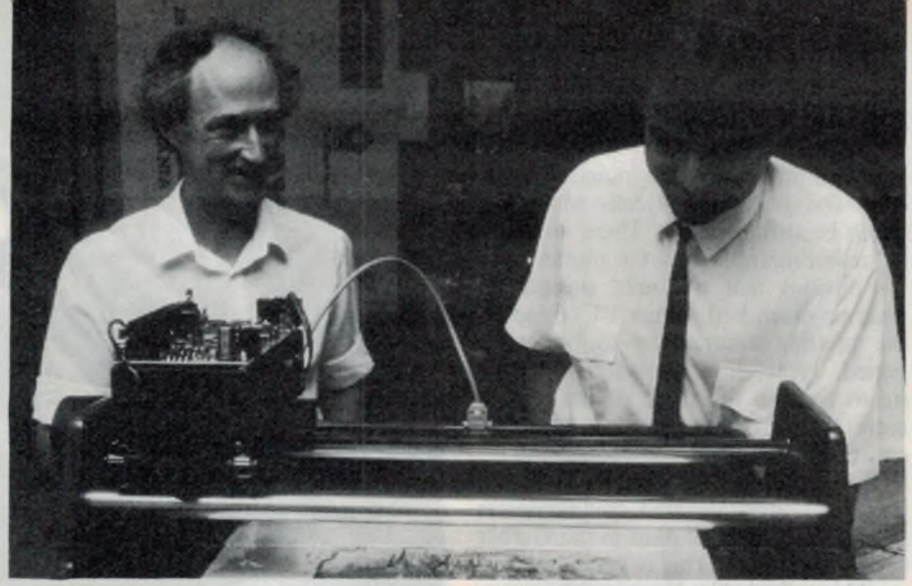
How Protel did it

Protel's photoplotter consists of a photo head which can be moved up and down, right and left, over a flat table upon which the film is laid. The head is moved along each axis by a lead-screw arrangement, which is rotated by a stepper motor. The stepper motor looks like any other motor, except that it rotates in discrete increments of degrees. Each increment of rotation is brought about by hitting the stepper motor with a short belt of electric current. If you give it ten pulses, it will move ten steps, and so on.

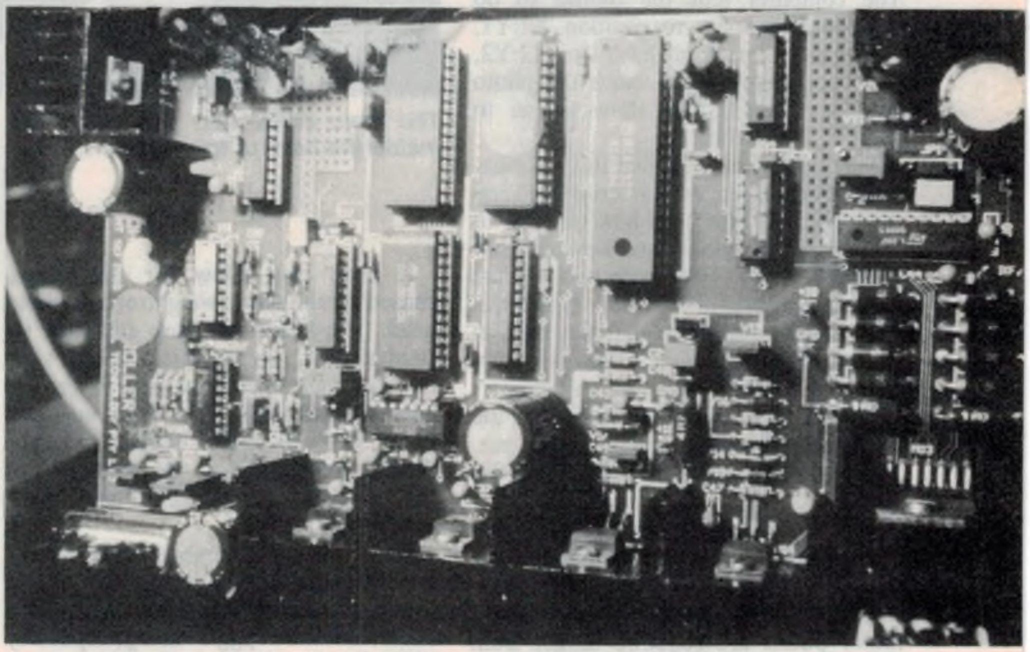
This is a convenient arrangement because you can cause the photo head to move from one known spot to another by giving it a known number of pulses for each of the two directions of movement; X and Y. If you gave the X and Y motors an equal number of pulses, the head would move along a 45° diagonal – in theory at least. But in practice, life is much harder.

In the Protel plotter, each stepper pulse moves the photo head exactly 1/1600 of an inch (we're using inches here since we're talking PCB's). So there are 1600 individual 'locations' in a linear inch, or more than 2-1/2 million in a square inch. The plotter must be able to position its photo head over any one of these locations, time after time. So every movement of the plotter must be ultra-precise.

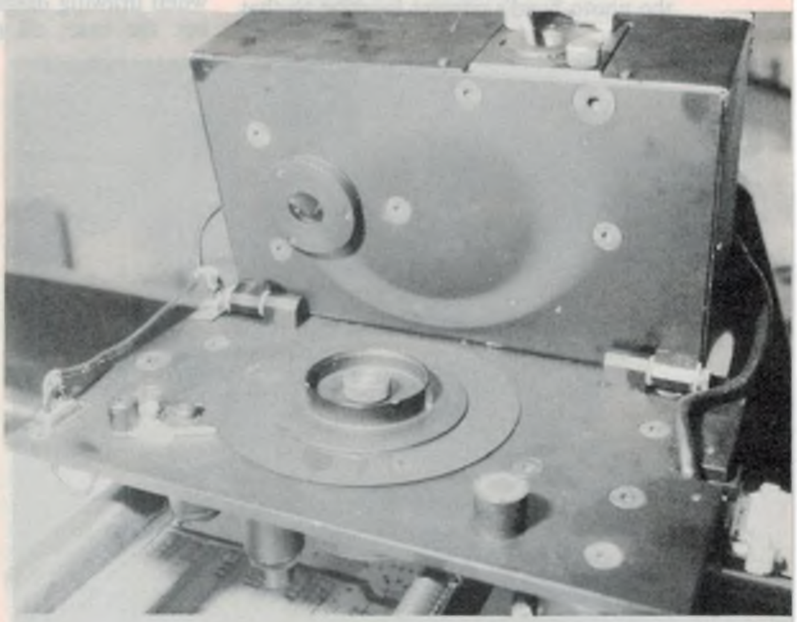
To further this end, Protel's photoplotter uses the brute force method. They simply built the thing like a battleship. The 'works' are all mounted on a heavy, solid aluminium casting.



Dr Barry Giles (L), research physicist, and Dave Warren, manager of Protel Photonics, with the new photoplotter.



The electronics built into the plotter's photo-head.



The photo-head opened up, showing an aperture wheel in place.

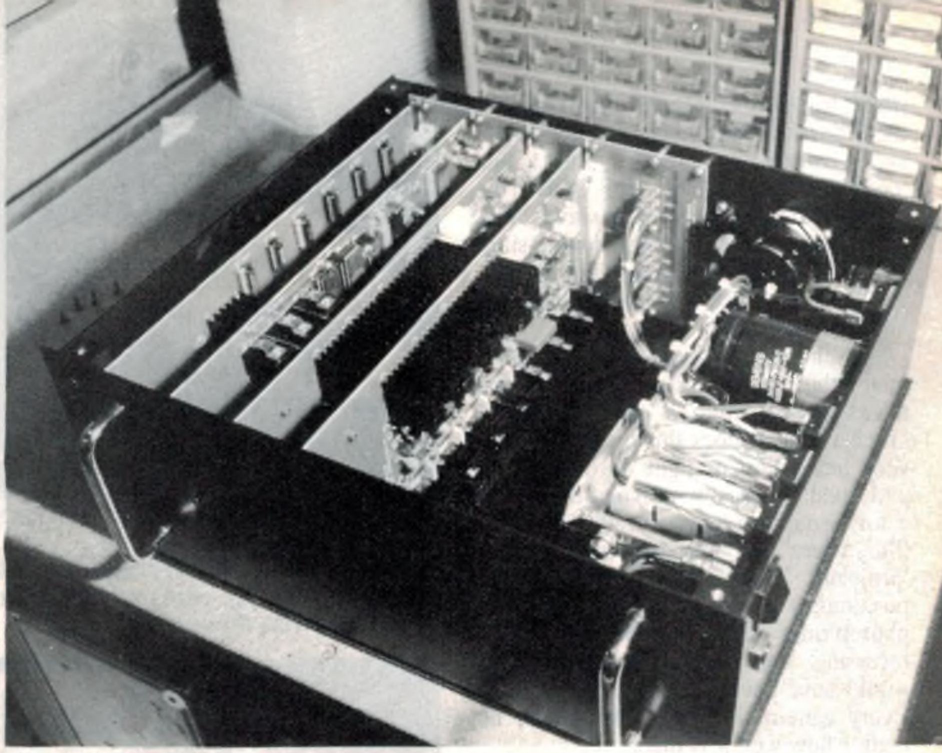
Photoplotter

Within the casting are mounted hardened and ground steel rails which the photo head rides along. There are similar rails running across the plotter, and it's obvious that the rails' positioning must be much better than 1/1600 inch if the plotting accuracy is to be maintained. Protel have designed a special jig to position the rails; in fact it's the secret of the whole system's accuracy, so we weren't allowed to photograph it.

The plotter is driven by an IBM PC, using any software that communicates via the command set used in the Gerber series of plotters. This is pretty much a world standard, like Epson printer commands and Hayes modem commands. The computer tells the plotter to do something like 'go to position X1:Y1, then draw a line from X1:Y1 to X2:Y2, then stop drawing and move the photo head to X3:Y3, then draw a line to X4:Y4', and so on.

The plotter must receive this information, which it gets over a serial line, and then figure out for itself how to move to the desired positions, and how to draw the lines. This is done with two internal microprocessors, of Motorola type 6802. This is the same micro that was used in *Electronics Australia*'s DREAM computer of 10 years ago, but this doesn't mean the processor is obsolete. On the contrary it is well designed, easy to use, and easy to program, and ideal for this job.

One 6802 is located in the main electronics unit in the base of the plotter. Its job is to take the 'goto Xm:Yn' commands and work out how many stepper motor pulses are required to get from the photo head's current location to that point.



The main electronics unit which fits inside the base of the plotter.

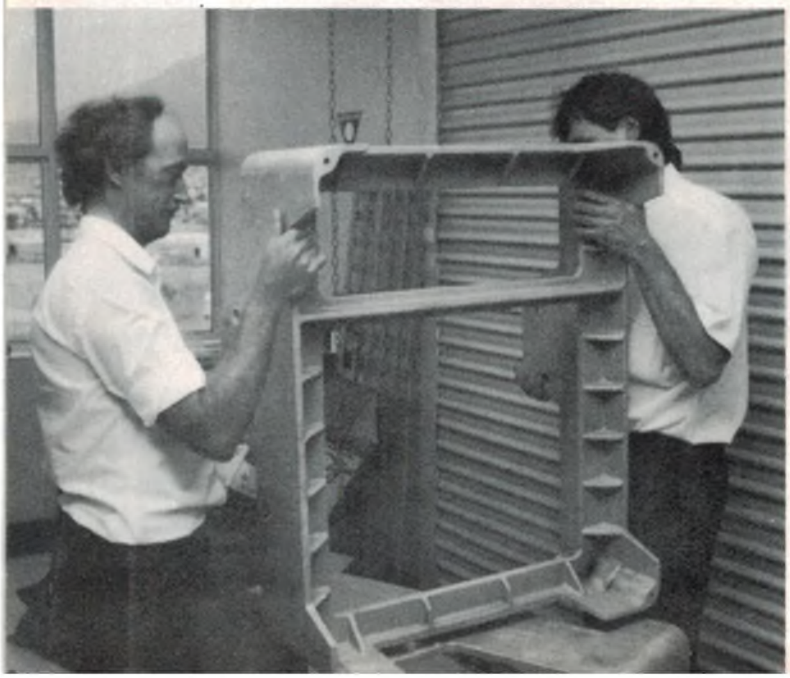
It must also allow for the inertia caused by the sheer weight of the photo head. The head can't stop and start instantaneously, so the micro has to send out the pulses slowly at first to get the head moving. The rate is then increased to get it up to 'cruise' speed, and then slowed down again at the other end of the travel to stop the plot head gradually.

With the plotter's movements coming from discrete steps in both the X and Y directions, one would expect the photo head to kind of 'jiggle' along, especially when drawing diagonal lines. But this is not the case; all movements are very fluid and steady. This is ensured by some vibration-absorbing couplings between the stepper motors and the shafts they drive, as well as the inertia of the plotting head itself. Fig.1 is a close-up photo of the plotter's output, with both direct north-south lines as well as diagonal lines. There is no sign of jitter.

Dr Giles working on the plotter's software with an IBM-PC. The 6802 machine code is assembled on the PC and then transferred into the plotter's memory for testing.

There are also some mathematics required from the microprocessor. Consider the case of a 45° line exactly one inch long. You can't just send 1600 X-pulses and 1600 Y-pulses and expect the head to get there; you must multiply each number of pulses by the square root of two, to work out the third side of a 45° triangle. This factor of course would change with every angle, so there's a lot of number crunching to be done.

The second microprocessor is actually in the plotter's photo head. It has several jobs; first to operate a shutter to turn the drawing beam on and off. But 'on



Dr Giles and Mr Warren with castings used for the base of the photoplotter. They're SOLID!

and off' isn't good enough; the light beam must also be varied in intensity. This is because, while the plotter is moving slowly, the beam spends more time over each point on the film. So to maintain a constant exposure factor, the beam must be dimmed. When the head is moving quickly the beam spends less time at each point, so it must be made brighter to compensate.

The light comes from an incandescent globe, which can be controlled over a 100 to 1 brightness range. The second microprocessor is in charge of this task as well; it must get speed information from the main micro and then use it to calculate a varying brightness to give an even exposure.

The photo head also contains a wheel with a selection of 'apertures' cut through it; these control the size and shape of the line drawn. It's a bit like a slide projector with the aperture wheel at the focal point. You can rotate the wheel, moving each of a series of shapes into the focal plane. The shape is then projected onto the film. Selection of the desired aperture is also under control of the photo head microprocessor.

All of these automatic activities are totally invisible to the IBM-PC which is in charge of the plotter. It simply sends the commands, and gets a confirmation back from the plotter when each command has been carried out. It knows nothing about how fast the photo head is moving, or how bright the light is.

Protel's aperture wheel is an interesting development, and is one of the reasons they expect their machine to be a winner on the world market. The wheel is simply a photographic copy of a master, and there are many different types of wheels for different applications. Aperture wheels in other makes of photo-plotters are usually precision-machined to make sure that every aperture around the wheel falls directly below the light source. Because of the precision required, the wheels are very expensive, up to $10,000 for a custom-made one.

Protel's wheels, being photographic reproductions, aren't so precise, and thus are a fraction of the cost of metal ones. But accuracy is restored when each new wheel is installed. The plotter's micros then run it through a calibration sequence, which works out and stores the location of 'dead centre' for each aperture.

This is done by moving each aperture over a small sensor embedded in the base of the plotter. The computer then moves the photo head up-down, left-right, until the edge of the aperture covers the sensor. It can then work out the exact centre of each hole, and include whatever offset correction is necessary when that aperture is being used for plotting.

Bright future

So how successful will this new Australian-designed and manufactured photoplotter be? Well, Protel is launching the instrument on the world market, with the intention of beating the opposition hands down. Competing photoplotters cost between $70,000 and $500,000, but the Protel model will go for around $30,000. They say that the Protel's performance will be somewhat better than the bottom-of-the-range competition model.

With full-scale manufacture under way, just about every mechanical part of the plotter will be manufactured in Tasmania, so most profits from the project will stay in Australia. The photoplotter project represents just the sort of high-tech industry that's been mooted as the saviour of Australia's economy and manufacturing reputation. It will be interesting to see how it goes.

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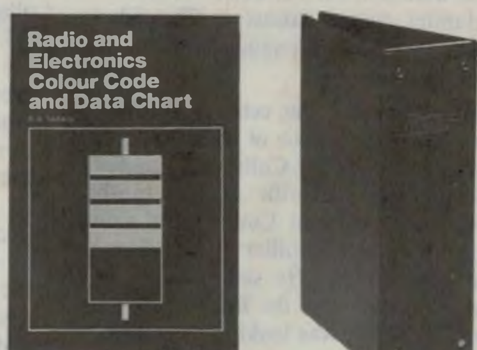

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When I Think Back...

by Neville Williams

Sir John Ambrose Fleming: He invented radio valves – or did he?

Sir John Ambrose Fleming – a gifted scientist of his day.

Dr/Professor Sir John Ambrose Fleming is remembered primarily as the inventor of the Fleming thermionic diode and the 'father' of radio valves, which were fundamental to the subsequent development of the industry. Whether or not this is strictly correct is debateable but, either way, Ambrose Fleming made a very considerable contribution to basic electrical and electronic technology.

Curiously, one finds scant mention, in relevant textbooks, of Fleming's personal background or his academic career. Beyond the fact that he was born in 1849, the texts to which I had access make little or no reference to his birthplace, his family or the steps in his career which led to his ultimate knighthood.

The British technical writer/consultant S. Handel comes closest in *The Electronic Revolution* (Penguin Books, UK, 1967). I quote:

At the turn of the century Fleming, then a young professor of electrical engineering at University College in London, was appointed scientific adviser to the Edison Electric Light Company of London and became familiar with Edison's lamp experiments. He subsequently became a consultant to the British Marconi Company which was looking for a better detector of wireless signals than the clumsy and troublesome devices used by Marconi.

It so happens that Handel was, himself, educated at the same University. Clearly, in the 50-odd years between 1849 and the turn of the century, Fleming had earned sufficient recognition at an academic and practical level to commend him as an independent consultant to the Edison & Swan Electric Light group and later (in 1889) to the newly formed British Marconi company.

As a consultant, he had ready access to Edison's lamp technology and to Marconi's pioneering ventures into wireless telegraphy – involvements that complicated subsequent litigation about patent rights in respect to the thermionic diode; but more about that later!

Fleming the academic

Curious about Fleming's academic career, I checked through a number of old reference books in my possession.

First off, a brief entry in a 60-year old Pear's encyclopedia indicated that Fleming's involvement with the University College spanned 40-odd years, from 1885 to 1926, by which time he would have been in his mid '70s.

Next in line was a 1931 copy of the *Admiralty Handbook*. Prompted by the index, I re-discovered several long-forgotten references to Fleming's left-hand and right-hand rules, which correlate current flow, the direction of magnetic flux and the mechanical force in magnetic systems (Fig.1).

The 'Fleming' responsible is not identified by the Admiralty Handbook, but I have little doubt that the 'rules-of-thumb' we were invited to memorise in other days were devised by John Ambrose Fleming, the subject of this present article.

There is no ambiguity, however, about the Dr J.A. Fleming whose work features prominently in another old textbook: *The Calculation and Measurement of Inductance and Capacity*, by W.H. Nottage of the Marconi Works, Chelmsford (Wireless Press, London, 1916).

Nottage quotes basic research into capacitance by Fleming, as described in his book *The Principles of Electric Wave Telegraphy*, 2nd Edition, page 179.

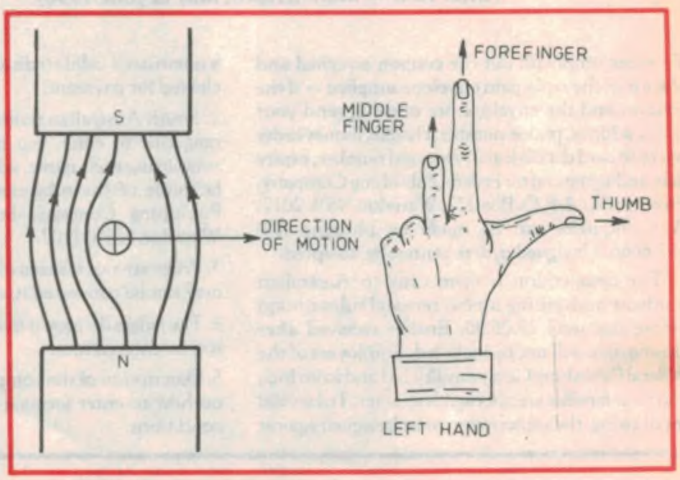


Fig.1: Fleming's left-hand rule for remembering the relationship between motion, magnetic field and induced voltage.

A further reference is to adjustable waveform filters devised by Fleming and Dyke, to facilitate their investigations into power factor and the conductivity of dielectrics. (*J.I.E.E.*, xlix 1912, p.323).

Again, a method of measuring capacitance is described, with a low-resistance battery as a DC source. Attributed to Fleming & Clinton, it used a spinning commutator to pulse charge the unknown capacitance at a rate of typically 100pps and to pulse discharge it alternately at the same rate through a ballistic galvanometer, the readout being interpreted in terms of capacitance. (Fig.2).

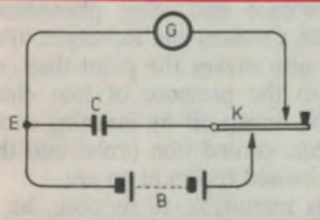


Fig.2: Fleming and Clinton devised this simple system for measuring capacitance, using a galvanometer.

According to Nottage, the method was detailed in Dr Fleming's books: *Wireless Telegraphist's Pocket Book* and *The Principles of Electric Wave Telegraphy and Telephony*, published at the time by Wireless Press, UK.

(A similar contemporary title by Fleming, *An Elementary Manual of Radiotelegraphy and Radiotelephony* was quoted as a reference by Peter Jensen for his article 'Spark: an old-time Induction Coil' in the April and June '89 issues of this magazine).

But back to Nottage: the measurement bridge illustrated in Fig.3 is credited to Fleming and Dyke and was used by them to measure capacitance or, more importantly, in researching power factor and the conductivity of dielectrics.

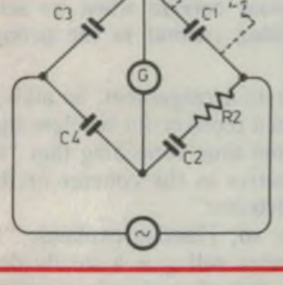


Fig.3: The capacitance measurement bridge attributed to Fleming and Dyke, by Nottage. It also measured dielectric performance.

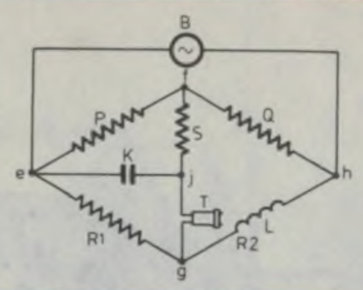


Fig.4: The Fleming-Anderson bridge, developed to measure inductance.

The Fleming-Anderson bridge (Fig.4) provided a means of measuring inductance. According to the text, it could be used with alternating current input or with direct current in conjunction with a buzzer-interrupter or a make-and-break key. It was nulled by adjusting for minumum sound in the phone T, but could reportedly yield more accurate results with the benefit of measurement methodology described in Watson's *Practical Physics*.

Fleming & the diode

While there is ample evidence as above of an active and innovative academic career, the fact remains that most biographical references to Fleming concentrate on his rationalisation of the so-called 'Edison effect' culminating, in November, 1904, in the almost legendary Fleming diode.

For sure, it was an important breakthrough in its in own right, but to acclaim Fleming's elementary thermionic diode as the the original radio valve and the genesis of the electronic revolution may be open to question.

That he was so acclaimed is evidenced by the fact that, in 1927, a landmark year for wireless broadcasting, full-page advertisements in popular wireless magazines for Amplion horn loudspeakers carried a personalised product endorsement by Dr J.A. Fleming, described as 'the original inventor of the thermionic valve' (see illustration).

More recently, on the 60th anniversary of the Fleming diode, the well known English journal *Practical Wireless* for January 1965 published a commemorative article under the heading: 'FLEMING ... AND THE DIODE – 60th Anniversary of the invention of the Thermionic Valve by Sir Ambrose Fleming FRS.'

Quite a few writers insist, however, that some of the credit allocated to Fleming really belongs to others. Again – more about this later!

Fleming's own reaction to the thermionic diode appears to be in relatively low key. A snippet of a letter to Marconi, in his own handwriting, reproduced with the above-mentioned *Practical Wireless* article gives no hint that Fleming's evaluation of the diode extended beyond his immediate area of concern – a potentially useful method of sensing wireless telegraphy signals. It reads:

I have found a method of rectifying electrical oscillations that is making the flow of electricity all in the same direction, so that I can detect them with an ordinary mirror galvanometer.

I have been receiving signals on an aerial with nothing but a galvanometer and my device, but at present only on a laboratory scale.

This opens up a wide field of work, as I can now measure exactly the effect of the transmitter.

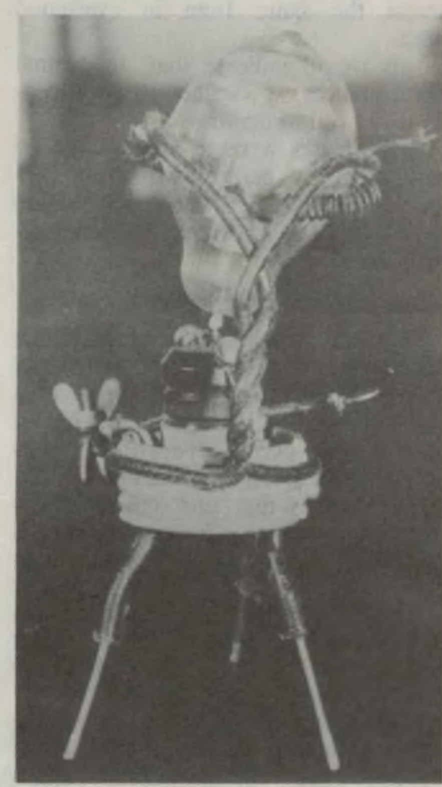
I have not mentioned this to anyone yet as it may become very useful.

Yours very sincerely,

J.A. Fleming.

Contemporary paper

If the above is more characteristic of an academic than an enthusiast and a visionary, the same goes for his contemporary paper on the thermionic diode, a copy of which was made available to me some time ago by Mr C.H. Scott of Ip-



Fleming's first experimental diode detector valve, developed in 1904. It became the subject of considerable legal argument.

swich, Qld. It comes from *Technics*, a monthly publication from George Newnes, London, dated April 1905.

Contemplating such an innovation, one rather expects a title along the lines of: 'A New and Revolutionary Method of Detecting Wireless Signals'. Instead, we have the bland and predominately academic heading: 'On the Electric Conductivity of a Vacuum' by J.A. Fleming, MA, DSc, FRS.

Perhaps wireless communication and a device based on electron emission was such a non-issue to readers of *Technics* in 1905 that the notion of an electrically conductive vacuum was judged to be more titillating; that's certainly the way it's presented by the author.

In the paper, Fleming envisages a glass tube containing two electrically accessible platinum plates, the whole assembly being sealed and evacuated to one hundred-millionth of an atmosphere. With a gap between the plates of as little as 1mm, he says, no measurable current flows between them, even with an applied potential difference of 100,000 volts.

Equally, a spark coil, which might bridge a gap of several centimetres in air, would produce no evident discharge across the same 1mm in evacuated space.

This would indicate that, in normal circumstances, a vacuum is an exceptionally good insulator.

If the plates were to be replaced by platinmum or carbon wires, or filaments, exactly the same observation would apply – provided the wires remain cold.

Current in a vacuum

However, continues Fleming, if one of the wires is heated in the manner of a lamp filament by connecting it to a suitably insulated battery, a discharge of current may occur between the wires across the intervening evacuated space.

It transpires that such current flows only when the incandescent filament is negative with respect to the one which is not artificially heated. If an alternator is connected between the two filaments, in series with a galvanometer, the latter will register a steady reading due to the flow of a unidirectional current.

Fleming points out that the rectifying effect is broadly similar to that of the 'Nodon valve', an electrolytic ('slop') rectifier that would be familiar to his readers. I quote:

It is well known that, if a carbon or iron plate is placed, together with an aluminium plate, in some electrolyte yielding oxygen, then a current of positive electricity can pass from the carbon to the aluminium but not in the reverse direction.

The Marconi wireless station at Poldhu, in Cornwall, UK, pictured in 1901. Designed by Fleming, it was used for the first trans-Atlantic communication.

To explain conduction by an evacuated thermionic diode, along with a rectifying action, Fleming says:

In any mass of matter, such as a metal, there must be, in addition to the complete atoms or molecules constituting the mass, a distribution throughout it of free electrons, the percentage of these increasing with the temperature. These electrons cannot escape from the mass when cold because if they did they would leave it positively electrified. If on the other hand, we electrify the mass negatively to a high potential and raise it to a high temperature, electrons can escape freely from it.

Very new concept

Nowadays, any student of high school physics is aware of the molecular/atomic composition of matter, of sub-atomic particles and of electron emission phenomena. But in 1905, it was at the leading edge of new and unfamiliar technology, being expounded as such by eminent physicists like Ambrose Fleming.

In the process, he was already confronted with the apparent conflict between electron flow (negative to positive) and the purely arbitrary convention that electricity flowed from positive to negative. In his explanatory diagram for a diode (Fig.5) he adopts the verbal device of a flow of 'negative electricity'.

Another diagram in his paper (Fig.6) emphasises that conduction through a diode does not obey Ohm's Law, behaving quite differently from a resistive circuit.

At this stage, the author diverges into a broad discussion of electron emission effects, including the influence of the degree of evacuation and the order of the applied voltages, along with phosphorescence and other phenomena to do with Crookes and Roentgen tubes.

He also makes the point that current due to the presence of free electrons can be drawn off by inserting a carbon or water-cooled iron probe into the active, ionised region of an arc.

It is reasonable to suppose, he adds, that free electron phenomena even play an integral part in ordinary combustion in a coal fire, with 'carbon positive ions' (formed by losing free electrons) exhibiting an affinity for 'negative oxygen ions' (having absorbed such electrons) to promote the creation of electrically neutral molecules of carbon dioxide.

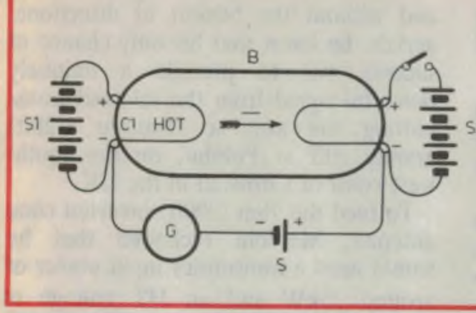
The diode detector

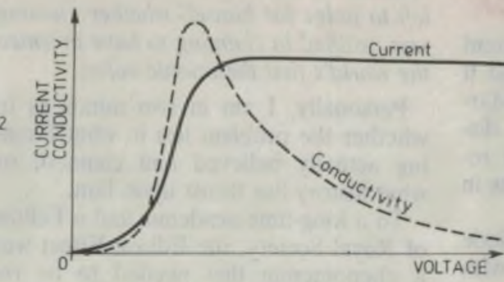
Only towards the end of the 7-page paper does he get around to the use of his diode for detecting wireless telegraphy signals. But even then it is in the context of a laboratory experiment (Fig.7), consistent with his hand-written note to Marconi. For his *Technics* readers he explains:

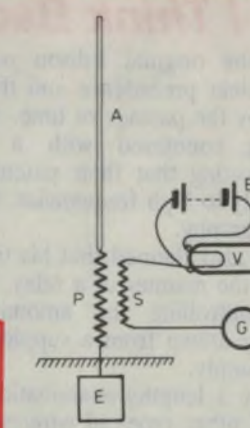
We may, for instance, set up an electric oscillation by the discharge of a condenser in one circuit. Then, at a distance of several feet or several yards, we may set up another circuit including a galvanometer and a vacuum tube, and we may produce a deflection in the galvanometer showing it is transversed by a continuous current when we set up an alternating current in the primary circuit.

Such an arrangement, he adds, can be used as a receiver for wireless signals, at the same time conceding that "it is not so sensitive as the coherer or the magnetic detector".

Even so, Fleming explains, "the galvanometer will give a steady deflection all the time that electric waves are falling on the wire, and if the galvanometer is that kind of instrument called 'a speaking galvanometer' it will give de-







Figs.5 and 6 (above left, right): Diagrams from Fleming's 1905 paper explaining diode operation. Fig.7 (far right): From the same paper, his diagram showing the use of the diode as a detector for wireless signals. Note the lack of any tuning arrangement.

flections larger or smaller in proportion as the wave trains falling upon the aerial are longer or shorter. In this manner, signals in accordance with the Morse Code alphabet may be rendered visible by the deflections of the galvanometer."

(Fleming notes in the following paragraph that speaking galvanometers were currently being used for undersea cable telegraphy).

In evaluating Fleming's apparently low-key attitude to his thermionic detector, the present day reader needs to realise that, in 1905, the role of a 'detector' was to indicate audibly or visually the presence of bursts of unmodulated or randomly modulated arc-sourced wireless energy, sufficient for them to be recognisable as Morse Code.

While Fleming saw his diode as new and potentially useful, he also admitted that it was less sensitive than other currently available devices – a crucial consideration prior to the introduction of receivers using valve type signal amplifiers.

Wireless telephony was also in its infancy and the consequent role of a detector as a demodulator of incoming amplitude modulated speech and music signals was not widely appreciated – perchance even by Fleming in 1905.

In this connection, Marconi was said to have been singularly uninterested in speech communication. His commercial objective was to establish reliable long-distance communication using brute-force, arc-based wireless telegraphy, rather than getting involved in the considerable complications of voice transmission. His attitude would undoubtedly have had a bearing on Fleming's outlook as a consultant to British Marconi.

Diode origins

For their book *From Tin Foil to Stereo – Evolution of the Phonograph* (Howard Sams Inc., 1976) Oliver Read and Walter Welch had occasion to look fairly critically at the history of the thermionic diode; this as background to the evolution of thermionic valves generally and to electronic disc recording and playback.

John W. Stokes did similar research for his book *70 Years of Radio Tubes and Valves* (Vestal Press, N.Y. 1982) and what follows draws on their findings.

They agree that in 1883, Thomas A. Edison realised that charged particles of some sort were being emitted from the incandescent carbon filament in evacuated lamps. His observations were documented by Prof. Edwin J. Houston and became the first paper to be published by the AIEE (American Institute of Electrical Engineers).

In the following year (October 1884) Edison took out a patent, which covered the idea of intercepting the particles with a metallic plate placed within the evacuated envelope and using the resultant current as a method of monitoring the line voltage. The patent had no real practical value for Edison, but was taken out as a purely precautionary cover.

Nevertheless, this discovery, paper and patent, according to Read and Welch, provide the real starting point for what is now known as 'electronics'; this in 1883/4.

While experimenting with one of the tubes, John W. Howell, an associate of Edison in the Harrison laboratory, discovered that it could also be used as a rectifier. This, too, was written up in the AIEE *Transactions*, but was ignored on principle by Edison – a fanatical DC man who would have nothing to do with AC mains, or rectifiers!

In 1885, Edison gave several of the tubes to Sir William Preece (Chief of Engineering, British Post Office) who had arranged the first demonstration of the phonograph in England to a scientific body. Sir William passed one or more of them on to Professor Fleming, describing them, possibly for the first time, as 'Edison Effect' tubes.

Taking advantage of his association with Edison & Swan, Fleming had a number of similar tubes made up for himself. Having verified Edison's and Howell's findings, he put them away in a laboratory cupboard, where they still were in 1897 when J.J. Thompson came up with his electron theory.

In the light of this new concept, and aware of Marconi's need for a more reliable detector, Fleming decided to check out his 'Edison Effect' rectifier tubes in that role. They had their limitations, but worked well enough to justify application for a patent, on the basis of their use with different external circuitry for a totally different purpose: the detection of high frequency wireless waves.

A patent was duly granted in November 1904 and, under the terms of his contract, was assigned to the Marconi Company, with no pecuniary reward to Fleming other than his regular retainer as a consultant.

On the strength of the patent, the Marconi Company began manufacturing thermionic diodes in 1907, mostly with 4-volt filaments, plate connections on the side of the bulb and, ironically, Edison-lamp type bayonet or medium screw bases.

US Federal Court

The tenuous nature of the Fleming/Marconi patent came under scrutiny some time later, when the Marconi Company took action against Lee de Forest in the Federal Court for the Southern District of New York, claiming that his American-built equipment using thermionic diodes and triodes (modified diodes) breached their 1904 patent.

By way of defence, it was put to the

When I Think Back

court that the original Edison patent (1884) had clear precedence and that it had lapsed by the passage of time. Marconi/Fleming countered with a disclaimer indicating that their patent related uniquely to high frequencies, as in wireless telegraphy.

De Forest also claimed that his triode operated in the manner of a relay, with the grid controlling the amount of energy being drawn from a supplementary or 'B' supply.

This led to a lengthy examination by the court of other types of wireless detector, and claims that a supplementary voltage had been used before to improve their performance (as in the coherer) – thereby anticipating de Forest's patent.

In the end, and in some degree because Edison was not a party to the action, the Fleming/Marconi patent was allowed to stand.

There was much more to it, which I shrink from trying to include here, but the summation by Read and Welch reads as follows:

There is revealed a great disparity in the philosophy and reasoning of patent reviewers and of the courts in dealing with the relative merits of basic inventions and of contributory inventions and/or new uses.

In this case, although careful distinctions were made between the relative claims of de Forest and Fleming, historic justice was denied Edison, whose research and accomplishment was so unique in this particular instance that the contributions of both Fleming and de Forest are quite secondary.

Considered from this viewpoint, which was tacitly admitted by the court, the contribution of de Forest towards the new use in adding the all-important third element, was the greater of the latter two.

Amongst others, this last observation is supported by E. George Griffith of Pennsylvania State University, in his book *Basic Electronic Devices* (Rinehart Press, San Francisco, 1971). I quote:

When Lee de Forest introduced a third electrode between the cathode and plate of the diode, he started the vast electronics industry that exists today.

John Stokes (*70 Years of Radio Tubes & Valves*) records the above sequence of events, but leaves the reader to ponder a quite different footnote which reads:

In view of an earlier patent by A. Wehnelt in January 1904, the reader is left to judge for himself whether Fleming was justified in claiming to have invented the world's first thermionic valve.

Personally, I am in two minds as to whether the problem lies in what Fleming actually believed and claimed, or what history has thrust upon him.

To a long-time academic and a Fellow of Royal Society, the Edison Effect was a phenomenon that needed to be resolved and written into scientific literature. Under commercial pressure from Marconi, however, he may well have taken the further step of applying for a patent, which might never have been granted if Edison (or Wehnelt?) had seen fit to oppose it.

Morgan E. McMahon (*Vintage Radio*, 2nd Edition, 1973) is supported by John Stokes in adding that Fleming's patent had an unusual personal aspect: a victim of impaired hearing, he had difficulty in coping with the wireless signals which he encountered by reason of his association with the Marconi Company. Because of this, he was especially interested in the rectifying action of the Edison Effect diode and gratified to find that telegraphy signals could be rendered both visible and measurable by using it in conjunction with a galvanometer (Fig.7).

Indications are that, as an inventor, de Forest's expectations for his 1906 Audion tube were much broader and industry-based. Morgan McMahon rates his triode as 'the most important discovery in radio'.

De Forest's triode opened the way to RF and audio amplifiers, and to receivers more sensitive than anyone had ever dreamed of; to vastly improved transmitters, to radio telephony, sound broadcasting and a world of valve-based electronics that reached its peak in the '60s.

Trans-Atlantic wireless

If the foregoing observations appear to diminish Fleming's contribution by way of the thermionic diode, his role in another wireless 'first' is recounted by way of compensation.

In the late 1890s, some five years before the diode patent, Marconi was seized with the idea of bridging the Atlantic by wireless telegraphy – an ambition that many ridiculed, on the grounds that wireless waves could not possibly follow the curvature of the earth. Marconi thought otherwise and, without knowing anything of ionospheric propagation, was willing to back his intuition with his reputation and £50,000 of company funds.

Limited to a simple zero-gain receiver and without the benefit of directional aerials, he knew that his only chance of success was to provide a uniquely powerful signal from the selected transmitting site atop a 37-metre (120ft) granite cliff at Poldhu, on the southwest coast of Cornwall in the UK.

To feed the 70m (200ft) inverted cone antenna, Marconi reckoned that he would need a transmitter input power of around 25kW and an HT voltage of around 20kV, bridging a 50mm (2") spark gap to excite the resonant 'oscillation coils' to which the antenna was coupled.

The design of a transmitter to satisfy these unheard-of criteria was entrusted to an independant consultant – none other than Professor J. Ambrose Fleming. A photograph in the Marconi Company archives reveals the installation as a major undertaking, bedecked with 'DANGER' and 'STAND CLEAR' notices. But it worked.

Success came at 12.30pm on December 12, 1901. In Marconi's words:

Unmistakably the three little clicks corresponding to three dots sounded in my ear; but I could not be satisfied without collaboration. "Can you hear anything, Mr Kemp?", I said, handing the telephone to my assistant. Mr Kemp heard the same thing as I...

Those words have been reproduced countless times in articles and textbooks, more often than not without any thought of the man who was primarily responsible for the transmitter which radiated the signals in the first place.

Fittingly, in his biography of Guglielmo Marconi, David Gunstan refers to a granite column erected on the cliffs near Poldhu. On the column is a bronze plaque which carries the words:

One hundred yards North East of this column stood from 1900 to 1933 the famous Poldhu wireless station, designed by John Ambrose Fleming and erected by the Marconi Company of London, from which were transmitted the first signals ever conveyed across the Atlantic by wireless telegraphy.

One may well quibble about the genesis and the heritage of the Fleming diode, but it is difficult not to respect a scientist/engineer able to project a signal from Poldhu to Newfoundland using the hazardous, primitive technology of 1901.

Sir Ambrose Fleming died in his 96th year on April 18, 1945 at Sidmouth, UK, where he had spent in retirement the last few years of an intensely active life.

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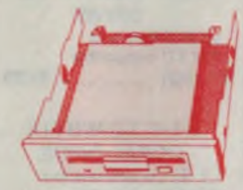

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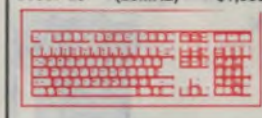

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- Auto answering / Dialing
- 100 voice mail boxes
- Password protection
- Message mailing
- Auto redialing
- Beeperless remote control
- Toll saver
- Call screening
- Electronic phone book
- Works in background
- Menu driven software
- Simple and concise 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 .... $149

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

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

X11097 .... $199

180W SWITCH MODE POWER SUPPLY FOR BABY AT* COMPATIBLES

X11098 .... $175

FULL RANGE OF EPSON PRINTERS AVAILABLE ON REQUEST CALL NOW FOR BEST PRICES !!!

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

IBM* CARDS

G7 CGA/ MGP X18007	$95
MGP X18003	$89
HEGA X18070	$169
VGA 256K X18071	$199
VGA 512k X18072	$299
RS232 X18026	$39
RS232 & Clock X18028	$49
Clock X18024	$39
Printer X18017	$29
Games X18019	$29
Multi-function X18040	$99
Multi I/O X18045	$99
2 M/Byte Ram X18052	$225
3 M/Byte Ram X18056	$275
Serial /Parallel /Games X18151	$115
Floppy Disk Drive X18005	$52
4 Way Drive Controller - 360K/ 720K/ 1.2M/ 1.44 X18006	$129
XT* Hard DiskController X18060	$129

TEST CARD

POSTCARD DIAGNOSTIC MODULE

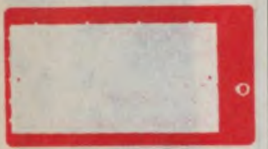
Pinpointing component problems in IBM* compatible motherboards can take hours. Usually the whole system has to be working to isolate the troubled area. But not so with the new Postcard Diagnostic Module. So no other cards are necessary to test a bare motherboard.

"It now only takes seconds."

Simplified debugging for:
- Field service- for on-site repairs or maintenance depot work
- Manufacturing test- for burn in test flaws and to do quality control
- Inspection- Postcard simplifies incoming and outgoing test processes on stand

X18048........................$849

GENERAL COMPONENTS



BREAD BOARDS

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

- 100 holes

P11000..................$2.75

- 640 + 100 holes

P11007..................$14.95

- 1280 + 100 holes

P11010..................$26.95

- 2560 + 700 holes

P11018..................$69.95

HEAT SHRINK TUBING

- Price per metre

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

GOLD INSERT LOW PROFILE IC SOCKETS

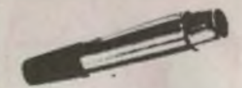
- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

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

LOW PROFILE IC SOCKETS

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

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



CANNON TYPE CONNECTORS AT SPECIAL PRICES !!

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

12V DC FANS

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

T12469..................$12.95

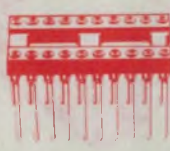
10+ fans only $11.95 each

BALL BEARING FANS

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

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

10+ fans (mixed) only $13.95 each



WIRE WRAP IC SOCKETS

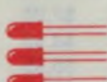
These quality 3 level wire wrap sockets are tin-plated phosphor bronze

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

JUMP WIRE KIT (KS-350)

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

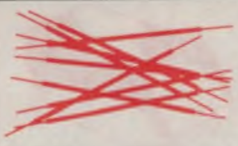
Q11278..................$19.95



FLASHING LEADS

- Red, 5mm

	1-10	10+
Z10159	$1.10	$1.00



WIRE WRAP WIRE

- Precut wire
- Pack of 100

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

- Spool wire

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

QUALITY LEDS

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

CRYSTALS

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].90
Y11010	3MHz	[illegible]90
Y11015	3.5795[illegible]	[illegible]00
Y11018	3.9[illegible]	[illegible]0
Y11020	[illegible]	[illegible]4.90
Y11022	[illegible]z	$3.90
Y11023	[illegible]MHz	$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

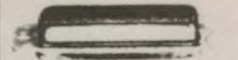
		1-9m.	10+m.	100+m.
W12614	14 way	$1.90m	$1.80m	$1.20m
W12616	16 way	$1.90m	$1.80m	$1.20m
W12620	20 way	$2.50m	$2.20m	$1.50m
W12624	24 way	$2.90m	$2.70m	$1.70m
W12626	26 way	$3.60m	$3.30m	$2.20m
W12634	34 way	$3.90m	$3.60m	$2.30m
W12636	36 way	$1.90m	$1.80m	$1.20m
W12640	40 way	$4.90m	$4.00m	$2.80m
W12650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

COMPUTER CABLE

- Six conductor shielded computer interface cable
- m = metre

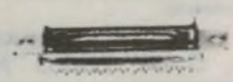
		1-9 m	10+ m	100+ m
W12670	CIC6	$1.30m	$1.10m	$1.00m
W12672	CIC9	$1.60m	$1.50m	$1.20m
W12674	CIC12	$2.50m	$2.20m	$1.90m
W12676	CIC16	$3.50m	$3.20m	$2.50m
W12678	CIC25	$3.90m	$3.40m	$3.00m

PLUGS & SOCKETS



D TYPE SOLDER PLUGS

		1-9	10+	100+
P10880	DE9P	$1.75	$1.25	$0.80
P10890	DA15P	$1.85	$1.55	$0.90
P10900	DB25P	$1.95	$1.60	$0.90
P10910	DC37P	$3.95	$3.75	$3.50
P10920	DF50P	$5.95	$5.75	$4.95



D TYPE SOLDER SOCKETS

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

D TYPE SOLDER COVERS

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

CARD EDGE CONNECTORS

1" SPACING

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

ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

AUSTRALIA'S CHEAPEST DISKS!

"NO BRAND" DISKS

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

(ALL PRICES PER 10 DISKS)

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

10+ DISKS	100+ DISKS	1,000+ DISKS
$5.25	$4.95	$4.75

5 1/4" HIGH DENSITY DISKS

(DOUBLE SIDED)

10+ DISKS	100+ DISKS	1,000+ DISKS
$14.95	$12.95	$11.95

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

10+ DISKS	100+ DISKS	1,000+ DISKS
$13.95	$12.95	$10.95

VERBATIM DISKS

(ALL PRICES PER BOX OF 10 DISKS)

DESCRIPTION	1-9 BOXES	10+ BOXES
3 1/2" 1S/2D	$37.95	$35.95
3 1/2" 2S/2D	$36.95	$34.95
3 1/2" 2S/HD	$74.95	$72.95
5 1/4" 1S/2D	$20.95	$19.95
5 1/4" 2S/2D	$24.95	$23.95
5 1/4" 2S/4D	$75.95	$70.95
5 1/4" 2S/HD	$32.95	$31.95

NEW DISKS - TEFLON* COATED

VERBATIM DATALIFE PLUS

Teflon* Coated

(ALL PRICES PER BOX OF 10 DISKS)

5 1/4" DS/DD

	1-9	10+
C12522	$29.95	$27.95

5 1/4" High Density

	1-9	10+
?12523	$38.95	$35.95

DISK BOXES

DISK STORAGE UNITS

- 80 x 3 1/2" - Lockable
C16038.........$16.95
- 40 x 3 1/2 " - Lockable
C16035.........$14.95
- 40 x 3 1/2 " "Eclipse"
C16040.........$8.99
- 120 x 3 1/2 " - Lockable
C16039.........$21.95
- 50 x 5 1/4 " - Lockable
C16025.........$14.95
- 100 x 5 1/4 ""Eclipse"
C16042.........$9.95
- 100 x 5 1/4 " - Lockable
C16020.........$15.95
- 120 x 5 1/4 " - Lockable
C16028.........$19.95

P.C ACCESSORIES

MINI VACUUM CLEANER

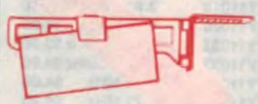
Use it to clean:
- Computer keyboards
- Printers
- Video recorders
- Computer circuit boards

C21087.........$14.95

MAGIC STAGE

A working bench for your Mouse.
- High quality ABS plastic and anti-static rubberised top
- Stationary holder
- Includes pull-out shelf for Mouse
- Dimensions: 280 x 260 x 25mm
- Fits over keyboard

C21080.........$24.95



GRIP CLIP COPY HOLDER

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

C21065.........$14.95

I/O ACCESSORIES

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.........$69

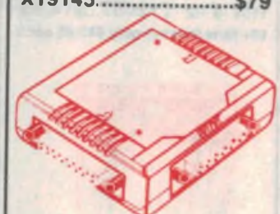
4 Way RS232
X19125.........$79

2 Way Centronics
X19130.........$69

4 Way Centronics
X19135.........$79

RS232 2 X 2 Auto Switch
X19140.........$79

Centronics 2 x 2 Auto Switch
X19145.........$79



POCKET AUTO AB SWITCHES

- Pocket size, auto-scanning
- Allows 2 PCs to share one laser
- Serial model: MS-201 - Host-powered

X19150.........$79.95

8087 CHIPS

GENUINE INTEL CHIPS

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
8038720	(20MHZ)	$895
80387-25	(25MHZ)	$1,095

MEMORY

	1-9	10+
1MB - 80ns	$24.95	$22.95
4164-15	$2.95	$2.75
4164-12	$3.95	$3.50
4164-10	$5.95	$5.50
41256-15	$4.50	$4.25
41256-12	$4.75	$4.50
41256-10	$4.50	$4.95
41256-08	$5.95	$5.75
4464-10	$11.95	$10.95

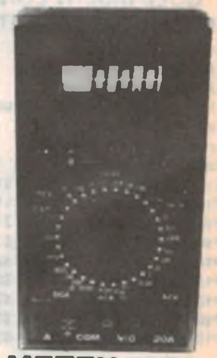
METEX 4500H MULTIMETER

10A, 4½ digit multimeter with digital hold, transistor tester and audible continuity tester.

CHECK THESE FEATURES...
- Readout hold
- Transistor Tester
- 4½ digit x ½"(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

Don't be a bunny!
Hop to Rod Irving's



METEX 3530 MULTIMETER

Compact, rugged, battery operated, hand held 3½ digit multimeter

Features...
- ½" 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 3½ 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

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...................... $59

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.................... $89

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.................. $169

SHORT TESTER

- Instantly shows the open/short position of PCB
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Q11276............... $19.95

LOGIC PULSER (LP-540H)

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

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

DIGITAL METER (YF-120)

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

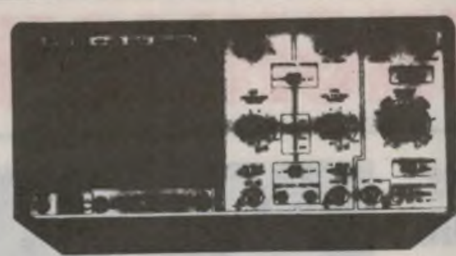
Q11270.................$79.98

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..............$29.95

NEW CRO'S



20MHZ DUAL TRACE OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

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

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

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

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

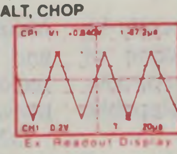
OTHER SPECIFICATIONS
- Weight: 7Kg Approx
- Dimensions: 162(H) x 294(W) x 352(D) mm

Q12105
$695.00

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

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NEWS HIGHLIGHTS

SYSTEM TURNS VEHICLES INTO WEIGHING MACHINES

Australian firm Wray-Tech Instruments has developed a new version of its novel microprocessor-controlled weighing system which allows front-loading waste disposal trucks and similar vehicles to act as weighing machines.

The Wray-Tech WT6000 operates by sensing the hydraulic pressure required to raise the vehicle's load to a pre-defined weighing position, with the vehicle in a standard attitude. The system is easily re-calibrated at any time, by having it lift a known weight to the weighing position. All operations are controlled by the internal microprocessor, which will only display a weight estimate when it senses that the measurement conditions are correct.

Both static and dynamic measurements are possible, and the system is adaptable to a wide variety of vehicles, types of load and industrial applications. Other features include accumulation of load totals and printout of weighing data. The WT6000 can also sense the overall loading of the vehicle, and sound a warning when the safe loading level is reached or exceeded.

The original WT6000 system was developed in 1985, but more recently Wray-Tech has targetted the burgeoning waste-disposal industry for further development of the system, and has set up a wholly-owned subsidiary company in Chicago to address the US industry. Already the fourth largest waste disposal firm in North America, with a fleet of 3500 trucks, has specified the new version of the WT6000 as standard for its vehicles – after an extensive testing program.

The company is now involved in discussions with the local Australian industry, and already one large municipal council in NSW has ordered the WT6000 for its waste disposal trucks. Other councils and private contractors are expected to follow, while there is also interest from the logging and timber industry.

Mr John Clarke, Wray-Tech group MD, said that the firm had selected the US waste disposal market to launch the improved system, because of its enormous size and strong growth. The hydraulically operated front-loading trucks used in the waste disposal industry also seemed ideal for demonstrating the system's cost efficiency.

"Our recent breakthrough is therefore very gratifying", Mr Clarke added, "considering the investment we've made in developing the waste-disposal version of the system."

Enquiries can be directed to Wray-Tech Instruments, 231 Tooronga Road, Terrey Hills 2084 or phone (02) 450 2927.

D2MAC FOR CHINA

A letter of intent, signed recently by Philips, will see the introduction of D2MAC to the Xinjiang Uygar Autonomous Region of the People's Republic of China by the end of this year.

Also covered are the purchase of D2MAC equipment and a co-operation for manufacturing and sales in China.

The letter of intent was signed at a ceremony in the Netherlands by Professor Zhang Zhijian, on behalf of China's Ministry of Radio, Film and Television, and Mr P Groenenboom, managing director of Philips Consumer Electronics division.

D2MAC, a European developed standard for high quality satellite television transmission, is designed for compatibility between current TV systems and the high definition television (HDTV) standard proposed by Europe's Eureka HDTV project.

LOCAL RESEARCH INTO VLSI CHIP DESIGN

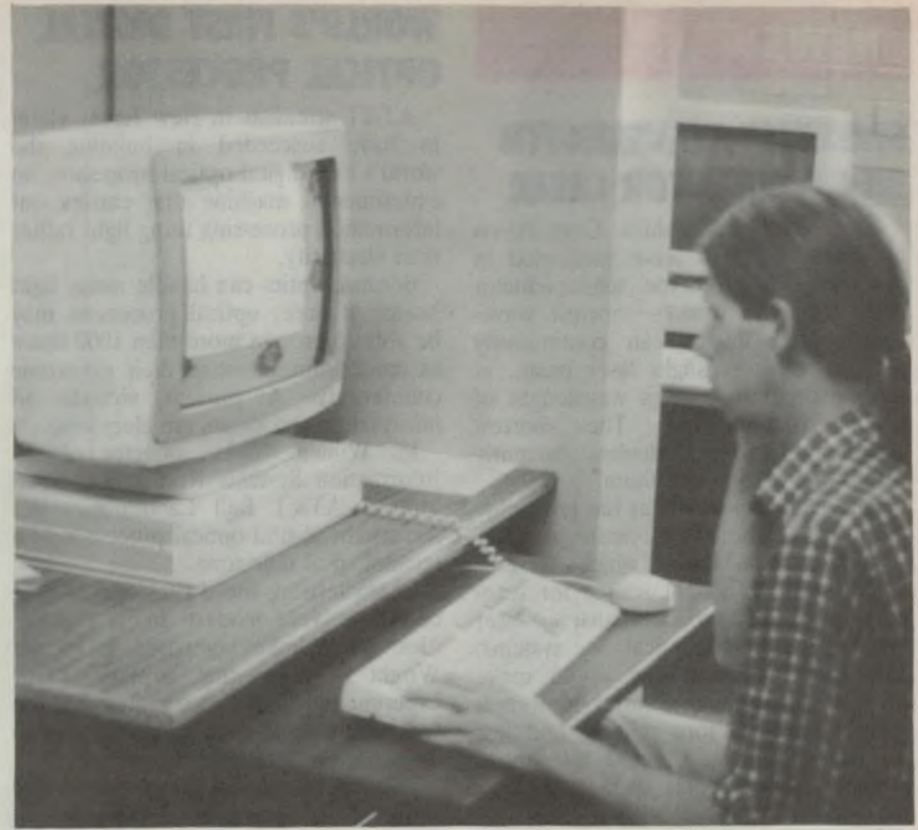
Research being conducted at the University of Queensland is expected to yield software which may give Australian companies a lead over overseas competitors in the design of advanced integrated circuits.

Researchers at the university's Centre for Information Technology Research (CiTR), working with the university's Key Centre for Software Technology and Adelaide-based Austek Microsystems, are engaged in two projects into the design and simulation of advanced integrated circuits. Research support by Digital Equipment Corporation has advanced the pace of both projects.

In the Sea-of-Gates project, researchers are developing improved algorithms for the placement and routing of high density, very large-scale integrated (VLSI) circuits. These algorithms will be incorporated in computer aided design (CAD) software which will substantially reduce the design time for VLSI circuits.

Although CiTR intends to make the software commercially available, Austek stands to gain the technology around six months in advance of other companies through its involvement in the research.

Mr Colin Lythall, CiTR's engineering manager or microelectronics, said, "Austek will effectively have a 12 month head start on other firms, since it generally takes up to six months before software can be put into production."



Austek Microsystems designs, develops and markets VLSI components for high performance products such as engineering workstations, high-end personal computers, file servers, accelerator cards and standard bus cards. The company currently exports around $A10 million per year.

The second project under way at the University of Queensland is a simulation project which will work in conjunction with the Sea-of-Gates project. This project will be used by engineers to certify that the circuits contain the correct logic. The design is transferred to a workstation, where a simulation program is run before the chip design is committed to silicon.

SCIENCE PARK FOR ADELAIDE

Construction has begun of a new Science Park industrial development in Adelaide, adjacent to the Flinders University and Flinders Medical Centre.

Premier of South Australia Mr John Bannon said "Science Park Adelaide will be critical in our pursuit of the new brain-based and high technology industry, which we see as a vital part of South Australia's economy in the 1990's and beyond."

It is intended that the new park will focus primarily on medical technologies and the development of biological sciences. At the centre is a $9.3 million multi-tenant complex of 7250 square metres, incorporating research and workshop areas with a wide range of support services.

Apparently the impetus to develop the new park came from the success of SA's Technology Park, in the hi-tech area.

D-MAC DECODING ICs FOR BSB

British Satellite Broadcasting (BSB) has ordered a 'significant' quantity of MAC decoding integrated circuits from Philips Components and Plessey Semiconductors, with delivery due to take place during the first half of 1990.

For each D-MAC satellite receiver chip-set, Plessey will supply the three VLSI CMOS decoding circuits and Philips will provide the analog functions together with the peripheral chips.

Fully working D-MAC circuits have already decoded encrypted test transmissions from the BSB satellite at Philips Components' application laboratories.

The chip sets will be used in the professional data receivers being manufactured by Norsat and the BSB SNATV head-end receivers being produced by Wolsey Electronics.

NEWS

SHORTEST-WAVELENGTH SEMICONDUCTOR LASER

Researchers at Toshiba Corporation in Japan claim to have succeeded in developing a prototype semiconductor laser with the world's shortest wavelength. The device can continuously emit a visible red-light laser beam, at room temperature, at a wavelength of 638nm (nanometers). The shortest wavelength of such devices currently sold in the market is 670mm.

This achievement opens the possibility of replacing the helium-neon gas laser (wavelength: 633nm), which is now widely used as a light source for scanners in various products such as laser beam printers and optical disc systems. The semiconductor laser could make present equipment battery-powered, more compact, more reliable and less power-consuming. It could also make possible new products such as cordless bar-code readers.

Because of its short wavelength, the perceived brightness of the emitted beam is greater than that of any present semiconductor lasers at the same output power level. To apply semiconductor lasers to non-contact type bar-code readers, the visibility of the beam emitted is important, as it enables the equipment operator to easily check whether the light beam is striking the bar codes printed on commodities.

MAJOR HDTV TUBE PLANT FOR US

Philips Components is to build a $120 million factory in the United States to produce colour television picture tubes and future products for high definition television (HDTV) applications. Initially, more than 300 new jobs will be created.

The new plant is expected to be built in two phases. Phase one, which is projected to be completed 18 months from ground breaking, will have a capacity to produce one million 27V (29") standard and high-grade picture tubes.

Phase two will produce tubes which will be used in Philips' upscale HDTV television sets. The specific time frame for phase two has yet to be determined.

Sites under consideration for the new plant are in Tennessee, Kentucky, Ohio and Michigan. A decision is expected to be announced soon.

WORLD'S FIRST DIGITAL OPTICAL PROCESSOR

AT&T scientists in New Jersey claim to have succeeded in building the world's first digital optical processor, an experimental machine that carries out information processing using light rather than electricity.

Because optics can handle many light beams at once, optical processors may be able to process more than 1000 times as much information as their electronic counterparts. At present, virtually all information processors are electronic.

Mr William Ninke, director of the Information Systems Research Laboratory at AT&T Bell Laboratories describes the digital optical processor as a technological milestone.

Characterising the digital opitcal processor as 'very modest' in its capabilities, Mr. Ninke compared it to the Wright Brothers' first airplane. "Our experimental unit demonstrates that the technology works, and points the way to its future exploitation," he said.

The digital optical processor is the result of a five year effort by scientists in many parts of AT&T Bell Laboratories. Fundamental advances were required in the areas of computing theory and optical devices, and scientists made extensive use of sophisticated device-fabrication technology invented at AT&T Bell Laboratories.

The optical processor demonstrated at AT&T Bell Laboratories operates at one million cycles per second, less than most personal computers. However, AT&T scientists say an optical computer operating at several hundred million cycles per second – faster than most supercomputers – is possible in the near future.

LOCALLY DEVELOPED ANTI-STATIC MAT

Melbourne firm DSC Management has developed a new polymeric anti-static mat for protecting computers and other sensitive equipment, with assistance from Telecom Australia's Product Development Fund. The new mat is believed to offer significant benefits over imported products, and is expected to save many millions of dollars in imports as well as generate export income.

DSC's MD Stan McTighe says that his firm's mat has 'truer anti-static properties' than its overseas counterparts, many of which he says "can actually exacerbate the problem rather than solve it."

The mat incorporates a grounding lead with a resistor to control discharge rate, and also an optional wrist strap. DSC is also developing a mouse mat, a technician's mat and a floor mat.

WORLD'S LARGEST PCB PLANT?

NEC Corporation of Japan has announced that it will build a major new plant for mass production of printed circuit boards, in Akita prefecture. The plant will involve an investment by NEC of some 25 billion yen – around $250 million – and is planned to begin production in mid 1991. The *Asahi Shimbun* describes the proposed facility as 'the world's largest-scale PCB production plant.'

As the new plant will require between 500 and 600 employees, most from Akita, authorities hope it will have a major positive impact on the local economy. The plant will include development and design facilities as well as manufacturing.

SONY DEVELOPS 'BONZAI' DAT

Sony has announced its development of a new ultracompact, high sound quality digital tape recorder for memo and dictation applications. The unit provides two hours of recording and playback on a cassette of 2.5mm metal-evaporated tape the size of a postage stamp – only 30 x 21.5 x 5mm.

Key to the extremely small size of the new recorder is a helical-scan system which involves a 'non-tracking' (NT) playback technique. Instead of using a tracking servo, the recorder runs its heads at twice the speed used for recording, so that they make multiple sweeps over the recorded tracks. Each track is split into multiple blocks, each with an address code, and the recorder uses a semiconductor memory system to re-assemble the semi-randomly replayed blocks into the correct order.

The recorder also uses a new 'non-loading' system, where the 14.8mm-diameter head drum projects directly into the cassette.

Sampling is at 32kHz, with 12-bit non-linear encoding. Sony claims a frequency response of 10 – 15,000Hz, with a dynamic range of 80dB. The company has some 178 patents pending in relation to this new recorder, and expects to release it on some markets later this year. However it probably won't reach Australia until 1991.

Designed in the US, the IFC CoolSaver is a microprocessor controller for air conditioning plants, claimed to allow typical savings of 20% on running costs over conventional controllers. It is also said to provide protection against compressor overload damage. Further details from Actrol, 69-75 Glenvale Crescent, Mulgrave 3170 or phone (03) 560 6077.

NEWS BRIEFS

- The ninth ***Australian Microelectronics Conference*** will be held in Adelaide from July 2 to 4. For further information contact the Institution of Radio and Electronics Engineers.
- The last of the ***PCB seminars*** titled ***Components*** will be held on April 11, at the site of CIMA Electronics, 2nd floor, 3 Chester Street, Oakleigh 3166. For enquiries phone (03) 563 1699.
- ***Dynamic Component Sales*** has moved to larger premises, trebling in office space. DCS is located at Showroom 6, 17 Heatherdale Road, Ringwood 3134, phone (03) 873 4755.
- Instrumentation and Computer Rentals has changed its name to ***Imagineering Rentals***. In addition a new office has been opened in Perth. For further information contact PO Box 294, Mitcham 3132 or phone (03) 872 3999.
- ***PJL Associates*** has been appointed representative for Secomak Vitavox, for its range of industrial microphones and loudspeakers, and also representative for Dowkey Microwave for its range of RF co-axial relays and switches. PJL is located at 1A Windsor Place, Windsor 3181, phone (03) 529 4061.
- Mr John MacDuffie has been appointed Managing Director of ***AT&T Communications*** while Ms Andrea Galloway has been appointed General Manager for ***AT&T Data Systems Group***. Both held management positions in California before their appointments in Australia.
- ***John R. Turk & Sons*** has opened a new branch in Wollongong, NSW, pushing up the number of Turk outlets in the area to two.
- Defence Science & Technology Organisation has signed a licencing agreement with the South Australian based company ***AUSTEK Microsystems*** to manufacture a digital signal processor for surveillance. The processor computes the frequency spectrum of an electronic signal.
- Following the marketing agreement with the US company Carlon, ***HPM Industries*** will be the supplier of a broad range of products designed specifically for the US marketplace. HPM is located at 4 Hill Street, Darlinghurst 2010, phone (02) 361 999.
- ***Consumer Electronics Suppliers Association*** has appointed Mr John Hurley of NEC Home Electronics Australia as its Chairman and Mr Warwick Christie of JVC as its Vice Chairman.
- ***Texas Instruments*** has appointed Mr Nick Fondas as Regional Marketing Manager, Industrial Controls Division for Asia Pacific region.
- ***Queensland Electronics Development Association*** will hold its annual Electronics Exhibition at the Boondall Entertainment Centre on April 4 & 5, from 10am to 8pm.

DATACRAFT, AWAM WIN TELECOM CONTRACT

Datacraft Limited and AWA Microelectronics have joined forces to develop and supply advanced communications equipment for Telecom's Digital Data Network.

Melbourne-based Datacraft has won a contract to develop a new high speed Network Termination Unit (NTU) for Telecom. The NTU which is dedicated to digital data transmission, has two VLSI chips in the unit, which provide echo cancellation, line driving and interface functions to existing Telecom and customer equipment.

Datacraft has awarded AWA Micro electronics the contract to manufacture the digital Application Specific Integrated Circuit (ASIC). AWA will manufacture the ASIC at the new microelectronics facility at Homebush Bay NSW, which provides important engineering support during the ASIC development.

Datacraft is expected to complete the NTU development by August this year. Full scale manufacture is due to begin shortly after, with Datacraft expected to supply 20,000 of the devices a year over a five year period in a contract worth an estimated $25 million.

Surround sound in the movies

With all of the current interest in surround sound decoders for more realistic presentation of video movies in the home, it's interesting to realise that the idea isn't new. In fact it dates back to the beginning of 'talkies', in the 1920's, and has appeared regularly in various forms since then.

by CHARLES SLATER

Keen videophiles have been showing much interest of late in so-called 'stereo surround sound decoders'. With the aid of such a device it is possible to extract quadraphonic-style surround sound from stereo videotapes and television broadcasts.

Properly set up and adjusted, a surround sound system can provide, in one's own home, sonic delights of the type previously attainable only in 'selected theatres'. Location ambience and background mood music, divorced from the constraints of a television cabinet, freely permeate the entire room. In addition, spacecraft appear to soar overhead, claps of thunder envelop viewers while dialogue remains logically on-screen.

Indebted as we are to modern technology for enabling us to experience these dramatic effects, it should be noted that the desire to provide movies with multi-channel sound is far from being a recent one.

Original ideas

On the 17th of January 1929, hardly a year after the launch of the first successful 'talkie' feature, Earl Sponable of the Fox-Case Corporation in the USA was granted patent 1,851,117. (Remember that number, it may prove useful later). The patent was for a method of automatically keying additional speakers, in order to produce a surround sound effect.

This rather primitive system relied on notches carved along the edge of an otherwise normal film, to operate micro-switches which activated the speakers at appropriate moments.

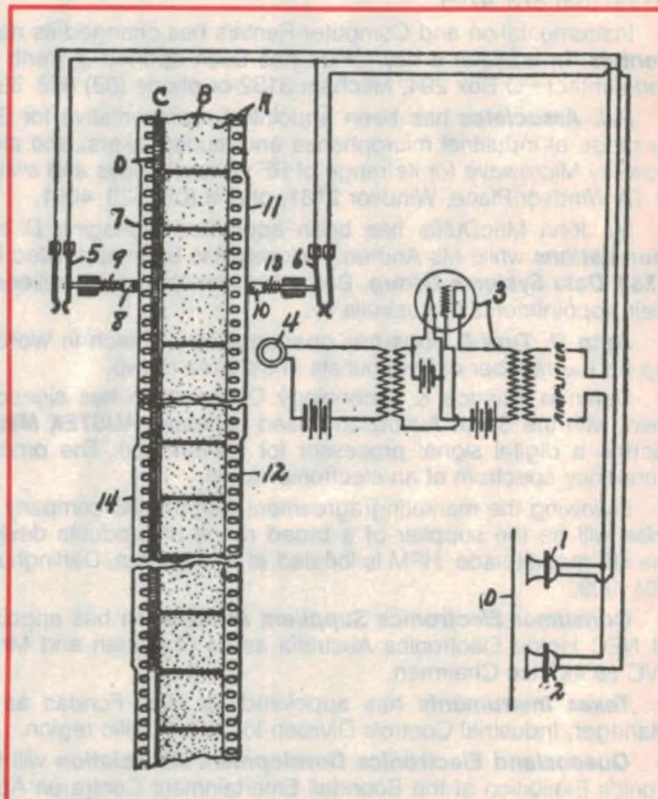
Coincidentally a week before Sponable's patent (1,851,117 in case you've already forgotten) was granted, a French inventor by the name of Henri Chretien, secured a US patent for a wide screen movie process which he had initially conceived in 1927. Chretien lumbered his innovation with the awkward sounding title of 'Hypergonar'. For the next 24 years nothing was done with Henri's Hypergonar until suddenly, in 1953, it was to burst into prominence after being adopted by 20th Century Fox and renamed 'Cinemascope'. But more of that later.

The earliest record of a stereophonic 'broadcast', believe it or not, harks back to 1881. In that year, concerts from the Paris Opera House were transmitted via dual pairs of telephone lines to the drawing rooms of affluent subscribers.

During the mid-1920's, several experiments with stereophonic radio broadcasts took place in the USA. These were mostly intended to be heard via headphones, binaural fashion. Programs were transmitted using separate AM stations for respective left and right channels. Shortly afterward, a pair of commercial 'wireless stations' in Sydney teamed to transmit a brief series of experimental dual channel transmissions.

Given this ardent, albeit sporadic, fascination with directional sound among the pioneering audio fraternity, it is not so surprising to learn that, after solving the more important problems of synchronisation and intelligibility, 'talking picture' engineers should consider exploiting the added impact of using multiple sound sources.

Much investigation into the nature of stereophonic phenomena took place in



Patent No. 1,851,117. In 1929 this scheme was proposed by Sponable as a means of automatically switching in extra speakers, thus creating a rudimentary 'surround sound' effect.

the late 1930's. The journals of the SMPE (Society of Motion Picture Engineers) published in this era contain numerous articles defining most of the basic principles that were to be rediscovered when stereo discs revolutionised the hi-fi industry 20 years later.

The bulk of this early research was carried out by Bell Laboratories and RCA in America. Australia was not left out however, thanks to the talents of one of our leading electronics pioneers: Ray Allsop. In the early 1930's he designed, manufactured and installed cinema sound equipment under the trade-name 'Raycophone'.

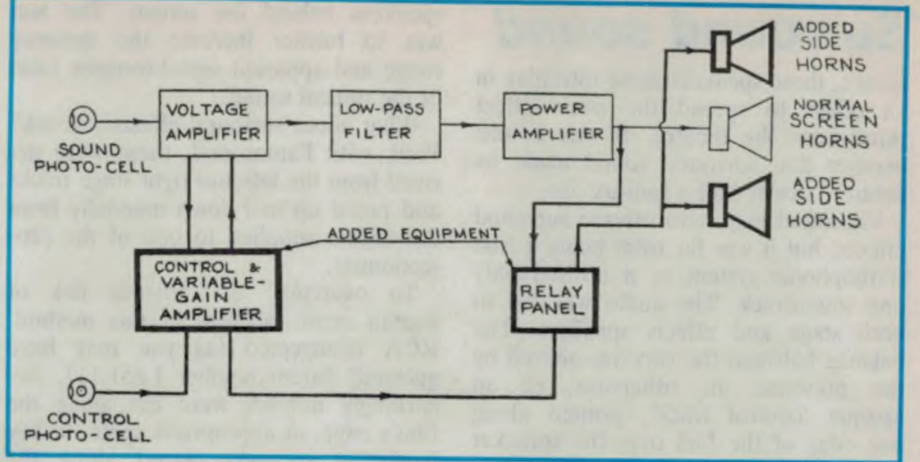
Allsop's installations not only competed with, but in many ways excelled those using equipment imported from the giant overseas companies. (I believe there are still a few cinemas today that are using original Raycophone sound systems).

At the 1938 Sydney Radio Convention, Ray Allsop screened a demonstration movie utilising twin optical sound tracks squeezed into the space where one previously existed. This arrangement so closely foreshadowed modern technology that, had the film survived, it would no doubt reproduce stereophonically on present day Dolby cinema equipment. Alas, such ingenuity was well ahead of its time and made negligible impact on the industry.

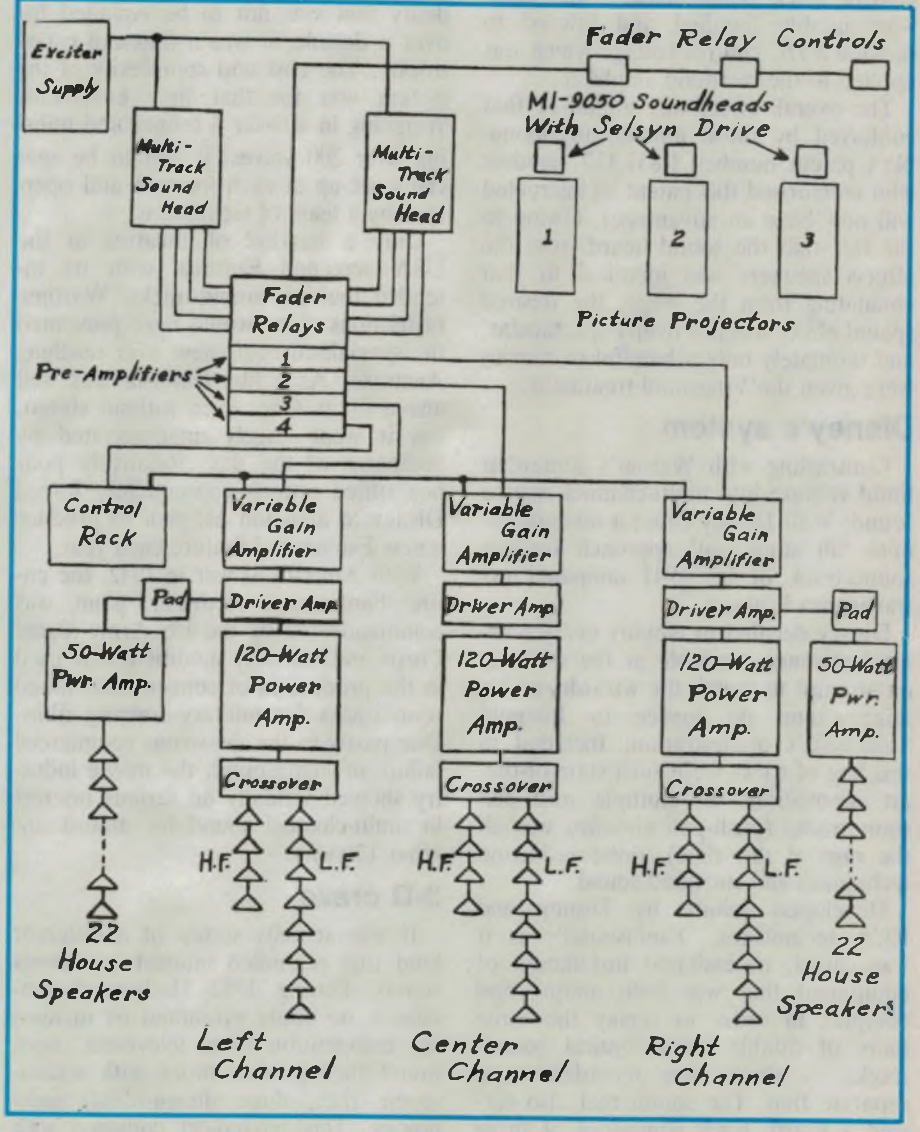
There were several reasons for this, perhaps the most significant being the fact that at the time, movies were doing quite well without the added complications of stereophonic sound, wide screens or even colour. Competition from television was still many years away. Also technically, the signal-to-noise-ratio of Allsop's stereo talkies was very poor, due to the narrowness of the twin sound-tracks.

Back in the USA, and a couple of years later, the Warner Brothers were first to introduce surround sound to a paying cinema audience using a method they designated 'Vitasound'. (In 1927, this same studio was responsible for the successful release of the first sound feature movie *The Jazz Singer*. This film had used a synchronised sound on disc format, known as 'Vitaphone').

It was in 1940 that Warner Brothers filmed an otherwise routine western, *Santa Fe Trail*, starring Tasmania's own Errol Flynn and Washington's own (ultimately anyway) Ronald Reagan. For the premiere screening of this saga, Warners equipped several of their theatres with a multitude of loudspeakers along the side and back walls. During cavalry charges and other appropriate



Block diagram of Warner Bros' 'Vitasound' surround sound system of 1940. The normally clear film perforation area was selectively darkened, in order to produce a 96Hz signal when optically scanned. Presence of this tone cued the conventional single soundtrack to simultaneously feed additional 'house speakers' during appropriate scenes.



Basic configuration of Disney's 1941 'Fantasound', the first true stereophonic/surround movie sound system. Costly and overly complex, it was only used in a handful of US cinemas.

Surround sound

scenes, these speakers came into play in an effort to spread the sonic effect throughout the theatre. It was in this manner that surround sound made its debut – nearly half a century ago.

Vitasound may have offered surround effects, but it was far from being a true stereophonic system as it utilised only one soundtrack. The audio was fed to both stage and effects speakers. The balance between the two was altered by the presence, or otherwise, of an opaque 'control track', printed along one edge of the film over the sprocket hole area.

The sprocket holes were scanned by a separate exciter lamp and PEC (photo-electric cell), resulting in the generation of a strong 96Hz pulse whenever the control track went black. This signal was suitably rectified and filtered to provide a DC control voltage which was applied to the surround amplifier.

The overall effect was similar to that conferred by those notches in Sponable's patent number 1,851,117 (readers who memorised this patent as instructed will now have an advantage). Owing to the fact that the sound heard from the effects speakers was identical to that emanating from the stage, the desired spatial effect was not overly spectacular, and ultimately only a handful of movies were given the Vitasound treatment.

Disney's system

Contrasting with Warner's somewhat timid venture into multi-channel cinema sound, Walt Disney chose a no-compromise 'all stops out' approach for the sound-track of his 1941 animated extravaganza *Fantasia*.

Disney decided to employ every technical advance available at the time, in an attempt to match the wizardry of his images and do justice to Leopold Stokowski's orchestration. Included in this bag of tricks were such state-of-the-art innovations as multiple push-pull soundtracks (push-pull circuitry was all the rage at this time), noise reduction techniques and surround sound.

Developed jointly by Disney and RCA technicians, 'Fantasound', as it was called, necessitated installation of equipment that was both unique and complex in order to replay the three pairs of double width optical soundtracks – which were recorded on a separate film. The sound reel also carried a fourth track comprised of three discrete audio tones. The level of these tones altered the gain of the three amplifiers feeding the left, right and centre speakers behind the screen. The aim was to further increase the dynamic range and apparent signal-to-noise ratio of the optical sound.

What about surround effects you ask? Well, with Fantasound, these were derived from the left and right stage tracks and faded up and down manually from cue sheets supplied to one of the projectionists.

To overcome the obvious risk of human error inherent in this method, RCA resurrected (as you may have guessed) patent number 1,851,117. Accordingly notches were cut along the film's edge, at appropriate spots, to key banks of speakers placed along the theatre walls. This added an ethereal quality to choral sequences and the like.

Although, with its multiple sound sources and 70dB dynamic range Fantasound set a standard of cinema sound fidelity that was not to be equalled for over a decade, it was a financial catastrophe. The cost and complexity of the system was for that time enormous. Weighing in at over 6 tonnes and utilising over 200 valves, it had to be specially set up at each location and operated by a team of technicians.

Only a handful of theatres in the USA screened *Fantasia* with its intended multiple sound-tracks. Wartime restrictions alone would have prevented the specialised equipment ever reaching Australia. As a film *Fantasia* was well ahead of its time, even without stereo, but it went largely unappreciated by audiences of the day. Relatively poor box office returns consequently forced Disney to abandon his plan to produce a new Fantasound feature each year.

With America at war in 1942, the entire Fantasound recording plant was commandeered by the US Army Signal Corps and, suitably modified, was used in the production of conventional mono soundtracks for military training films. Due partly to the disastrous commercial failure of Fantasound, the movie industry showed virtually no serious interest in multi-channel sound for almost another 12 years.

3-D craze

It was actually stereo of a different kind that rekindled interest in cinema stereo. During 1952 Hollywood producers, no doubt prompted by increasing competition from television, were found flirting once more with stereoscopic (i.e., three dimensional) technology. This on-and-off dalliance with 3D had been going on since 1922, when two features and several shorts were released.

The big year for 3D however was in 1953. Over 45 features were produced that were intended to be viewed through Polaroid spectacles. (This system should not be confused with the vastly inferior method using red/green coloured filters).

It was not long before dimensional sound was resurrected, to complement the depth-enhanced screen image. Those innovative Warner Brothers again led the way, with *House of Wax* in 3D and (what else) 'Warner Sound'. The multiple soundtracks used at this time were also on a separate reel of film.

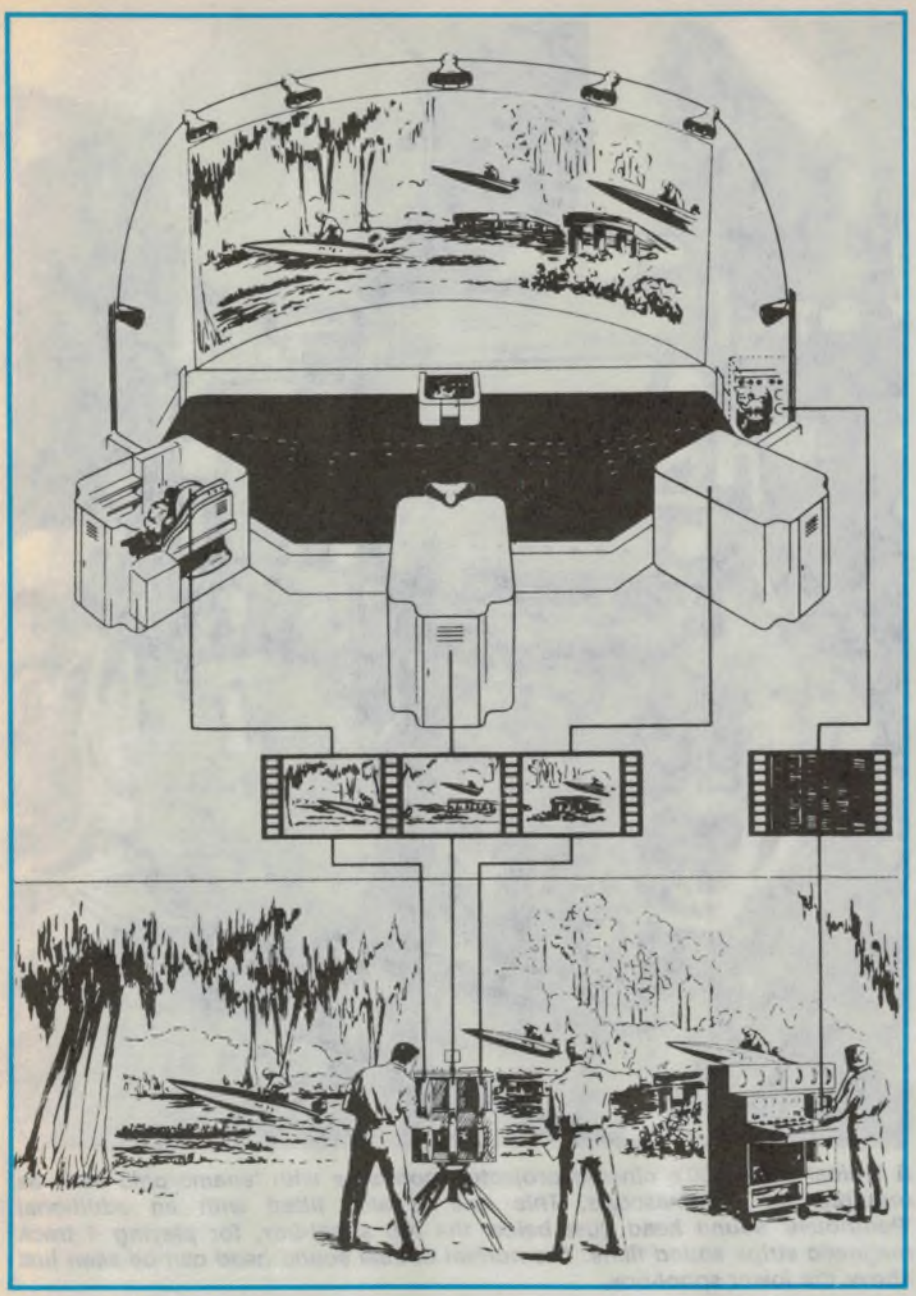
Since the Fantasound experiment, magnetic recording technology had been developed which provided fidelity superior to conventional optical tracks. Nevertheless, the inherent clumsiness of running two separate picture reels (for 3D) plus a third for sound, prevented wide acceptance of this stereophonic technique. It was never used in this country.

Concurrent with the 3D craze came the dawn of the wide screen era. It was in the November 1952 pages of this very journal (then known as *Radio & Hobbies*) that many, including myself, first learnt about the revolutionary techniques incorporated in 'Cinerama'.

Briefly, the idea was to forget the 3D aspect of vision and concentrate instead on widening the spectators' field of view, to the extent that they were partially enveloped in the picture. This was achieved by projecting three films simultaneously and side-by-side, to create the effect of one super-wide panoramic image. The immense curved screen called for the use of correspondingly impressive sound, and so a six-track stereophonic surround process was developed.

Although Cinerama enjoyed record breaking runs in many capital cities throughout the world, the expense of redesigning a theatre to accept the mammoth proscenium required – plus three additional projection booths – was considerable. So too were the technical problems of slaving triple projectors in perfect synchronisation to the 35mm magnetic sound tape. These factors coupled with the limited number of productions available (only seven 'three-strip' Cinerama films were ever produced, and all but two of these were travelogues) meant that this technology was totally impractical for most theatres.

Despite its limitations, Cinerama had demonstrated to the motion picture world that the public was at last ready



An explanation of 'Cinerama' which appeared in the program handed to patrons when it was unveiled in 1952. Cinerama's six channel sound was sourced from a separate high speed 35mm tape, and provided movie sound quality that is yet to be surpassed.

for big screens and stereophonic sound. What remained was to find a way of achieving this more economically.

Enter CinemaScope

At this stage Spyros F. Skouras, who was then head of 20th Century Fox, remembered 'Hypergonar' – the 1927 invention of Henri Chretien. This wide screen system used standard camera and projection equipment, relying on a so-called 'anamorphic' lens to compress a wide field of view horizontally to fit the conventional 35mm film frame. During projection, the distorted image was 'stretched' to restore its original shape. The result was a screen image approximately double the then-standard width. Skouras purchased the rights to the process and renamed it 'Cinemascope'.

When the first Cinemascope feature *The Robe* was released here in 1953, it offered Australians their first opportunity to experience true stereophonic surround sound. By reducing the width of the perforations it was possible to fit four magnetic stripes onto standard 35mm film. Three of these tracks carried information for sound emanating from the respective left, centre and right screen areas, while the fourth took care of the surround or 'audience participation' speakers as they were then called.

The introduction of 3D and Cinemascope sparked off a frenzy of activity within the movie industry, reminiscent of the talkie revolution 25 years earlier. At the time there was much speculation as to which process, if any, would endure.

None other than Mr Neville Williams wrote in *Radio and Hobbies* (the July 1953 issue to be exact) an accurate account of the situation, under the heading 'Those Shadders On Ther Wall' (sic). The predictions offered by Neville Williams in that article proved to be totally accurate, and before long 3D virtually disappeared and widescreen/Cinemascope became the norm.

Although Fox initially decreed that all Cinemascope releases were to feature stereophonic sound, most exhibitors were reluctant to invest the extra capital necessary for multi-channel reproduction. Before long conventional optical mono sound versions were made available. As a result, relatively few owners equipped their theatres to exhibit Cinemascope productions in their full stereophonic splendour.

Unfortunately, for those that did, the quality of those four narrow magnetic tracks was quite variable. Too often they exhibited a mediocre signal-to-noise ratio and quite inconsistent channel balance. Many installation technicians chose to 'play safe' by winding up the level of the most important 'centre' channel, a practice which negated much of the stereo spread.

The high frequency response was potentially better than the normal optical track, but this was often negated by worn play-back heads and quality control problems with the laminated magnetic stripe. The surround track, being appreciably narrower than the stage sound-tracks, suffered most from these defects. Projectionists often took the easy way out by running it at a low level.

If there was any sound-related complaint from patrons or management during the screening of a four channel print, the distrusted 'audience participation' channel was often turned down or completely silenced for the entire run. Little wonder that the number of films released with magnetic sound-tracks progressively dwindled, to become negligible by the early 1970's.

The 'Todd-AO' wide screen system made its appearance a few years after Cinemascope. Utilising film 70mm wide, it provided space not only for a much larger and consequentially sharper picture, but also allowed for wider magnetic sound-tracks – six of them, in fact.

The 70mm film ran faster than normal (initially 28.13 inches/sec compared to 18 inches/sec for normal 35mm cinema film), which benefited audio quality if not film preservation. The six tracks were distributed so that there were five channels for on-screen sound and a sixth for surround effects. In many of the later 70mm productions, however, two of the screen channels were dropped.

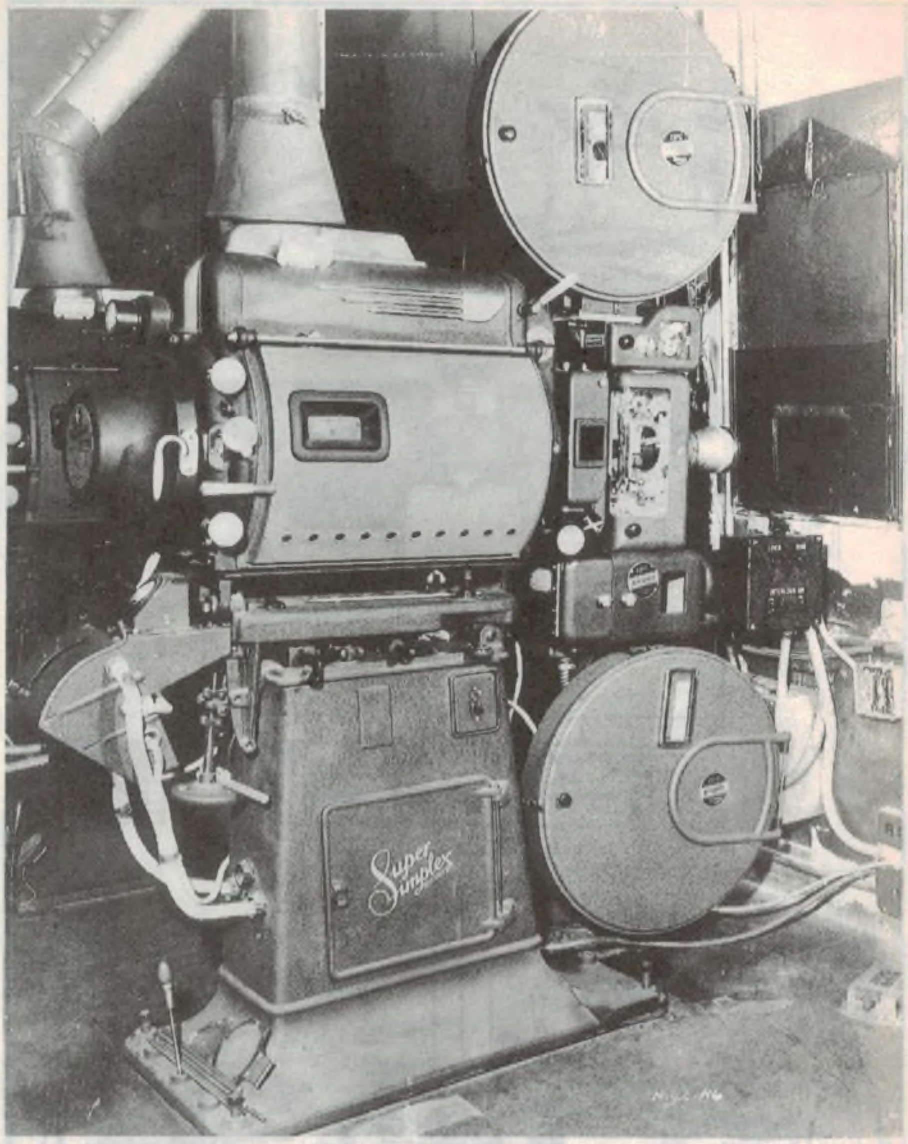
Todd-AO and its variants required completely new projection equipment. Although less expensive to install than the original Cinerama, only a relatively few prestige cinemas considered it a viable proposition. This fact, coupled with the escalating rarity of magnetic sound 35mm releases by the mid 1960's, led to the demise of the stereo-surround cinema sound era that began so promisingly with *The Robe* in 1953.

Before leaving the 1950's, mention should be made of one other ill-conceived and, perhaps deservedly, ill-fated technique of providing directional sound. This was 'PerspectaSound', once employed extensively by MGM. Hawk-eyed viewers may notice in amongst the opening credits of many MGM releases of the early Cinemascope era the 'PerspectaSound' logo.

In spite of its supporters' claim that it was a stereophonic system, Perspecta utilised a conventional mono optical sound-track. During the final mixing session three low frequency tones of 30, 35 and 40 hertz and of variable level were mixed in with the otherwise standard audio. When played in a suitably equipped theatre this single sound-track was fed via three separate amplifiers to respective left, centre and right speakers behind the screen.

The three low frequency tones were filtered out, separated, then rectified. The resulting three DC voltages were then used to vary the gain of the respective left, right and centre amplifiers. As the level of the recorded tone increased, the gain of its respective amplifier decreased.

This meant that if, for example, sound was to emanate from the left speaker only, then the 35 and 40 hertz tones would be present (to mute centre and right channels respectively). Presence of a 30 and 35 hertz tone with none at 40 hertz steered the sound to the right channel, and so on.



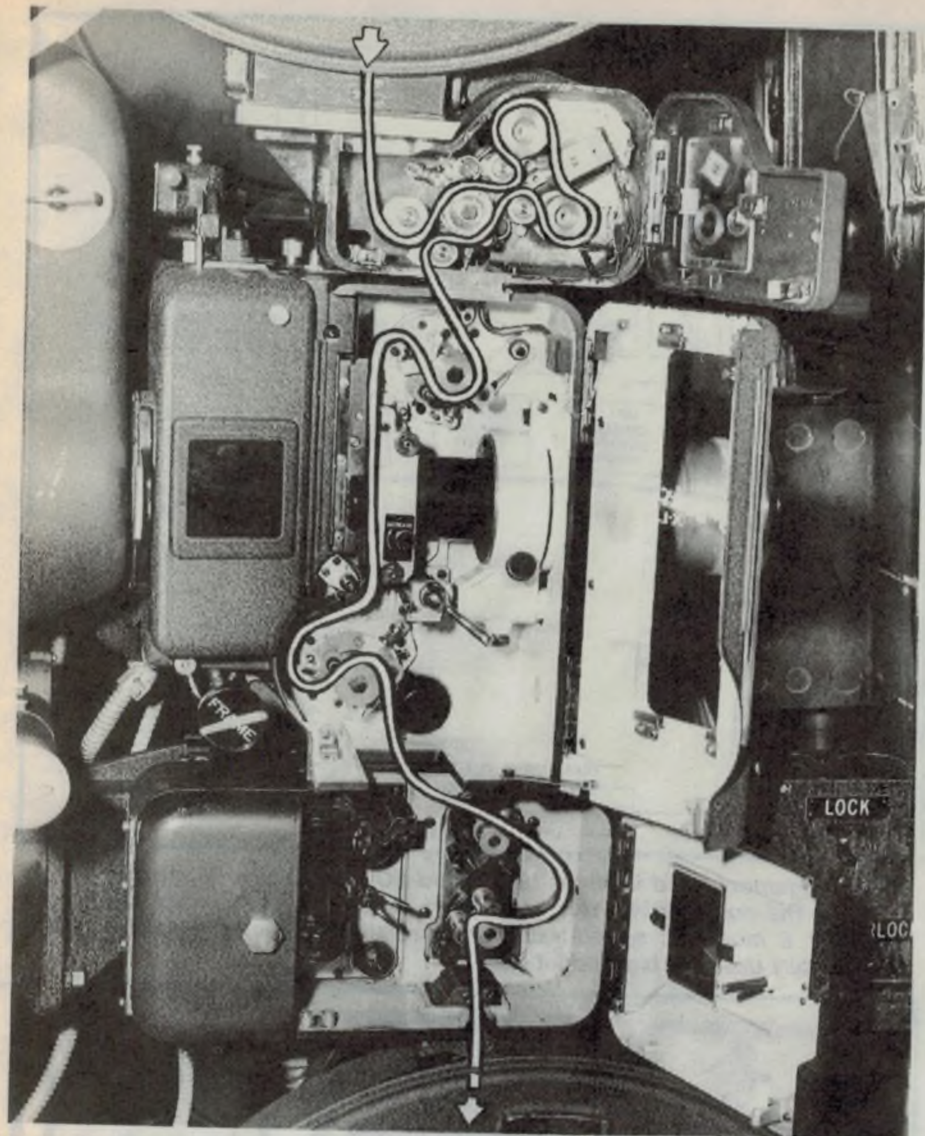
A typical mid 1950's cinema projector, complete with 'anamorphic' lens as required for Cinemascope. This one is also fitted with an additional 'Penthouse' sound head, just below the top spool-box, for playing 4 track magnetic stripe sound films. The normal optical sound head can be seen just above the lower spool-box.

In short, Perspecta was merely a programmed balance control which enabled actors' voices to seemingly travel across the screen in accordance with their image. Unfortunately whatever else was on this mono track was likewise shifted – background music, sound effects and so on.

The idea had two advantages: compatibility, prints could be run in any cinema (although those supposedly subaudible tones caused peculiar pounding sensations in certain theatres) and the additional cost of producing Perspecta prints was nil. It was probably this something-for-nothing aspect, together with an apparent misunderstanding by many producers as to what stereo was all about, that allowed 'PerspectaSound' to survive as long as it did.

Although Universal and Paramount each made a few features which utilised the process, MGM saw fit to include Perspecta control tones in the sound-tracks of nearly all of its features and cartoon shorts from 1954 to 1958. Even Clark Gable's voice was panned across the screen (accompanied by Max Steiner's orchestral score) in the re-release of *Gone With the Wind*, by courtesy of 'PerspectaSound'.

Many exhibitors, discouraged by what seemed a lack of interest by the general public in multi-channel film sound, felt there was little benefit in running magnetic sound prints at all. Consequently, many theatres which had stereo sound heads and amplifiers did not bother



The film path in the Super Simplex projector, when running a 4 track magnetic stereophonic film.

maintaining them. Why bother, when by the mid-1960's less than one in a hundred films were stereophonic? Not surprisingly, these exhibitors took the easy way out and ran the tried and tested mono versions exclusively.

For the next decade virtually 99% of all movies were released with conventional monophonic optical soundtracks. Then suddenly, around 1976, interest in improving cinema sound revived. This time however a different approach was used.

Optical + Dolby

In the early 1950's it was generally thought that magnetic recording held the most potential for high quality cinema sound. This time around it was decided that problems of quality control, compatibility and cost cancelled out most of the benefits of magnetic soundtracks.

It was time to take a closer look at the standard optical sound track, which many argued had never reached its full potential. After a few unsuccessful attempts by other companies, the Dolby sound laboratories came up with their stereophonic movie process that is now an industry standard.

In the space normally occupied by the standard bi-lateral (variable area) mono optical soundtracks, 'Dolby Stereo' prints carry two independent half-width tracks that are picked up by two separate light cells. If this arrangement sounds a little familiar there is good reason: it is in fact the same idea that Ray Allsop demonstrated to an Australian audience way back in 1938. The difference is mostly one of refinement.

Firstly, in the current 'Dolby' system the two channels are recorded with 'Dolby A' encoding. During playback, electrical audio signals from the dual photo cells are applied to a pair of high gain preamps, then to the appropriate professional 'Dolby A' noise reduction units. ('Dolby A' works in a similar fashion to the Dolby used in your cassette deck except it provides subjective noise reduction over the whole audio range, not just the top end). This more than compensates for the decreased signal-to-noise ratio which would normally result from using narrower than usual sound tracks.

Secondly, the stereo signal is encoded, matrix quad fashion, so that up to four channels (left, centre, right and surround) can be derived from them.

A precise explanation of the techniques used to regain the four channels for playback in a theatre is quite complex, and would require many pages and reams of maths. However a basic summary of what happens when such a pair of Dolby optical sound tracks are 'decoded' is as follows:

Program material recorded only on the outer soundtrack (the one nearest the film perforations) is fed to the left channel power amplifier and speaker system. Material recorded on the other track is fed (not surprisingly) to the right channel. So far this is much the same as happens with say a normal stereo cassette player. The major difference is that our source is a pair of photographic soundtracks instead of magnetic ones.

From here on however things get rather more complex. In a cinema we require a real 'centre' channel instead of the virtual one afforded by our two channel stereo setup at home. The main reason for this is due to the fact that only a small percentage of theatre patrons would be seated in the optimum position for two channel stereo, equidistant from left and right speakers, and for the majority dialogue would seem to emanate from an off-centre position.

During the final mixing session, dialogue and other 'centre' information is recorded at equal level and in-phase on both channels. In the cinema the signal to drive the centre speaker is derived from the two optical soundtracks by simply adding them together. In other words a left-plus-right 'mono' signal is fed to the centre.

Signals required to emanate from the 'surround' speakers is also recorded equally on both channels, but 180° out-of-phase. During playback the surround channel is fed by a mix of the two sound-tracks in phase opposition. This difference signal contains a mix of extreme left and right signals, but theoretically it contains no 'centre' information as, being common to both channels this gets cancelled out.

I stress *theoretically* here as, in practice, it is impossible to ensure absolute balance between the two tracks and some un-cancelled dialogue often sneaks to the surround speakers. This could become quite irritating and so sophisticated electronic processing is employed to prevent the audience hearing sound that was meant to originate from the screen area, from popping up from behind.

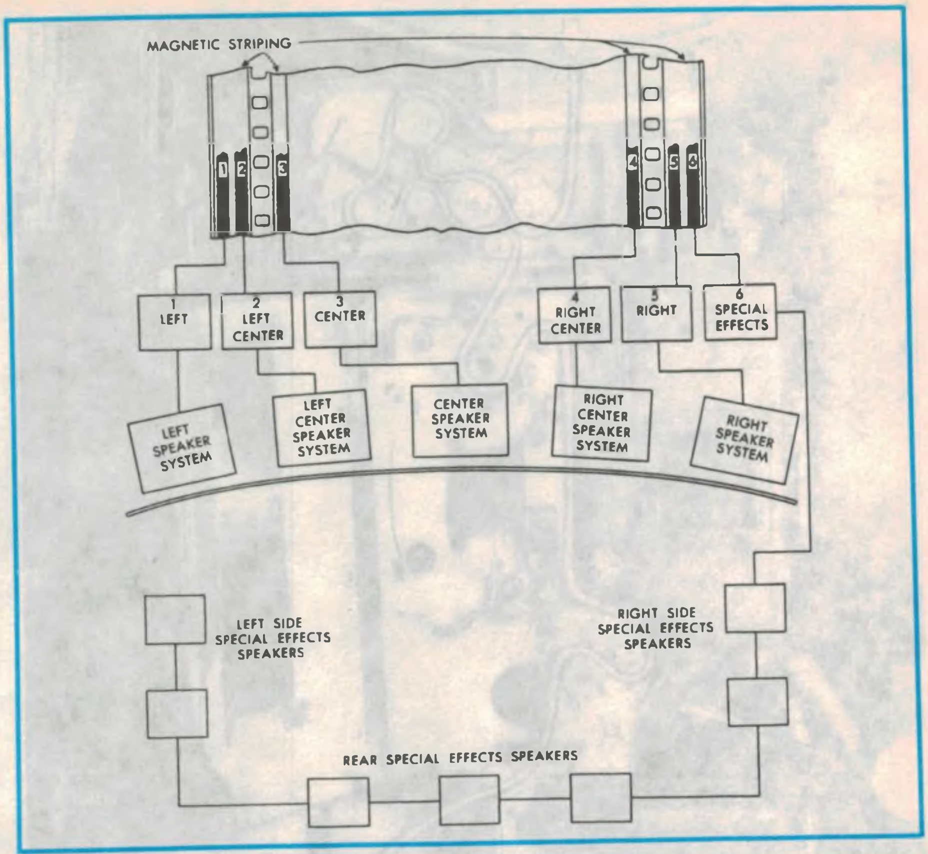
Dolby optical stereo uses a variation of 'Tate logic' circuitry in order to obtain the requisite separation between the four derived channels. This processing effectively shifts the relative gains of all four channels from moment to moment, according to the distribution and phasing of the film's stereo sound-track.

If, at a particular moment, both tracks were carrying identical in-phase signals (in other words a mono signal) then the logic circuitry would sense this and effectively drop the gain of the left, right and surround channels by leaving only the centre channel 'full on'. Similarly, the presence of a wholly balanced but out-of-phase signal would cause a gain reduction of the left, centre and right channels leaving our surround effects speakers going 'flat out'. At times when the left track only is modulated, the centre, right and surround are turned down. Conversely, the instant sound appears on the right track only surround, centre and left channels are muted.

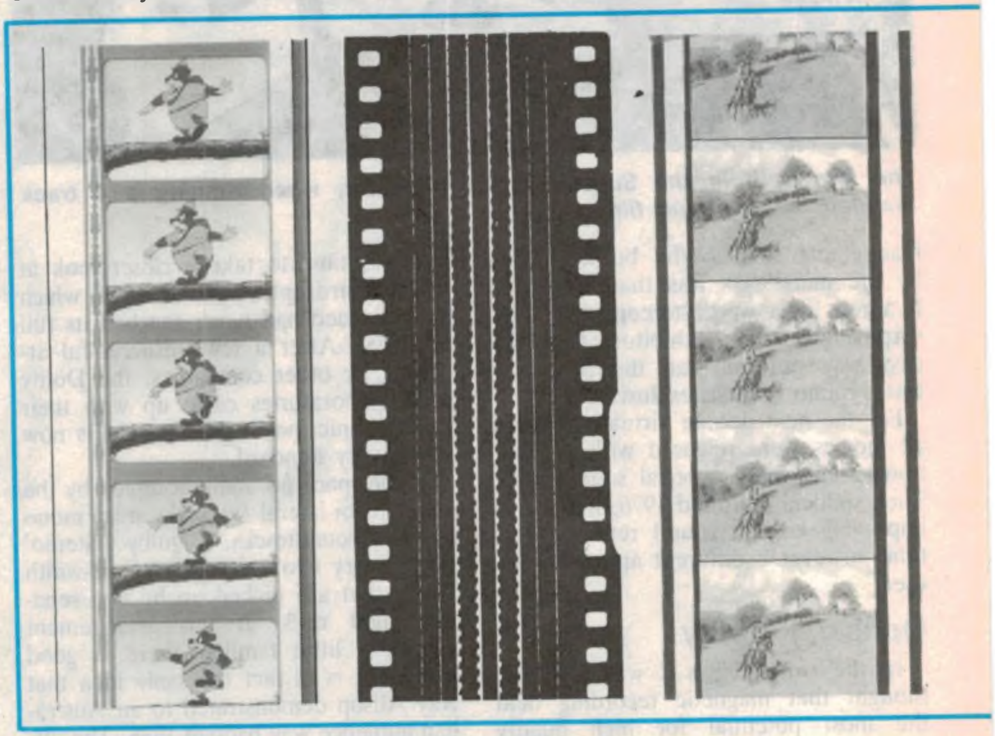
Unfortunately this so called 'logic steering' technique starts to let us down during more complex sequences. For instance when different sounds appear simultaneously on left and right tracks the separation between the four channels can become quite low.

The object is to retain the maximum possible separation between the most important 'centre' (dialogue) channel and the surround channel. For this to occur, separation is sacrificed between the left, right and surround. When sonically 'busy' scenes occur, separation between these channels can drop below six decibels.

Fortunately, in practice this is not as bad as it might look on paper, as any left/right sound that does spill into the surround channel mainly consists of music and/or off-screen sound effects. The people who mix sound for Dolby stereo movies usually make sure that dialogue stays firmly in the well-isolated 'centre' channel.



The arrangement used in circa 1955 'Todd-AO' and similar 70mm film sound systems. The double width format assures a sharper screen image and allows room for 6 magnetic sound-tracks. This relatively expensive format is still occasionally used for big budget epics.



Left to right: A conventional mono optical 35mm movie sound film, the notched sound film for the Disney-RCA 'Fantasound' system with its four push-pull tracks, and a 'Cinemascope' film with its four magnetic tracks. The samples shown here are reproduced actual size, to give you a better idea of the track dimensions.

As a further precaution against the distracting effect of dialogue appearing to come from where it shouldn't, the surround channel signal is run through a 'bucket brigade' type delay line. In this way, even if on-screen speech does cross-talk to the surround channel, it is heard approximately 30 milliseconds later than that coming from behind the screen. Thanks to what is known as the 'Haas effect', we then tend to associate the direction of a sound as coming from the source that reaches our ears first, ignoring the location of any related reverberation. In this case, the 30 millisecond delay imposed on unwanted stage sound fed to the surround channel ensures that we interpret dialogue as coming solely from the screen area.

Home shows

So much for the presentation of stereophonic movies in the professional cinema. For the enthusiastic videophile referred to earlier in this article, there is now an opportunity to enjoy the luxury of surround sound at home. Much the same impact can be achieved as in the cinema, but at a fraction of the expense.

Soon after VHS and Beta VCRs became available with stereo record/playback facilities, producers of pre-recorded videos began recording feature movies in stereo utilising the twin optical soundtracks indigenous to many 35mm prints.

It did not take long for some users to realise that videotapes sporting film-derived stereo sound would inherently contain out-of phase 'surround' information. In fact such tapes often sound disappointing, when played through conventional two channel stereo systems. Many contain little in the way of left-right stereo imaging, concentrating instead on centre/surround effects. Often, the result without a surround decoder is merely a vague sonic spread – the by-product of an inherently out-of-phase signal which constitutes the rear channel.

And so the audio fanatics amongst us dusted off their circa 1977 quadraphonic decoders, and connected them to circa 1987 hifi stereo video recorders. The results not only amazed their friends, but probably encouraged manufacturers to look hard at producing affordable hardware that would do the job properly. Which is exactly where we came in several pages ago.

It is now obvious that 'surround' sound and motion pictures have become securely wedded to each other. But how many would guess that their courtship has extended back some 60 years?

Left: 70mm film has six magnetic soundtracks, five for the screen and one for surround, although many producers now either discard two of the screen tracks or use them to key synthetic effects generators. At right is a modern 35mm 'Dolby' optical stereo print, with two dissimilar tracks which provide the stereo effect.

Commercials by force

Technology has its dark side, if we are to believe a report tabled at a recent conference held to discuss the future of TV advertising. With most TV networks in crisis, methods are being proposed that will effectively prevent viewers from ignoring TV commercials.

by PETER PHILLIPS

Readers will be no doubt be aware of the vicissitudes currently plaguing the commercial TV channels, with most major networks finding their running costs exceeding their revenue. However, the stations are loathe to cut back on the quality of their shows to reduce running costs, as ratings suffer, while advertisers are beginning to wonder if TV advertising is as productive as it used to be.

According to a report conducted by the TV Advertisers League, many viewers are now using their remote controls to either switch channels or to turn the volume down during commercials. A smaller number of people record the shows they intend watching, and during replay simply fast forward the recording when a commercial appears. 'Not fair!' say the advertisers, who are anxious to get a higher level of productivity from their advertising dollar.

Several proposals, some quite draconian, have been put forward to combat the problem, referred to in the report as 'commercial avoidance'. For example, it was suggested that copyright infringement for VCRs be more heavily policed, using techniques like those employed in the days of TV licences. In those days, vans were fitted with receivers able to detect the RF generated by the line scan circuitry of an operating TV set, making the lack of a TV licence a problem for the owner. Detecting the video content of an operating VCR is equally as simple, by merely tuning into its RF output frequency. However, opponents seem to have won the day with this one on the basis that such methods are an intrusion of privacy.

Another suggested scheme involves technology similar to that specified for DAT, in which special encoding makes certain programs impossible to record. So far, a list has been prepared for those programs to be exempt from the encoding, including all news broadcasts, religious programs and wild life specials, (except the Leyland Brothers). As well, political speeches and, naturally, advertisements will be not be encoded. But this still doesn't get around the problem of real time viewers and their remote controls. And here we have technology at its worst.

One proposal is that a 'lock out' signal be added to a TV transmission to prevent a remote control from having any effect on the TV set. In principle, a pulse code modulated, quadrature biphased synchronously polarised triple sideband signal (PCMQBSPTSS) would be added to the transmission, at a centre frequency (relative to the vision carrier) of 5.07MHz. The modulation of the carrier would be a specially encoded signal capable of overriding the signal from a remote control unit, effectively jamming its operation. In fact, tests have shown that some remote control units respond by actually *increasing* the volume of the TV sound.

However there are several problems that need solving before the broadcasting standards are revised to allow implementation of this scheme. For example, it has been demonstrated that the additional signal can cause a randomly moving purple vertical line to appear on the screen, if the colour decoding circuitry in the TV set is not properly aligned. As this would only appear during advertisements, this is seen as a significant disadvantage. As well, the signal can interfere with the sound, as the sound carrier is spaced by less than 500kHz from the proposed additional signal. One effect heard on an early model Kreisler was a sound similar to a Scarlatti sonata being played on bagpipes.

But the most popular idea involves the introduction of an additional section to the electronics of all new TV sets. An IC has now been developed that actually recognises a TV commercial, and this chip could be used to disable the remote control receiver in the TV set. In fact it is proposed that it also disable all front panel controls as well, except any adjustments that enhance the sound and picture.

The IC uses an operating principle similar to the successive approximation register system used in a number of analog to digital converters. It first compares the image to a previous image to see if there has been a change. If not, it does nothing. If so, it then examines the sound signal to see if there has also been a change. When both the video and sound signals have changed, it uses a number of algorithms to determine if some typical advertising words are present, such as 'ninety nine', 'last chance', 'Father's day', 'super saver special', or 'lowest prices'. If so, it tests the inflexion of the speech pattern for sincerity. The video signal is also examined to establish if the dollar sign is present.

The designers had difficulty devising algorithms for all commercials, but according to one of the designers, most advertisements have certain characteristics that make them readily identifiable. He listed bad taste, jingoistic music, bright colours and use of female models as typical, but cited repetition as the

key. To take advantage of the latter, the chip includes a memory capable of storing up to 47 60-second commercials, which can be used for comparison.

Tests conducted so far have returned a success rate of 92%. The 8% of commercials not detected are those that viewers would probably not mind watching anyway, although some shows have been incorrectly sensed as advertisements, much to the embarrassment of the TV station proprietors. It seems shows like 'The Brady Bunch', 'Flipper' and 'Diff'rent Strokes' fall foul of the repetition algorithm, while certain game shows have all the characteristics of a commercial, except they last longer.

Once this IC is perfected, retrofitting to existing TV sets is planned, and legislation is in the formative stages to make this compulsory. On the positive side, the installation will be free and the TV set overhauled. Those sets without remote controls will be exempt, but all sets manufactured after a specified date will be remote control only.

As a result, viewers who watch TV while eating will not be able to ignore pet food commercials, and those with a weight problem will have to devise new strategies to cope with chocolate commercials.

Various interest groups have tabled their concern about the lack of control parents may have over advertisements promoting toys, and nutritional experts are already forecasting problems with the nation's eating habits. On the bright side, the non-commercial channels will be urged to increase the quantity of family shows, and we understand the ABC is seeking the rights to a series tracing the development of the housebrick and other fascinating building materials.

We at *EA* intend to develop more radio projects, as we believe no plans are in progress to make commercial locks for radios. Yet!

FORUM

Conducted by Jim Rowe

Computer viruses, help for hackers and the accuracy of DVMs

There's a rather mixed bag of correspondence for Forum this month, with one letter in response to Neville Williams' piece on computer viruses, another suggesting we should provide readers with more help in upgrading their computers, and finally one raising a new topic altogether: is your DVM really as accurate as it seems?

In the January column, you may recall, I passed the Forum baton back temporarily to its original conductor Neville Williams, who contributed a piece giving his observations on the topic of computer viruses, worms, Trojan horses and associated nasties. So far there has been only one response to this, but as the letter concerned is an interesting one, I thought we'd use it to kick off this month's column.

It comes from reader Neville Harlick, who hails from Auckland in New Zealand. Here's what Mr Harlick has to say:

I was quite interested to read Neville Williams' article on viruses, etc., in January's Forum. I tend to agree with what he seemed to conclude, namely that 'computer virus' is the phrase of the year, but while the news media like to sensationalise such things out of all proportion, the viruses do exist. They can be a major problem to those who operate computer networks which are accessed by a wide range of 'outside' users.

Bulletin boards are a prime target for those wishing to disseminate such programs, as well as coming under attack from them. I have included a couple of files taken from a BBS in Auckland, which will demonstrate the existence of a few virus programs. I'm not suggesting that you should publish the source code for the Marijuana virus, but if you take the trouble to follow the instructions, you can create a perfect working copy of it.

The list from TAIC OPUS may be valuable to some users as it shows how to identify some of the known virus programs.

The Marijuana virus itself is what prompted my original interest, as my 14-year-old son brought home a games disk from one of his school friends and booted my computer with it. The infection was instantaneous, but I didn't discover it for a couple of weeks as the virus seems to only produce its message ('your computer is stoned – legalise marijuana') about one time in six. It does, however, copy itself on to any and all disks (hard or otherwise) that go through the machine, and it is a laborious job going through a couple of hundred disks checking for the virus.

Fortunately, Wellington University (rumoured to be where it originated) provide a program called 'Killer' which can be used to detect and remove this virus. But my son discovered the real meaning of the word 'boot'!

This virus appears to be relatively harmless, merely replacing the boot sector with its own code and re-locating the original. Apart from the irritating message and the feeling that one's computer has been raped, there is no other harmful effect.

I don't know how a computer running Xenix or Netware would get on. I suspect that what is a boot sector under DOS may be something else under these operating systems, and considerable damage may result if the virus loaded itself onto one of these systems.

Mr Williams did seem a bit skeptical in his article – perhaps a suitable punishment would be to get him to type in all those hex numbers and prove that the Marijuana virus really does exist?

I don't think that last suggestion would be a good idea at all, Mr Harlick – for two reasons. One is that Neville's machine is an Apple; goodness only knows what kind of havoc this 'IBM/Intel environment' code would wreak in a totally different environment again. I shudder to think!

The second reason is rather more selfish. Neville nowadays sends his articles in to me electronically, via modem, so his machine is frequently in direct contact with those I use myself both at home and in the office. If his machine became infected, then my own would probably catch the virus as well. And as mine communicates via disk with the company's typesetting system, this might well become infected as well – with potentially catastrophic results!

So frankly, I don't want Neville to even see a copy of the virus listing, let alone key it into his machine and try it out. Nor do I want to try it out myself, for that matter.

I'm sure Mr Harlick is right, though, about so-called 'bulletin boards' being a virtual breeding ground for things like viruses. Those I've seen have always seemed wide open to abuse by anti-social people, who can easily log in and leave a virus or other nasty routine, disguised as or hidden away in a 'useful program utility' or whatever.

Perhaps I'm a bit too cautious, but frankly I'm extremely nervous about even trying out any program whose source is not absolutely above board. Quite apart from the legal complications of using programs of unknown or dubious origin, it seems to me there's also a strong risk of them being contaminated.

For the same reason, I personally wouldn't ever leave any computer running with an auto-answer modem, able to accept computer files automatically over the line. You'd never know who might happen to call up, and leave something nasty!

Although I use modems quite frequently to exchange files for the magazine, I far prefer to use simple manually-operated modems and file transfer software. Then I'm assured that the only people whose computers communicate with mine are people I trust, and at times when I'm there to watch...

Some of our readers may well brand me as a spoilsport, but I'm not going to reproduce the listing of the Marijuana virus that Mr Harlick sent in with his letter, together with its installation in-

structions. I think that would only be encouraging its use, and quite irresponsible. Better a boring spoilsport than indirectly responsible for the infection of more computers, I reckon.

However I am going to reproduce his second listing, with its table of at least some of the known DOS-environment viruses. It's all very matter of fact, even giving details of displacements and hex patterns which allow the presence of the virus to be detected, plus other useful data.

I can't see how publishing this listing could do any harm, as it will hopefully;

(a) convince more readers that viruses are indeed a worrying reality; and
(b) disseminate at least some useful information on tracking them down.

All the same, I must confess to finding the whole thing rather sordid, don't you? It's sad that the technology that some humans have developed to expand our collective productivity and enhance our intellectual power, can be corrupted by others for pretty selfish and antisocial ends. Still, I suppose this sort of thing has been happening ever since humans started to walk upright and live in caves...

Help for hackers

But on to other, and more cheerful things. The second letter to arrive came from Mr Lawrie Debnam, of Elizabeth in South Australia. Mr Debnam is essentially responding to my comments at the end of the Forum column in last June's issue, to the effect that I didn't want *EA* ever to become a clone of the US computer magazine *Byte* – even though that magazine is highly respected around the world. My belief, right or wrong, is that *EA* should try to cover as many facets of electronics as possible, rather than concentrate on just one aspect to the exclusion of the rest.

Here then are Mr Debnam's thoughts on this topic:

Certainly DON'T turn into a 'Byte' clone – but some other diversions might be worthwhile. First, though, a little background to what I have to say, just to reinforce my opinion.

The first copy of 'Radio & Hobbies' that I read was in about June 1949. When I picked it up I didn't even know what 'radio' was – we had always called it 'wireless' – and I looked at the magazine only because it had something about modifying a 16mm projector. Those other funny squiggles, circles and lines that went nowhere in 'circuit diagrams' were a complete mystery.

However they were interesting, and I bought the following month's issue even though it cost a lot at 1/6d (my pocket money at the time was 1/- per week). Since then I have been a regular reader, and even a contributor – you published a series of my articles in 1970-71.

As I said, do not become another 'Byte'. But out in the non-electronics world there are many people who play with computers. If they can find something of use in EA, they may also become interested in hardwired electronics and become regular readers.

Many of these people want to add to, or modify their systems and cannot get the information they need. This is especially true for people in country towns.

For example, I wanted to add a second hard disk to my XT, as the first one was nearly full with data that needed processing, and there was more data to add. I could not find out how to do it, and even the people who offered to do it for me, for a fee, could not guarantee that data would not be lost from the first hard disk. I had backup copies, but re-

Forum

loading and checking some 8000 files would be a long job in the case of a crash.

No-one to whom I spoke had actually fitted a second hard disk, and they would only work to the same vague written instructions that I had access to – which actually refer to fitting a FIRST hard disk.

My suggestion, therefore, is to have a section to which people can write asking for information – e.g., how can extended memory be fitted? How can a hard disk or second floppy be added? Can the slots all be filled at will, or is a larger power supply needed?

If you cannot answer the questions yourselves, you could solicit answers from other readers. These, by the way, are the kind of questions that the 'computer' magazines tend to answer only vaguely – they seem more interested in software.

To round off, 'Forum' should be called 'Let's Buy an Argument' again, then I could argue with the '50 years ago' column for June. The steel tape used in the metal tape recording excerpt would need more than a 'small motor' to drive it. The tape (if of the dimensions given) would have a mass of about 8 tonnes. In fact I would call it 'bar', not 'tape'!

By the way, if contributions to sections of the magazine such as 'The Serviceman' are acceptable on disk, why not publish the format that you prefer – e.g., MS-DOS 360K, ASCII etc. This may ease your editing and typesetting.

MESSAGE FROM DELPHI (645-593 1200/2400 24 hours) on 26/08/89 12:00

===

To All
From Sysop
Subject Viruses

With the kind permission of the Opus network, Delphi brings to you:

* Original: FROM.....Samson Luk (711/403)
* Original: TO.......All (770/101)
* Forwarded by.......Opus Xpress

Follow is a list of KNOWN virus affecting IBM PCs and compatibles, including XTs, ATs and PS/2. The hexadecimal pattern can be used to detect the presence of the virus by using any pattern searching software such as Norton Utilities.

Seen and disassembled viruses

Name	Aliases	Type	Displacement/Hexadecimal Pattern	
405		POC	00AH	26 A2 49 02 26 A2 4B 02 26 A2
Brain	Pakistani	BF	15EH	8B 0E 07 7C 89 0E 0A 7C E8 57
Cascade (1)	Fall,1701,	PRC	01BH	31 34 31 24 46 4C 75 F8
Cascade (2)	1704	PRC	01BH	31 34 31 24 46 4C 77 F8
Datacrime	1280 or 1168	PNC	000H	2E 8B 36 01 01 83 EE 03 8B C6
Den Zuk	Search	BF	03EH	8B 90 7C 53 C3 B9 B0 7C 51 C3
Fu Manchu	2086(COM), 2080(EXE)	PRA	1EEH	FC B4 E1 CD 21 80 FC E1 73 16
Italian	Pingpong	BD	07CH	C7 06 4C 00 D0 7C 8C 0E 4E 00
Jerusalem	PLO, Israeli, Friday 13th	PRA	095H	FC B4 E0 CD 21 80 FC E0 73 16
Lehigh		PRO	01CH	B4 19 CD 44 04 61 1E 51 52 57
New Zealand (1)	Stoned,	BM	045H	B8 01 02 0E 07 BB 00 02 B9 01
New Zealand (2)	Marijuana	BM	043H	B8 01 02 0E 07 BB 00 02 33 C9
Pentagon		BF	03EH	8E D8 FB BD 44 7C 81 76 06
Saratoga (1)	Icelandic, 642	PRE	088H	2E C6 06 79 02 02 90 50 53 51
Saratoga (2)	656	PRE	0C6H	2E C6 06 87 02 0A 90 50 53 51
Suriv101	Israeli, 897	PRC	30AH	81 F9 C4 07 72 18 81 FA 01 04
Suriv201	Israeli, 1488	PRE	05EH	81 F9 C4 07 72 28 81 FA 01 04
Suric300	Israeli, 1813	PRA	099H	FC B4 E0 CD 21 80 FC E0 73 16
Traceback	3066	PRA	108H	89 B4 51 01 81 84 51 01 84 08
Vienna (1)	Austrian, 648	PNC	005H	8B F2 83 C6 0A 90 BF 00 01 B9
Vienna (2)	Unesco 648	PNC	005H	8B F2 81 C6 0A 00 BF 00 01 B9
Yale	Alameda, Merritt	BF	00EH	A1 13 00 F7 E3 2D E0 07

Type Code:

A = Infects all program files (COM & EXE)
B = Boot virus
C = Infects COM files only
D = Infects DOS boot sector on hard disk
E = Infects EXE files only
F = Floppy (360K) only
M = Infects Master boot sector on hard disk
N = Non-resident (in memory)
O = Overwriting
P = Parasitic virus
R = Resident (in memory)

* Origin: TAIC OPUS - HONG KONG, FrontDoor Support Asia (3:700/1)

Neville Harlick's second listing, of known computer viruses.

Thanks for your comments, Lawrie – I found them very interesting indeed. It's true, as far as I can see, that most of the dedicated computer magazines seem to be rather heavily biased towards the software side, and shy away from helping readers sort out hardware hassles. That may well leave an opening for magazines like *EA* to be of greater help to our readers – and at the same time help boost our own readership.

A couple of days ago I was browsing through the largest technical and general bookstore in Sydney, for example. I couldn't help but notice the *enormous* array of books dealing with almost every conceivable area of computer software – programming, languages, operating systems, mastering applications packages, you name it. But the number of books dealing with the hardware side of PCs was miniscule by comparison – and those covering the rest of electronics weren't all that more numerous, either!

There's no doubt about it, software is very much the hot subject area at present.

Yet as Mr Debnam points out, many computer owners of a reasonably 'handy' bent are really quite capable of looking after many aspects of expanding their system's hardware. All they need is a good basic understanding of the way the system works, and information on the practical techniques and procedures to be followed in making changes. And that's presumably where we can contribute – after all, computers *are* electronic.

I'm not sure if Mr Debnam's suggestion that we have a 'your questions answered' column devoted exclusively to computers is the best answer, though. We already have one general section of this kind, 'Information Centre' – currently looked after by Peter Phillips – and in principle there's no real reason why this can't deal with questions regarding computer hardware. In fact I suspect Peter would rather welcome the idea, as he's a fairly experienced computer enthusiast anyway (although perhaps a little more familiar with the Apple environment than with IBM derivatives).

Perhaps other readers might like to comment on this aspect – would you prefer this sort of thing to be handled in Information Centre, with other areas of electronics, or would you like computer hardware problems to be given a section of their own?

Now to Mr Debnam's crack about the item in the '50 Years Ago' section of last June's issue, about metal tape recording. He's quite right, of course – what an embarrassing error! According to the excerpt, the tape was supposedly

120mm wide, 8mm thick and 360 feet long. I haven't gone through the calculations myself, but I suspect Mr Debnam's figure of 8 tonnes wouldn't be far from the mark.

One would certainly need a pretty hefty motor to coax this endless loop of 'tape' around a system of rollers, to be sure. And the recording head would probably have needed quite a solid driving current, to impress any recordings on it. The term 'bar' would certainly be more appropriate than 'tape', I agree.

Of course we got the dimensions wrong – not in the original story, but in last year's reprinted excerpt. I checked back in the original issue for June 1939, and the correct dimensions for the tape's cross-section were given as 120 x 8 *mills* – the American term meaning the same as our 'thou', or .001". So the tape actually measured just on 3mm wide by 0.2mm thick, much lighter and more acceptable even by modern standards.

It's really a very understandable error, as our Production Co-ordinator at the time was rather more youthful than either Lawrie Debnam or yours truly, and could not have been expected to have any familiarity with rather dated American measuring units – especially units that *look* as if they might well be the same as today's millimetres.

Mind you, at least two other people would have read that text before it was printed – including myself! – and neither of us spotted it. Ah well, we'll need to try even harder, won't we?

So you see, Mr Debnam, there's no need to change 'Forum' back to 'Let's Buy an Argument' in order to take issue with something in the magazine, or to rub our noses in an error we've made. It's really still the same column, whatever the name...

Before leaving Mr Debnam's letter I should perhaps comment on his last suggestion.

We *are* happy to accept contributions on disk, as this does make things easier for us to prepare them for publication. It also helps prevent further typographical errors from creeping in, when someone re-types the material into our system!

This is actually explained in our 'Notes for Intending Contributors to EA', which we're happy to send to anyone thinking of sending in a contribution. However for those who haven't been aware of these notes, here are the details of the format we prefer: 5.25" floppy disk, MS-DOS formatting, and either Wordstar or plain ASCII text format. If you're using a word processor other than Wordstar, the latter format can usually be achieved by 'printing' to a disk file.

We *can* cope with 3.5" diskettes if necessary, and also with disks produced on a number of other computers. For example we can accept disk files from quite a few of the older 8-bit computers using the CP/M operating system – thanks to that most valuable Australian software utility, FBN Software's 'PC Alien'. We can also cope with files on disks from *some* computers from the Apple family, by calling on the resources of people like Peter Phillips and other magazines published by our parent company.

DVM accuracy

And so to this month's third letter, which came from our old friend and long-time reader Mr Bert Heinemann, of Fairfield in NSW. The topic which has spurred Mr H. to write this time is digital voltmeters, and whether or not their readings can be assumed to be as accurate as they look:

May I suggest that the time has come to survey readers' experience with DVMs – both for function and accuracy.

I recently became aware of problems with my Korean-made Metex 3650. The meter was reading about 40% low on the 200 ohm range, and the battery voltage turned out to be 8.3V (–10%), yet there wasn't any warning from the battery status indicator. Voltage readings seemed OK.

At no time have I experienced a similar case with analog meters. If this is a general requirement, of having to check battery condition regularly, it is like a 'Sword of Damocles' hanging over your head, if you forget.

My 1968 R&H bridge will still hold my allegiance for R and C testing. Its standards are accurate within 0.2%.

The accuracy of a DVM seems to be derived from not requiring a precise mechanism, nor being subject to positional error or mechanical shock. Their accuracy seems more to be incidentally available than really necessary.

I consider that the ability to hold accuracy with battery voltage variations within a reasonable margin should be a test applied by EA to any DVM that it reviews.

In terms of function, I would prefer a 3-1/2 digit instrument with a maximum count of 4000 (3999), to a 4-1/2 digit instrument with a count of 2000 (1999).

Thanks for another interesting letter, Mr Heinemann. You've opened up a fairly wide topic, and one that to my knowledge hasn't been discussed much as yet.

Digital instruments such as DVMs *do* have the appearance of being much more accurate than many of the analog instruments with which many of us are familiar (particularly those of us getting a little longer in the tooth). No doubt this is because of their higher *resolution* – the ability to present readings which differ by quite tiny amounts.

With an older analog multimeter it was unusual to be able to read a voltage of say 1.5V to within more than a few tens of millivolts. Often the resolution was somewhat less fine again, depending upon the ranges provided. Yet with a modern DVM, even a low-cost 3.5-digit instrument will give a reading to the nearest millivolt, while a 4.5-digit instrument will give a reading within a hundred microvolts!

Of course the accuracy of these measurements is not necessarily as great as this increased resolution may lead you to expect – even when the battery is brand new and they're working well within specs.

For example one millivolt represents 0.06% of 1.5V, so for a reading of this resolution to be really meaningful, the instrument's accuracy would need to be better than 0.06% at this voltage level. Yet the rated accuracy of a typical medium priced 3.5-digit DVM, for DC voltage measurements, is generally around 0.8% of full-scale reading – plus/minus one digit in the least-significant position.

On the usual 1.999V range, this in fact translates to an error band of just on +/–17mV. In other words, a voltage which produces a reading of say 1.500V on such an instrument can in fact be anywhere within the range 1.483 – 1.517 volts.

So, far from being accurate to within one millivolt, as its resolution would suggest, a typical 3.5-digit DVM can be at least 17 times less accurate. And this is on one of the DC voltage ranges – which is typically rather more accurate than for AC or resistance measurements.

Of course a 4.5-digit instrument will generally be rather more accurate than this, as you'd expect from the somewhat higher price tag. But its resolution is also typically a factor of 10 better, so there will tend to be about the same ratio between resolution and working accuracy.

I haven't even picked a critical measurement level for the above example, either. In fact you can get even less favourable accuracy/resolution ratios, if you're forced to measure a voltage or current down near the bottom of a range – and this is often necessary, particularly with typical 3.5-digit instruments with a maximum count of 1999.

Say you're trying to measure a voltage just above 2V, for example. You can't use the nominal 2V range, because this will overflow. So you're forced to use the 20V (19.99V) range, instead. Here the error band corresponds to +/–160mV (0.8% of 20V), +/–10mV (1 LSD count) – or a total of +/–170mV.

As a percentage of the actual reading you're making, this corresponds to an accuracy of no better than +/–8.5% – a very sobering figure, I think you'll agree, and rather less impressive than the instrument's rated figure of 0.8%. In fact it's rather poorer than many of the analog meters now gathering dust!

The sudden jump in both resolution and accuracy of a DVM when you change ranges is something about which many users aren't too aware. And not surprisingly, the manufacturers haven't been all that eager to draw it to everyone's attention. After all, what the customer doesn't notice probably won't do them any harm...

Of course, making an instrument that is really much more accurate than currently available DVMs costs a lot more money, because it involves circuitry and components of much greater precision and stability. You simply can't sell such instruments for the kind of money that most of us can afford.

In any case, Mr Heinemann is right in suggesting that to a large extent, most of us really don't *need* the kind of apparent accuracy that is implied by the resolution of typical DVMs – even 3.5-digit instruments.

When you're measuring a transistor's bias voltage, for example, does it really matter if the voltage is 2.425V, or 2.573V, or even 2.677V? Most of the time, it's of no consequence. The voltages will easily vary over this kind of range, because the resistors we use are rarely better than 5% tolerance. And this kind of variation is generally quite compatible with normal operation.

So far from griping about the accuracy of typical DVMs being so much poorer than their resolution, perhaps we'd be better off sticking a piece of cardboard over the least significant digit of the display – to prevent us from having ourselves on!

But Mr Heinemann is quite right to draw attention to another source of error: the risk of faulty readings due to low battery voltage. I can't say I've struck this myself, or at least not that I've noticed, but it sounds very possible.

Of course the performance of any battery-operated instrument will tend to deteriorate when the battery voltage falls below a certain threshold, determined by the internal voltage regulation circuitry. That's not the problem, as I'm sure Mr Heinemann would agree.

Normally, one would expect, with an instrument like a DVM the 'battery low' indication would come on *before* the performance began to deteriorate significantly. It's really worrying if this doesn't happen, leading to a situation as Mr Heinemann describes in his letter.

Up until now, we haven't tested for this when we've been reviewing this kind of instrument. But it sounds like we better test them in future, doesn't it?

Thanks again for drawing attention to this matter, Mr Heinemann. Hopefully other readers may care to offer their experiences and opinions, now you've started the ball rolling.

Do I hear the distant sound of analog multimeters being dusted off and put back onto the bench?

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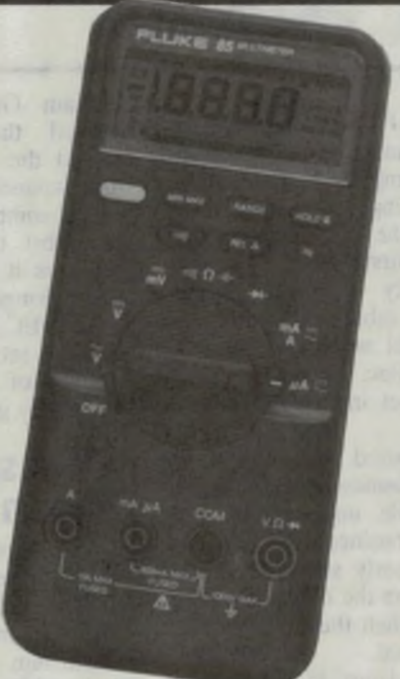

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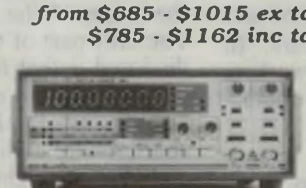

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Silicon Valley NEWSLETTER

IBM to let another 10,000 go

Years of stagnation in its US-based business has forced IBM to make additional deep cuts in its operating expenses, including another major reduction of no less than 10,000 people in the company's US workforce. International operations are not affected, as IBM's business outside the US has continued to show steady growth.

In keeping with its non-lay-off policy, IBM has said it will not put any of its workers out on the street. Instead, the reductions will be accomplished through natural attrition and lucrative early-retirement incentive programs for veteran IBM workers. The offer includes giving each retiring worker two weeks pay for every year of employment. The maximum bonus is a full year's pay.

A spokesman for IBM said it had not yet been determined where the cuts would take place, but he added that it is fair to assume they "will be across the board at our US facilities."

To cover the cost of the lay-offs and plant consolidations, IBM said it has taken a whopping US$3.2 billion charge against its earnings in the current quarter.

In a related move, IBM said it has also reserved another US$4 billion to buy back millions of its own shares on the New York Stock Exchange. The company hopes the move will boost the price of the firm's stock which has been trading below US$100. At its peak, IBM shares traded for more than $175 per share.

The latest IBM cuts are the third such measure in less than three years. In 1987 and 1988, a total of 23,000 workers accepted IBM's early retirement offers.

H-P negotiates for Soviet, Polish plants

Hoping to turn Eastern Europe's sudden drift towards Western-style economic policy into a major business advantage, Hewlett-Packard announced it has initiated negotiations with the Polish and Soviet governments aimed at building manufacturing facilities in those countries.

According to H-P's vice president for International Planning, Bill Johnston, the Palo Alto company is particularly interested in making ultra-sound scanning systems in the two Eastern-Bloc countries. In the first phase, the facilities would merely assemble various components and subsystems into finished products that would be for sale only in the East Bloc. At a later stage, the groups may get involved in actual manufacturing.

Johnston emphasised that despite the 'much improved business climate', there remain considerable uncertainties and risks in doing business in Eastern Europe. At this early stage, it is too soon to speculate on the outcome of the negotiations and when the first facilities would be operational.

H-P is but the latest in a series of major US companies that have announced their intention to do business in Eastern Europe. Johnston said H-P have successfully maintained a sales office in Moscow since 1969, and the company is exploring the possibilities of expanding its Eastern Europe business interests elsewhere in the East-bloc as well.

Intel & NEC settle microcode feud

After five years and millions of dollars in legal expenses, Intel and NEC said they laid their bitter microprocessor microcode copyright infringement dispute to rest.

Neither company wanted to disclose the terms of the settlement agreement. The only part of the agreement that was disclosed is that NEC has agreed not to proceed with an unfair competition lawsuit against Intel, in the wake of its court victory earlier this year in the V20 and V30 copyright infringement cases.

Ever since Intel first filed the suit against NEC in 1984, NEC has claimed Intel was using the copyright infringement suits to scare potential customers away from buying NEC's microprocessors in fear of legal retaliation by Intel if the Santa Clara company had prevailed in court. Shortly after Judge William Gray sided with NEC and cleared the company from having copied the 8086 and 8088 microcodes, the Japanese firm vowed to file an unfair competition suit against Intel in an effort to recuperate some of the damages it has suffered as a result of the prolonged legal battle.

At NEC, a company spokeswoman said the settlement was "just the wrapping up of loose ends. Now hopefully, everybody gets on with the business."

Wyse sold to Taiwan consortium

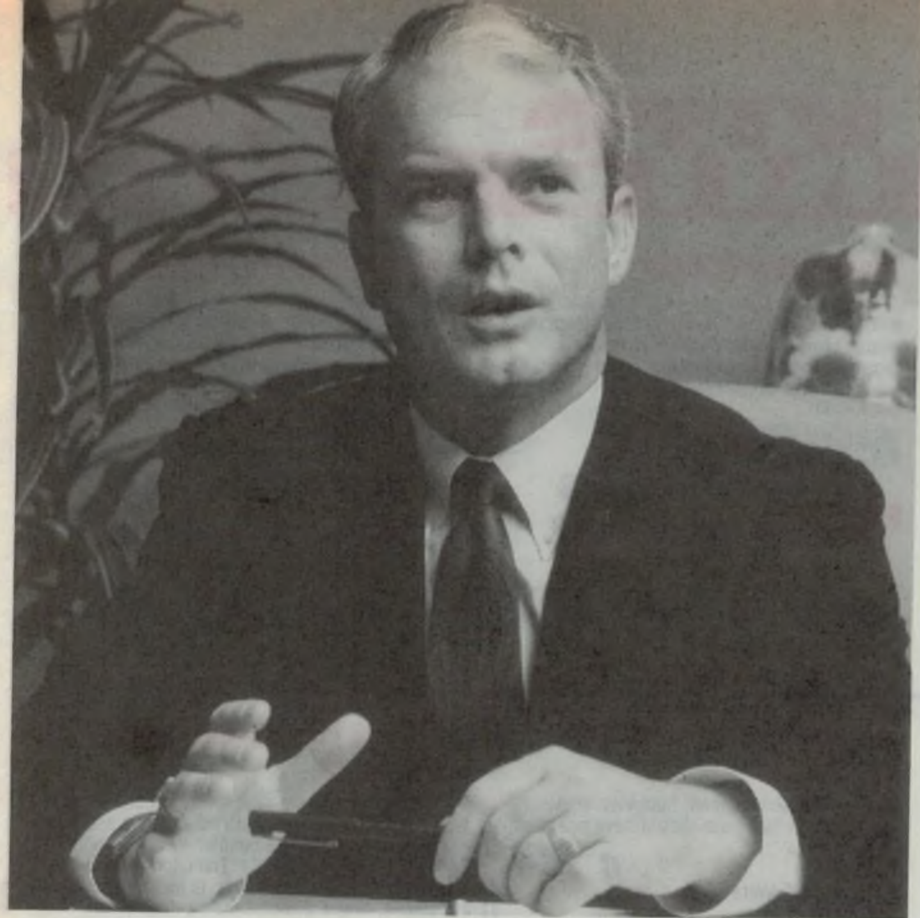
As expected, San Jose-based terminal maker Wyse Technology has accepted a US$268 million buy-out plan offered by 'The Channel International Group,' a consortium of Taiwanese investors including Mitac, one of that nation's largest personal computer makers.

As part of the deal, the Channel group has agreed to pay Wyse shareholders US$10 a share, amounting to a buy-out price of US$156 million. In addition, the group said it will assume $120 million of the company's outstanding debts.

The deal marks the first take-over of a publicly traded US company by Taiwan interests. It probably also marks the first time any US company has been acquired by a foreign government, since the Channel group is 20% owned by the Taiwanese government.

The sale means the end of a rags-to-riches story for Wyse, which until recently was one of Silicon Valley's brightest stars and seemingly on its way to becoming a major force in the computer industry.

After growing at an astonishing rate for most of the 1980's, Wyse suddenly ran aground early in 1988, in large part as a result of the crisis in the DRAM market. The company was forced to raise the price of its computers to compensate for the much higher prices it had to pay for the critical memory chips. To complicate matters, most of Wyse's products were nearing the end of their product cycle, a time the market usually demands lower prices in order to remain competitive with newer



Gary Moore, the president and CEO of Hitachi Data Systems – formerly National Advanced Systems, the mainframe computer arm of National Semiconductor, which Hitachi of Japan and General Motors' Electronic Data Systems (EDS) bought some 12 months ago for US$398 million. A 17-year veteran of EDS, Moore aims to build HDS from its present US$900 million level into a US$3 billion firm by 1993.

higher performance systems. The crisis caused Wyse's sales to be cut in half almost overnight, from nearly US$130 million a quarter, to less than $70 million.

Bernard Tse, founder and president of Wyse will be replaced as part of the move. While Tse will stay on as Vice Chairman, it is not known whether he will be taking part in the day-to-day operations of Wyse following the takeover.

Industry analysts said the sale is a good deal for shareholders, who were facing a possible total loss in the event that Wyse had folded. They agreed that the main asset Wyse offers its new owners is the company's broadly established US distribution network, through which the Taiwanese hope to establish a significant position in the US computer market.

US Memories meets 3 in 5

US Memories ended 1989 meeting three of its five key objectives. The DRAM start-up said it had finally concluded the negotiations with IBM for obtaining that firm's advanced DRAM design and manufacturing technology.

US Memories president Sanford Kane said that the agreement with IBM will make it much easier for his group to be able to go into production quickly with state-of-the-art 4-megabit DRAM chips.

Earlier, US Memories completed its business plan and received clearance from the anti-trust division of the US Justice Department. It failed, however, to meet two other key objectives by its self-imposed year-end deadline: select a manufacturing site, and line up sufficient financial support by the end of 1989 to secure its entry into the DRAM market. Not one company beyond the original seven firms has pledged its support.

Still, Kane remains optimistic. "Today we have announced an important step for US Memories. I hope IBM's support will encourage those who are considering investing in this project to make a positive commitment to the future of the US semiconductor and electronics industry."

MiniScribe files for bankruptcy

Less than six months after it admitted fudging with sales figures and shipping bricks in boxes marked as disk drives, struggling MiniScribe said it has filed for bankruptcy.

At the time of filing, MiniScribe said it had US$200 million in assets and US$351 million in liabilities. The company has asked the court for protection from creditors to give it a chance to re-establish some order in its desperate financial affairs.

MiniScribe problems surfaced 10 months ago, including the admission that it has been falsifying its financial records for more than three years. At one point the firm shipped out bricks in boxes that were labelled as disk drives, and counted the bricks as shipments to retailers in its profit and loss statement.

Because of the special circumstances involving the fiscal fraud and subsequent damage to the company's reputation, MiniScribe officials said they expect that the firm's creditors will buy the company's assets and form a new company.

IBM stores 1 gigabyte per inch on disk

IBM has announced a breakthrough in magnetic disk technology, with the development of a disk that is able to store up to one gigabyte of information per square inch – enough data to fill 100,000 double-spaced typed pages which, when stacked, would reach more than 30 feet into the air.

If put to use, the new disk capacity would be 9-15 times greater than current state-of-the-art disks.

In an experimental disk drive, IBM showed how the machine was able to read and write data to and from the disk at a rate of 3.5 million bytes per second.

Also, IBM said the error rates with the disk had topped out at 1 per billion bytes, well within industry-accepted limits. The error rate was reduced toby one in 10 trillion when an automatic error correction feature was applied.

The new disks were developed at the company's Almaden Research Laboratory in San Jose.

IBM officials said it would be at least several years before the company would be able to put the new disks to commercial use. The incredible data density on the new disks was achieved by applying a thin coat of a magnetic cobalt alloy to the surface of the aluminium disk.

EASTER SPECIALS

HURRY, WHILE STOCKS LAST!

Walkabout Wadio

Why build yourself an AM radio? Just for the fun of it! This portable radio kit puts the life back into AM reception.

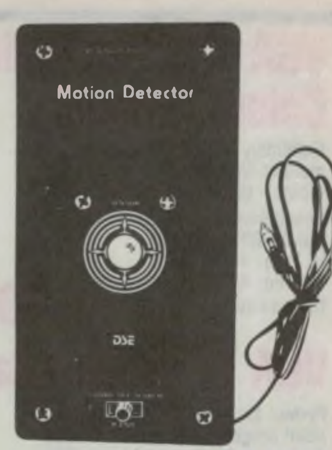
Cat K-2720

SAVE OVER $10!

$14.95

Very Latest IC Technology Optical Motion Detector

Use as part of an alarm or as a door minder, etc. A special optical IC actually detects movement by change in light level. Two modes - 'guide' for sensing movement, and 'search' for beam cutting operation. Self-contained (battery operated).



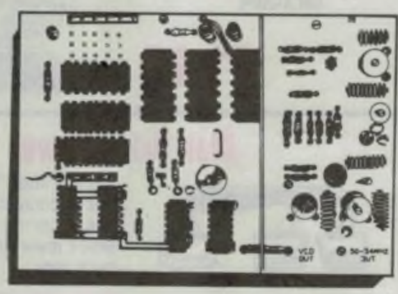
Cat K-2721

SAVE OVER $15!

$24.95

NEW KITS SOON TO BE RELEASED!

Converter For The 144 - 148MHz Band



Here it is - Our first innovative converter module, now making it possible for you to receive the 2m amateur band on a 50-54MHz receiver, and it easily incorporates into our 6m FM receiver (K-6005)! It even lets you monitor the 144-148MHz band -Changing bands is simply a matter of flicking a switch! And talk about saving money!!! The Converter not only saves you the cost of another box (an expensive item nowadays!), but it works out much cheaper than having two separate recievers for each band! Short-form kit with PCB and components.

Cat K-6006

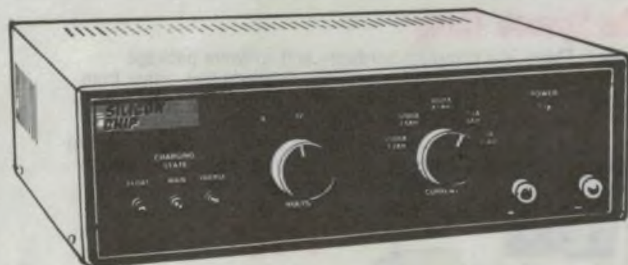
EA March '90

Dual Tracking Power Supply

You'll be suprised at how a unit this compact, can be so amazingly highly-efficient! The new ±50V, 1.5 AMPS Dual-Tracking Power Supply Kit is capable of delivering OVER 130 watts at substantial current, making it useful for testing your amplifiers! You'll even find it handy for very low voltage or modern single cell operated circuits, and quite invaluable for most laboratory applications. Full-form kit, complete with case, transformer, front-panel label and all neccessary components. Top features!

Cat K-3465

SILICON CHIP April '90



The Thinking Man's Battery Charger!

New & clever 6/12 volt SLA (sealed lead acid) battery charger! Apart from having four LED indicators and five switchable charge rates, there's something quite unique about it; it continuously monitors the battery voltage, and then automatically adjusts the charge rate to suit! Unfortunately, most existing battery chargers do not charge a battery at the correct current OR the correct voltage. Furthermore, they continually belt current into the battery, whether it's fully charged or not (doing considerable damage to the batteries & greatly shortening their service life) and don't provide an 'end-of-charge' condition! Our charger however, maintains the battery at a constant float voltage once it has been fully recharged. This means it can remain connected to the battery indefinitely and still keep it in peak condition! Short form kit with all components, hardware and front panel label. Case (H-2812) & Transformer (M-2000) not included.

Cat K-3220

SILICON CHIP March '90

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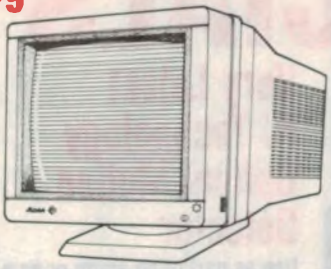
PLEASE CONTACT YOUR NEAREST DICK SMITH ELECTRONICS STORE FOR THE PRICE AND AVAILABILITY.

DICK SMITH ELECTRONICS

VGA Multi-Scanning Colour Monitor



Extremely versitile multi-scanning monitor with analogue and digital inputs - suits CGA, HGC, EGA, VGA.
Resolution: 800 x 600
Band width: 35 MHz
H. Freq: 15-36 KHz
V. Freq: 45-90 Hz
Cat X-2410

$899

VGA Graphics Adaptor

Perfect for AutoCAD, games, text, paint programs, graphics, charts, desktop publishing! Fits any IBM Compatible (XT or AT). Includes utilities for emulation of EGA, Hercules and CGA. With an astounding array of graphics modes! Comes with drivers and manual. 8 Bit Version.
Cat X-2018

$249

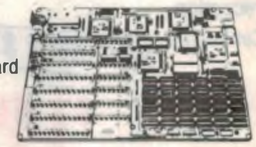
Buy Both For Only $999!
Add $50 for 16 Bit VGA Adaptor.
Cat X-2019

IBM AT Compatible 80286 Motherboard

Building your own computer or upgrading the old one? Our new 12MHz motherboard is the way to go for the ultimate computing power. DRAM not included.

Just take a look...

- Expandable to 1Mb using 256K chips
- Expandable to 4Mb using 1Mb DRAM chips
- Keyboard or hardware selectable 8/12MHz operation
- Six 16-Bit and Two 8-Bit expansion slots
- Selectable for RAM speed - 80 or 100 nanosecond
- Selectable from 0 wait states on read operations (with 80 nanosecond RAM)
- Socketed for 80287 Co-processor
- Performance - 13.7 using Norton S.I.
- Battery backed real time clock on board
- AMI Bios ROM's included
- OK RAM supplied

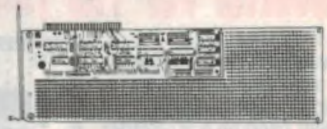


Cat X-1002

$399

XT Prototype Card

A veroboard on an XT compatible expansion card. Complete with interrupt and memory addressing circuits already installed to enable easier construction of more advanced project ideas. With comprehensive manual.
Cat X-2034



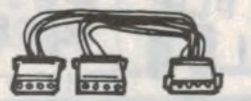
$149

The Speech Thing

'Speech Thing' is a complete hardware and software package which adds sound capability to your PC. Converts text, either from keyboard or ASCII files, to high quality speech. Installation is as easy as plugging Speech Thing into the parallel port - and it doesn't interfere with its operation. Can be used in conjunction with the 'Voice Master' (X-2038) to sample and edit digital sounds.
Cat X-2036

$149

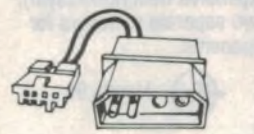
Disk Drive Power Splitter Cable



A great idea! The 'Y' adaptor allows you to connect two disk drive to one power connector. Spilts a 4-line Molex male into two females.
Cat X-2604

$6.95

3.5" Disk Drive Power Adaptor Cable



For IBM PC/XT/AT and Compatible Computers

- Allows connection of standard 3.5" disk drives to the IBM PC/XT/AT or comp. pwr. supplies.

Cat X-2605

$6.95

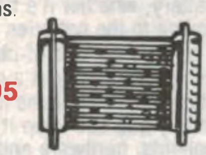
RS232 Loopback Tester

Used for diagnostic testing of RS232 circuits. The tester consists of 4 LED's which monitor lines 2 to 3, 4 to 5, 6 to 20 and 15 to 17. Acts as a data verifier by sending data back to the transmission device. Includes male to female DB25 connectors.
Cat X-2651

$19.95

RS-232 Serial Jumper Box

25 pin male and 25 pin female connectors. With jumper pads and wires which allow permanent soldering for RS-232 connections.
Cat X-3569



$9.95

Floppy IDC Universal Data Cable

A floppy drive data cable which is fitted with both Edge and DIL socket connectors. Facilities the easy fitting of both 5.25" and 3.5" floppy disk drives.
Cat X-2606

$19.95

Disk Notcher

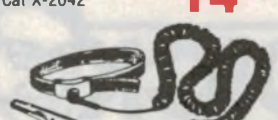
Gives you extra disk space on your Apple II or CAT computer. The disk notching tool allows you to use both sides of a disk in a single sided disk drive. Easy to use.
Cat X-3504

$9.95

Anti Static Wrist Strap

A must for when installing expansion cards or changing memory chips. Stray static charges can destroy chips in an instant. With adjustable fastening, coiled ground lead and high value series resistor for added safety.
Cat X-2042

$14.95



3-Way Switch Boxes

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

$49.95 ea

DICK SMITH ELECTRONICS

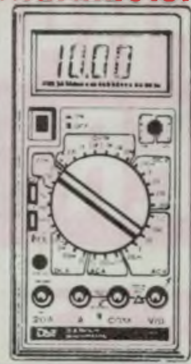
LCD Multimeter Cap/ Transistor Checker

Not just the usual voltage, current and resistance ranges — through it's certainly got those — it also checks capacitors (2 ranges, up to a whopping 20uF) PLUS transistors and diodes. And even more: It's got an audible continuity checker. Plus other features — such as automatic zero of all ranges, high surge voltage protection, automatic overrange indication, high current measurement (10AC & DC) etc, etc — makes this the one about everything with! Looks like you'll have to check it out!

Cat Q-1500

$99 Save $20 Limited Stock

Multimeter with Bargraph & Frequency



Includes Trans, Continuity & Capacitance. A fantastic all rounder for hobbyists, technician and service people alike. Both digital and bargraph displays give you the best of both worlds. Large 30 position rotary dial for function and range selection makes it quick and easy to use.

Cat Q-1526

Just look all these function...

- Automatic overload indication
- High surge voltage protection (1.5KV -3KV)
- Capacitance measurement
- Diode and continuity
- Transistor hFE test
- Frequency measurement
- Has bargraph

$149 Save $30!

Safety Yellow 3.5 Digit with Tr, Diode & Continuity, plus Battery Checking

At last! Someone's got away from basic black or basic grey in a multimeter! This one has all the usual ranges, including current to 10A and resistance to 200 megs, but it also has a continuity checker with a fast 100ms response time, a diode and transistor checker, plus a battery checker — it tests under actual load conditions. It takes a single 9V battery (and tells you if it's low) and comes complete with a flip-down handle that doubles as a stand.

Cat Q-1445

$79.95 Save $5! Limited Stock

3.5 Digit LCD Panel Meter

'Full Scale' of 200mV or 2V (user selectable) and a super high input impedance (100 megaohms) makes adaption to a range of applications very simple. The meter can be self mounted — includes a mounting bezel.

Cat Q-2200

Features:

Single supply rail (9V)
Low supply current (2mA max)
High accuracy (.01% 2 digits)
Auto zeroing and overrange inbuilt
Meter size: 71 x 46 x 21mm

$59.95

Universal Panel Meters

Universal 100uA panel meters that can be easily adapted for just about any situation -Volts, Amps, mA... anything! There's two sizes to choose from so you can match all your equipment.

Small

Dimensions: Scale Area - 55 x 30mm
Overall — 55 x 52mm
Mounting: hold Required — 45mm
Bolt Holes — 38mm square

Cat Q-2045

$16.95

Large

Dimensions:
Scale Area - 96 x 82mm
Mounting:
Hole Required: - 65mm
Bolt Holes - 64mm x 80mm centres

Cat Q-2065

$21.95

Shunt Pack

Designed to suit the above panel meters. Comes with shunt resistors from 1.1 to 1,000,000 ohms, resistance wire and instructions.

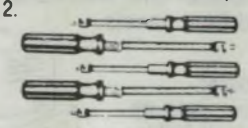
Cat Q-2046

$1.95

Insul-Holding Screwdriver Set

A quality 5-piece screwdriver set which is fully insulated and actually holds the screws. Comes with 3 flat blades — 5 x 150, 4 x 125 and 3 x 125mm, and 2 Phillips heads nos. 1 & 2.

Cat T-4395

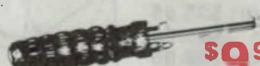


$25.95

5 Bit Screwdriver

Comes with 3 flat blades (1.2 x 6, 6.5 & 7mm) and 2 Phillips heads (nos. 1 & 2). All bits fit neatly in the handle for easy storage and carrying.

Cat T-4500

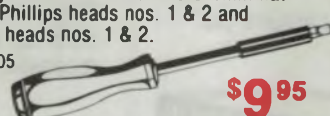


$9.95

Magnetic Screwdriver Set

A fully insulated, screwdriver set with 6 bits and magnetic heads. With 4.5 & 6mm flat blades, Phillips heads nos. 1 & 2 and Pozidriv heads nos. 1 & 2.

Cat T-4505



$9.95

Push-Action Screwdriver Set

Features clockwise, anti-clockwise and fixed direction selection. Comes complete with 6 x 4mm flat heads, nos. 1 & 2 Phillips heads plus hole reamers (2 & 2.8mm). All bits are conveniently stored in the handle.

Cat T-4512

$9.95

T-Bar Magnetic Screwdriver

The T-bar handle. Lets you get plenty of grip. Comes with 6 magnetic bits - 2 Phillips heads. 2 flat blades and 2 Torx bits. Bits are stored in handy plastic holder.

Cat T-4515

$9.95

Screwdriver Bit Set

Includes a ¼" magnetic bit holder, 2 Phillips heads, nos. 1 & 2, 2 flat blades (4.5 & 7mm), and 2 Pozidriv bits, nos. 1 & 2.

Cat T-4518

$3.95

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DICK SMITH ELECTRONICS

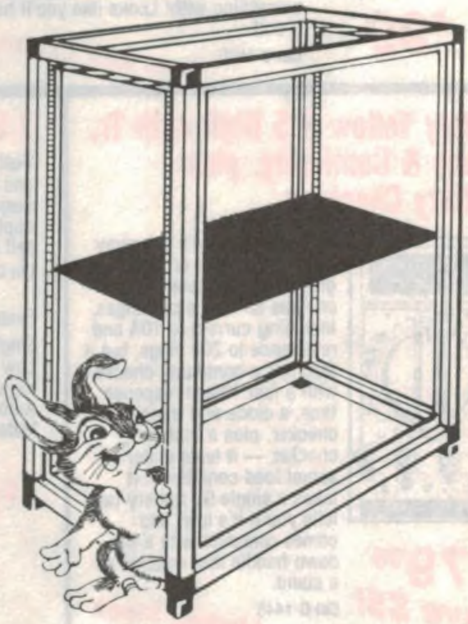
WHO FRAMED THE EASTER BUNNY?

HIGH PERFORMANCE LOW COST

19" Zip Rack 420 Series

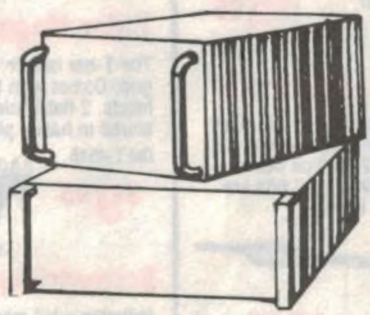
The unique interlocking assembly system using black corner connectors provides a self-aligning, rigid frame. Front and rear face riveting option for extra strength when required. Ready to assemble. 6 rack sizes. Optional covers. Low cost.

RACK CODE	RACK SIZE	HEIGHT O/A	PRICE	COVER SET CODE	COVER SET PRICE
H2380	6U	358MM	**$129**	H2381	**$59**
H2382	12U	625MM	**$139**	H2383	**$69**
H2384	18U	893MM	**$149**	H2385	**$89**
H2386	24U	1158MM	**$179**	H2387	**$119**
H2388	30U	1425MM	**$199**	H2389	**$139**
H2390	40U	1870MM	**$259**	H2391	**$159**



'Horwood' Instrument Cases

Favourites of hobbyists and professionals around the world - Horwood cases feature removable front and rear panels, lids and front-mounted handles to make them look really professional.



Available in many sizes:

H2453	8x4x6"	**$39.95**
H2454	8x4x8"	**$42.95**
H2455	8x4x10"	**$45.95**
H2456	8x4x12"	**$49.95**
H2457	8x4x17"	**$56.00**
H2462	9x3x6"	**$36.95**
H2463	9x3x8"	**$39.95**
H2464	9x3x10"	**$42.95**
H2465	9x3x12"	**$45.95**
H2466	9x3x17"	**$49.95**

K & W Instrument Cases

These sturdy cases are made with aluminium bases, steel top covers with hammer tone finish and recessed, satin finished front panels.

Dimple feet pressed into base:

H2802 150 x 52 x 100mm. **$12.95**

Bolt-on plastic feet (nuts & bolts incl.):

H2804 100 x 77 x 130mm **$13.95**

H2806 200 x 65 x 130mm **$15.95**

Slotted vents in top & end panels.

Bolt-on plastic feet (nuts & bolts incl.):

H2808 255 x 77 x 155mm **$18.95**

H2810 255 x 150 x 155mm **$25.95**

H2812 305 x 90 x 200mm **$25.95**

H2814 305 x 200 x 165mm **$29.95**

DICK SMITH ELECTRONICS

The Serviceman

The VCR that would only receive snow, snow and more snow!

Over the last couple of months I have been struggling to track down and fix a very elusive fault in a video cassette machine. The job would have been one heck of a lot easier and faster if the manufacturer's circuit diagrams and manuals had been rather more helpful.

When I started writing up this story, I didn't know if it was ever going to make it to press. The problem at that stage was that I hadn't cured the fault yet, and in fact wondered if I was even likely to do so. But if I hadn't started typing then, I would probably have forgotten the details, and might not have been able to write the story now. *(Ed: Please spare us those wailing violins!)*

The story concerns a Sanyo model VTC 5300 Beta video recorder. It came to me with three faults – noisy picture on replay, broken front panel control buttons, and the inability to tune any channel for off-air recording.

The first problem was simply dirty video heads, and this was easily cured. The second problem required a bit of ingenuity, but was also eventually solved. (More on this one later!)

It was the third problem that had me stymied – and for quite a while. The machine would not record off air, nor would it display the usual 'E to E' programme normally seen when a recorder is in the standby mode.

Naturally, I tried all the tuning presets, but could get no sign of signals on screen. The only response was a change in the pattern of snow as I pressed different programme buttons.

My first thought was that the input amplifier was shot. This usually generates a snowy picture, but in this case there was *only* snow. So I tried injecting the signal straight into the tuner, bypassing the normal input. It made no difference.

From here on I could do nothing without the service manual, so I opened up to the circuit diagram of the tuner/IF strip. At first glance it looked like a very simple system, but then I realised that there were no voltages given anywhere on the circuit. Even the main DC input was shown as 'Reg'. Not 'Reg 12V' but just 'Reg'!

At the tuner end of the circuit, the input voltages are shown as VB, UB and TU. One is left to guess what the voltages might be. They could be anything from 5 to 50V, but the diagram gives no clue.

Then to make matters worse, there's a serious omission on the main B+ rail. The B+ enters the module at socket S6003, pin 2 and goes only to R6026 at the feed to IC Q6006 and R6011, feeding the RF AGC rail. According to the diagram, the IF transistor and IC, and the two video amplifier transistors do not have any connection at all to the B+ rail.

I presume that the drawing should have had a dot at the intersection of the input from S6003 and the line connecting the collectors of Q6003 and 6004, with R6003 feeding the IF transistor. (I still like the old fashioned 'croquet hoop' crossovers! At least there was no confusion then about whether a line joined or didn't join.)

At the tuner, I found VB and UB were about 11.5 volts and TU was about 33V. These figures agree closely with those found in normal TV tuners, so it seemed reasonable to assume that the tuner was OK and should be working.

At Q6001, the first IF amplifier, the collector was at about 8V, the base at 1.6V and the emitter at about 1V. Again, these all seemed to be reasonable so I moved on to Q6005, the IF chip.

The only voltages there that made any sense were on pin 11, the main Vcc input at 11.8V, and pin 13, ground. The 11.8V looked to be correct because, assuming a junction dot on the circuit diagram, it was connected directly to the 12V input at S6003/2.

The various circuit elements shown as blocks within the IC symbol gave no clue as to what the associated pin voltages might be.

From this point on the service manual gave me no help at all. I was on my own, and would have to work out the problem in my own way. And my own way was to go back to the early days of radio servicing and use a signal tracer/-generator to follow the signal path throught the set.

I've mentioned my TV signal tracer in these pages before. It consists of a small portable TV, with access from its tuner and to its IF strip. And it certainly proved its worth in this exercise, because it showed that the tuner in the recorder was working perfectly, as was the first IF amplifier – Q6001.

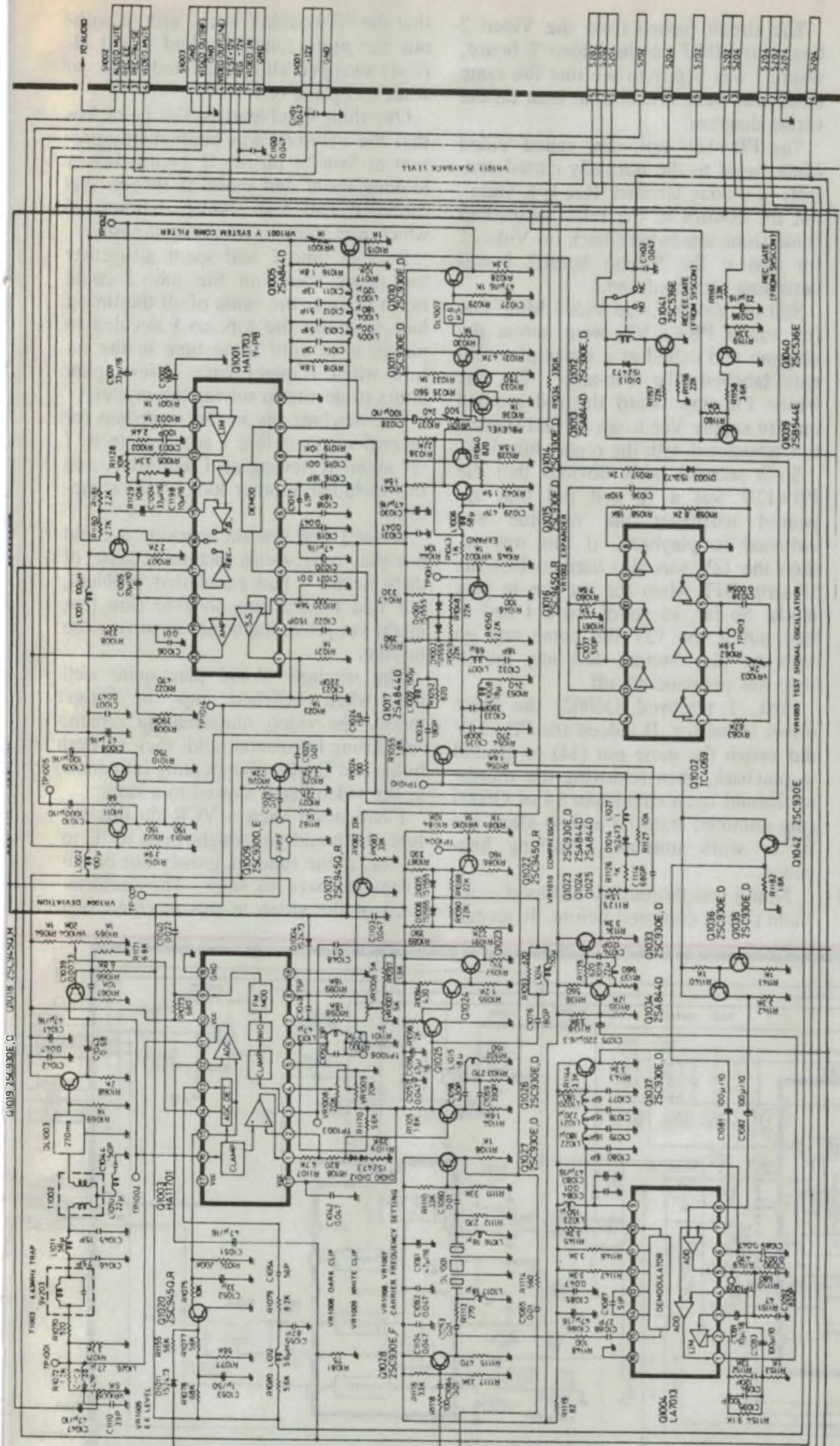
The input to the ceramic SAW (surface acoustic wave) filter F6001 was normal and its output was of perfect quality, although down in level. This is what I would have expected from an SAW filter, a loss of between 10 and 20dB. The filter shapes the IF bandpass, but introduces a fairly heavy loss into the circuit.

So far so good, but here the signals disappeared. Or not so much disappeared as simply vanished, if you can see what I mean. From here on everything happened inside the IC and was totally inaccessible. If all was well, I should have found demodulated video on pin 12, but even without checking I knew that I'd find nothing. And nothing is just what I found.

To make sure that the IF was truly dead, I fed signal from my TV tuner to the input of the chip. It was just as before – not the slightest sign of an output. For some reason the chip was not processing the IF being presented to it. I had two avenues of approach, and I decided to take them both.

I called on a colleague who had long experience with Sanyo VCR's and asked him if he had (1) a spare IF board that I might borrow for substitution tests, and (2) a copy of the training manual for the particular model. I was almost lucky on both counts.

He didn't have an exact IF board to lend me, but he did have a board from a slightly later model which used much the same parts in a more compact arrangement. It had all the right transis-



Part of the Sanyo VCR's 'Video 2' board schematic.

Record/play video switching takes place inside Q1001.

tors, IC's and filters and with any more luck it would provide all the substitute parts I would need to check out the set in my workshop.

The training manual, or circuit description as some manufacturers call it, turned out to be the 'Basic Manual' in Sanyoese. (I suppose life would be too easy if everybody called everything by uniform names!) But by whatever name, it turned out to be exactly what I needed.

In the description of the tuner and IF section, I learned that the sound and video are muted in the IF chip whenever the recorder is set to 'Play'. This is so that off-air video will not interfere with replay video. In all other modes the IF is open and should present E to E video to the RF output modulator.

So that was it! In this set, the IF chip was permanently muted – and my job was to find out why.

To open the proceedings, I tried substituting parts from the borrowed IF board. First the ceramic filter, then the IC found their way onto the faulty board. Both behaved exactly as the original parts had done, so I assumed that the fault lay elsewhere. (I was prepared to change my mind later, but for the moment I assumed that substitute parts were all serviceable.)

The basic manual does not explain the muting circuit in detail but merely notes that 'a voltage forcibly applied to pin 14 of Q6005' is used to mute the IF system. Then from the circuit diagram I found that pin 14 went to the collector of Q6002. The emitter of this transistor was grounded and the base went off to pin 1 of socket S6002.

Now, unless I am quite mistaken, any voltage 'forcibly applied to pin 14 of Q6005' must be applied from within the IC. It couldn't be applied through the base of Q6002, and the emitter is grounded! In fact, Q6002 seems to be only a switch, to ground pin 14 whenever a voltage appears on its base. And its base is driven by a signal appearing on pin 1 of socket S6002.

Pin 1 on S6002 is shown simply as 'Play', with no indication as to where it goes to (or comes from!). To find out, I had to turn back to the main wiring diagram at the front of the book.

This showed S6002 linked to S1201 on the 'Syscon, Video 2' board. This seemed reasonable because the playback switch should logically be on the System control board. But it wasn't!

The 'Syscon, Video 2' board is presented in two parts, on two different pages in the manual and S1201 is in fact on the Video 2 part of the diagram. So

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we unfolded another long, long page and eventually found S1201 in the top right hand corner.

Unfortunately, the labels applied to each connector had been changed. S6002/1 on the IF board was shown as 'PLAY', while the label on S1201/1 was 'PB+12V'. I could only assume that these were opposite ends of the same lead, but the diagrams were not at all convincing.

My next task was to track down the source of this PB+12V, and this proved to be a major undertaking. The lead goes to many places on the Video 2 board, including one of three electronic switches in Q1203, the emitters or collectors of half a dozen or more transistors, and finally clear across the board to exit on S204/4.

Again, there was no indication of where S204 led to, so it was back to the wiring diagram at the front of the book. This proved even more confusing because there was no S204 shown on the Syscon, Video 2 board. To shorten a story that was becoming longer and more confusing by the minute, I eventually worked out that S204 was a set of labelled but unnumbered contacts at the top of the diagram.

The labels were 'Audio Mute', 'Rec E E', 'Rec Pause' and 'Video Mute'. These labels tied in with the circuitry I was chasing, but I was amazed at how many different labels could be attached to a single circuit!

The circuit passed from the Video 2 board to S1002 on the Video 1 board, where I was happy to see that the same labels had been retained, at least on the wiring diagram.

The PB+12V rail, now called Video Mute, went to the normally closed contacts of a relay labelled 'Rec E E Gate', but the control of the relay seemed to come from somewhere back on Video 2 (or was it the Syscon board? I was becoming very confused.)

Still on Video 1, the Video Mute line (or was it PB+12V?) went across the diagram and exited at a series of terminals labelled 'To Pre-amp'. On the Video Pre-amp board the rail seemed only to supply Vcc to an IC and transistors associated with the replay function.

So it seemed fairly obvious that the PB+12V was a 12 volt rail that appeared whenever the machine was switched to playback. If this was so, then the 12V was also used to bias the IF strip OFF when the set was in play mode. So far, so good!. Now I had to find out if the 12V did come and go with the play button, and why the IF strip was permanently off.

First, I removed Q6002, the mute driver transistor. If indeed the PB+12V did switch the mute pin (14) to ground in playback, then removing the transistor should open circuit pin 14 of Q6005 (the unmuted state!?!) and so allow the IF to work normally. Nothing happened.

Now I was thoroughly confused – if I hadn't been confused before. It seemed that the IF wouldn't work, with or without the mute function. And I had already swapped all the affected parts, so what was going on?

One thing I did learn at this point was that the PB+12V was permanently present at S6002/1 on the IF board. It was looking more and more as though this recorder had two faults, neither of which was going to reveal itself easily.

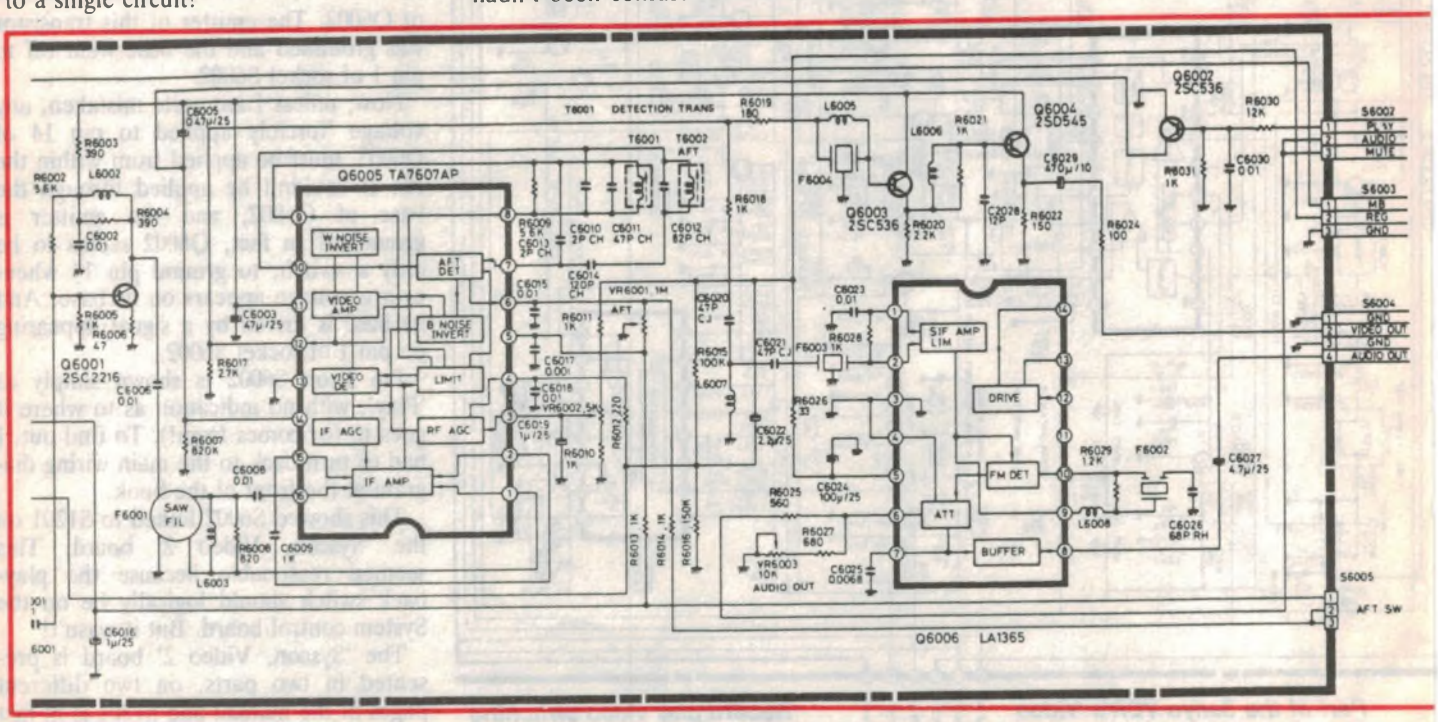
By this time I had spent altogether too many hours on the job. I could never recover the value of all the time I had spent on the job, so I decided to put it aside until some time in the future when I might have a few spare hours to devote to solving the mystery.

The machine lay in the workshop for several weeks before I got back to it. I set about reviewing all I had done, and this included another look at the symptoms.

When I first saw the machine it could not play a viewable picture because of dirty heads. I had cured that problem, but had missed one possible clue that might yet prove important in solving the mystery.

The machine would play quite well but, when switched into the 'Stop' mode, the video remained on screen, first losing horizontal hold, then vertical hold, and finally disappearing into snow as the video heads slowed to a stop.

I had never seen a VCR do this before. It should go straight back to 'E to E', or, if the tuner is grossly out of adjustment, back to snow. The performance of the video in this machine sug-



The schematic for the Sanyo VCR's IF strip. It turned out to be perfectly OK!

gested that not only was the IF permanently muted, but also that the video channel was permanently locked in the Playback mode. With any luck that could point me in the right direction, as both symptoms might even originate from the one fault.

I turned back to the circuit diagrams and began to trace out the video path, first from the IF board and then from the playback preamp. Both sources eventually arrived at IC Q1001 on the Video 2 board. What's more, they met in the IC at an electronic switch, the output of which went to the video line out terminal and the RF modulator.

On the IC block diagram there was no indication as to how the switch was toggled, but then I noticed that pin 8, although shown with no internal connection, was in fact connected via a 10k resistor to the PB+12V rail. This had to be the control point for the switch, and if I could prove that voltage on this pin came and went with the play mode, then I'd be half way to solving the problem.

Unfortunately, other work had been piling up while all this investigating had been going on, and now I had a string of customers demanding my immediate attention. At this point my story had to go into 'pause' mode again. I wasn't too sure if I was ever going to find the answer. It was going to be a case of 'waiting and seeing'.

(This story has been written in bits and pieces during the several months the job took to complete, so it does seem a little disjointed on re-reading. But this is as nothing compared with the disjointed train of thought I suffered during the exercise!)

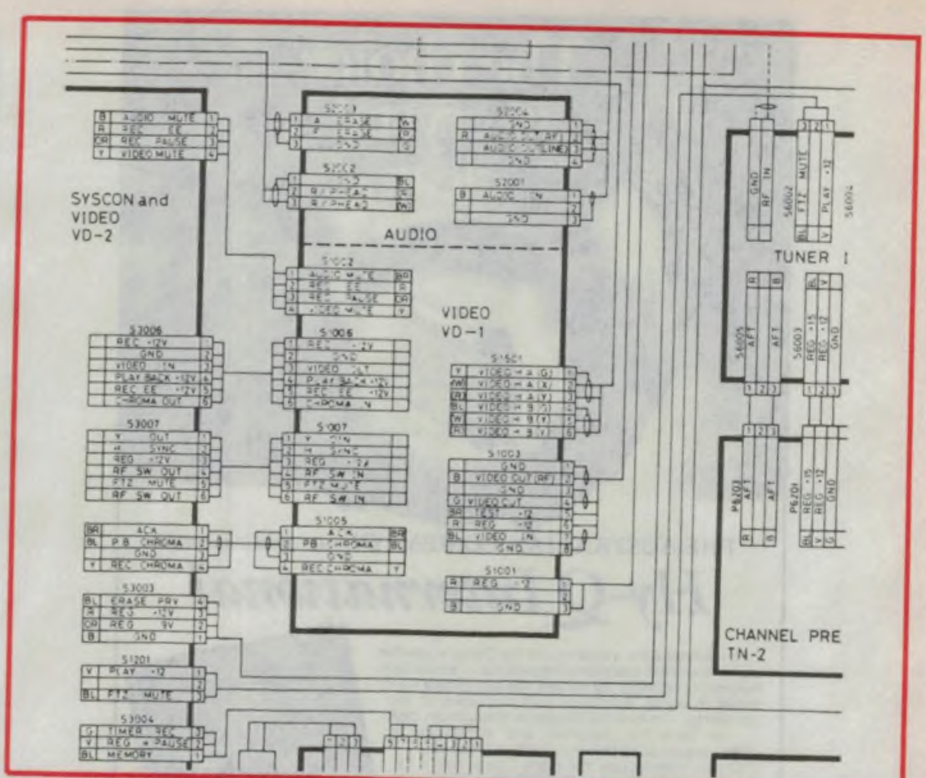
Final session

I took the service manuals home with me and every night, after tea, I spent half an hour or so poring over the drawings trying to sort out the practicalities of the system.

By the time I got back onto this job, I had decided on a course of action. First I had to check the voltage at pin 8 of Q1001, the assumed toggle voltage for the video switch. Then if this voltage was permanent (i.e., switch fixed in the playback position) then I would check RL1, the relay mentioned earlier in this story.

I had reasoned that the relay must be the source of the PB+12V and if this had stuck in the NC position, or if the coil was open which amounted to the same thing, then it could explain all the symptoms that I was seeing.

There was another possibility which didn't bear thinking about. It could



Part of the VCR's system block diagram, which is intended to show how the various boards connect together.

have been that the relay drive from the microprocessor might have been faulty.

I settled for first things first and began to work back from the video switch in Q1001.

The voltage on pin 8 was 1.8V and this remained fixed, in both play and record modes. So much for that! Next I tackled the relay. It was a tiny thing, not much bigger than an eight-pin IC, but I was able to remove it and to check continuity through the coil and between each of the switch contacts.

While the relay was out of circuit, I turned the machine on and got an immediate response from the monitor. Admittedly, the picture wasn't very good, but it was an off-air image, and responded to changing channels just as it should do.

Having decided that the relay was probably not the cause of the trouble, I looked next at the relay driver, Q1041 – the 'Rec E E Gate' mentioned earlier. At first test the transistor appeared to be OK, but something about its response puzzled me. So I decided to test it out of circuit.

I unsoldered the transistor then lifted the board to remove it from the component side. And as I glanced at the transistor, I saw the cause of all of my troubles.

Lying across the circuit board, from one edge toward the relay, was a white, powdery mark; a stream of some dried substance that certainly didn't belong. What's more, where it had flowed around the leads connecting two of the resistors it had set up a powdery black corrosion on the wires. One of these was so badly corroded that the resistor was no longer in circuit.

In what I hoped would be the last-ever reference to the circuit diagrams, I found that the damaged resistor was R1157, a 22k 1/4W unit feeding the base of Q1041, the 'Rec E E Gate'!

I replaced the resistor, then fired the machine up for a test run. It was perfect! The faulty off-air pix seen earlier when the relay was out of circuit was now totally cleaned up. I can't work out why this is so, because earlier I had removed Q6002 which did more or less the same thing.

It took a long time to solve that one. Several times I almost gave the job away. An old Beta machine is probably not worth more than $100 and I spent much more than that value in time on this one. (*Those damn violins again – Ed!*)

Yet another problem showed up when I had the set working again. I didn't have a Beta tape to test record on! I do have a good pre-recorded test tape, but I'm not keen to record over that. So I had to go out and buy a Beta tape, something I hadn't been guilty of up to now.

This has been a useful exercise because it has taught me a lot about video recorder service. I have never been too

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deeply involved with videos, considering that there are others better qualified to tackle the work. I was happy to stick with TV and audio, but circumstances are propelling me toward more video service, so practise on an old machine like this is really quite valuable.

At the head of this article, I mentioned that one of the faults on this machine was broken front panel buttons. Specifically, the REW, PLAY and FWD buttons had broken away from the panel and had fallen down inside the machine.

When I removed the panel, I found that the buttons had broken away from the moulding which had carried all six control buttons. At first, there seemed to be no way to repair the panel without replacing the whole six-button moulding.

Then I had an idea. First, I placed the buttons into their correct positions, then working from the back of the panel, I used a fine soldering iron to melt the plastic and force a thin, flexible wire into the mixture. The wire replaces the original plastic hinge and the repair works like a charm.

The buttons are not quite in perfect alignment, but they *are* firmly held in place and they perform their functions smoothly and reliably. It's much better than having to poke the microswitches with a pencil – the only mode of operation that was available before I came along.

That's all for this month. I'm back to the bench for the present, to earn a little of the money I lost on that VCR!

Fault of the Month

Philips K9 chassis

SYMPTOM: Height reduced to only 25mm (1") or so at the centre of the screen. The picture is visible, but is grossly distorted in the vertical direction.

CURE: C547 (100uF 25V electro) dried out. This capacitor couples the vertical oscillator (in U335 on the small signals board) to the vertical output stages on the large signals board. Its failure reduces the drive to the vertical output stage.

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.

Construction Project:

An easy to build digital Amphometer

OK, so you've probably never even heard of an Amphometer, let alone know what it does. But read on – as soon as you find out, and discover how elegantly this one works, you may well want to build one. It can be used for a variety of jobs, both big and small...

by JIM ROWE

Have we got your attention? Good. But don't feel bad about not knowing what an Amphometer is and does; most people are probably in the same boat. We didn't know ourselves, until only a few weeks ago.

Alright, let's keep you in suspense no longer. If you look up the Macquarie Dictionary, you'll find that an Amphometer is 'a device for estimating the speed with which a vehicle covers a specified distance'. In other words, it's a meter to measure the speed of vehicles.

Goodness knows where the name came from, although it just *might* have been a contraction of 'a MPH-o-meter', back in the distant days of miles-per-hour. That's our theory, anyway.

Police radars are presumably *one* kind of amphometer, although the name is apparently used mainly for devices which directly sense the time taken for a vehicle to move a known distance, between two sensor tapes or light beams.

Police in several states still use this latter kind of device to apprehend speedsters, because they are reliable, cheaper than radar, virtually undetectable and perhaps not quite so subject to challenge as radar readings.

The amphometer project described here is intended for use in motor sports, for measuring the speed of vehicles on racetracks or rally routes for example. However it can also be used with different sensors to measure the speed of radio-controlled model cars, boats, slot cars or even model trains.

A word of warning, though: we strongly recommend that you *don't* use it to check vehicle speeds on a public road. The various Road and Traffic authorities would probably not approve of this, and it's unlikely that the Police would warm to the idea either. So please use it only on PRIVATE roads, racing tracks and rally courses!

For measuring the speed of normal

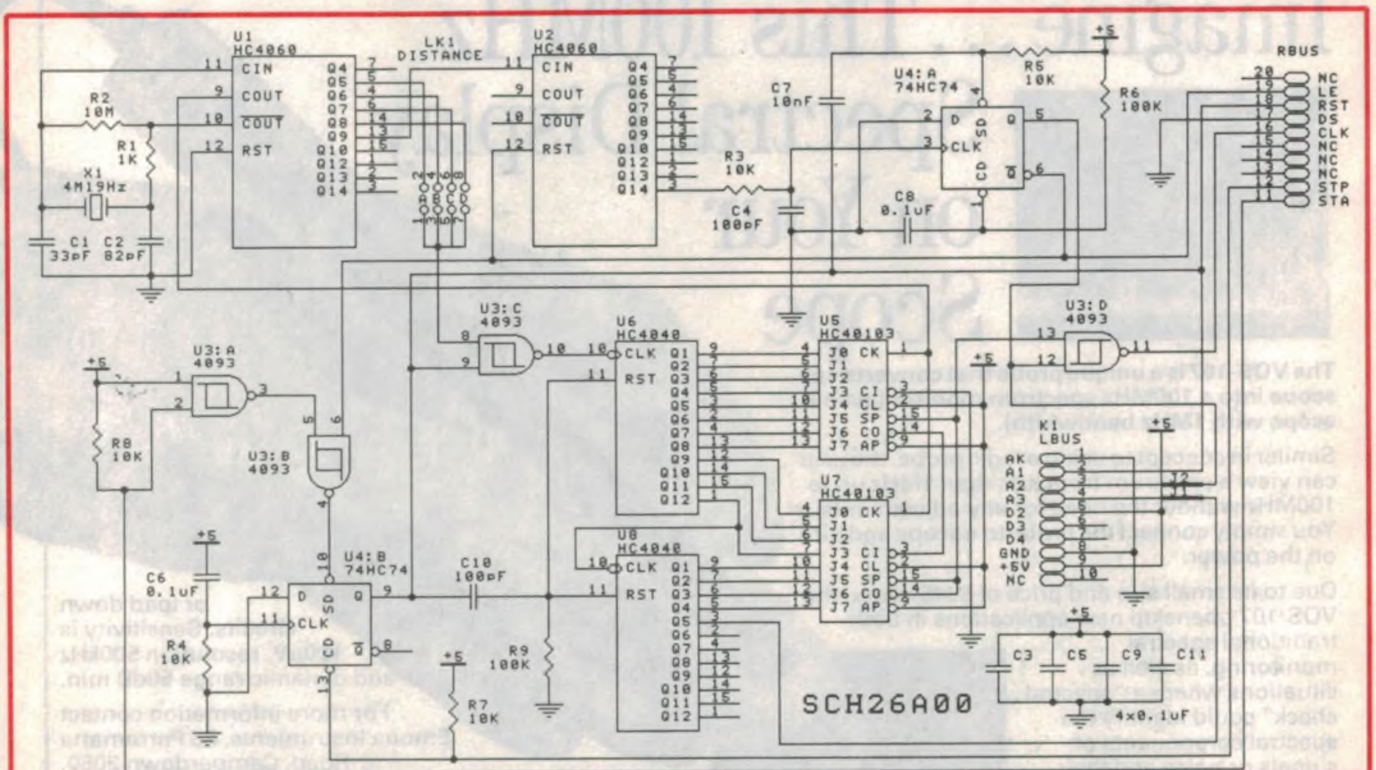


Fig.2: The schematic for the 'calculator board' circuitry, which converts transit time to frequency.

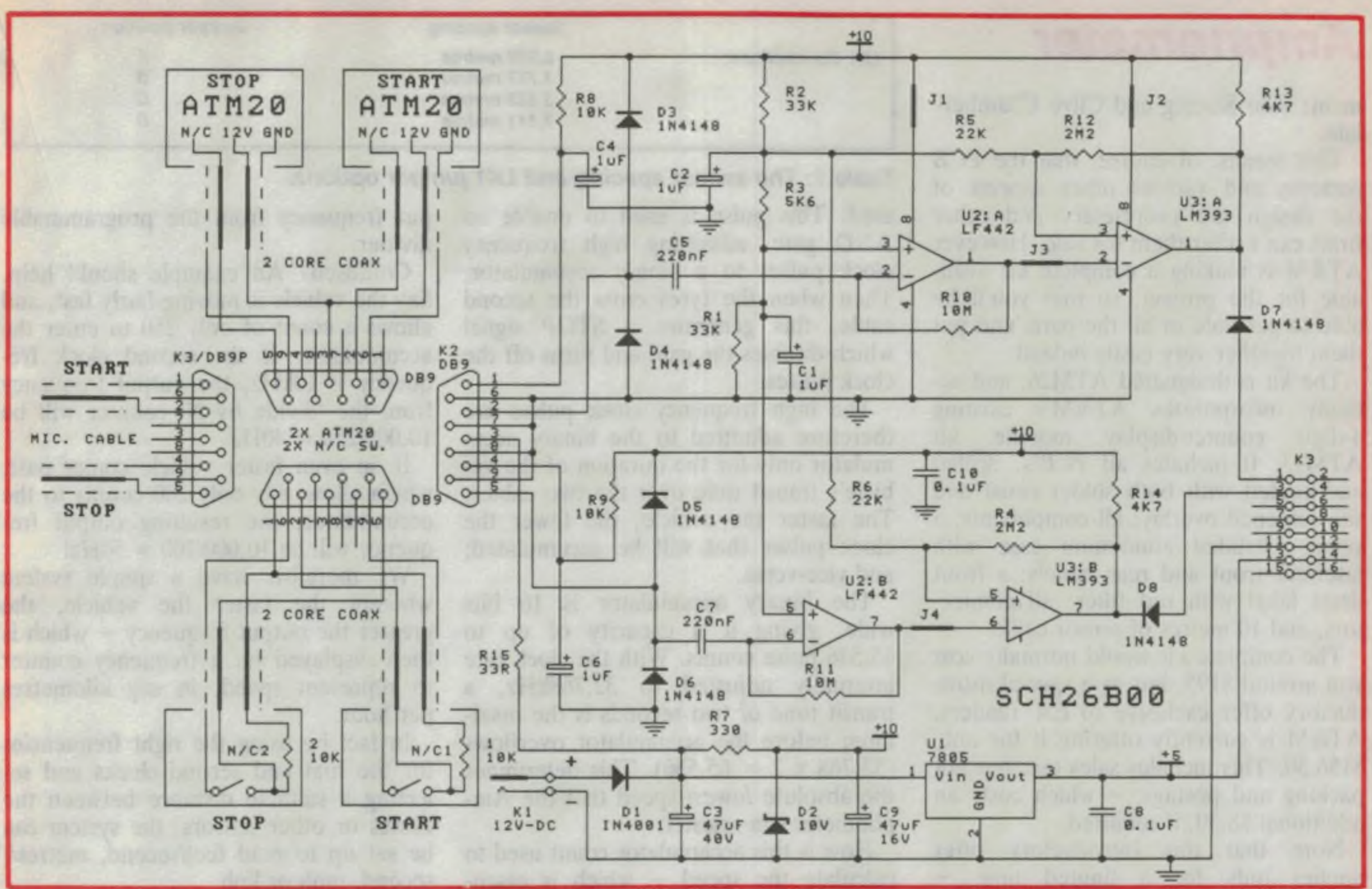


Fig.1: The schematic for the input sensing, conditioning and power supply circuitry.

full-size vehicles such as racing cars and bikes, two cables are firstly taped to the road or track exactly perpendicular to the vehicle's path. The distance between the cables is a constant in the mathematical calculations, and must be accurately measured out for meaningful results. In special applications involving say runners or slot cars, switches or light beam sensors can be used as detectors in place of the cables.

With the cables, the wheels of the vehicle exert pressure on each cable as they pass over it. This is used to generate electrical pulses, in a very simple and elegant fashion – explained shortly. Essentially what the Amphometer does is measure the time which elapses between the pulse produced by the first sensor, when the vehicle's front wheels pass over it, and the pulse produced when they pass over the second sensor.

Since speed is 'distance moved' divided by 'time taken', and we know the distance between the sensors, this allows us to work out the speed. Or more accurately, the Amphometer does this for us – giving a readout directly in kph, or metres per second, or millimetres per day (snail races?), or whatever you wish.

"Wait a minute", we hear you ask, "how can the meter indicate the speed in kph, or whatever, when it's only measuring the elapsed *time*? To measure speed, it would have to work out the reciprocal of the time, or divide it into a constant!"

Quite right, too – and that's exactly what it does. And very elegantly, if we may say so. But before we explain just how it performs this nifty little trick, a brief word from our sponsor.

We cannot tell a lie; the design of this intriguing little project is not due to our own honest labours. All credit is due to those creative folks at the R&D department of Australian Test and Measurement: Ron Koenig and Clive Chamberlain.

This means, of course, that the PCB patterns and various other aspects of the design are proprietary and other firms can't offer them for sale. However AT&M is making a complete kit available for the project, so that you'll be able to get hold of all the parts and put them together very easily indeed.

The kit is designated ATM26, and actually incorporates AT&M's existing 4-digit counter/display module kit ATM13. It includes all PCB's, drilled and coated with both solder resist and silk screened overlay; all components; a smart extruded aluminium case with laser-cut front and rear panels; a front dress label with red filter; all connectors, and 10 metres of sensor cable.

The complete kit would normally cost you around $195, but as a special introductory offer exclusive to *EA* readers, AT&M is currently offering it for only $156.50. This includes sales tax, but not packing and postage – which costs an additional $8.50, if required.

Note that this introductory offer applies only for a limited time – AT&M reserves the right to increase the price after a reasonable period.

How it works

Let's return to the two sensing cables, taped down to the roadway. When the front wheels of our vehicle pass over the first cable, a START pulse is generated. This pulse is used to enable an AND gate, admitting high frequency clock pulses to a binary accumulator. Then when the tyres cross the second cable, this generates a STOP signal which disables the gate and turns off the clock pulses.

The high frequency clock pulses are therefore admitted to the binary accumulator only for the duration of the vehicle's transit time over the two cables. The faster the vehicle, the fewer the clock pulses that will be accumulated; and vice-versa.

The binary accumulator is 16 bits wide, giving it a capacity of up to 65,536 pulse counts. With the clock rate internally adjusted to 32.768kHz, a transit time of two seconds is the maximum before the accumulator overflows (32,768 x 2 = 65,536). This determines the absolute *lowest* speed that the Amphometer can register.

How is this accumulator count used to calculate the speed – which is essentially its reciprocal? Basically by using it to load a programmable 'divide by N' counter, to which a second high frequency clock is applied. This means that the first accumulator count is used as the division factor for the second clock frequency, so that the higher the accumulator count, the lower the final output frequency from the programmable divider.

Confused? An example should help. Say the vehicle is moving fairly fast, and allows a count of only 250 to enter the accumulator. If the second clock frequency is 10kHz, the output frequency from the 'divide by N' counter will be 10,000/250 = 40Hz.

If an even faster vehicle comes past, which allows say only 200 counts to the accumulator, the resulting output frequency will be 10,000/200 = 50Hz!

We therefore have a simple system wherein the faster the vehicle, the greater the output frequency – which is then displayed on a frequency counter to represent speed, in say kilometres per hour.

In fact by using the right frequencies for the first and second clocks and selecting a suitable distance between the cables or other sensors, the system can be set up to read feet/second, metres/-second, mph or kph.

For convenience, repeatability and accuracy, both the first and second clock frequencies of our Amphometer are derived from a crystal controlled oscillator, followed by a binary divider so the two frequencies will always be related by powers of 2. For this project the designers chose a crystal frequency of

	Sensor spacing	Jumper position
LK1 Connections:	0.888 metres	A
	1.777 metres	B
	3.555 metres	C
	7.111 metres	D

Table 1: The sensor spacing and LK1 jumper options.

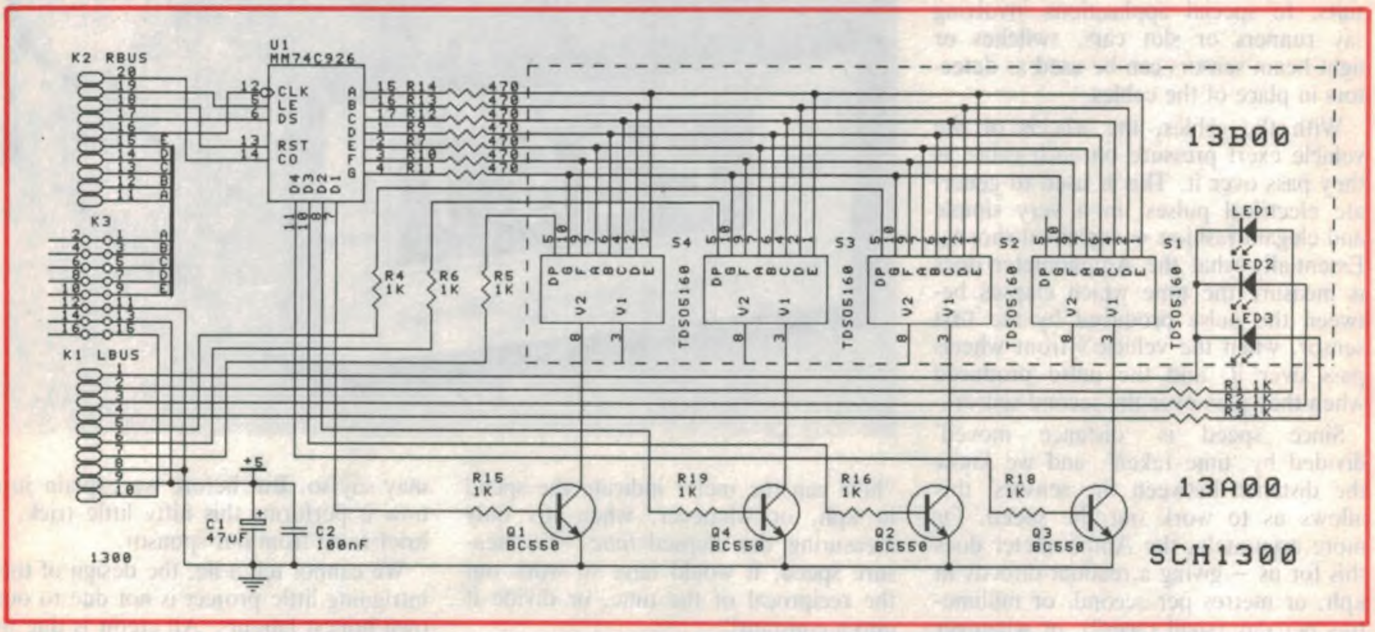
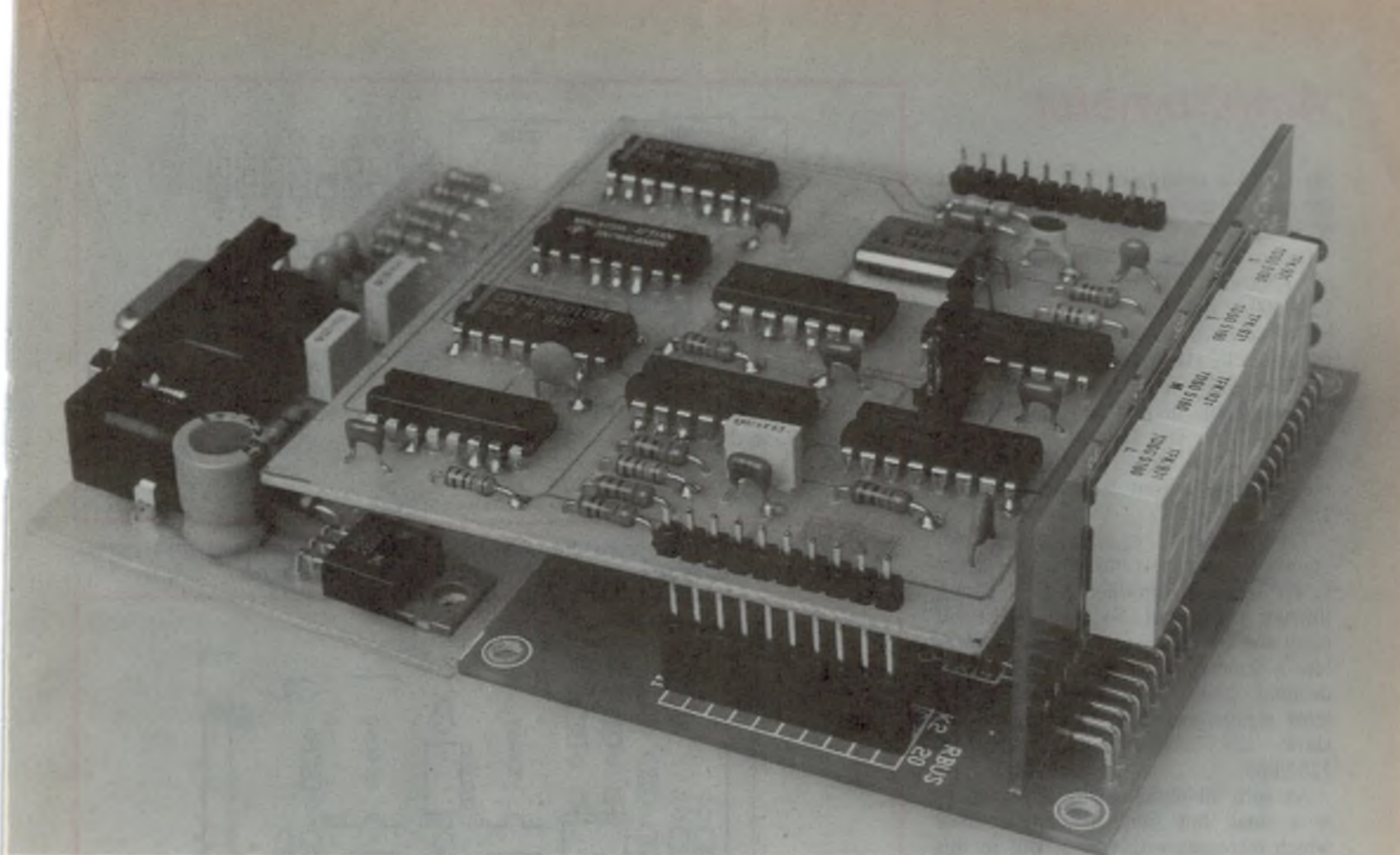


Fig.3: The schematic for the ATM13 frequency counter module, which forms the display section of this project. The section in the dashed box fits on the vertical PCB.



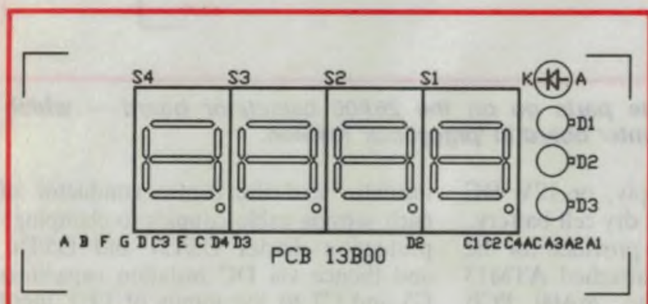
Here's how the various PC boards fit together, to make a very compact assembly.

4.194304MHz, because it conveniently divides down to 0.5Hz – after 23 bits of binary division (1/8,393,604). This 0.5Hz is pressed into service to control the final frequency counter section of the instrument.

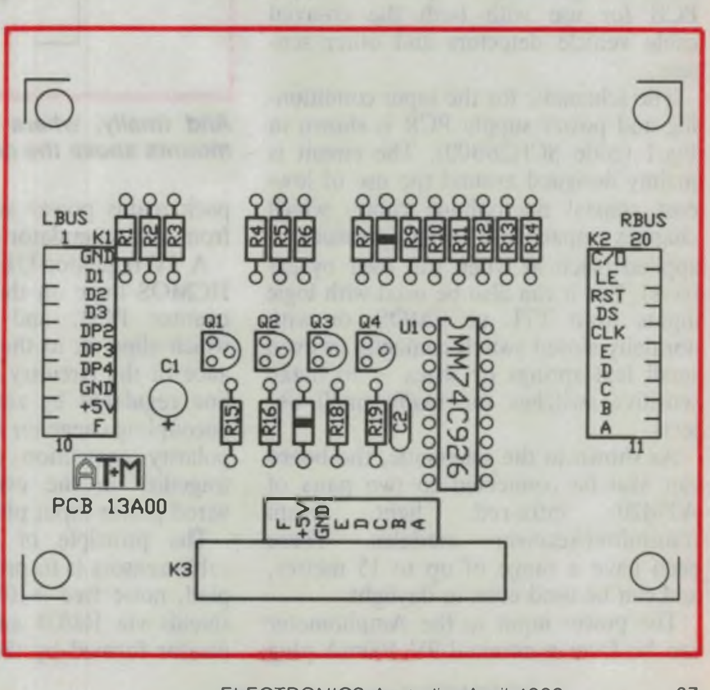
Although the full binary divider totals 23 bits, a number of intermediate frequencies are picked off to provide a choice of clock frequencies for the initial gating function. These frequencies are 131.072kHz, 65.536kHz, 32.768kHz and 16.384kHz, which as you can see are all multiples of 2.

Having a choice of frequencies means that there will also be a corresponding choice of cable or sensor spacings – because doubling the frequency will halve the cable spacing for a given speed calibration, and vice-versa. This enables the unit to be used with sensor spacings of less than one metre, for model cars etc., and out to over seven metres for full-sized cars and bikes.

As a specific example, consider the case where the first clock (gated by the vehicle) as set to 16.384kHz, the cables



Above: The parts location diagram for the 13B00 display board, which mounts vertically at the front.



Right: Where the parts go on its companion 13A00 frequency counter board. The 13B00 board mounts along the top edge, via 90° pin strips.

Amphometer

are set to a spacing of 7.11 metres and the second clock fed to the 'divide by N' is set to 4.194304MHz.

If a car crosses the cables at a speed of 128kph, or 35.55m/s (1,000M x 128/3600s), the time to move 7.11m will be 0.2 seconds, or 200ms. This will gate the 16.3846kHz first clock to leave a count of 3276 in the accumulator. The programmable divider will therefore divide by 3276, and since it is being fed by the second clock at 4.194304MHz, the resulting output frequency will be 1280Hz.

This frequency is sent to the frequency counter section, which uses the 0.5Hz signal to produce a final gating time of 1.0 second. So 1280 pulses will enter the counter – and as the counter has a four digit display with a fixed decimal point positioned before the least significant digit, the display will show '128.0', to be interpreted as 128.0kph.

As with all digital instruments, there is a small but finite resolution error which increases with speed. But in this case the readings are still within 1% to over 600kph, which should be accurate enough for almost everyone!

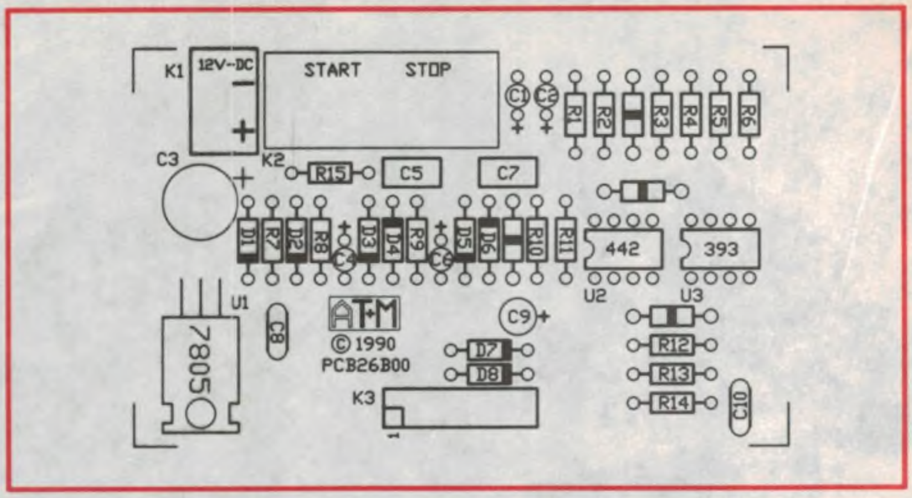
The circuit

Getting down to specifics, the Amphometer is based on a standard ATM13 four-digit LED general purpose counter module, to which has been added a custom designed clip-on speed calculator PCB and a special input conditioning amplifier/power supply PCB for use with both the co-axial cable vehicle detectors and other sensors.

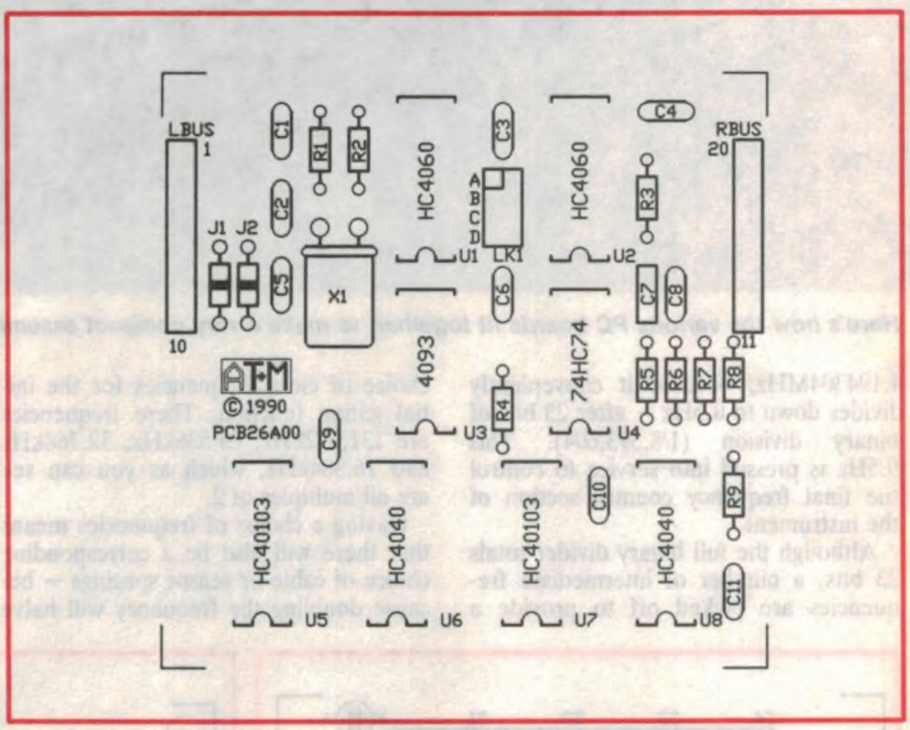
The schematic for the input conditioning and power supply PCB is shown in Fig.1 (code SCH26B00). The circuit is mainly designed around the use of low-cost coaxial microphone cable, which changes capacitance when pressure is applied (such as when run over by car tyres). But it can also be used with logic inputs from TTL or CMOS; or with normally closed switch contacts, or even small leaf springs or wires – to make sensitive switches for *really* small objects.

As shown in the schematic, the board can also be connected to two pairs of ATM20 infra-red light beam transmitter/receiver modules. These each have a range of up to 15 metres, and can be used even in daylight.

The power input to the Amphometer can be from a nominal 9V 100mA plug pack mains power supply, or 12V DC from an accumulator or dry cell battery.



The parts location diagram for the 26B00 input conditioning and power supply board, which attaches to the rear of the counter board.

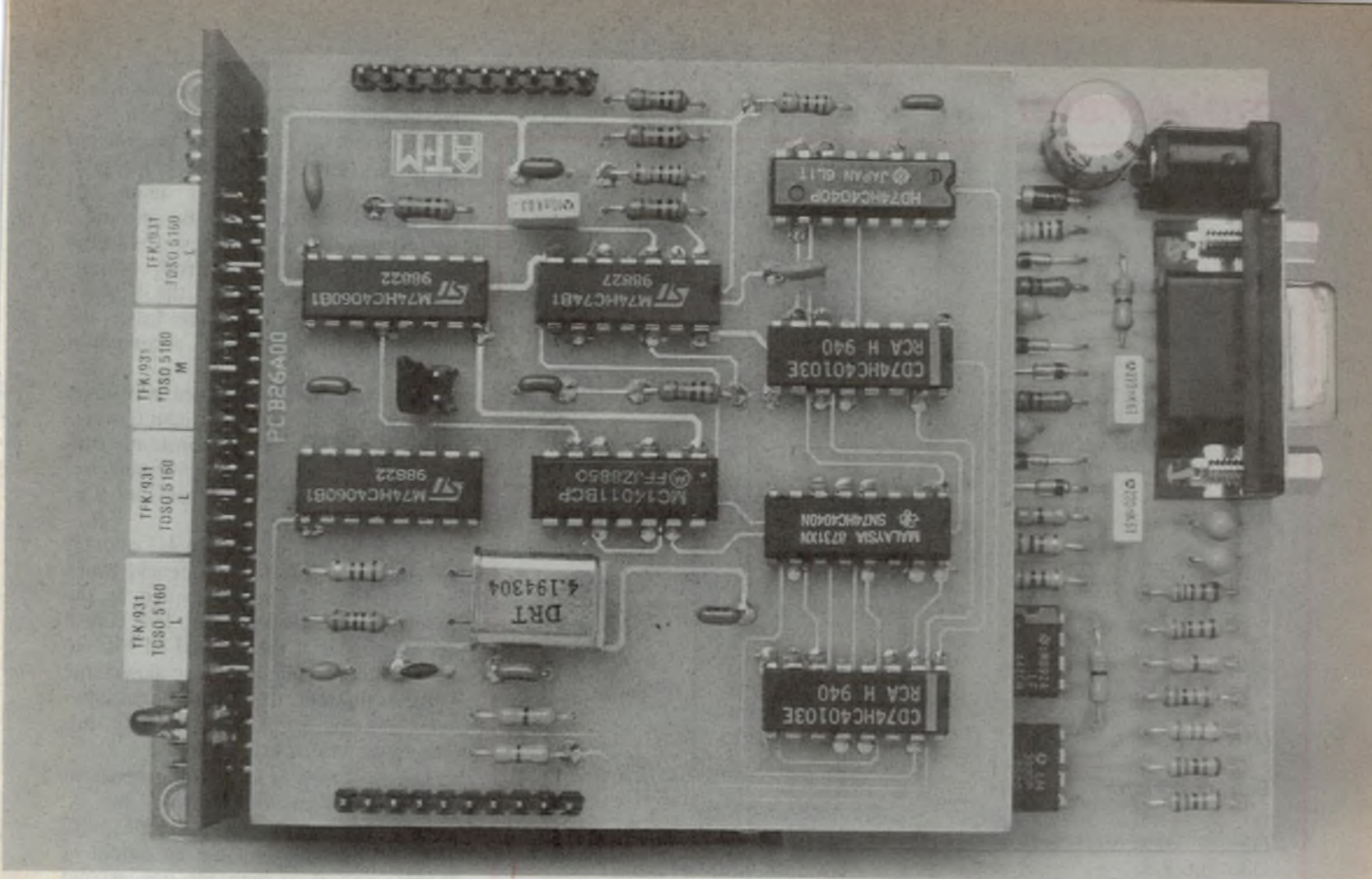


And finally, where the parts go on the 26A00 calculator board – which mounts above the counter board in 'piggyback' fashion.

A 5V regulator U1 is provided for the HCMOS logic on the attached ATM13 counter PCB, and the 26A00 PCB which clips on to the ATM13. The balance of the circuitry runs from a +10V line regulated by zener diode D2 and decoupling capacitor C9. D1 is a reverse polarity protection diode, to prevent tragedies in the event of a wrongly wired power input plug.

The principle of operation for the cable sensors is to provide a well decoupled, noise free +10V DC to the cable shields via R8/C4 and R9/C6. The capacitor formed by the outer shield, the insulator and the centre conductor of each sensing cable couples to clamping/-protection diodes D3/D4 and D5/D6, and thence via DC isolation capacitors C5 and C7 to the inputs of FET input op-amps U2:A and U2:B, which are configured as differentiators.

When a small capacitance increase occurs in the cable, the output of the respective op-amp (pin 1 or 7) will quickly slew negative, then return to the resting voltage set by the R3/R2/R1 voltage divider – approximately 5V. U3:A and U3:B are configured as threshold detectors with positive feedback, to give sharply defined negative-going output pulses (from +10V to 0). These are



This top view of the complete PCB assembly shows an early version of the calculator board.

coupled out to the calculator PCB via D7 and D8.

As noted above, other types of sensor can be used to trigger the START and STOP gates. However it should be noted that with sensors such as ATM20 infra-red transmitter/receiver units, the positioning of the transmitter and receiver units is no less critical than with the cables in regard to spacing and perpendicular aspect to the vehicle trajectory.

If ATM20's are used for sensing, these should be assembled as per the instruction manuals included in the kits – with the addition of a 1k/0.5W (5%) load resistor connected between each normally closed (N/C) output and 12V. The ATM20's are each linked to the PCB26B00 with two-core coaxial microphone cable, the braid being connected to GND on the ATM20's and K2 pins 6, 7, 8 or 9 on the PCB26B00.

Similarly the +12V from K2 pin 3 is applied to one conductor in each cable, to power the ATM20s via the screw terminals marked '12V' and the N/C outputs from the START and STOP ATM20's are returned via the second conductor in the coaxial cable to K2 pin 2 and 5, respectively.

Another possibility for the START and STOP detectors would be a pair of (normally closed) switch contacts or even fine wires, suitably arranged mechanically. Here again a two-core coaxial cable can be used to connect them up, with the braids connected to K2 pins 6, 7, 8 or 9 and K2 pins 1 and 4 going to the load resistors connected to the START and STOP switches as shown in the schematic (Fig.1). The switches then connect between each load resistor and ground, with the second conductors returning the signals to the PCB.

The circuit for the calculator PCB is shown in schematic SCH26A00 (Fig.2). This board carries out the reciprocal calculations and provides the various crystal-controlled clock frequencies and timing signals.

The START signal from D7 on the conditioning PCB arrives via pin 11 of K2 and pulls down pin 2 of U3:A, normally pulled high by R8. Pin 3 therefore goes high. The signal is then gated by NAND gate U3:B, which is controlled by flipflop U4:A – in turn controlled by the 0.5Hz gate control signal for the frequency counter.

The purpose of this loop is basically to act as a 'lock out' circuit after the START pulse has triggered circuit operation, so that any further start pulses are ignored until a full calculation is complete. For example in many cases the rear wheels of the vehicle might well trip the START sensor again before the front wheels have crossed the STOP sensor. Without the lockout logic this would result in a scrambled reading.

Control of the initial timing logic is performed by flipflop U4:B, whose resting condition is with the Q output low. This is because a power up differentiator C6/R4 resets it to this condition.

When the START pulse reaches the flipflop through the lockout gate U3:B, the Q output goes high. This enables NAND gate U3:C to pass one of four clock frequencies, selected from the outputs of clock oscillator/divider U1 via LK1, to the accumulator formed by U6 and U8. These are both 12-bit binary counters, connected in series with the first 16 bits used as the accumulator. The accumulator has previously been cleared before the count, by a brief positive-going reset pulse generated by C10 and R9 from the rising edge on the Q output of U4:B.

After receiving the START pulse but before receiving the STOP pulse, clock pulses from U1/LK1 via U3:C will con-

Amphometer

PARTS LIST

Conditioning PCB:

Capacitors

C1,2,4,6
1uF TAG tantalum
C3,9 47uF 16VW electrolytic
C5,7 0.22uF polyester
C8,10 0.1uF ceramic

Resistors

R1,2 33k 1/4W
R3 5.6k 1/4W
R4,12 2.2M 1/4W
R5,6 22k 1/4W
R7 330 ohms 1/4W
R8,9 10k 1/4W
10,11 10M 1/4W
R13,14 4.7k 1/4W
R15 33 ohms 1/4W

Semiconductors

D1 1N4001 power diode
D2 BZX55C10 zener
D3,4,5,6,7,8
1N4148 silicon diode
U1 7805 regulator
U2 LF442 dual FET opamp
U3 LM393 dual opamp

Miscellaneous

1 x 5mm/2mm co-axial type DC power input socket, PCB mounting (K1); 1 x DB9 socket, PCB mounting (K2); 1 x DB9 plug for input cable (K3); 12 x '0 ohm resistor' links (J1,2,3); printed board, code PCB26B00

Note: Complete kits for the Amphometer will be available directly from Australian Test & Measurement, 28 Hotham Parade, Artarmon 2064. For a limited time and as an exclusive offer to EA readers, the kits will cost $156.50 plus $8.50 for packing and postage, if required.

Frequency counter:

Capacitors

C1 47uF 16VW electrolytic
C2 0.1uF ceramic

Resistors

R1,2,3,4,5,6,15,16,18,19
1k 1/4W
7,9,10,11,12,13,14
470 ohms 1/4W

Semiconductors

Q1,2,3,4
BC550 transistor
U1 MM74C 926 counter IC
S1,2,3,4
TDSO5160 7-segment display
LED1,2,3
3mm red LED

Miscellaneous

2 x 10-way PCB socket strips (K1,2); 2 x 10-way 90° PCB pinstrips; 2 x '0 ohm resistor' links (J1,2); printed boards, code PCB13A00 and PCB13B00.

Calculator PCB:

Capacitors

C1 33pF ceramic
C2 82pF ceramic
C3,5,6,8,9,11
0.1uF ceramic
C4,10 100pF ceramic
C7 10nF polycarbonate

Resistors

R1 1k 1/4W
R2 10M 1/4W
R3,4,5,7,8,9
10k 1/4W
R6 100k 1/4W

Semiconductors

U1,2 HC4060
U3 MC14093
U4 74HC74
U5,7 HC40103
U6,8 HC4040

Miscellaneous

2 x 8-way PCB pin strips (RBUS/LBUS); 2 x 4-way PCB pin strip with link (LK1); 2 x '0 ohm' resistors (J1,2); 4.19MHz crystal (X1); printed board, code PCB26A00.

tinue to increment the accumulator to a maximum possible count of 65,536.

On receipt of a STOP pulse, via pin 12 of K2, the Q output of U4:B goes low, disabling gate U3:C again and blocking further counts to the accumulator. At this time a count is stored in the accumulator which is inversely proportional to the closeness of the START and STOP pulses, i.e., the faster the vehicle the smaller the accumulator count.

The accumulator addresses two series connected 'divide by N' counters U5 and U7, which are being constantly supplied with a clock at the crystal frequency of 4.194304MHz from pin 9 of U1.

The net result is that the U5 and U7 will output a constant frequency, which is the crystal frequency divided by the number in the accumulator. This is how the reciprocal of the elapsed START to STOP time is computed; the slower the vehicle, the more counts in the accumulator and the lower the frequency output – and vice versa.

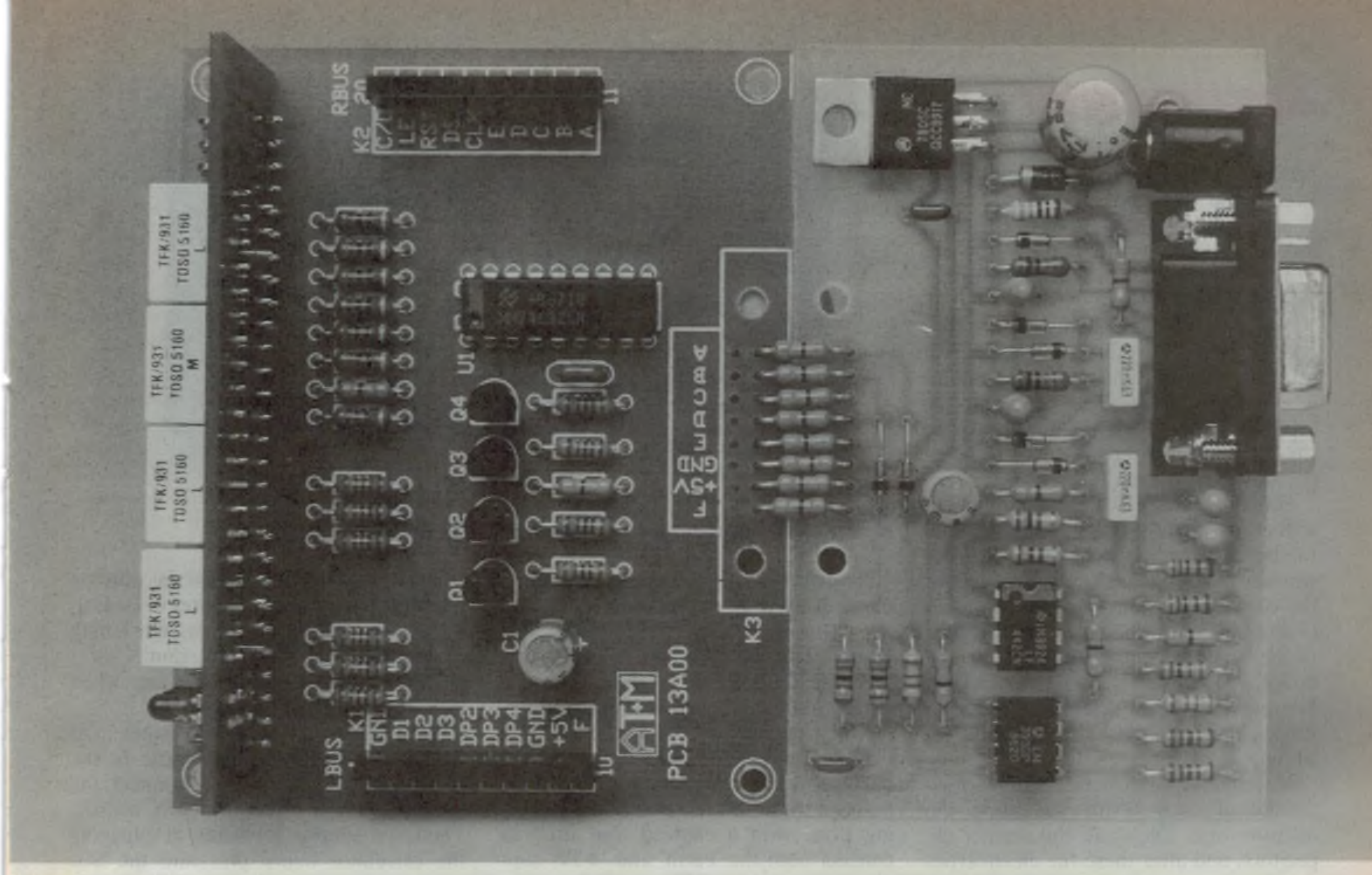
The final step is to gate the resultant frequency from the 'divide by N' counters with a one-second wide pulse from Q14 of U2. This has an output of 0.5Hz, i.e., it is high for one second and then low for one second.

The one-second wide gate is generated by flipflop U4:A, which has a power-on reset circuit formed by R6/C8 to leave it in the waiting state with Q low and Q-bar high. This keeps U2 reset, with all Q's at logic 0, and U3:B pin 6 enabled to pass a START to U4:B and perform the accumulator loading sequence.

When the output of U4:B goes low after the arrival of a STOP pulse, differentiator circuit C7/R5 applies a set pulse to U4:A via pin 4. This causes U4:A to flip to the set state, with its Q-bar output going low, releasing the reset input of the timebase counter U2. At the same time the Q output goes high, enabling gate U3:D so that output pulses from the 'divide by N' counter are admitted to the frequency counter via K2 pin 16.

One second after the reset has been removed from U2, output Q14 will go high. This resets U4:A, via R3/C4, and as gate U3:D is then disabled, the frequency counter therefore receives output pulses from the 'divide by N' counter for only one second.

The rising edge on the Q-bar output of U4:A as the latter resets is taken to pin 19 of K2, and used to enable the latches on the frequency counter module, so that the end result is displayed



Another top view, this time with the calculator PCB removed to show both of the lower boards.

steadily – until replaced by that of the following cycle (assuming another vehicle crosses the sensors).

The schematic for the ATM13 frequency counter module is shown in Fig.3, for reference. As you can see it is based on the MM74C926 four-digit LSI counter chip U1, which includes an internal multiplexing system. All that is required to drive the four 7-segment LED displays S1-S4 are the appropriate digit selector transistors Q1-Q4, controlled by U1 output pins 7, 8, 10 and 11.

LEDs 1, 2 and 3 on the ATM13 module are here driven by logic signals from the calculator PCB (Fig.2), so that they indicate the Amphometer's functions. LED1 is driven by the Q output of the START/STOP flipflop U4:B, so it illuminates during the initial transit timing count; LED2 is driven from the Q output of frequency count timing flipflop U4:A, so it illuminates during the frequency counting phase; and LED3 is driven from the Q5 output of second accumulator chip U8, so that it illuminates in the event of accumulator overflow.

Note that the operation of the Amphometer is fully automatic: there are no manual controls or adjustments at all. The complete counting/calculation sequence is initiated by the arrival of a pulse from the START sensor, and then proceeds until a reading is displayed. The reading then remains on the display, until another START pulse begins the sequence again. At the end of the second sequence the first reading will then be replaced by the second, and so on.

Construction

The Amphometer is packaged very neatly and compactly in a small instrument case made by the Amalgamated Instrument Company, and measuring 96 x 48 x 137mm. The case is made from a length of rectangular aluminium extrusion, with custom moulded plastic bezels to form the front and rear panels.

The case extrusion carries a system of slots on the inside of the side walls, designed to support PC boards. The board assembly which forms the 'works' of the Amphometer is designed to slide snugly into a pair of these slots, from the rear. The front and rear panels hold it securely in place, without the need for any screws.

As noted earlier, the Amphometer is essentially based on the existing AT&M four-digit counter kit ATM13. The two PC boards of this existing kit form the heart of the unit, with the small display board mounted vertically at the front of the main board and connected to it by a pair of 10-way 90° PCB pin assemblies.

The additional circuitry for this project is mounted on two extra boards, as you have probably gathered already from the schematics. The input conditioning and power supply circuitry is on the board with code PCB26B00, which mounts immediately behind the frequency counter board and butted to it, while the timing, calculator and control circuitry is on the board coded PCB26A00. This mounts in 'piggyback' fashion above the frequency counter board, just behind the display board and connecting to the latter via two further 10-way PCB pin assemblies, which mate with SIL sockets.

The connections from the vehicle sensors to the input conditioning board are made via a DB-9 socket, mounted on the rear of the board and accessible via a cutout in the rear panel. The DC power input is via a small standard 'coaxial' power socket, compatible with the plugs fitted to most plug-pack supplies. There are only four connections between the input conditioning board and the rest of the circuitry, and these are made via four links (actually '0-ohm resistors') between this board and the frequency counter board. However to provide further mechanical linking between the two boards, four further dummy links are used as well. The eight links ensure that the two boards are firmly supported and held together when slid into the case.

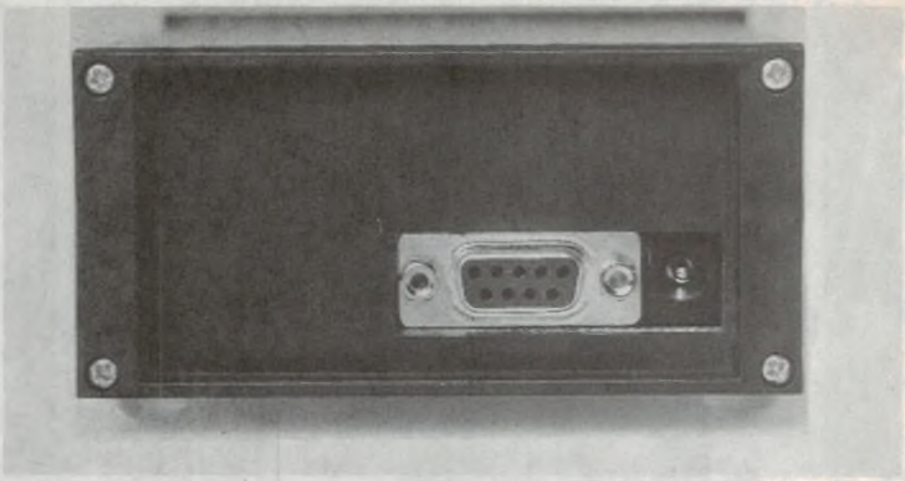
Assembly of components on the four boards should be quite straightforward, using the overlay diagrams and photographs as a guide. The boards to be supplied in the AT&M kit will also be silk-screened with component ID information, to help even further.

The only board which could be described as 'slightly tricky' is the calculator board, which is double-sided – but without plated-through holes, to reduce the cost. As a result, some of the leads of the IC's and other components need to be soldered on both sides of the board, to ensure correct operation. However the other three boards are all single-sided, and very simple to put together.

As usual we suggest that you start assembly of each board by fitting the resistors first. Then add the smaller capacitors, and after these the electrolytics – taking care to fit these with the correct polarity as marked. Then you can add the diodes and discrete transistors, again making sure of the orientation and making sure that their leads are not strained.

The next step would be to fit the various interconnecting sockets and PCB pin assemblies. Note that the two long straight pin assemblies mount on the calculator PCB, being pushed through from the top of the board but soldered on the underside. The two 90° cranked pin assemblies mount on the lower front of the display board, with their short straight ends pushed through this board and the longer cranked ends pointing downward (away from the display LEDs). The short ends are then soldered on the rear side.

At this stage you can mount the quartz crystal on the calculator PCB. Do this by first bending its leads very carefully at right angles to one side, about 3mm from the glass seals – using a pair of needle-nosed pliers to prevent strain. Then fit a small piece of double-sided adhesive 'foam' tape to the same side of the crystal case. Finally push the leads through the appropriate holes in the PCB, until the double-sided tape attaches the crystal to the board's top surface; then solder the leads carefully on the underside of the board, being careful not to apply too much heat.



A rear view, showing the sensing input and power connectors.

Now you can fit the LEDs and 7-segment displays to the display PCB, and the various ICs to the other three boards. Pay careful attention to the correct orientation of all of these – a mistake could easily result in damage.

Note that most of the ICs are CMOS devices, and therefore susceptible to damage from static charges. It's good practice to use a reliably earthed soldering iron, with a cliplead also used to connect both the 'earth' and '+5V' supply tracks of the PCB you're working on to earth as well, during the fitting and soldering of the IC's. Careful workers also solder the IC supply pins first, before the others.

As an extra precaution you can also fit an earthing lead to yourself, to dissipate any charge you may acquire. This needn't be a short-circuit, though – if you're worried about the risk of shock. A series 100k resistor will still allow rapid dissipation of any charge, while safely limiting any current that could flow.

When you're fitting the IC's to the calculator PCB, don't forget to solder all of those which link the top and bottom copper tracks to *both* sides. The pins concerned will be clearly identifiable on the boards supplied with the kits, as the green solder resist is masked clear to reveal the tinned pads. It would also be a good idea to make sure you've double soldered all of the other component leads that link top and bottom layers, at the same time – this is quite important.

With all of the IC's fitted, you are now ready to fit the boards together.

First of all, push the 'cranked' ends of the pins on the lower edge of the display PCB into the holes along the front of the frequency counter board, until the two boards are touching. Then make sure that the boards are aligned correctly at 90°, and solder the pins on the underside of the counter board. If necessary, cut off any excess pin length to ensure that the pins don't short against the inside of the case when everything is assembled.

Now butt the input conditioning PCB to the rear of the counter board, fit the eight link 'resistors' which connect the two and solder them to both boards. Then it's simply a matter of plugging the calculator board pins into the SIL sockets on each side of the counter board, and your Amphometer's electronics assembly is complete.

Setting it up

All that remains is to set the timing clock selector link LK1 to the appropriate position, and the assembly can be fitted into the case – there are no other adjustments to be made.

Which position you use for link LK1 depends upon the kind of measurements you'll be making with your Amphometer. The options are shown in Table 1, which also shows the corresponding sensor spacings. Note that if you want your instrument to read in other than kph, you'll have to determine the appropriate sensor spacing and setting for LK1.

Having set the timing clock link, you can mount the board assembly carefully into the case from the rear. Then you'll be ready to apply 12V DC, from either a plug-pack supply or a battery pack, and start measuring some vehicle speeds!

Don't forget, though, that for accurate results you need to have your sensors spaced quite accurately. The cables or light beams should also be set up as accurately as possible at 90° to the direction of vehicle travel. But providing you observe both of these precautions, your Amphometer will give very accurate and unambiguous readings.

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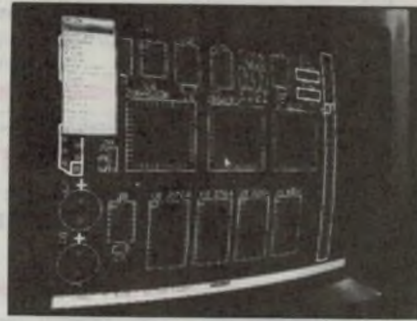

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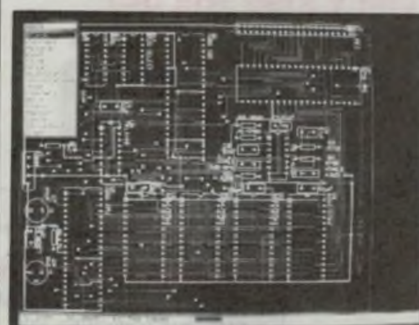

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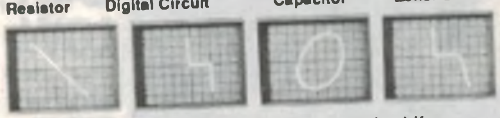

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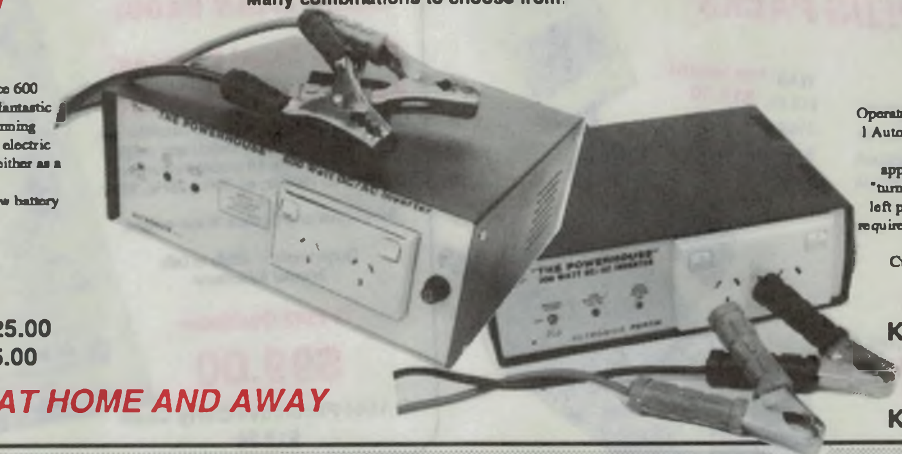

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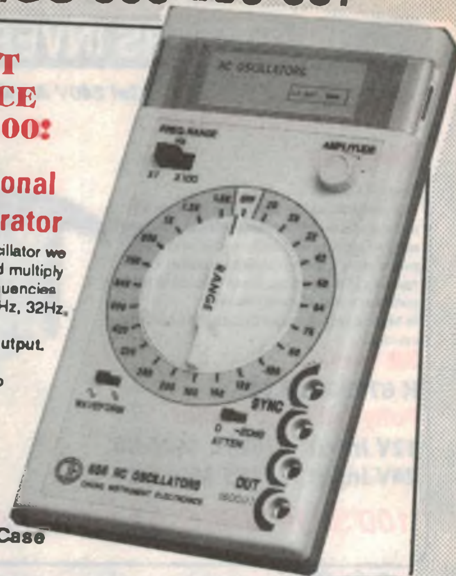
Pocket Sized Personal Audio Signal Generator



Quite the finest portabel audio oscillator we have ever seen. Range switch and multiply enable selection to 46 preset frequencies from 20Hz to 150kHz, eg 20Hz, 28Hz, 32Hz, etc.
Sine Wave and Square Wave output.

Output control -20db to 0db
Internal 9V battery

Q 1542 Oscillator
$99.00

Q 1544 Protective Carry Case
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If you have trouble with fine PCB work or component identification but still want both hands free, this is for you. We thoroughly recommend this quality Australian made product.
TECHNICAL INFORMATION: Illumination: 22W Fluorescent Weight: 8.16kg Lateral Extension: 254mm Vertical Extension: 254mm Fixing: Heavy table base (grey or ivory) with two chrome plated flexible arms.

A 0980 Normally $279 This month
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R 5208	2,200uF	63V	RB	$4.70	$3.50
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TWIN RANGE LED TACHO

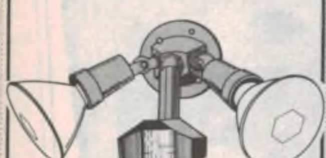
(See ETI Aug '80)

0-1000RPM/0/10,000RPM

This unit is suitable for 1, 2, 3, 4, 6 and 8 cylinder vehicles, both 2 stroke and 4 stroke. Fully compatible with conventional CDI and transistorized ignition systems. Includes protection circuitry to prevent noise and high voltage spikes from the points and the coil circuit damaging the electronics. Display flashes when over-revving occurs. Only requires 3 connections to the electrical system.

K 4324 Normally $32.00 This month even more fantastic value at only $20.00. SAVE $12.00! That's an incredible 37.5% off!

Passive Infra-Red Lite Guard Floodlight Control



How often have you thought there could be a prowler outside your door? Install a Lite Guard & (once armed) any "guest" will be floodlit when detected by this highly sensitive Infra-Red Detector. Specifications: ● All weather operation ● Operation Time, 1-20mins ● Sensitivity: 20' - 50', 30 beams ● Aimable ● Switching Capability: 500W max. incandescent ● Operation Modes: OFF, AUTO, TEST, MANUAL, ON.

S 5350 was $135.00
SPECIAL ONLY
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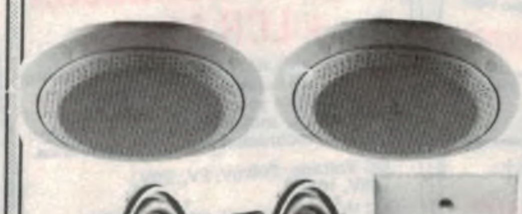
CEILING SPEAKERS KIT



The ideal high grade extension speakers for the games room, den, study, workshop, back verandah, kitchen or wherever else you want quality sound.
Kit includes everything you need - right down to the screws.
Ceiling mounting can actually enhance the sound so that the 4", 15Watt drivers that comprise the heart of the system really sound stunning!
Kit Includes: 2 x Redford C 0626 drivers, 2 x C 0810 grilles, 1 x A 2300 60W stereo volume controller, 2 x 20M rolls speaker wire and mounting screws.

C 0988 **$99.00**

Beautifully packaged, they make the perfect house warming gift.

45V 2A Dual Tracking Power Supply

(See Silicon Chip Feb '90)

This NEW dual tracking power supply is a must for your workbench. The two rails track exactly with each other on any voltage and precise voltage is obtained with the multi-turn rotary control. It also has a clear display and meter movement, a dropout indicator and load ON/OFF switch. Housed in a medium sized instrument case with a silver anodised and pre-punched and screened front panel.
FEATURES:
- Housed in a tough "ABS" instrument case
- Floating ground
- Load switch

NEW '90

K 3375 **$149**

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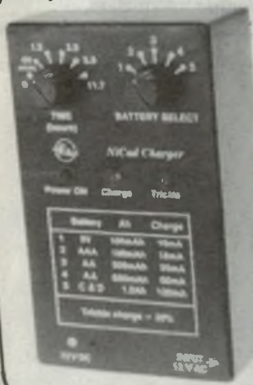
Automatic Charger for NiCads

(See EA July '89)

Get 100's more recharge cycles from your nicads Its now well known that correctly charging nicad cells greatly extends their service life.



Here is a fully automatic NiCad battery charger that enables differing charge rates as appropriate for AAA, AA, C, D cells or cells in series up to 9V. Once the battery is charged, the unit automatically switches to trickle charge until you switch it off.

K 1650 $39.50

M 9020 (Plug-Pack Extra) $16.95

Telephone Extention Bell

INSTALLED IN MINUTES.

Connects via P 0995 double adapter to telephone line at existing wall socket. Double adapter accepts both telephone and extension bell, which is supplied with a 10 meter lead. NOT SUITABLE FOR COMMANDER PHONE SYSTEMS.

P 0996 $29.50

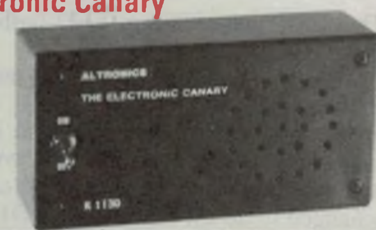
Hot Canaries - The Electronic Canary

(Silicon Chip Feb'90)

Get that atmosphere of tranquility that only birds can give. The realism of this project is remarkable. Sounds for all the world like two trilling canaries.

- Battery powered

K 1130 $25.95



NEW IN '90

Bel Express 3 Radar Detector

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The new industry standard! Express 3 contains the latest Bel breakthrough. Image Rejection Technology for KA band Photo Radar detection and twice the X and K band sensitivity of ordinary superhet radar detectors. Fully equipped, Express 3 has no equal.

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- Automatic K/Ka Band Override: Express 3 instantly alerts to the presence of K or Ka Band radar when the FSR mode is engaged.
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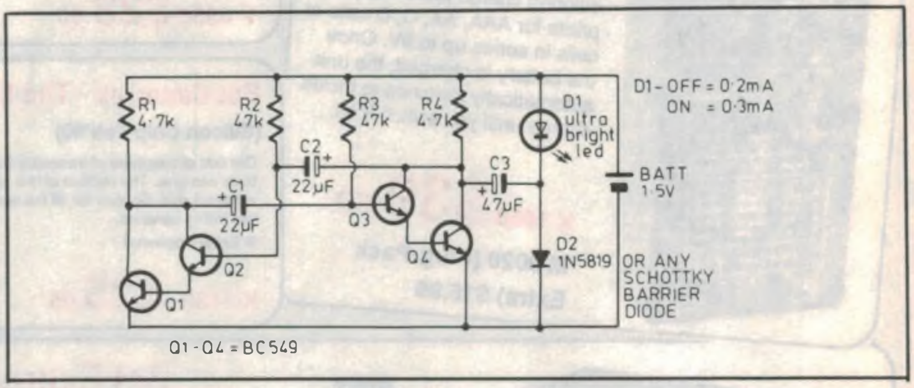
Circuit & Design Ideas

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

High-efficiency 1.5V LED flasher



This 1.5V high efficiency LED flasher circuit is simple to construct.

The circuit is actually an astable multivibrator and voltage doubler. Q1 – Q4 are wired in darlington mode to increase gain and reduce current consumption. The values of C1 and C2 can be changed to adjust flashing rate. D1 is an ultra-bright LED, obtainable from Radio Spares (RS part number 588-263). Ordinary LEDs can be used, but the flashing intensity is very much reduced since the circuit is trimmed for minimum current consumption. D2 is a Schottky barrier diode, type 1N5819 or Tandy part number 276-1165. Again, ordinary diodes like 1N4148 can be used, but it will reduce the LED intensity as the output voltage is slightly reduced.

In operation, the idle current is 0.2mA and with the LED active, the current goes up by 0.1mA to 0.3mA. With such a low current consumption, a 1.5V cell will last a long time. The popular LM3909 LED flasher IC idles at typical 0.55mA and with LED active it drains 0.75mA. So if you need minimum current consumption, this discrete circuit will provide it.

Michael Y.K. Ong,
City Beach, W.A.

$35

The purpose of this circuit is to adjust the volume of a car radio etc., in relation to ambient noises in the car. At idle in an automobile the ambient noises are at a much lower level, due to lower engine noise and less or no wind noise.

To take advantage of this fact, the circuit switches the volume of the radio to a lower level, as the engine approaches idle condition. As the engine revs increase and the car pulls away, the volume is switched to the higher (normal) level.

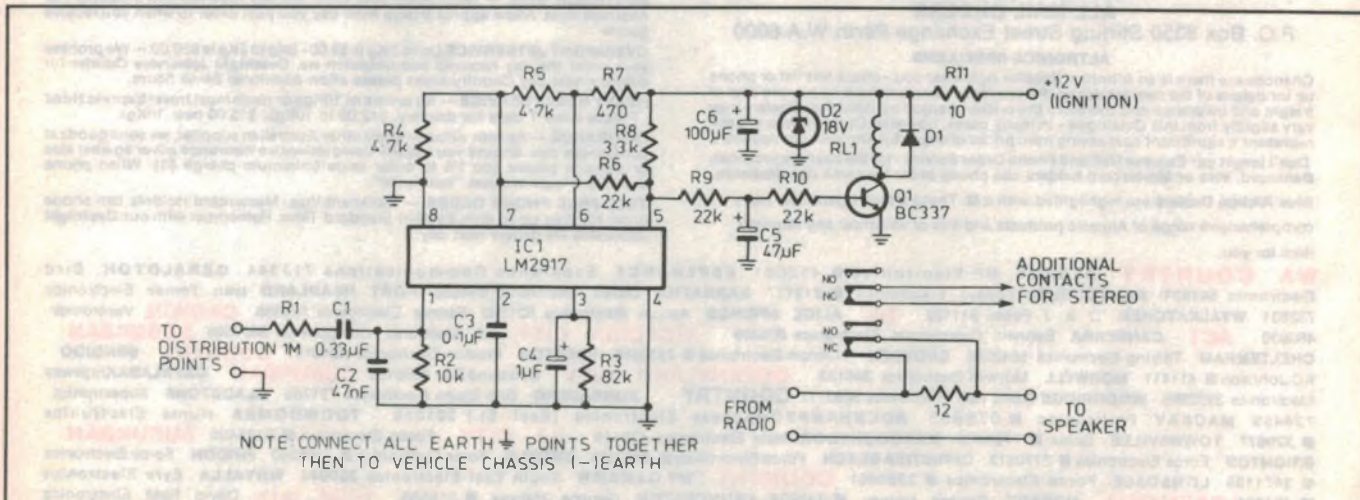
IC1 is a tachometer IC, which converts incoming pulses from the ignition points, via the input protection circuit (R1, R2, C1, C2), to a DC level inside the IC which is compared with a reference voltage. At low engine revs the output from pin 5 goes high, turning on TR1 and operating the relay. As the relay operates, its contacts insert a resistor(s) into the speaker(s) circuit and the volume drops.

The value of the resistor in the speaker line can be selected to suit the individual's needs. I suggest starting with something like 8 or 12 ohms, with a power rating at least equal to the speakers, or equal to the amplifier rating.

D1 protects the rest of the circuit from the back emf produced by the relay as it releases. D2, R11 and C6 protect the circuit from any large voltages which appear on the battery line.

Eric Rodda,
Marion, S.A.

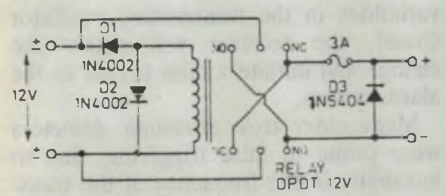
$40



Auto polarity selector

I used to have a CB transceiver, which I would lend to people while I repaired their unit. This unfortunately was often a problem for me in that they got the polarity wrong, blowing the fuse and safety diode. Then they would compound the problem with a higher value fuse!

I used a bridge rectifier for a while, bu the 1.2V drop was unacceptable in the circumstances, so I developed the auto-polarity circuit shown.



The relay and DI either let the power straight through or if the polarity is wrong, exchange the power connections. D2 is to stop the spike from the relay as the field collapses and the fuse and D3 are in case the device fails. The device draws very little current and has no appreciable voltage drop.

I suggest you mount D1 and D2 on the relay and mount the whole thing in the CB for best results.

David Angus,
Berry, NSW **$40**

Versatile 8-bit decoder/display driver

This versatile decoder circuit uses a pre-programmed EPROM as a 'look-up table', to simplify the hardware required for digital code conversion and display.

A 2-kilobyte EPROM is formatted into 256 primary address blocks, accessed according to the 8-bit code presented on the incoming data lines. Each primary address block contains eight secondary addresses, which are continuously stepped through, with the resulting sequential data read from the EPROM then driving a multiplexed display.

Using this approach a unique, user-determined display of up to eight digits can be programmed for each primary address presented by the eight data bits at the inputs.

The circuit simply looks up (in the EPROM), and displays the numbers programmed-in to correspond to a particular set of input data.

The display need not follow any particular pattern with respect to the input data. It may simply represent the decimal equivalent of the binary code applied to the outputs, or it may take on a more complex relationship (for example, to produce a digital readout of output operating frequency by monitoring the programming data presented to a frequency synthesiser PLL).

In this manner, it is possible to perform decoding tasks which would have been difficult to implement or which would have required a complex array of hard-wired logic devices – it all depends on the data programmed into the EPROM!

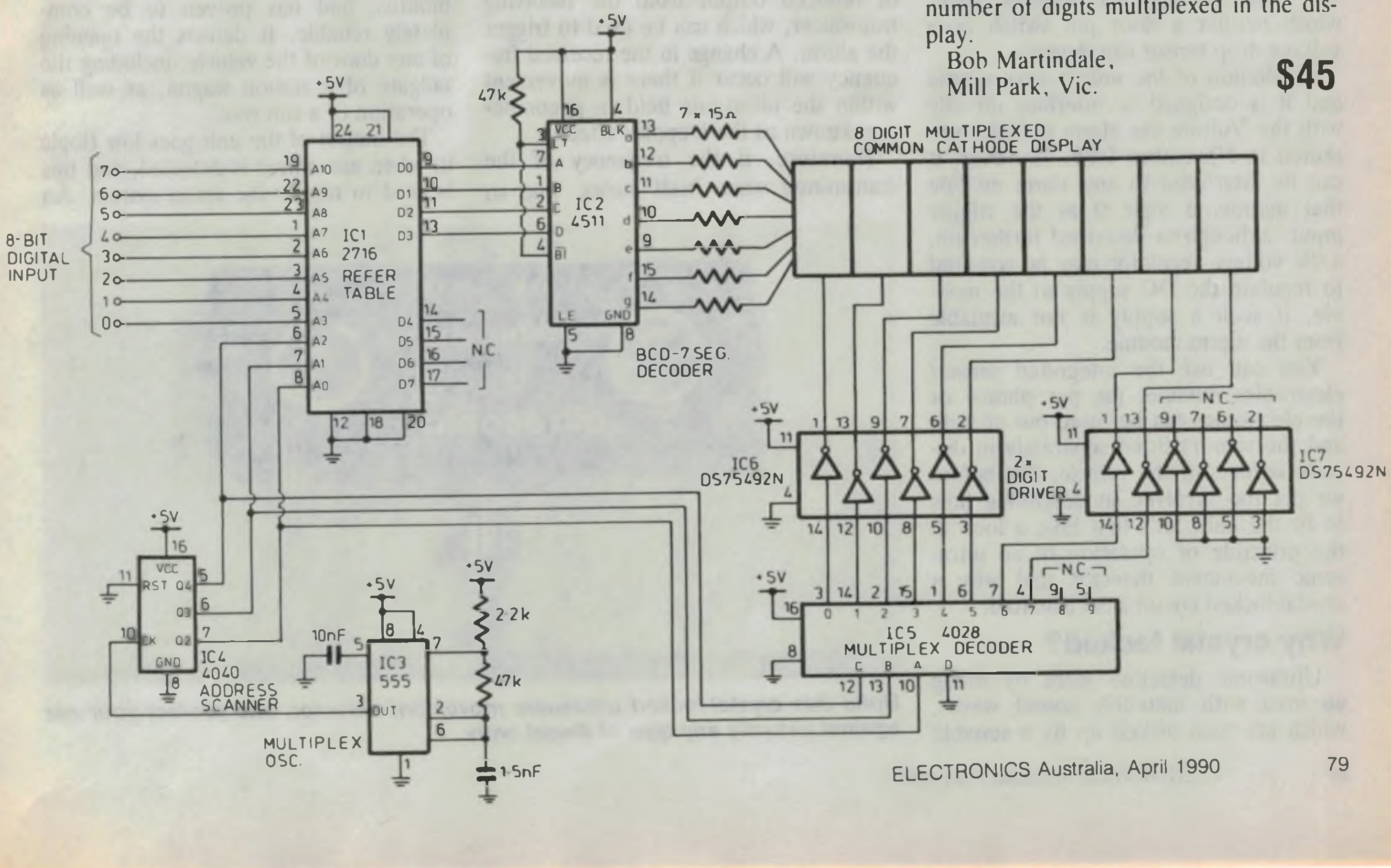
The eight-bit input data to be decoded is applied to addresses A3 to A10 of the EPROM. IC3 (555) is the multiplex oscillator, running at about 10kHz. IC4 (4040 multistage binary counter) counts oscillator clock pulses and generates a 3-bit sequencing address, which is applied to the lower three address inputs, A0-A2, of the EPROM (IC1), to form a composite address with the input data at A3-A10.

The data at A0-A2 selects the display information from within the primary address block specified by A3-A10, and is also used after further decoding via IC5 (a 4028 binary to decimal decoder) and processing via IC6 and IC7 (DS75492N display drivers) to switch on the corresponding display digit cathode so that the information is placed in its correct position in the display.

'Decoded' output information is obtained from EPROM data pins D0 to D3, in four-bit BCD format. IC2 (a 4511 BCD to seven-segment display decoder/driver) decodes this data into seven-segment form and drives the multiplexed display segments.

If more than eight input data lines are to be decoded, it will be necessary either to use an EPROM with more available address inputs, or to reduce the number of digits multiplexed in the display.

Bob Martindale,
Mill Park, Vic. **$45**



Construction Project:

Crystal-locked ultrasonic movement detector

Continuing on with our high performance Vulture car alarm system, this month we present a quartz crystal-locked ultrasonic movement detector. It is suitable for all types of vehicles, needs no alignment and because it is crystal locked, the unit is extremely stable. Best of all, it will cost you a lot less than commercial units of equal performance.

by JEFF MONEGAL

Most of today's top range car alarm systems incorporate an ultrasonic movement detector, as a sensor to detect illegal entry or occupancy of the vehicle. They provide protection against entry for cars without door switches on the rear doors, for cars fitted with a sunroof (normally difficult to protect) and are ideal in hard to protect vehicles such as vans or buses, as no switches are required. Their mode of operation makes an ultrasonic movement detector hard to fool, providing protection against the old brick through the window trick, which neither a door pin switch or a voltage drop sensor can detect.

Installation of the unit is very simple and it is designed to interface directly with the Vulture car alarm module presented in November 1989. However, it can be interfaced to any alarm module that accepts a logic 0 as the trigger input, although as described further on, a 9V voltage regulator may be required to regulate the DC supply to the module, if such a supply is not available from the alarm module.

You can use the integrated sensor/electronics module, (as per photo) or the electronics can be fitted out of sight and the sensors fitted separately in discrete corners of the vehicle. But before we get too involved in describing how to fit the unit, let's first take a look at the principle of operation of an ultrasonic movement detector and why a crystal-locked circuit is so essential.

Why crystal locked?

Ultrasonic detectors work by filling an area with inaudible sound waves, which are then picked up by a suitable receiver. The transmitting and receiving transducers are specially constructed piezoelectric devices, with a fixed operating frequency and a narrow bandwidth. The devices specified in this project have a resonant frequency of 40kHz and a bandwidth of around 600Hz. They are therefore very frequency selective, simply as a result of their construction and the nature of the devices themselves.

Thus, any change in the transmitted frequency will be detected in the form of reduced output from the receiving transducer, which can be used to trigger the alarm. A change in the received frequency will occur if there is movement within the ultrasonic field, a phenomenon known as the Doppler effect.

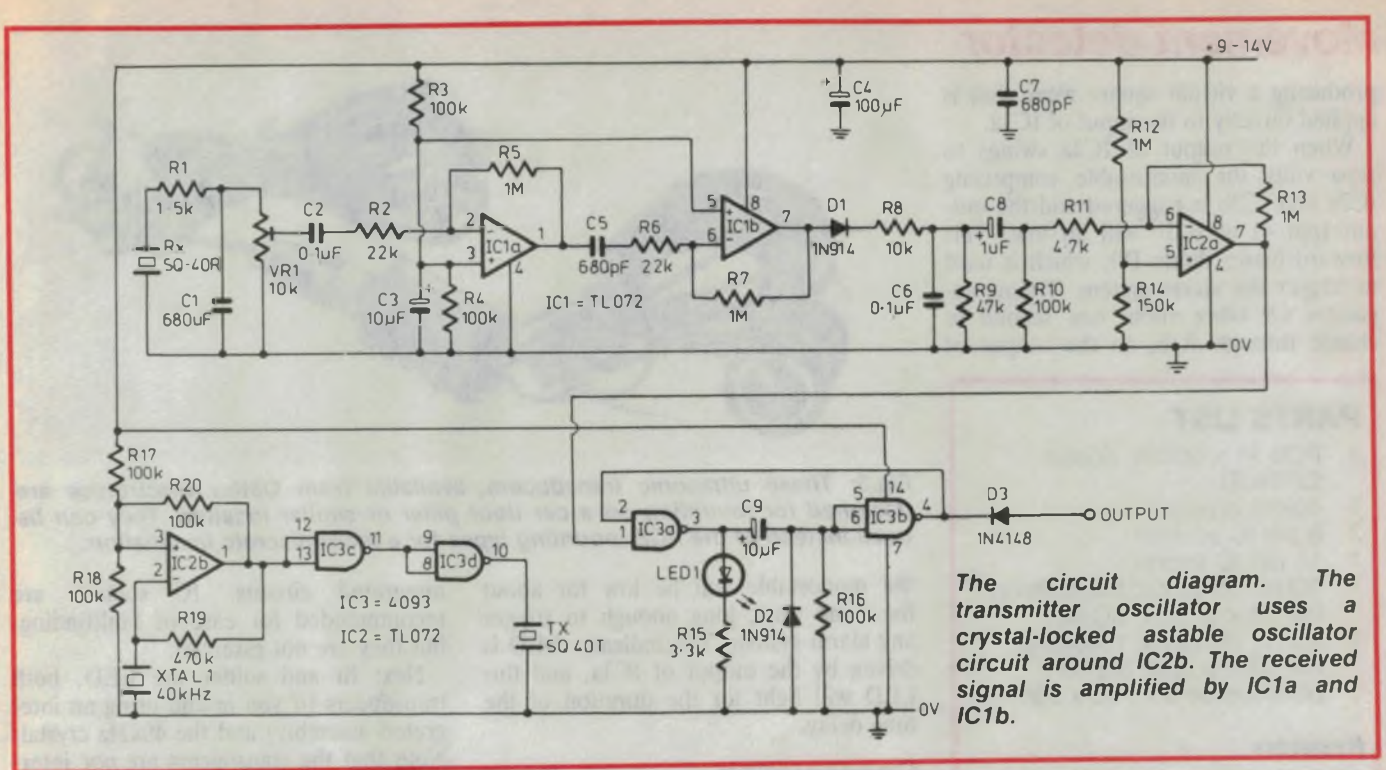
Therefore, if the frequency of the transmitted wave itself varies, due to variations in the transmitting oscillator circuit, the receiver will detect the change and initiate a false trigger to the alarm system.

Many older style ultrasonic detectors were prone to false triggering, due to instability in the frequency of the transmitted signal as the transmitter oscillator circuits were usually of the free running type, with a tendency to drift around their nominal operating frequency. Temperature variation is a prime factor in instability, and as the inside of a car is prone to extreme changes in temperature, it is no wonder false alarms were common.

By using a crystal-locked oscillator circuit for the transmitter, the problems of frequency instability are removed, giving the reliability required for any burglar alarm system. The prototype has been tested in several different vehicles over a period of some three months, and has proven to be completely reliable. It detects the opening of any door of the vehicle, including the tailgate of a station wagon, as well as operation of a sun roof.

The output of the unit goes low (logic 0) when movement is detected, and this is used to trigger the alarm system. An

Build this crystal-locked ultrasonic movement detector, and protect your car against virtually any type of illegal entry.



The circuit diagram. The transmitter oscillator uses a crystal-locked astable oscillator circuit around IC2b. The received signal is amplified by IC1a and IC1b.

indicator LED on the front of the unit operates when the device is triggered, giving a visual indication that is useful in testing the unit. No complicated alignment procedures are involved because of the crystal oscillator circuit and when construction is complete and the unit tested successfully, the only adjustment needed is sensitivity. In most cases even this will not be necessary.

Circuit details

The transmitter oscillator is formed by IC2b, which is a 40kHz crystal controlled astable oscillator. Resistors R17 and R18 provide bias for the amplifier while R20 gives the necessary positive feedback to sustain oscillations. The frequency of operation is determined by crystal XTAL1, and negative feedback is provided by resistor R19 to also help stabilise the operation. The output of the oscillator is buffered by inverters IC3c and IC3d, which in turn provide the drive signal to the low impedance ultrasonic transmitting transducer (TX).

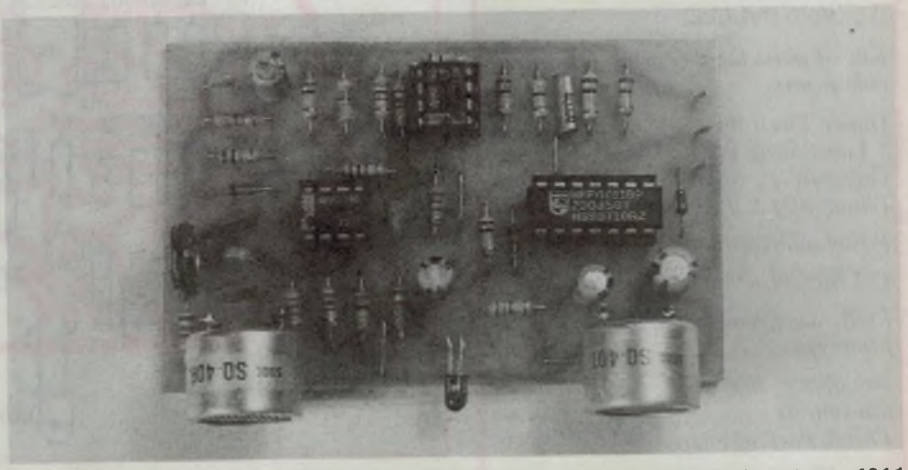
The oscillator runs continuously while power is applied, and the output transducer will fill the inside of the vehicle with a 40kHz ultrasonic wave, which is reflected back to the receiving transducer (RX). This transducer converts the received ultrasonic waves into an AC signal, which is fed to a high pass filter consisting of R1 and C1 before being applied to the sensitivity control, VR1.

Capacitor C2 connects the signal from the wiper of the sensitivity control to the input of IC1a, which is configured as an inverting amplifier with a gain of 45, as set by R2 and R5. The output of IC1a is biased to half the supply voltage by R3 and R4, decoupling across R4 being provided by filter capacitor C3.

The output of IC1a is coupled to the input of the second stage amplifier (IC1b) by C5. This amplifier is identical to the first, also with a gain of 45 as determined by R7 and R6. The total gain of IC1a and IC1b is therefore around 2000, and the output signal at pin 7 of IC1b is a much amplified version of the received ultrasonic signal.

The output of IC1b is connected to diode D1, which passes the positive half-cycles to capacitor C6, charging it accordingly. While the received signal is constant in both level and frequency, the voltage across C6 will be a steady DC level and no signal will be applied to the input of inverting amplifier IC2a, due to the DC isolation provided by capacitor C8.

If movement occurs within the protected area, the change in either frequency or level of the received signal will produce a change in the DC level across C8. This change, although often very small, is amplified by IC2a, an inverting amplifier with a gain of around 200, as determined by R11 and R13. Because of the high gain, the output of IC2a will swing between the limits of ground and the DC voltage supply,



This photo shows the PCB as used in the prototype. Although a type 4011 quad NAND gate was used for IC3, we recommend the use of the specified 4093, as it has Schmitt trigger inputs.

Movement detector

producing a virtual square wave that is applied directly to the input of IC3a.

When the output of IC2a swings to zero volts the monostable comprising IC3a and IC3b is triggered and the output (pin 4) of IC3b will go low. This forward biases diode D3, which is used to trigger the alarm system. Timing capacitor C9 takes about one second to charge through R16, so the output of

Fig.3: These ultrasonic transducers, available from Oatley Electronics are designed for mounting on a car door pillar or similar location. They can be used instead of the PCB mounting types for a more discrete installation.

PARTS LIST

- 1 PCB 81 x 50mm, coded OE89UD
- 1 40kHz crystal
- 2 8 pin IC sockets
- 1 14 pin IC socket
- 1 40kHz ultrasonic transmitting transducer, type SQ-40T
- 1 40kHz ultrasonic receiving transducer type SQ-40R
- 1 plastic case 90 x 55 x 30mm

Resistors

All 1/4W, 5%: 1 x 1.5k, 1 x 3.3k, 1 x 4.7k, 1 x 10k, 2 x 22k, 1 x 47k, 7 x 100k, 1 x 150k, 1 x 470k, 4 x 1M.

- 2 10k vertical mount miniature trimpots

Capacitors

- 3 680pF ceramic
- 2 0.1uF ceramic
- 1 1uF 16V electrolytic
- 2 10uF, 16V electrolytic
- 1 100uF, 16V electrolytic

Semiconductors

- 3 1N4148 diodes
- 2 TL072 dual operational amplifier IC
- 1 4093 quad Schmitt trigger NAND IC
- 1 3mm red LED

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, case and components as per prototype............................$34.90

As above but with free mounting transducers.........................$41.90

Post & Packing charge............ $2.50

the monostable will be low for about the same time, long enough to trigger any alarm system. The indicator LED is driven by the output of IC3a, and this LED will light for the duration of the time delay.

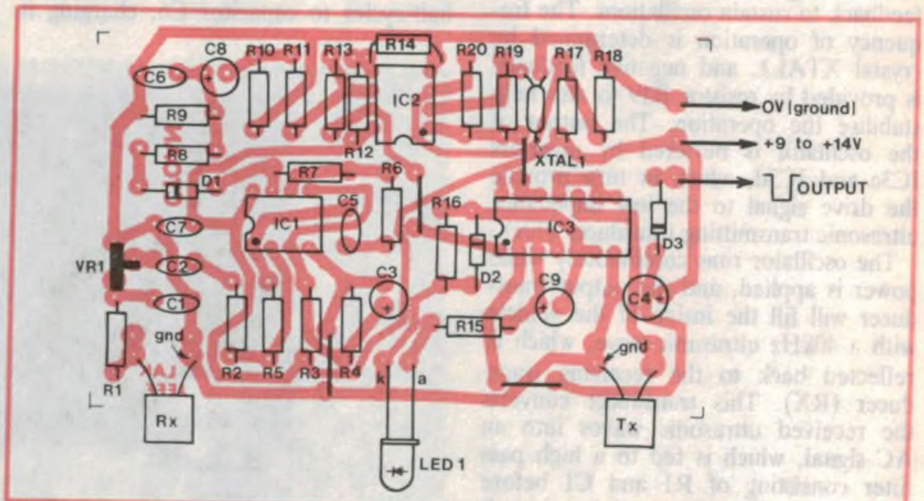
Construction

A kit of parts for the complete project as shown in the photographs of the prototype is available from Oatley Electronics for $34.90. Note that separate sensors (see Fig.3) can be used rather than the onboard types. These are available from Oatley Electronics instead of the PCB types, for an extra $5.00.

Begin construction by checking the PCB for any shorts across adjacent tracks, and any breaks that may have occurred during manufacture. The passive components and the four wire links can then be mounted and soldered in position, using the layout diagram as a guide. Follow with the diodes and the integrated circuits. IC sockets are recommended for ease of faultfinding, but they are not essential.

Next fit and solder the LED, both transducers (if you intend using an integrated assembly) and the 40kHz crystal. Note that the transducers are *not* interchangeable. The transmitting unit is marked with a 'T' and the receiving unit is marked with an 'R'. If you are using external sensors, solder the leads from these to the PCB, again checking that the receiver and transmitter transducers are identified and correctly connected. The earth braid of the shielded cable should be connected to ground, as shown on the layout diagram. Be fairly quick when soldering the crystal, to prevent damaging it. Finally, check your work for any bridges between soldered joints, or for incorrect orientation of components.

If all is well, test the unit by connecting it to a 12V DC supply. Assuming it



The layout diagram. If separate transducers are used, connect them in place of those shown. Make sure the earth braid of the shielded leads are connected to the points marked as ground.

is functioning correctly, the LED indicator will come on for a second or so, then extinguish. After this the unit should respond to movement as indicated by the LED turning on when the movement occurs. If the LED remains on or flashes continuously, try placing the unit in an enclosed area, such as inside a small room. If the unit still fails to function correctly, switch off the power and recheck the PCB for faults.

If the unit is functioning correctly, the case can now be prepared for mounting the electronics. Because the prototype was constructed as an integral unit, holes for the transducers were required. If separate transducers are being used, obviously these holes are not needed, although some form of entry for the connecting leads will still be needed.

The holes in the case holding the prototype were cut using a small milling tool fitted to a PCB drill, although a similar result could be achieved with careful filing using a smooth cut round file. Ideally, the two transducers should be mounted so that they face slightly off centre, though the contours of the vehicle''s interior should ensure dispersion of the transmitted signal. Holes for the indicator LED and an exit for the wiring are also needed.

Installation

The unit can be installed in a number of places, such as on the rear parcel shelf of a sedan, although care should be taken not to place it too close to the back of the seat in case rear seat passengers damage it. The prototype was fitted with a bracket that enabled it to be tilted, and of sufficient height to clear the top of the rear seat. Once the location, wherever it may be, has been selected, the wires to the main alarm unit can be run.

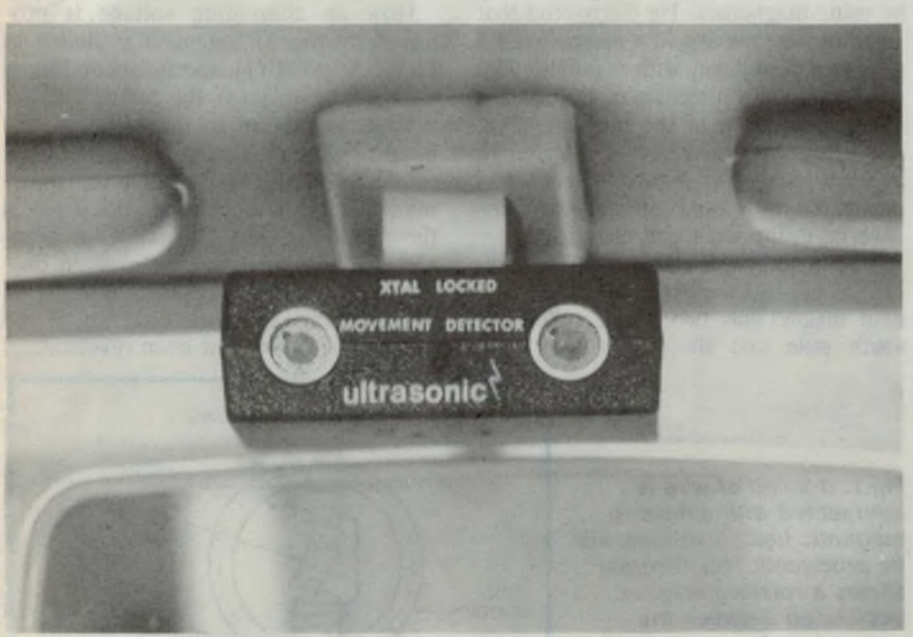
Connect the positive supply to the 9V output terminal of the Vulture alarm unit, or to a suitably regulated 9V or 12V supply if you are using another type of alarm.

Because the unit was designed to interface with the Vulture alarm, it has not been tested for operation from the car's 12V supply. It is possible that noise and voltage fluctuations will cause unreliable operation, and if this voltage exceeds 15V, damage to the unit may occur. For this reason, a 9V regulator is recommended. Also, the voltage supply should not be switched by the ignition switch, as power to the unit is required continuously. An interruption to the DC supply will cause a trigger pulse which will set off the alarm.

The ground wire should be connected to a suitable point on the car chassis. Make sure that good contact is made with the chassis, by scraping away any paint to expose bare metal. A smear of vaseline over the connection will help inhibit rust. Connect the output of the unit to one of the negative trigger inputs on the Vulture alarm module, or to an equivalent input on the alarm module you are using.

The detector can also be mounted on the dashboard, although the high temperatures that occur could cause the case to distort and damage might result to the electronics. As shown in the accompanying photos, the unit can even be attached to the top of the rear vision mirror, using double-sided tape. Alternatively the PCB can be positioned under the dash and the two transducers connected to the board via shielded cable. In this case the two transducers can then be attached to the windscreen or the front door pillars.

The photo of Fig.3 shows the remote mounting transducers available from Oatley Electronics, and although not clearly visible, they have clips to allow them to be attached to a door pillar by lifting the trim and fitting the clips around the pillar.



The integrated unit can be mounted on the rear parcel shelf or as shown, attached to the rear vision mirror.

Testing and adjustment

Testing of the unit should be done with the alarm disarmed (it's quieter that way!), as the Vulture alarm will provide the 9V DC required to power the detector when disarmed and operation of the LED indicator will show if the unit is functioning. First close all the windows, then sit inside the car and remain as still as possible. Then, while observing the LED, move an arm and check that the LED lights for a second or so. Winding a window down should also light the LED, as should any slight movement within the vehicle.

From outside the car and with one window down, try putting an arm through the open window. Again the LED should come on. In the prototype installation it was found that one window could be left down without causing false triggering, but two windows resulted in continual triggering of the unit. The reason is that movement outside the car will act as a trigger, as both the transmitted and received signals are no longer attenuated by the glass. However, a car fitted with a sophisticated alarm system but left with its windows down is a rather unlikely combination!

If you have installed the unit in a station wagon then check that the sensor responds if the tailgate is opened. In short, try everything to confirm correct operation of the unit, adjusting the sensitivity control where necessary.

In the prototype, the sensitivity control was left at maximum, but different installations will require different settings.

As a last test, confirm that the unit actually triggers the alarm. Then, once satisfied that the unit is fully functional, tidy all the wiring, replace all covers and relax with the knowledge that your vehicle is now fully protected. But don't forget to keep those windows wound up when the alarm is armed!

Alternating current and inductance

Alternating voltages are everywhere; in the form of radio signals, as a power source from a domestic power point, even as the signal from a microphone or a tape player. So, to really get into electronics an understanding of AC voltages is essential. But it's a big story, as we will see in this chapter...

by PETER PHILLIPS

DC voltages have been described fairly fully in previous parts of this series, as it is the type of voltage normally used to power an electronic circuit. However, unless you only ever use batteries, obtaining a DC supply is a problem, as alternating voltage and current (AC) are the standard for power distribution in all parts of the world.

We need to examine alternating voltage before we even start describing electronic circuits, as apart from providing the power, most circuits use alternating voltages as their signals. For example music, when converted to an electrical signal, becomes an alternating voltage – as are the signals received by a radio or TV antenna. In fact, DC voltages are generally only used to provide the power to the circuit, and DC generally needs to be produced from an AC source anyway.

We will start by examining the characteristics of an AC voltage, in particular those relating to the output of a power point. But we cannot stop there, as the world of electronics is full of all types of alternating voltages.

As we get deeper into the discussion, components such as the inductor and the capacitor will need to be described; until finally, we can *really* start by describing transistors and other semiconductor devices. But we have a bit to do before we get into actual electronic circuits...

Generating AC

In the last chapter, an alternating current was defined as one that periodically changes direction. To produce such a current requires a voltage that periodically changes *polarity*. And that's the definition of an alternating voltage – one that regularly changes polarity.

While it may seem difficult to produce such a voltage, it turns out to be very easy, easier in fact that producing DC voltage.

As described in part 3, dissimilar metals in an electrolyte will develop a potential difference – a DC voltage in fact, as it never changes polarity. But generating electricity using chemical means is only useful for small amounts of power, and other methods are necessary if useful power outputs are required.

It was Michael Faraday who first discovered a means of producing electricity by using magnetism. He discovered that a coil of wire moving in a magnetic field produced a voltage, with a polarity depending on the direction of the motion and the direction of the magnetic flux. The effect he discovered is referred to as *electromagnetic induction*, and was one of the most important and basic discoveries in the science of electricity.

Most readers will know about magnetism, at least to the extent that a permanent magnet has two poles, called the south pole and the north pole. The magnetic field created by a magnet is described as containing a number of magnetic *lines of force*, and the direction of these lines is assumed to be from the north pole to the south pole.

We don't need to get too involved in a discussion on magnetism at this stage, except to say that some materials, such as iron and ferrite pass magnetic flux lines more easily than air. As we proceed you will see that use is made of these materials to concentrate the magnetic field.

For the purposes of magnetic induction, it doesn't matter whether the magnetic field is moving and the coil is stationary, or vice versa, so long as there is *relative* motion between the two.

The diagram of Fig.1 shows a rotating magnet positioned so that its magnetic flux lines pass through a fixed iron *stator* holding the windings. The iron concentrates the magnetic field, to give the highest possible number of magnetic lines of force to interact with the windings.

How an alternating voltage is produced by this arrangement is shown in Fig.2. At point (1), the magnetic flux is not passing through the stator and no voltage is induced in the windings. At point (2), the maximum magnetic flux is produced in the stator, and the maximum voltage is generated. Point (3) is the same as point (1), while at point (4), the maximum voltage is again produced, but with the opposite polarity to that of point (2), as the direction of the magnetic flux has now been reversed.

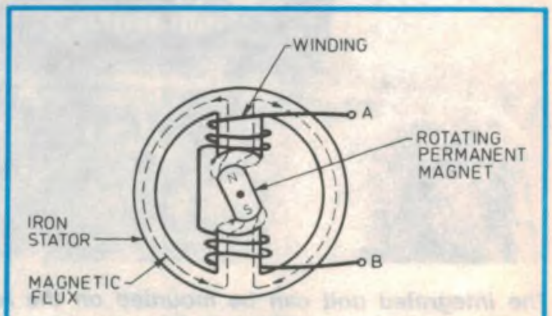


Fig.1: If a coil of wire is intersected with a moving magnetic field, a voltage will be produced. This diagram shows a rotating magnet, positioned between the poles of an iron stator which has a coil of wire wound around the poles.

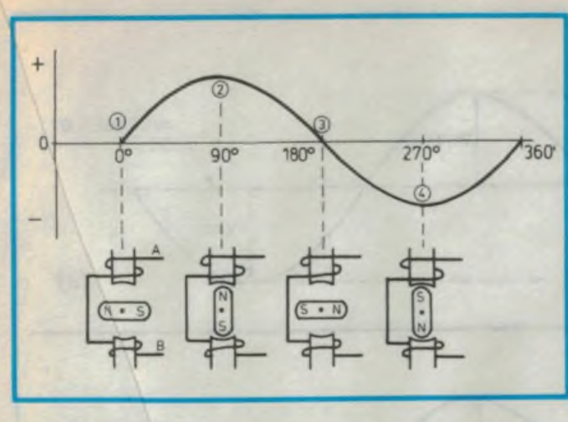
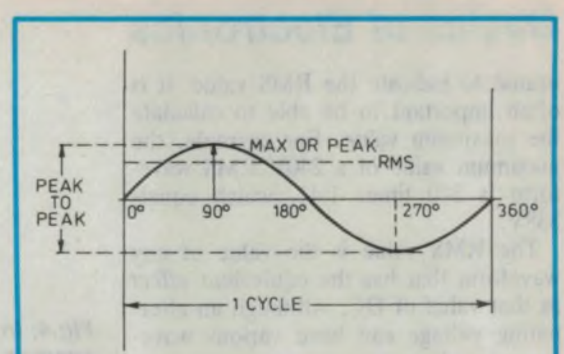


Fig.2: An induced voltage's magnitude and polarity depends on the direction and strength of the magnetic flux.

Fig.3: A sinewave's amplitude can be expressed in terms of peak, peak to peak or RMS values.



The lighting system of a pushbike is powered by a simple alternator constructed like that shown in Fig.1, in which a permanent magnet is caused to rotate by friction against one of the wheels. As any cyclist knows, the faster the rotation the higher the output voltage, and the brighter the light.

But why, if the output voltage periodically falls to zero, as shown in Fig.2, does the light appear to maintain a constant brilliance (i.e., without flickering)? The answer is that the filament of the globe has sufficient *thermal inertia* to smooth the cyclic variations of the voltage.

But this raises another interesting question – what value of DC voltage and current is equivalent to the AC making the light glow in the first place? To answer this and other questions, we need to look at the waveform shown in Fig.2 in more detail.

The sinewave

The waveform of Fig.2 is referred to as a *sine wave*, as it follows a mathematical relationship that conforms to the trigonometric sine of an angle. Those of you who up on trigonometry will be familiar with the term sine, cosine and so on, but for our purposes it is sufficient to identify the name, rather than get too involved in a lot of description about why! All waveforms have a specific shape, although some are so complex that they cannot be reduced to a simple mathematical equation.

The sine wave is an interesting waveshape, as it is the most fundamental of all the shapes. In fact, sinusoidal movement is common in many aspects of science. A pendulum, or someone on a swing traces a sinewave movement, in which the velocity is a maximum as the zero point is passed, but a minimum (i.e., actually stopping) as the direction is reversed. We will have more to say about sinewaves in future chapters, but just remember for now that it is a most important waveshape.

There are two aspects to any waveform; *time* and *amplitude*. The amplitude is the height of the wave at a particular point in time. This is also known as the *instantaneous value*, which for a sinewave can be calculated given certain other information. To understand how, refer back to Fig.2 which also includes the degrees of rotation of the alternator. As shown, it takes 360° for a complete *cycle*.

A cycle is the distance between any two identical points on the waveform, and always occupies 360 *electrical* degrees. The time taken for a complete cycle is called the *period*, and the number of cycles occurring per second is the *frequency*, measured in Hertz (abbreviated to Hz).

OK, that's the time or horizontal aspect of the wave; now for the height of the wave.

Fig.3 shows the various ways of expressing the value of a sinewave. Those occurring at the 90° and 270° points are the *maximum* or *peak* values, while the distance between the two maximum values is the *peak to peak* value. The third value shown is the *root mean square* value, written as RMS. But first, how about the instantaneous value we started to describe?

For a sinewave, the instantaneous value is calculated by multiplying the maximum value by the *sine* of the angle at which the value is occurring. For example, if the maximum value of an alternating voltage is 10V, the instantaneous voltage at 60° will be sin 60° times 10V, which equals 0.866 x 10, giving 8.66 volts.

By using this equation, it is possible to work out the value at any point along the wave, just by knowing the maximum value and the electrical degrees relative to the start of the cycle. And now to the RMS value.

The RMS value

One of the important aspects of an alternating voltage is its relationship relative to a DC voltage. If you have a 6.3V lamp, you know that it requires 6.3V of DC to operate correctly. Familiarity will probably tell you that the lamp will also operate properly with 6.3V of AC voltage – but is this the maximum value, or the peak to peak value of the voltage?

In fact it is neither, it is the RMS value. For a sinewave, the RMS value is calculated by multiplying the maximum (peak) value by the reciprocal of the square root of 2. As a close approximation, this equals 0.71 times the maximum, and a waveform with a maximum voltage of 10V has an RMS value of 7.1V.

By rearranging the terms, it is possible to calculate the maximum value of a sinewave given the RMS value, in which the maximum value (Vmax) equals the RMS value times the square root of 2, or Vrms times 1.41.

Because most multimeters are cali-

Table 1

Voltage measurements for a sinewave

$V_{max} = \sqrt{2}V_{rms} = 1.41V_{rms}$

$V_{rms} = 1/\sqrt{2}V_{max} = 0.71V_{max}$

$V_{p-p} = 2V_{max}$

$V_{max} = 0.5V_{p-p}$

$V_{dc} = 0V$ (for a full cycle)

$V_{dc} = 0.637V_{max}$ (for half cycle)

$V = \sin\theta V_{max}$ (V = instantaneous value at angle θ)

Time and frequency measurements

$\text{period } (t) = \frac{1}{\text{frequency}}$

$\text{frequency } (f) = \frac{1}{\text{period}}$

Inductive Reactance $(X_L) = 2\pi fL$

(f = frequency in Hz, L = inductance in henries) brated to indicate the RMS value, it is often important to be able to calculate the maximum value. For example, the maximum value of a 240V RMS waveform is 240 times 1.41, which equals 338V.

The RMS value is the value of any waveform that has the equivalent *effect* as that value of DC. Although an alternating voltage can have various waveforms, such as a square, triangular or complex form, most are sinusoidal. But it is important to realise that the equations given above are for the sinewave only.

Because the RMS value is the most useful, at least when it comes to applications involving power, this is the value that will normally be stated, unless otherwise indicated. The output voltage of a transformer is usually given as an RMS value, as is the mains voltage available from a power point. And by knowing or measuring the RMS value, the other values can be calculated by using the equations listed in Table 1.

There is one other value to be mentioned: the *average* value of a waveform. The average of any set of values is their sum divided by the number of values, and the average value of a waveform is calculated in the same way. If the average value of the waveforms of Figs.1 or 3 were calculated by adding, say 10 instantaneous values from the positive half cycle, then the same set of instantaneous values from the negative half cycle, the average would be zero. In fact, most AC waveforms have an average value of zero, but now we throw in a bit of confusion, sorry to say!

Average & DC values

The confusing point is that the average value of an AC waveform is also the value of its DC component.

What's this, I hear you say – isn't the RMS value the same thing? No, the RMS value is the value that has the same *effect* as that value of DC. In other words, a 10V RMS waveform, with a DC (or average) value of 0V has the same effect as 10V of DC. The waveform is said to have no DC component if its average value is zero. But can a waveform have a DC component?

Most certainly, and signal waveforms in an electronic circuit often have such a component. Fig.4 shows three sine waves, one with no DC component as already discussed and two others with a DC component. The waveform in (b) of Fig.4 has a positive DC component of 2V, and (c) shows one with a negative component of 4V. Note that the peak to peak value of all three waveforms are the same at 20V, but that the maximum (or zero to peak) values are all different. Also, the DC component can be calculated by adding the maximum values together and dividing their sum by two. Try it!

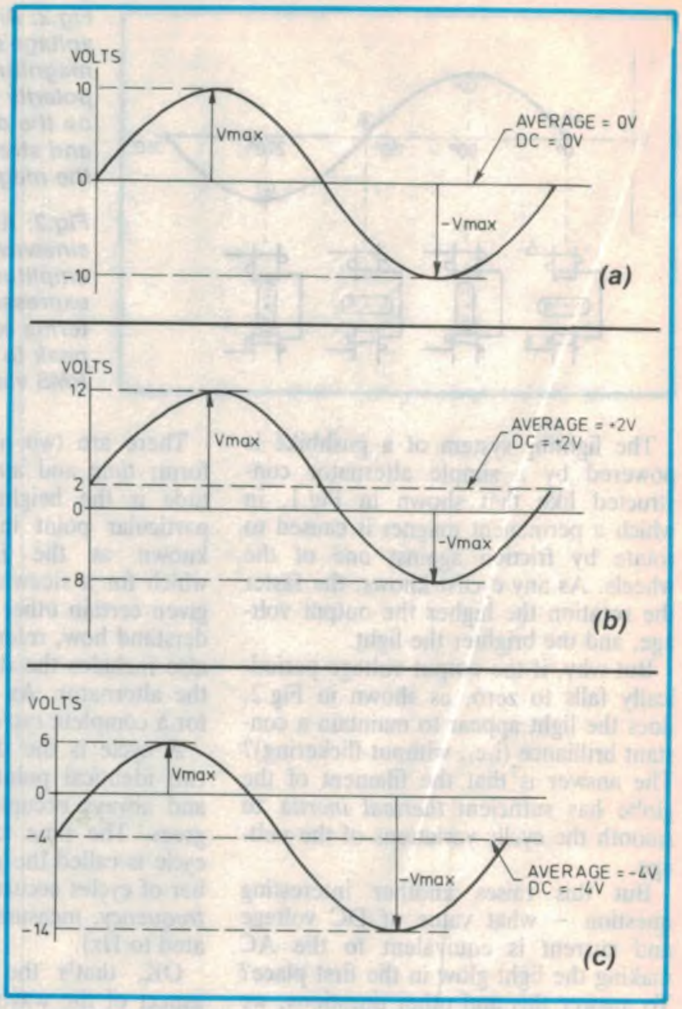


Fig.4: In (a), the average or DC value of the waveform is zero. In (b) and (c), a DC voltage has been added to the sinewave, giving the average values shown. In electronics it is quite common to have a waveform with a DC component.

The question arises as to the RMS value of a waveform with a DC component. In effect, if a waveform has a DC component, the DC component is additional – giving a corresponding increase in the RMS value. However, in practice, waveforms with a DC component are generally not used for power applications, meaning we don't need to consider the RMS value for these types of waveforms.

One final point, before we leave the topic of amplitude measurement of a waveform, is the average value of *half* a cycle. For a sinewave, the average (or DC) value of either half cycle (considered by itself) is 0.637 times the maximum value. This value has limited application, as only rarely is half a cycle considered – although it does effect the reading of some kinds of AC meter.

The complete list of equations relating all the ways of measuring the value of a sinewave are listed in Table 1. The values shown are voltages, but the equations apply equally as well to current values.

Frequency & period

We've discussed the vertical aspect of an alternating voltage in some detail, so now we need to return to examining its relationship to time.

As already stated, a complete cycle of any waveform takes a certain amount of time to occur. If the alternator of Fig.1 revolves at 60rpm, one revolution will take one second. The AC waveform produced will therefore have a period of one second, and the frequency will be 1 cycle per second, or one hertz.

Mains power is supplied at 50Hz, from large alternators that usually spin at 3000rpm. By knowing the frequency, it is possible to calculate the period, by using the equation of period (t) equals one divided by the frequency (f). That is $t = 1/f$, or t is the reciprocal of f.

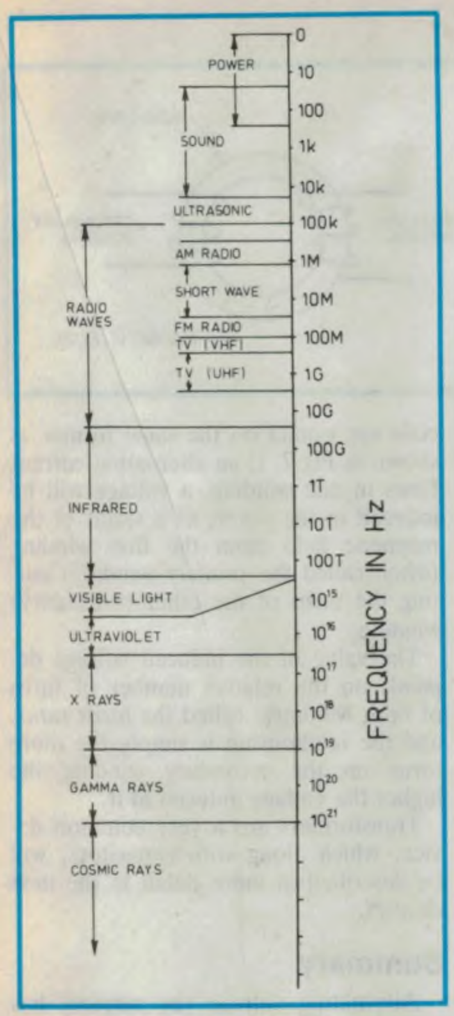


Fig.5: This diagram shows the frequency spectrum, and the applications of the varous frequencies.

Conversely, if the period is known, the frequency can be calculated by finding the reciprocal of the period, or f = 1/t. For example, the 50Hz mains supply has a period of 1/50, which equals 0.02 seconds, or 20 milliseconds (ms). A waveform with a period of 1 millisecond has a frequency of 1/0.001, which gives 1 kilohertz (kHz, equal to one thousand cycles per second).

Frequency is a most important aspect of a waveform, as it usually identifies the purpose of the waveform. We will have a lot more to say about frequency in future chapters, but for now here's a brief description of the frequency spectrum, also shown in Fig.5.

Frequencies from DC up to around 400Hz are found in power applications, such as the 50Hz used in Australia and the 60Hz used in the US, while 400Hz is occasionally used in aircraft. The range of human hearing is generally defined as being from 20Hz to 20kHz, although 20kHz is usually too high for most people, with 16kHz being a more typical figure.

Frequencies above 20kHz, ranging to 100kHz or so are often used in *ultrasonic* applications, where the frequency is still regarded as a sound, but outside the range of human hearing.

Radio waves are usually at frequencies above 100kHz or so, although some specialised systems use lower frequencies. The AM (amplitude modulation) broadcasting radio band occupies frequencies from around 500kHz to over 1600kHz. Shortwave frequencies follow on up to approximately 70MHz, after which comes the FM (frequency modulation) band using frequencies from 80MHz to 108MHz.

The TV (VHF or Very High Frequency) band starts at around 100MHz and continues up beyond 300MHz, followed by the UHF (Ultra High Frequency) band, which extends up to around 3GHz (3000MHz).

Microwave, millimetre waves start at 3GHz or so, and infrared frequencies start at 1THz (10^{12}), while visible light starts at 3.7 x 10^{14}Hz, becoming ultraviolet energy after 10^{15}Hz. Thereafter we are into X-rays and so on.

In this series we will be mainly interested in power, sound and radio waves, but it is interesting to look at the whole spectrum to see just how little of it these three applications occupy.

Now that AC voltages have been described, it's time to have a brief look at the effect of electromagnetic induction again, but this time from the reverse point of view. That is, what happens in a coil when current is caused to flow in it...

The inductor

Earlier we saw previously that Faraday discovered the effect of electromagnetic induction, in which a moving magnetic field caused a current to flow in a coil. It doesn't take much figuring to realise that a current in a coil will cause a magnetic field, and most readers will be aware of this phenomenon.

An electromagnet is nothing more than a coil of wire wound on an iron core. If a direct current (DC) is passed through the coil, one end of the core will become a magnetic north pole and the other the south pole, depending on the direction of the current.

But what happens if an alternating current (AC) is passed through the coil? Obviously, the north and south poles will regularly interchange as the direction of the current changes. But that's the easy bit, as now the effect of *inductance* comes into effect.

Inductance

The word inductance comes from the term *induce*, itself used to describe the fact that a voltage is produced in a wire if it is exposed to a moving magnetic field. But let's examine this a bit further.

The electromagnet is proof that a current produces a magnetic field, which actually encircles the wire as shown in Fig.6(a). By looping the turns, the magnetic lines of force are concentrated, as shown in Fig.6(b). An iron core concentrates the magnetic flux even more, illustrating that the number of turns, the current and the type of core all contribute to the strength of an electromagnet. The symbols shown in Fig.6 (c) and (d) are those used for an air-cored inductor and an inductor with a core (iron or similar) respectively.

So, if a moving magnetic field causes current to flow in a conductor, and a current creates a magnetic field, what is the total effect? In a word – *inductance*! When the current first starts to flow, the magnetic field will build up from zero, on the way cutting the very conductor carrying the current. This will induce a voltage that effectively opposes the current. And when the current is flowing, the same effect tends to resist any change in current level – either up or down.

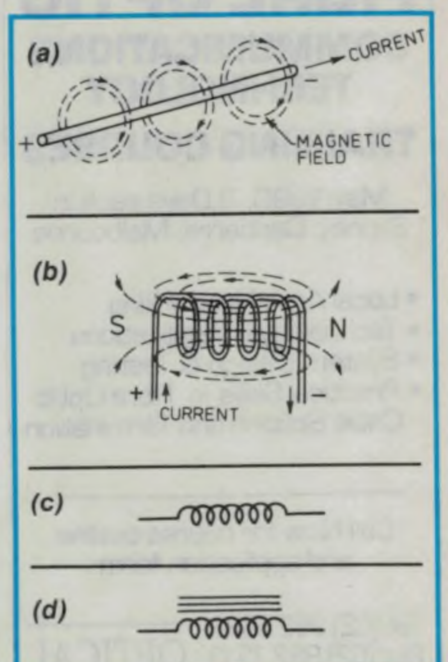


Fig.6: (a) the lines of force created by a current flowing in an inductor; (b) the effect of coiling the inductor; (c) the electrical symbol of an air-cored inductor, and (d) the symbol of an inductor with a core.

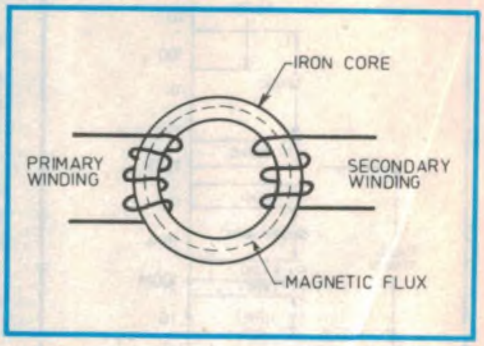


Fig.7: Mutual inductance allows one winding to induce a voltage in another. This is the principle of a transformer, and the voltage produced will depend on the number of turns in each winding.

This effect was first noticed in 1834 by Lenz, who came to the conclusion that *an induced emf is always of such a direction that its effect tends to oppose the motion or the change of magnetic flux which produces that emf.* This is similar to Newton's Third Law of Motion, which states that every action causes a reaction of equal force in an opposite direction.

When the current is changing all the time, as it is with the alternating current, the effect of inductance becomes quite significant. A single strand of wire doesn't have much inductance (though it has some), but a coil has quite a lot, depending on the number of turns and the type of core it is wound on.

All coils have inductance, and coils are often wound to have a specific value of inductance. Inductance is denoted by the letter L, and the unit is the *henry*. A typical inductance value for a small coil may be a few millihenries (mH), while a large coil could have an inductance of several henries.

Inductive reactance

The effect this inductance will have in opposing an alternating current will depend on the frequency, and the opposition is referred to as *inductive reactance*, abbreviated to X_L (X for reactance, L for inductance), measured in ohms.

The relationship is quite simple: the higher the frequency for a given inductance, the higher the opposition to the current, or the higher the inductive reactance. The equation to determine the value of inductive reactance is 6.28 x frequency x inductance. That is,

$$X_L = 6.28 \, f \, L \text{ ohms}$$

where f is the frequency in Hz, and L the inductance in henries. The value of 6.28 comes from 2 x π, and π fits into things because a circle and a sinewave are related.

But perhaps the most important effect is *mutual inductance*. A transformer operates on this principle, in which two coils are wound on the same former as shown in Fig.7. If an alternating current flows in one winding, a voltage will be induced in the other, as a result of the magnetic field from the first winding (often called the primary winding) cutting the turns of the other (secondary) winding.

The value of the induced voltage depends on the relative number of turns of both windings, called the *turns ratio*, and the relationship is simply the more turns on the secondary winding the higher the voltage induced in it.

Transformers are a very common device, which along with capacitors, will be described in more detail in the next chapter.

Summary

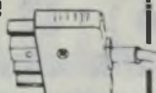
Alternating voltage (or current) has now led us more deeply into electronics. The most basic waveform is the sinewave, although many electrical signals have a more complex shape. A sinewave has two basic properties: frequency and amplitude, in which the latter is often expressed as either a maximum (peak) value or as an RMS value. A pure alternating voltage has a DC value of zero, but its RMS value produces the same effect as that value of DC.

The relationship between magnetism and electricity is most important, and electricity is usually generated in the form of an AC supply using a rotating magnetic field in conjunction with a winding wound on an iron core.

Inductance is a property of a coil determined by the number of turns and the type of core. Inductive reactance is the opposition a coil offers to an alternating current, increasing as the frequency and the inductance are increased.

So, putting it all together, alternating voltage (current), magnetism and inductance are a trio that today's world is very dependent on. A big story, but we are now on our way...

Telephone Bits & Pieces



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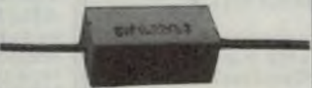

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Auto and manual ranging, 3.5 digit large 14mm LCD display - all in a handy probe. Logic testing function for CMOS/TTL. Data Hold button, Diode test, Continuity buzzer. Display shows all functions. Protected to 250V

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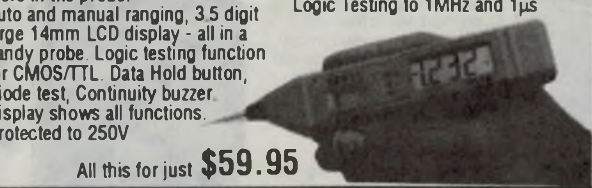
AC/DC Current to 200mA
Diode Test 2V
Continuity check to 2kΩ
Logic Testing to 1MHz and 1μs



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Quality, beige coloured, screws together. Removable aluminium end plates. PCB ribs. Rubber feet

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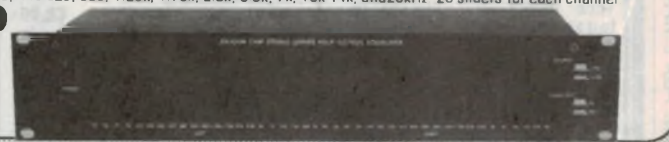
JAYCAR - NUMBER 1 FOR KITS

RADFAX DECODER

Ref: Silicon Chip Nov. 1989
IBM or compatible + short wave radio = non-voice transmissions via this kit on your PC. Kit includes PC board, front panel, box and all specified components except D plug.
Cat. KC-5059
$44.95

STUDIO SERIES HALF OCTAVE EQUALISER

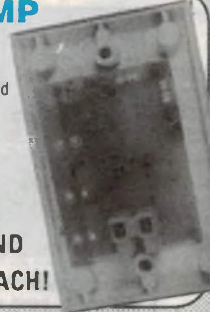
Ref: Silicon Chip Sept 1989
Completely new stereo equaliser has a performance equal to or better than the finest commercial models. The half octave freq. are: 28, 39, 55, 78, 110, 156 220, 319, 440 625, 880, 1.25k, 1.75k, 2.5k, 3.5k, 7k, 10k 14k, and20kHz. 20 sliders for each channel.
Cat. KC-5055 **$349**



TOUCH LAMP DIMMER

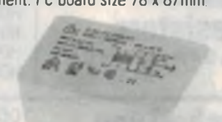
Ref: Silicon Chip June 1989
Turn your lights on and off and dim them just by touching a decorative plate. Kit includes PCB, HPM wallplate and all components.
Cat. KC-5052
$32.95

SPECIAL BUY 5 AND PAY ONLY $30 EACH!



ECONOMY MAINS FILTER

Ref: EA Oct 1989
Incorporates our bargain PCB mount filter network together with 2 varistors and a fuse mounted on a PCB. Short form kit designed to be mounted inside equipment. PC board size 78 x 67mm.
Cat. KA-1722
$18.95

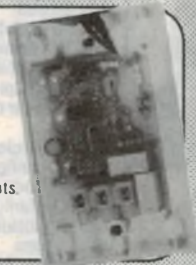


VERSATILE SUB-WOOFER ADAPTOR

Ref: EA May 1989
Incorporates active low-pass filter with variable cutt-off frequency and dual phase outputs for running a stereo amp in bridge configuration. The kit includes PCB, box, front panel and all components. Plug pack 12V AC Cat. MP-3020 $16.95 required.
Cat. KA-1717 **$29.95**

EXTENSION FOR TOUCH LAMP DIMMER

Ref: Silicon Chip July 1989
Includes PCB, silver decorator plate and all specified components.
Cat. KC-5053
$14.95



MULTIMETER KIT

Ref: Silicon Chip Nov 1989
An excellent way to learn about electronics and the result will be a quality analogue multimeter you can use for years. Ideal for educational areas, schools, etc. The unit is partially assembled with some soldering required. This 20kV/ohm unit has everything included including leads/probes and battery.
Cat. KC-5058
$34.95

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

NEW FOR 90

SPEED CONTROLLER FOR CEILING FANS

Ref: Silicon Chip November 1989
A gentle breeze from your ceiling fan rather than a gale! Full range control from fast to slow. Includes partially built Speediwatt module, wall mounting block and all components to connect to your existing fan control inductor.
Cat. KC-5063 **$16.95**

DIGITAL VOICE RECORDER

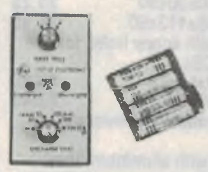
Ref: Silicon Chip Dec 1989
Can record your own voice, sound or music. Uses 4 separate RAM chips that can store 4 x 30 second messages or ganged together for 2 minutes. Kit includes PCB and all components. Speaker, mic insert and box not included.
Cat. KC-5072
$125

FM RADIO INTERCOM FOR MOTORBIKES

Ref: Silicon Chip October 1989
Provides communication between rider and pillion or riders on separate bikes. The unit is a 2-way radio system which allows you to communicate with more than one rider at a time. It operates on FM and even includes an FM tuner. Kit includes PCB, box, front panel, tuning label, mic inserts, speakers, plugs and sockets, mic cable and all specified components.
Cat. KC-5056
$69.95

NiCad DISCHARGER

Ref: EA Sept. 1989
Automatic discharger used in conjunction with KA-1718 NiCad charger. Kit includes PCB, box, front panel and all specified components. It is powered by the charger (KA-1718) or requires 15V DC.
Cat. KA-1719
$27.95



AUTOMATIC NiCad CHARGER

Ref: EA July 1989
It can charge single cells or cells in series up to 9V. Once the battery is charged the unit automatically switches to trickle charge until you switch off. Kit includes PCB, box, fronty panel and all components. You will need battery holders and a 12V AC plugpack. Cat. MP-3020 $16.95.
Cat. KA-1718
$42.50

RGBI TO PAL ENCODER/ MODULATOR

Ref: EA August 1989
Use your IBM or compatible on your TV. Kit is a low-cost RGBI to PAL video encoder and RF modulator. IBM or compatible must be fitted with CGA (colour graphics adaptor). Kit includes PCB, box, RF modulator, 9D plug and all components. Optional power supply parts not supplied. Cat. KA-1720 **$39.95**

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Sometimes the products we advertise are so popular they run out withina few days. At other times unforseen circumstances might hold up shipments so that advertised lines are not in the stores by the time the advert appears.
And, very occasionally, an error may slip through our checks and appear in the advert (we're human too!)
Please don't blame the store managers or staff, they cannot control a dock strike or a lost PCB artwork from a magazine to the PCB manufacturer for a new kit or fix an error that appeared in print.
If you are about to drive across town to pick up an advertised item, why not play it safe and call the store first - just in case.
Thanks

SEE OUR BRAND NEW CATALOGUE FOR FULL DETAILS ON THESE KITS

NEW JAYCAR CATALOGUE

Was issued FREE with March Silicon Chip and Electronics Australia. If you missed out simply call into any of our showrooms and buy your copy for $1. OR send $2 to PO Box 185 Concord 2137 and we'll mail you one. 148 pages - over 4000 products - many new ones.

PRO SERIES 1 POWER AMP - 140 WATTS RMS PER CHANNEL

Ref: EA Dec 1989/Jan 1990
NEW - upgraded design - now gives 140W rms channel into 8 ohms.
Dual toroidal transformers supplied
Cat. KA-1725
$599

NEW FOR 90

HOT CANARIES

Ref: Silicon Chip Feb 1990
This kit generates the sound of two birds singing and chirping, starting slowly and building up to both birds in full song. The kit is housed in a jiffy box and comes complete with PCB, speaker and all electronic components.
Cat. KC-5062
$24.95

NEW FOR 90

MASSIVE 12 & 16 CHANNEL AUDIO MIXERS

Ref: Silicon Chip Feb/March/April 1990
FULL 16 CHANNEL MIXER
Cat. KC-5065
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UNMOUNTED POWER SUPPLY
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NEW FOR 90

Jaycar Opens in Adelaide

As a result of great enthusiasm from our many customers in S.A. Jaycar now has a store right in the "electronic alley" of Adelaide at:

190 Wright Street (cnr Selby Street)
Phone: 231 7355

This huge showroom is packed with the full range of Jaycar products along with an extensive kit display area. Ample on and off street parking!

DC POWER LEAD BARGAIN

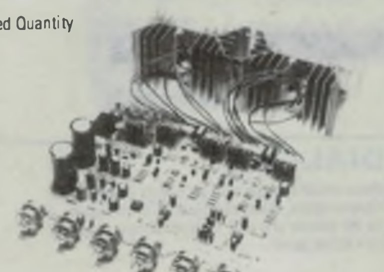
It consists of a fused cigarette lighter plug with 2 metres of heavy duty cable to a 1.8mm DC plug. Fuse is 3A. Fused cig. lighter plug is $2.95 on its own. Limited quantity.
Cat. PL-2008
ONLY $1.95 ea
10+ $1.50 ea

KNOB PACK

Another Jaycar surplus deal!
We have a quantity of Japanese Sato brand knobs, some lovely aluminium, some black and aluminium and some are just black. We also have a quantity of Rean knobs with different coloured caps. The Sato knobs are imperial and the Rean metric. This pack will include a minimum of 50 knobs - generally more. The majority will be Rean knobs - with caps, and the remainder Sato. The Rean knobs are worth about $1.20 each and the Sato up to $2 each. We figure there is about $60 worth of knobs.
Cat. HK-7050
ALL YOURS FOR ONLY $10

80+80 W RMS BUILT AMP

A complete preamp and high power amp - with power supply electronics and loudspeaker protector in the one package. All that you need to connect is a power transformer and a signal source. Transformer to suit Cat. MM-2015 $69.50.
Cat. AA-0310
Was $169.95
SAVE $40 NOW $129.95
Limited Quantity



SUPER HI FI BI-FET PREAMP

0.005% Distortion
Many features: phono in/out, aux input, loudness, bass, treble & midrange control + provision for tone defeat switch. Requires ±15V 200mA p/s). Size 203x106x40(H)mm
Cat. AA-0315
SAVE $25 NOW $59.95
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MAGNAVOX 8MV SELLOUT

8/30 replacement

Power Handling	120 watts rms
Resonant Freq	31Hz
Freq. Range	fo - 4kHz
Sensitivity	95dB
Qms	1.73
Qes	0.47
Qts	0.37
Vas	80L

Cat. CW-2110

WAS $99.50 ea

SAVE $24.50

NOW $75 ea

JC-250 10" WOOFER SELLOUT

Black square frame grey polypropylene cone. It requires a sealed enclosure of 70 litres.

Resonant Freq.	28Hz
Power Handling	75 watts rms
Freq. Response	45-4500Hz
Qma	3.54
Qes	0.85
Qts	0.68
Vas	170

Cat. CW-2120

WAS $64.95

SAVE $20

NOW $44.95

RE/Sponse SPEAKERS

- High Power
- High Quality
- Dual Impedance

See catalogue for full specs

6" woofer
4/8 ohm 80W rms Cat. CW-2140 **$69**

8" woofer
4/8 ohm 120W rms Cat. CW-2142 **$99**

10" woofer
4/8 ohm 160W rms Cat. CW-2143 **$149**

12" woofer
4/8 ohm 200W rms Cat. CW-2145 **$179**

Dome midrange
4/8 ohm Cat. CM-2090 **$47.50**

Dome tweeter
4/8 ohm Cat. CT-2010 **$29.50**

NEW FOR 90

SPEAKER STANDS

Get your speakers off the floor, these are made from aluminium anodised black, and are suitable for most speakers. They are supplied with castors and spikes (for carpet) and adhesive pads for wooden floors. Speakers sit off the floor approx 250mm (with castors). The width is adjustable from 148mm (ID) for small speakers to 250mm (ID) for large speakers. Depth is about 225mm. Supplied in pairs.
Cat. CS-2700

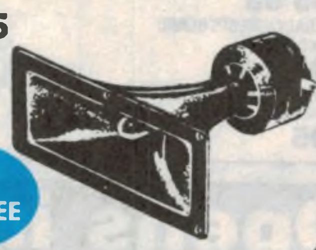
$49.95

NEW FOR 90

MOTOROLA KSN 1141A PIEZO TWEETER 400W RMS

Brand new Motorola Powerline horn. Includes a protection circuit internally which allows the new horn to handle 400W rms. It uses a miniature light bulb and a PTC resistor. Under extreme high power surges, the PTC opens up allowing the speaker to continue to play at a somewhat compressed power level. The resulting product is virtually blow-out proof.
Replaces the KSN1025A.
See catalogue for specs. 3 year warranty.
Cat. CT-1912

$37.95



3 YEAR GUARANTEE

TRUE RMS AUTORANGING 3.75 DIGIT METEX

- 5/sec sampling
- Data hold
- Frequency counter
- Diode continuity

See catalogue for full details
Cat. QM-1500

$169.50

NEW FOR 90

3.75 DIGIT 4000 COUNT - 39 RANGE

- Inductance
- Capacitance
- Frequency
- Temperature
- Peak hold
- Logic

See catalogue for full details
Cat. QM-1475

$179

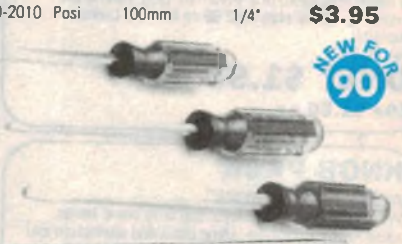
NEW FOR 90

SCREWDRIVERS

New for 1990. A range of quality Chrome Vanadium screwdrivers suitable for the hobbyist and electronics technician. There are 4 slotted, 3 Phillips and 2 Posidriver types.

Cat.	Type	Blade Length	Tip	Price
TD-2015	Slot	50mm	3mm	**$1.95**
TD-2016	Slot	75mm	4mm	**$2.40**
TD-2017	Slot	100mm	5mm	**$2.95**
TD-2018	Slot	100mm	6mm	**$3.95**
TD-2022	Phil	75mm	0 small	**$2.20**
TD-2023	Phil	100mm	1 med	**$3.50**
TD-2024	Phil	100mm	1 large	**$3.95**
TD-2012	Posi	75mm	3/16"	**$3.65**
TD-2010	Posi	100mm	1/4"	**$3.95**

NEW FOR 90

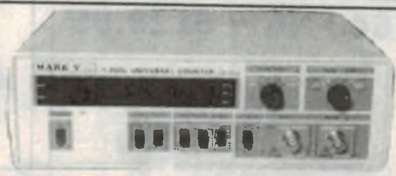


1.3GHz FREQUENCY COUNTER

Don't pay $499 - $700
See catalogue for full specs
Cat. QT-2332

$399

NEW FOR 90



ALARM PANEL TELEPHONE DIALLER

Connect to virtually any home/business alarm panel. It has built-in microphone which records a 16 second message by you and when the alarm is triggered will send the message to up to four different numbers, or any combination of the same. Suitable for tone and pulse systems. Also suitable as an alerting system for the elderly and sick. Easy to connect to both alarm system (N/C terminal) and telephone (2 wires). Requires 12V DC - from alarm panel.
We have seen this product for $249 in other electronic catalogues.
Cat. LA-5190

SAVE $70 **ONLY $179**

Simple LCD readout wind direction indicator

Here's an easy to build little project which will indicate the prevailing wind direction directly in degrees from North, on an LCD display. Based on a readily available DVM module, it's a lot simpler to put together than previous designs using reed switches and rotating magnets.

by B. MARSHALL

A wind direction indicator can be quite rewarding to build, whether you're into home weather forecasting, a keen sailing or hang-gliding enthusiast, or simply interested in exploring yet another application for electronics.

Earlier designs for this type of unit have tended to use a rotating disc coupled to the wind vane, with a small permanent magnet moving over a circular array of reed switches. The reed switches were generally connected to a set of LEDs and a power supply, so that each reed switch controlled a corresponding LED. The LEDs were arranged to form a circular display.

Only one or two of the reed switches would be activated at any one time, as the wind vane moved the magnet over them. Hence only one or two LEDs were illuminated on the display, making the wind direction fairly clear. (See the January 1982 issue of *Electronics Australia* for a project of this type)

It was a reasonably simple system electronically, but rather messy to build in a mechanical sense. The indication was also a little poor, in terms of resolution.

The wind direction indicator design described in this article uses a simpler approach. The wind vane is mounted directly on the spindle of a potentiometer, which is capable of rotating through the full 360°. The pot is connected as a simple variable resistor, forming part of a voltage divider across a DC supply. As a result, the divider output varies according to the wind direction and angular position of the pot rotor.

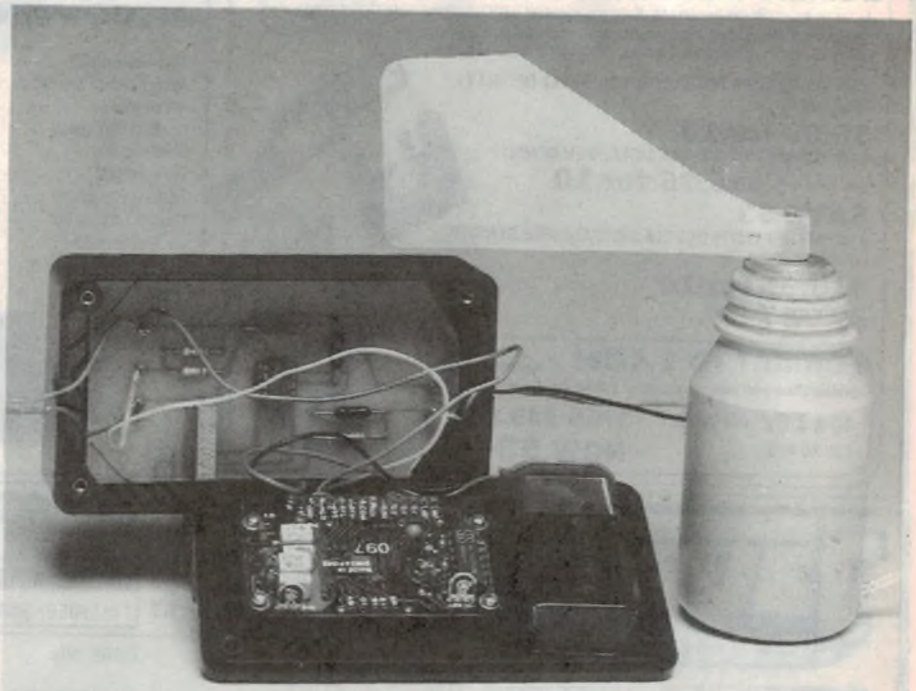
A simple op-amp buffer is then used to couple this varying voltage to a readily available LCD-readout DVM panel meter module. The gain of the op-amp buffer is adjustable via a preset pot, to allow the DVM readout to be calibrated directly in degrees.

The only special parts required for the project are the DVM panel meter module and the 360° pot, which has a value of 2000 ohms.

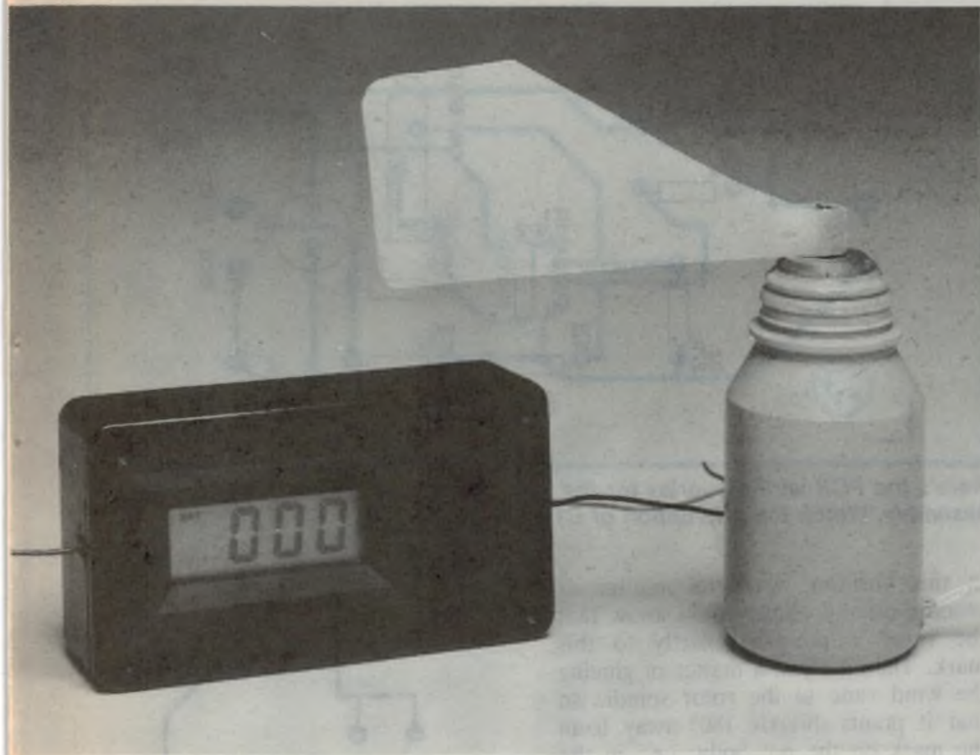
The DVM module used in the author's prototype unit was purchased in the UK, but a very similar unit is available from Dick Smith Electronics, and is listed in that company's catalog as Q-2200. It should therefore be readily available, although any other small DMM panel meter module with a full-scale sensitivity of 200mV, high input impedance and the ability to operate from 9V DC should be equally suitable.

(Editor's Note: DSE has a similar module in kit form, as K-3450, while Australian Test and Measurement also markets an LCD DVM module in kit form, as ATM-14. Both of these would seem to be quite suitable.)

The 360° pot is not so readily available, and you may have to hunt around a bit. That used in the author's prototype came from Farnell Electronics. Made by Spectrol, it is listed in Far-



Inside the author's prototype, showing the DVM module mounted in the case lid with the battery, and the PCB in the case itself.



The completed prototype, with power on to show the display digits – but with the sensor pot turned to give a reading of '000'.

nell's catalog as a '157 Series, Conductive Plastic Servo Mount' pot, and comes with a mounting kit comprising three clamps, nuts and screws plus mounting instructions. The ordering code is 157-2K.

Radiospares Components also lists a very similar if not identical pot in its catalog, as stock number 173-568.

One of these pots will cost you about $42 – they're not cheap, but of very high quality and rated for 10 million rotations of the shaft. You might be able to pick up a suitable pot from a disposals store rather more cheaply, however. They're of the kind made for position sensing in servomechanisms – hence the 360° rotation.

The rest of the components used are readily obtainable, with the electronics and display part of the project housed in a small jiffy box.

The circuit

As you can see, the circuit is very simple and straightforward – thanks to the use of a DVM module.

The 360° pot VR1 is connected as a variable resistor in series with R3 across the 9V supply, forming a voltage divider. The output of the divider will therefore vary between 0V and approximately 2.7V, with the rotation of VR1 in response to the wind vane.

The op-amp is configured as a simple non-inverting amplifier, with 10-turn trimpot VR2 adjusting its gain for calibration. This is followed by a 100:1 output voltage divider, consisting of R5 and R6, to make the circuit suitable for operation with almost any DVM module.

A CA3240E op-amp was used by the author, but if this is not readily available, a TL072, LF353 or MC1458 should be quite satisfactory.

The voltage gain of the op-amp stage is adjusted to 1.3, giving an output voltage swing of 0 – 3.6V for the complete rotation of VR1. After the 100:1 output divider this produces a swing of 0 – 36.0mV at the input of the DVM module. Since the module reads from 0 to 199.9mV, with a resolution of 100uV, this arrangement thus gives a direct readout of the wind vane angle in degrees, once the calibration is set using VR2.

The complete circuit, including DVM module, runs from a 216-type miniature 9V alkaline battery. The total current will be about 7.6mA, as the DVM module typically only draws around 1mA.

Construction

The electronics for the author's unit was housed in a medium-sized jiffy box measuring 130 x 68 x 41mm. The DVM module was fitted into the lid, with the 9V battery alongside, while the rest of the circuit components are mounted on a small PC board measuring 95 x 52mm, and fitted into the bottom of the case. A small hole in the side of the case is used for adjustment of calibration trimpot VR2.

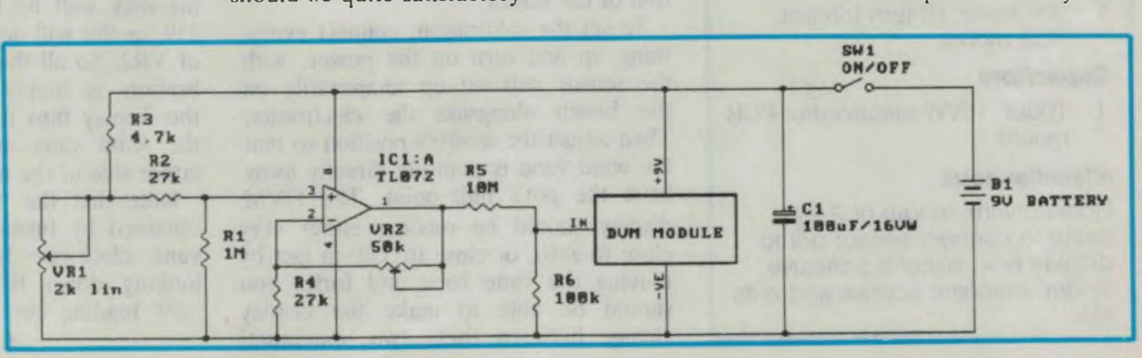
The author mounted the sensing pot VR1 into the neck of a small plastic drink bottle, which just happened to have the right internal diameter (22.2mm). Alternatively you could use a length of PVC tubing, fitted with matching caps.

The pot is cemented into the housing with silicone adhesive, after fitting the connection cable. The latter is brought out of the bottom of the bottle via a small close-fitting hole, and then sealed with silicone adhesive to keep out moisture.

The wind vane for the prototype was cut from a discarded plastic ice-cream container, and glued to the pot shaft with the same silicone adhesive. It is about 130mm long, 50mm wide and shaped as shown in the photographs.

Note that the vane must be glued to the shaft so that it points exactly 180°

As you can see from the schematic, there is very little circuitry involved apart from the DVM module.



away from the pot's internal rotor contact. This is easier to do than it sounds, though, and you don't have to pull the pot apart!

Connect up the rotor and one end of the pot element temporarily to your multimeter, set to a medium ohms range. This will enable you to monitor the pot's resistance, as the rotor is turned. If you choose the right end of the element, the resistance will increase smoothly from 0 to 2000 ohms, as the rotor is turned *clockwise*.

Take careful note of these connections, by the way – they're the correct ones to use for the pot when you're fitting the cable which runs to the display box. The only difference is that for the final wiring, the currently unused end of the pot element is tied to the rotor lug as well.

At this stage, you'll find that when you turn the rotor past the 2000-ohm point, the resistance suddenly flies up to infinity before coming back to zero. This is the point we're looking for, where the pot's rotor is passing over the 'null point' between the two ends of the resistance element.

The physical location of the null point is marked on the outside of the pot body. So if you leave the rotor carefully in this position, with the multimeter reading infinity ohms, you'll know that the rotor is pointing exactly to this mark. Then it's just a matter of glueing the wind vane to the rotor spindle so that it points directly 180° away from the mark on the pot body, i.e., in the opposite direction.

Assembly of the components on the PCB should be very straightforward, using the overlay diagram and internal photograph as a guide. The IC is probably best mounted in an 8-pin DIL socket, to ensure it isn't damaged by soldering.

In the prototype, the 9V battery was attached to the inside of the case lid with a small blob of 'Blue Tack' adhesive putty. However a small bracket cut from a scrap of aluminium sheet could be used if desired. Another strap of the same material can be used to attach the wind sensor assembly to the top of a post or other suitable pipe or bracket – but remember to allow clearance for the wind vane to rotate freely through the full 360°, and to orientate it correctly as described in the next section.

Setting it up

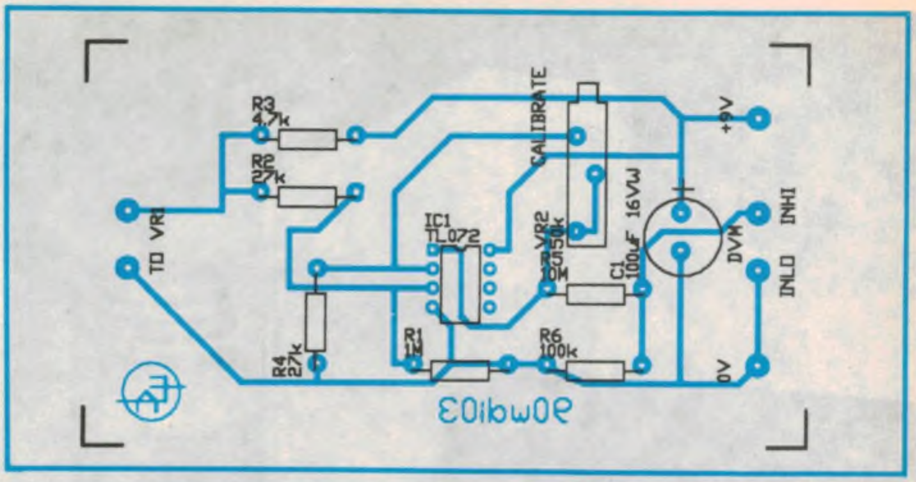
There is really very little involved in setting up this project. In fact there are only two steps: calibration and orientation of the sensor.

To set the calibration, connect everything up and turn on the power, with the sensor unit set up temporarily on the bench alongside the electronics. Then adjust the sensor's position so that the wind vane is pointing directly away from the pot's null point. The DVM display should be reading either very close to zero, or close to 359; in fact by moving the vane back and forth, you should be able to make the display change between these two 'minimum' and 'maximum' readings.

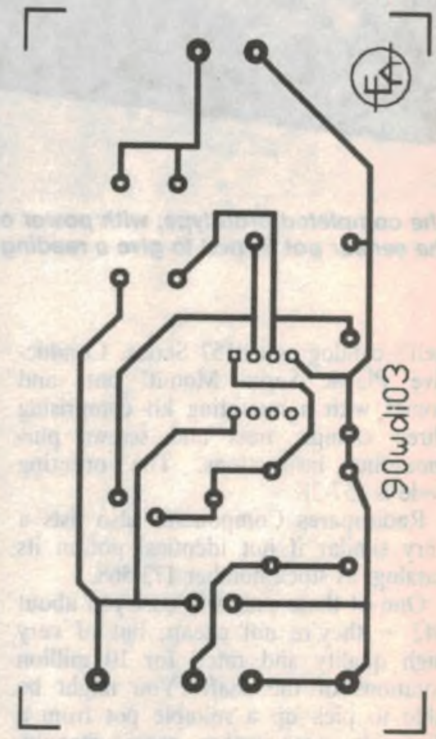
The minimum reading should be exactly 0, if the DVM module is correctly adjusted; however the maximum reading may well be higher or lower than 359, as this will depend upon the setting of VR2. So all this is involved, for calibration, is simply adjusting VR2 until the display flips from '0' to '359' when the wind vane and rotor are moved either side of the null point position.

Note that the '0' reading should be obtained by turning the pot rotor and vane *clockwise* from the null point, looking down from above, with the '359' reading obtained by turning *anti-*

Continued on page 100



Here's the PCB wiring overlay for the wind direction indicator, to guide you in assembly. Watch the orientation of C1 and IC1.



For those who like to etch their own PC boards, here is the pattern actual size.

PARTS LIST

1 Jiffy box, 130 x 68 x 41mm
1 PC board, 95 x 52mm, code 90wdi3
1 3.5-digit DVM module, LCD display (see text)
1 9V alkaline battery with matching battery snap lead
1 Miniature toggle switch, SPST

Semiconductors

1 CA3240E, TL072, FL353 or MC1458 dual FET op-amp IC

Resistors

All 1/4W, 5%: 1 x 4.7k; 2 x 27k; 1 x 100k; 1 x 1M; 1 x 10M.
1 2000 ohm linear pot with 360° rotation (see text)
1 50k linear 10-turn trimpot, PCB mount

Capacitors

1 100uF 16VW electrolytic, PCB mount

Miscellaneous

Hookup wire, length of 2-wire cable to connect sensor pot to display box, silicone adhesive, solder, machine screws and nuts etc.

Vintage Radio

by PETER LANKSHEAR

Repairing valves

As valve manufacture has virtually ceased, it is prudent to conserve remaining stocks. Often, valves were put aside because of a minor fault, and in salvaged receivers they will frequently be found damaged or with top caps missing. I am not advocating the installation of vacuum pumps and glass blowing equipment(!), but many valves have external faults that can be readily repaired.

Until the 1950's, the available cements and glues coped well enough with materials with porous or soluble surfaces, but there were no heat resistant adhesives that would bond really well to metal, glass or ceramic.

Prior to the advent of metal and all glass construction, valve production was based on techniques used for making electric lamps. Connections were made to pins inserted into moulded bases, to metal caps or to terminals. It followed that cements for fastening these fittings to the bulbs were those used for lamp bases, and a typical mixture consisted of pine resin and plaster of Paris. Another formula used yellow lead oxide and glycerine!

Considering their primitive nature, these old cements were remarkably effective. But after 50 years or more, they have often deteriorated, and vigorous extraction of a valve from a tight socket is likely to result in a loose or disconnected base. Similarly, grid and plate caps readily become unstuck with heavy handling.

It's for this reason that one should always grasp a valve by the base or prise it up with a screwdriver. For easing off grid or plate clips, I find the point of an old school compass useful.

Modern adhesives

With a high proportion of valves in need of recementing, it is fortunate that it is now possible to glue just about anything to anything. A loose base with intact wiring can be resecured by inserting some glue where it contacts the envelope, and applying mild pressure with a rubber band during setting.

The cyanoacrylic or instant 'Power Glues' are popular, but are not always ideal. This class relies on intimate contact between the mating surfaces, not always provided by crumbling base cement, and there is some doubt about their long term reliability.

A very suitable adhesive is an epoxy resin, of the type that comes in two packs. Moderately heat resistant and a good insulator, it bonds well to metal, valve bases and glass. Most importantly, it is gap filling and stable. I have valves repaired 10 years ago with epoxy, which still show no sign of coming apart.

The resin is rather viscous, and some is bound to adhere to areas where it is not wanted. Smears can be removed with a solvent, or can be scraped off with a craft knife a few hours after curing has commenced.

Metallised valves

Loose bases on valves with sprayed metal shielding are likely to cause insta-

***Fig.1A:** A common problem with metallising. Not only has the base become loose, but the earthing wire has lost reliable contact with the shielding.*

***Fig.1B:** Wrap a layer of 5A fusewire around the damaged shielding and solder to the earthing wire.*

***Fig.1C:** After re-gluing the base and coating the wire with epoxy resin, cover the repair with a strip of tape or paper.*

bility. A common method of earthing the shielding was by means of a fine wire embedded in the coating around the top of the base, and as can be seen in Fig.1A, any loosening of the base is likely to destroy the connection.

Figs.1B and 1C show one successful method of repair. Carefully lift out the earthing wire, scrape off the paint and then wind a layer of fuse wire on the metallising adjacent to the base, soldering the ends and the earthing wire together. Although these valves were often coated with lacquer over the metallising, contact to the fuse wire is normally adequate. If you have any doubts, first carefully clean the area to be covered with very fine sandpaper, being careful not to damage the coating further. After soldering, coat the wire and the base-envelope junction with epoxy resin.

The repair will not be very nice looking, but Philips in particular often stuck a narrow paper label around this area of their valves. A strip of tape or heavy paper to disguise the repair will not therefore look too much out of place.

Loose caps

Missing, or loose grid and plate caps and terminals are easily fixed. Melt the solder in the cap, and straighten the lead. Lift off the cap, and after removing any remaining solder and old cement, coat the inside with resin and thread it back into position. Resolder when the resin has cured.

Sometimes the wire will have broken off short. Before cementing the cap back on, extend the lead by soldering on a short piece of 5 amp fuse wire.

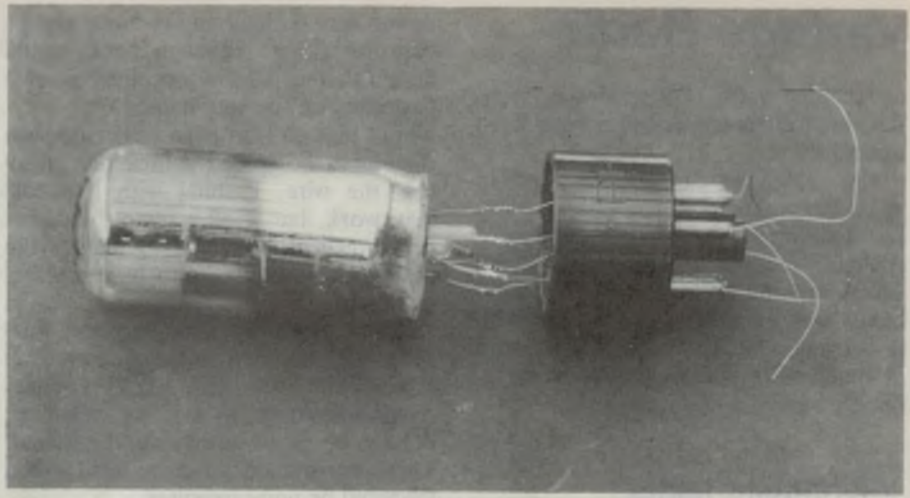


Fig.3: This 6X5GT/EZ35 has had the leads extended and inserted into the base pins ready for re-gluing. A 5-pin base would have converted it into a type 84, or with a side-contact type P base it would have become a replacement for a type EZ2.

More serious is the situation when the wire breaks off flush with the glass. At first sight this may seem to be a hopeless situation, but there is a remedy that works in most cases. Valve glass is relatively soft, and with a bit of care, can be cut with a fine file. Seals around leadout wires are usually generous, and can be cut back sufficiently to expose sufficient lead to salvage the valve.

The technique is shown in the photographs of Figs.2A and 2B. Use a *sharp* 4" or 5" fine-toothed triangular file and gently cut around the seal so as to expose about 0.3mm of wire. Loop a piece of 5 amp fusewire around the tip, and carefully solder the junction. Twist the tails of the fuse wire together and refit the cap as previously described.

Fig.2A: This type 24A valve has the grid lead broken off flush with the glass sealing tip.

Fig.2B: After the glass around the seal is carefully cut back with a sharp file, a loop of fusewire and a spot of solder make the valve ready for refitting the grid cap.

Replacing bases

Broken spigots, a problem peculiar to octal bases can be refastened with a little epoxy resin. However, if the spigot is lost, a base damaged, or any of the leads are broken, more drastic repairs will be necessary.

After melting the solder at the tips of the pins, remove the base. Then, in a good light, identify the leads and study where they emerge from the press. (The press, inherited from lamp manufacture, is the flattened glass tube that supports the electrodes and acts as the exit area for the leads). Comparison with the base connection diagram will show a sequence that enables the leads to go direct to their pins, usually without touching.

Straighten the leads and position them in the pattern that they should occupy. Sometimes one or two of the leads will have insulated sleeving fitted, if there is any risk of a short circuit. Renew the sleeving if it has perished.

Clean out any old cement and attempt a trial fitting of the base. Chances are that some of the leads will be too short, and will have to be extended with a piece of the ubiquitous fine fuse wire, but be careful to keep the diameter of the splices small enough to enter their pins.

When satisfied with the fitting, coat the inside of the base with epoxy cement and hold it in contact with the bulb with a rubber band. Carefully resolder the wires to their pins and trim off the surplus.

All this may sound a bit drastic, but it is relatively straightforward. Nevertheless, it is a good idea to practice first on

Vintage Radio

a discarded valve. Try triodes or rectifiers before tackling complex types such as octodes.

This technique can also be used to 'manufacture' hard to get valves, a better solution than the alternative of changing receiver sockets. Octal based valves are still relatively plentiful, and many were simply earlier types with new names. For example, a 6U7G can be modified to become a 6D6 by changing the base and grid cap.

Intermittent faults

It was only the tips of valve pins which received any solder, and dry joints in the pin connections can be the source of some very frustrating intermittent faults. Any electrode can be affected, but heater leads in particular can be troublesome. This is easily recognised when the signal fades away or recovers over a period of several seconds. Often sideways pressure on the valves will reveal the offender.

Resoldering may not be easy. Lead-out wires are generally a copper coated alloy with an expansion coefficient the same as glass. Oxidation makes resoldering very difficult and cleaning can be very frustrating. Although it may sound heretical, the judicious application of a paste flux can be very helpful.

Split pins on European style bases can sometimes be spread sufficiently to access the wire. Probing with a needle may work, but if all attempts fail, the only practical remedy is to remove the base and proceed as with base replacement.

One particularly annoying and puzzling fault sometimes encountered in valves with top grid caps produces symptoms similar to a faulty capacitor, but can be easily cured once it is found. There are sudden jumps in level, often triggered by noise impulses.

Once a valve has been identified by substitution as having this problem, melt out the solder in the grid cap. Frequently the lead wire will be quite black, without a vestige of tinning. Scrape it clean and resolder.

Although some repair attempts may be unsuccessful, a surprising number will succeed and it is worthwhile making every effort – because there aren't going to be any more valves made.

Finally, when discarding valves that really are beyond fixing, it is a good idea to save a selection of bases and top caps for future repairs.

Wind Indicator

(Continued from page 96)

clockwise. If your unit gives the opposite of this, you have wired up VR1 incorrectly – so open up the sensor unit, and swing the fixed element connection over to the *other* end of the element. Don't forget to link the 'other' end over to the rotor lug, too.

With this done, it only remains to mount the wind sensor in its final position, so that the null point mark is orientated as accurately as possible towards the North. Otherwise, the indicator will read accurately in degrees, but not with respect to North!

The best plan is to take a compass up alongside the sensor, and use this to orientate it so that the pot's null point mark is pointing towards North as closely as possible. Then you can tighten up the mounting strap.

Your wind direction indicator should now be complete, and working correctly. However, if you have any problems, the author has volunteered to help with advice. His address is:

Mr P. Marshall,
'Dewlands'
32 Fairfield Approach,
Wraysbury Nr. Staines,
Middlesex, UK TW19 5DS

Battery fluoro lamp: the rest of the story

When last month's article on Norm Bush's portable battery fluoro lamp was being prepared, we were in the midst of moving offices. It was only when the issue had been printed that we discovered we'd inadvertently left out both the parts list and an addendum by Peter Phillips, on using an alternative toroidal transformer. Sorry for the foulup, but here is the missing information – better late than never!

by PETER PHILLIPS

Using a toroid

Regular readers of Information Centre will be aware of the lead up to this project, which commenced with a correspondent asking about repair of portable fluorescent lights. Since then we have had several readers offering circuits and ideas and I have also conducted my own research. I had in mind using a toroid as the transformer for an inverter circuit; all I lacked was the inverter circuit itself.

When this project turned up, I contacted Oatley Electronics, who I knew stocked a toroid at a nice low price. They supplied me with several, and even wound the required windings. Here then is the result of my experimenting, which I'm sure will be of interest to anyone thinking of building this great little unit.

The toroids available from Oatley Electronics have a winding of some 230 turns already fitted, roughly equal to winding L3 of the circuit. To keep the ratios the same, 20 turns were wound over the existing winding for L2 and 5 turns for L1. Oatley Electronics gave me two versions, one with the extra windings wound with enamelled copper wire and the other using bell wire. I decided to try the latter, as it meant I didn't have to fit any sleeving, or tin wires other than those from the original winding, which uses enamel coated wire.

I strung the circuit together by fitting an AD149 to a heatsink and soldering the remaining components onto the terminals of the transistor. The result was instant success.

With 12V applied, the light output was not quite as high as that from the unit already described, but the current consumption was less than half at 230mA. As well, the circuit was totally silent and appeared more stable. Best of all, the transistor hardly got warm, suggesting it could be fitted directly to a PCB without a heatsink.

I also found that connecting a 1k resistor in parallel with R1 increased the light output to almost equal that of the unit fitted with the pot core transformer. The current consumption rose to around 350mA, but the transistor still operated without a significant increase in heat dissipation. So this gives a handy way to have an 'economy' setting for portable use,. and a 'flat out' setting when driven from a car battery.

A disadvantage is that the circuit would not operate at voltages less than 10V, unlike the pot core version, which seems to perform more efficiently at voltages less than 10V. In other words, if you want a portable fluorescent light that runs from a set of NiCads (7.2V), the pot core is still the best choice. For 12V operation, such as in a car, the toroid seems to offer a higher efficiency.

The toroid is very easy to fit to a PCB; either use wire straps or a centre *brass or nylon* screw. Also it is easy to identify the start of each winding by simply taking those wires from the top of the core.

One final point is the AD149 transistor. My first concern in presenting this project was the availability of these rather hard to get devices. Oatley Electronics have informed me they have been able to source these, probably at around $2 each.

Further, as a result of their input to this project, Oatley Electronics have decided to sell a kit (toroid version only) for this project at a cost of $12.90 plus postage. The kit will include a PCB, which has been redesigned to accommodate the toroid, all components (except the heatsink) and the necessary wire. You will have to get your own fluorescent tube however.

I suspect other suppliers will also eventually stock a kit for this project, as it really seems to answer the question of how to service a portable fluorescent light; don't – build this one!

PARTS LIST

1 PCB, 125 x 50mm
2 Miniature fluorescent tube holders
1 Toroidal ferrite core* (or FX2242 (or equiv) pot core)
1 Bobbin to suit pot core
Aluminium, 212mm x 50mm x 1mm
Lengths of 26, 32 and 38 SWG enamelled copper winding wire
Miscellaneous screws, spacers, hookup wire, 1mm and 1.5mm plastic sleeving

Resistors

1/4W, 5%: 1 x 680 ohm, 1 x 1k*
1W, 5%: 1 x 100 ohm

Capacitors

1 10nF polyester
1 0.68uF polyester
1 470uF, 25V electrolytic

Semiconductors

1 AD149 (or equiv.) germanium PNP power transistor

* for toroid version only

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.

April 1940

South sea expedition: An expedition will shortly leave New York for a cruise extending over two years. It will be known as the Fahnestock South Sea Expedition, and will be aboard the schooner *Director II*. The purpose of the expedition will be to record native music, collect bird groups for the American Museum of Natural History and also to make oceanographic studies for the US Navy.

The chief point of interest to shortwave listeners is the fact that the schooner will be equipped with a 1kW transmitter, which will be used to keep in touch with the USA, and also to give a series of 20 broadcasts to the National Broadcasting Company from various out-of-the-way spots. The experimental frequencies to be used are as follows: 4797, 6425, 9135, 12862, 17310 and 23,100kc.

Magnetising ships: John Moyle in an article titled 'Have we beaten the magnetic mines?' writes as follows:

The essence of the magnetic mine is a compass needle, which normally rests horizontally. While there are no iron or steel bodies in its vicinity the needle maintains this position and the mine remains a potential source of danger.

Should a ship come within its range, the magnetic needle is deflected from its normal position, and tends to point towards the hull. When the ship is approximately over the spot where the mine is lying, the needle, being upright, actuates a firing mechanism, and explodes, taking the ship with it.

A new device known as the 'de-gaussing' equipment passes a heavy current through a cable surrounding the ship, preventing the attractive effect on the needle which operates the mine's mechanism.

April 1965

Perth to east coast cable: According to an announcement by Postmaster-General Alan Hulme, his department was pushing ahead with a plan for a high capacity trunk system between Perth and the eastern half of the Australian continent. Initial capacity would be for 300 telephone conversations, plus telegraph channels, with subscriber dialling in view.

The link involves roughly the same distance as between London and Moscow but over vast areas with little population, little water or power and subject to climatic extremes. Tenderers are free to choose coaxial cable or a microwave link system.

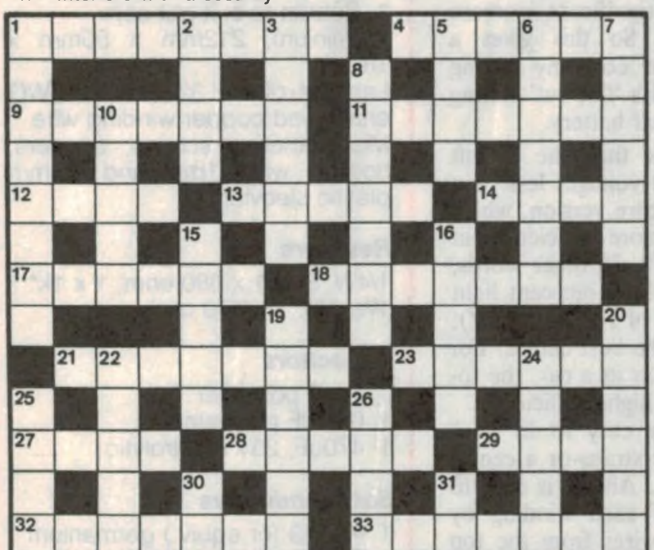
Electron welding: Electron beam welding outside a vacuum chamber is now said to be possible with a system developed by United Aircraft Corporation of Connecticut.

The necessity to enclose work-pieces in a vacuum has previously limited the usefulness of the electron beam in welding. The United system develops the beam in a vacuum but the welding is done outside the tube. This permits joining long tubes or the ends of coiled strip.

EA CROSSWORD

Across

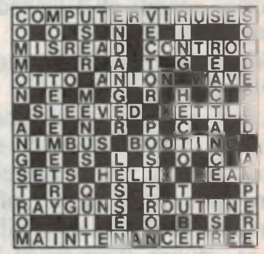
1. Radiation that activates a security sensor. (5-3)
4. Interfere with a security system. (6)
9. Caught with no apparent escape. (7)
11. Apprehends an offender. (7)
12. Said of an alarm that's not false. (4)
13. Where hot property changes hands. (5)
14. Example of a very well guarded building. (4)
17. Activating an electronic security system. (6)
18. Places where 20 down can get access. (7)
21. Rendered safe from burglary. (7)
23. Attach security chain, etc. (6.)
27. Type of switch. (4)
28. Audible warning unit. (5)
29. Cause of panic. (4)
32. Kind of sound from some piezo screamers. (3-4)
33. Made aware of 20. (7)
34. Takes property illegally. (6)
35. Sensor. (8)



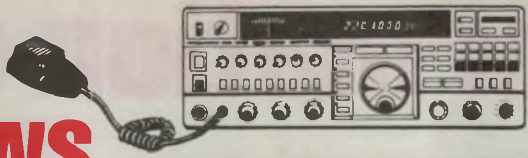
Down

1. Said of a typical alarm in domestic security system. (8)
2. Electrical units. (4)
3. Currents that can trigger alarms. (6)
5. Such is a house with doors and windows open. (4)
6. Nature of 1 across with 35. (7)
7. Again gets ready status. (6)
8. Wrongful removal of personal property. (7)
10. Triggered status of security system. (5)
15. What enters a sensor. (5)
16. Force an entry. (5)
19. Unit used to measure output of 28. (7)
20. One who violates home privacy. (8)
22. Security item for door use. (7)
24. Synonym for 8. (5)
25. Protective steel bars. (6)
26. Word of warning. (6)
30. Sound of 28. (4)
31. In a sense, the blue strobe indicates where. (4)

MARCH SOLUTION



Amateur Radio News



ARRL awards grant for packet research

The ARRL has made its first technology grant, of more than US$1000, to a team of amateur researchers led by Stephen Hall WM6P of Simi Valley, California. The grant is for research into diversity reception of HF packet radio signals, with the goal of coming up with practical diversity antenna systems, compatible modems and receiver designs.

Other researchers in the team are Andy Demartini KC2FF of Clearwater Florida, Wally Linstruth WA6JPR and Bill Lake WB6RIJ of Santa Barbara, California, and Herb Duncan WE7L and Peter LaCount W8UXD of Sierra Vista, Arizona.

The grant funds are for purchase of special equipment, materials and out of pocket expenses incurred with the research. Team members donate their labour, and use much of their own equipment.

The ARRL itself received a grant of US$10,000 for HF packet radio modem and protocol development back in October 1989, from the Federal Emergency Management Agency (FEMA). The new grant is the first made possible by the FEMA grant.

Aussie is new IARU vice president

Former WIA Federal President Michael Owen VK3KI has been ratified as Vice President of the International Amateur Radio Union (IARU), for a term of five years. This is the first time that a principal officer of the IARU has been elected from outside North America, and is regarded as a great honour for the WIA and Australian radio amateurs.

Michael Owen currently lives and works in London, UK. He was Federal President of the WIA from 1969 to 1972 inclusive, and served as a Director of the IARU Region 3 Association from its inception. In addition to holding the Australian callsign VK3KI he is also licensed as G3ZML and ZL1BGY.

New HF-UHF Rx coming from Icom

Did you see our review of Icom's new mouth watering IC-R9000 ultra wide-band communications receiver last month? Well, Icom isn't resting on its laurels. Already the firm has produced a similar receiver, but without some of the bells and whistles – and a correspondingly lower price tag.

Designated the IC-R100, the new receiver has a bandwidth of 100kHz – 1.856GHz. It has a built-in UHF preamp with 15dB gain, and also a 20dB RF attenuator to prevent overload on strong signals. Like the R9000 it offers DDS tuning, AM/FM/FM-wide receiving modes, both rotary tuning control and keyboard, and tuning steps from 1kHz to 25kHz. There are 121 memory channels, and a variety of scanning modes.

Operating from 13.8V DC, the new receiver has an LCD display and draws less than 1A – making it suitable for both mobile and fixed operation. Amazingly, the price is mooted at less than $1000! We hope to review a sample soon.

Also announced as 'coming' is the IC-R1, a triple conversion communications receiver covering 100kHz – 1300MHz, with similar specs to the R100 but measuring only 49 x 103 x 35mm. That's right – small enough to fit in your shirt pocket!

We'll pass on more details as they become available.

New committee for Townsville ARC

At the recent annual general meeting of the Townsville Amateur Radio Club, Peter Harding VK4PVH was elected president and Rob Male VK4RB vice-president. The new secretary is Gavin Reibelt VK4ZZ, with Iain Sutton VK4ZT as WICEN co-ordinator.

The club meets at the SES Headquarters in Green Street, West End. Mail address is PO Box 984, Townsville 4810. Further information is available from publicity officer Peter Renton VK4PV, phone (077) 81 4734 (BH) or (077) 72 1236 (AH).

Information centre

Conducted by Peter Phillips

Getting into some hot water

There are several 'hot' issues this month, including a reminder about copyright. On a less serious topic, we examine the question of why there is a difference in temperatures between the boiled water from an electric jug and that from other types of heating appliances. And just to prove that this is still an electronics magazine after all, there are also some technical items and our usual 'puzzler' question.

I am delighted that most letters I receive include favourable commentary on *EA* in general, and in particular on the content of Information Centre. It seems most readers like the variety we now offer in these pages, including the technical questions, the controversies and the discussions on matters electronic. Many readers probably turn initially to Information Centre for errata and project information, and on the way get interested in one or more of the topics.

I see the role of this section of the magazine as one that provides coverage of topics that are too small for Forum, too non-technical as a feature article, but too interesting to pass up. In other words, you just never know what will crop up next, and I am always keen to mix a few general interest topics (of a scientific nature) with those pertaining to electronics.

Of course I rely on your letters, and I am most grateful to those who have taken the time to write expressing an opinion, offering information or asking a question. I am now gathering letters on the topic of the 6502 versus the Z80, and hope to include these next month.

On the subject of letters, the first concerns copyright and where a contributor stands in the minefield of improper use of his material. I'll let the correspondent open the proceedings...

Dolby article copyright

It has come to my attention that at least one audio retailer has been giving potential customers of their business copies of an article on tape noise reduction systems written by me and published in the December 1989 edition of EA, on pages 141 and 142. As the author of the information, I hold the sole copyright on this article and EA published it with my permission, in the interests of helping readers in their quest for knowledge.

Furthermore, direct copying is also a copyright violation of the publisher's rights, in this case the Federal Publishing Company. Magazines such as EA have played a significant role in my education in the field of electronics, and I am more than happy to pass on any knowledge to others who request it. However, I will not tolerate any attempts to use this information for unethical purposes, especially in the case of unscrupulous salespersons out to get a quick buck. Make no mistake – anyone found attempting to abuse the privileges will be dealt with in the strictest sense of the law. I have not endorsed this article to any retailer in Australia. (S.M., Townsville Qld).

I have included this letter to make sure all contributors and readers know where they stand in regard to copyright. On receiving the above letter, my first response was to examine the original contribution to see if S.M. had stated that he wished to hold the copyright of the information he had so kindly supplied. If he had, we would have included this within the article printed in the magazine.

As this was not the case, and because the article was unsolicited, it may be that the law would disagree that S.M. holds the sole copyright. Unfortunate perhaps, particularly if others are using the information for monetary gain. However, there is no doubt that reproduction of an article without the written permission of the publisher is a violation of copyright, and this is clearly stated in every edition of the magazine, usually on page 4.

If a contributor wishes to retain copyright of the information supplied to us, this needs to be stated clearly in the original submission. If we consider the material to be suitable for inclusion in the magazine, the statement concerning copyright may well be printed with the material. If the contributor then finds his material being used in a manner he considers to be unethical, he can then use the due processes of the law. As well, the publishers of the magazine (F.P.C.) might join him.

Naturally, we would look very carefully at printing the material in the first place, as the volume of information received each month means we have to be very selective. Any conditions attached to publication are often a good reason to place that letter on hold, to make way for those with no 'strings attached'.

We will generally agree to legitimate requests for material to be reproduced, providing the request is made in writing. If the author has retained copyright, we would need his (written) permission as well before giving our clearance.

Finally, S.M. has noticed a small but significant typographical error in the article. The second paragraph in the middle column of p141 (December '89) states '0dB corresponds to a 200Wb/m field'. It should read '200nWb/m'; a difference of some magnitude, 10^9 in fact, which as S.M. points out, would be enough to pull the magnetic particles clear off the tape!

Electric jugs can't boil water!

I have several letters that support the statement made by correspondent G.G. (of parts unknown) in the January issue, that an electric kettle produces hotter water than an electric jug. The reasonings are interesting, though I must confess that I cannot tell the difference between water from either appliance. However, my mother agrees there is a difference, so who am I to argue!

Here's two explanations, but I wonder if any readers have ever conducted actual experiments with a thermometer to prove that a difference does exist. Now there's a challenge for someone...

I am writing to help clear up the question concerning the difference in temperature between water boiled in an electric jug to that from a kettle or urn. While I agree with your answer, it was not (intentionally so, I believe) complete. At first I thought that G.G.'s observation was imaginary, as water boils at the same temperature for a given pressure, and cooling would have a negligible effect (as he only made a cup of black tea).

However, he mentions a 'full bottom heater', which gives me the clue to the explanation. This type of heating element will cause a more thorough heating, as because hot water is less dense than cool water (until 4°C, of course), the heavier cool water will sink to the bottom where it is heated. Thus all the water is heated as a result of the convection currents that occur within the water.

In an electric jug, because the element is usually located to one side, well clear of the bottom, there will be a relatively cool layer of water at the bottom of the jug. This means that only part of the jug's contents are thoroughly heated, the rest being heated by conduction through the jug and through particles of water.

The element of the jug will also cause localised heating while an urn or kettle will cause generalised heating. If this reasoning is correct, a jug of water boiled in a microwave oven will seem even hotter as it is heated throughout simultaneously, with no cool layers. (D.O., Vista SA).

Fair enough, but I can't help thinking that lowering the element in the jug could be the answer. The next letter offers another opinion, this time from a contributor who remembers a similar discussion taking place many years ago.

Correspondent G.G. has revived a debate that seems as old as the utensil itself, namely 'You can't pour boiling water from an electric jug.' The corollary says, 'You can't beat tea brewed in a billy.'

EA was still in knee-pants as 'Radio & Hobbies' when I first read the arguments. In essence, the problem boils down (ouch!) to this. The double helix of a jug element is highly efficient as a heater, but will self destruct unless the heat is quickly dissipated. In any practical design, which includes the ceramic insulation of the jug itself, heat is lost rapidly as the water approaches boiling point. It continues to be lost during the short time that includes the safety feature of unplugging to mechanically release the lid (which leaves bare conductors accessible within) and actual pouring takes place. As the vessel is not pressurised, the poured contents will always be below their normal boiling point. In high mountain locations the decrease can be considerable.

The electric kettle, the electric urn and the immersion heater, by virtue of sealed element design together with the type of container used, permit less rapid dissipation – 'heat-sinking' in todays' parlance – allowing one to actually draw off water very close to boiling point. (K.G., South Oakleigh, Vic).

I can see that the sealed element, with its greater thermal inertia would be beneficial in holding the temperature of the water, but I think that the metal jacket of an urn or kettle is likely to conduct heat away more effectively than the ceramic material the electric jug is made of.

The 'Phillips' electric jug (that really boils water) would be a design that uses a ceramic or plastic container, a sealed element placed at the bottom, connected to the outside world with a connector at the bottom of the jug. But then, aren't the latest plastic electric kettles built this way? Perhaps you *do* get hotter water from an electric kettle after all!

Cathode ray tube wanted

Included in the first of these contributions to the discussion about hot water is a request for a DG7-32 type cathode ray tube. The request comes from Darren Oster, who wishes to build the oscilloscope described in *Radio, TV and Hobbies* in 1963. If any readers can help with this and some 9 pin valve sockets as well, please contact Mr Oster at 8 Walsh Street, Vista, 5091.

Binary Coded Octal?

It seems I can't get away with anything these days! A correspondent has picked up a technical *faux pas* in December's 'What??', concerning a counter decoding circuit I posed. He writes...

I hope that my students didn't see your question posed in December 1989, because I have always insisted that BCD needs four bits – numerals, wires, pins, memory cells and so on. The values 000 to 111 can be binary, or even octal, but not BCD.

Thanks for the continued quality of EA, and keep up the good work. (C.S., Mansfield Vic).

Indeed I have stated that the three bit input to the decoder circuit is BCD. And yes, I totally agree with C.S. that BCD codes are a four bit codes, making my description of the type of code incorrect. Binary codes are an interesting subject, and confusion is often caused by errors such as this one. For example, I wonder how often students have been posed with a question in an exam such as 'convert the BCD value of 1101 to decimal'. This is a common mistake, in which the examiner has forgotten that BCD codes only cover the decimal numerals of 0 through to 9. As binary 1101 equals decimal 13, a BCD code for 13 would be something like 0001 0011.

My thanks to C.S. for picking up this error, although I hope his students (and many others besides) read these columns and try the questions. Be assured that if a mistake is made, it will be picked up by someone and I will correct it. That's if I'm wrong of course!

Ignition disable for Super Vulture alarm

Oatley Electronics has advised me that the facility of an ignition disable is easily included in the Super Vulture car alarm, published March 1990. If the switch relay is retained in the VHF receiver, rather than being replaced by a 330 ohm resistor as described, the contacts of this relay can be used to switch a short-circuit across the distributor. One more hurdle for a thief to get past, and a very worthwhile addition.

Maxwell invented it

The topic of who invented radio has caused considerable discussion in these pages. Without wishing to reopen the subject, I feel the following letter deserves inclusion, as it states a point of view that was glossed over in past discussions:

In the discussion of the origins of radio, it was reasonably pointed out that no particular person could be identified as the 'true' originator. However, I suggest that there was one truly unique, creative act from which all early radio experiments flowed. I refer to the Maxwell equation which states that a changing electric field causes a magnetic field.

Early experimenters had established that a changing magnetic field caused an electric field. This was Faraday's law of magnetic induction, expressed as an equation by Maxwell. However, the converse relationship was quite unknown,

Information Centre

since the effect was far too small to be detected, much less measured by any equipment available at the time.

Maxwell introduced the relationship purely as a hypothesis, in order to make symmetry with the equation already established as Faraday's law. Two other equations, describing electric fields and magnetic fields, both mutually symmetrical, make a total of four basic equations of electromagnetism, known as Maxwell's equations.

It is only when these four equations are put together that the electromagnetic field equations can be deduced, and these predict the existence of electromagnetic waves in free space; the confirming evidence later coming from Hertz.

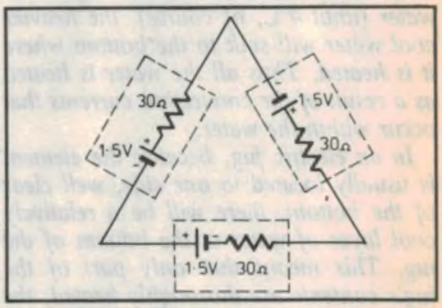
The picture then is of a vast number of pre-radio experiments converging on three of Maxwell's equations, plus an additional equation not supported by evidence, and a similar number of radio experiments fanning out from the four equations together. I therefore submit that James Clerk Maxwell was the true originator of radio. (B.S., Colac Vic).

What??

I normally pose a question comprising a circuit with component values and ask that something be calculated. This month I'm asking for the circuit.

I've built (in a black box) a circuit using op amps that needs a 7V positive supply, a ground line and a 2V (or so) negative supply. That is, it requires a dual polarity power supply. The positive line needs to supply a current varying from 1mA to around 10mA while the negative line needs to supply a constant 500uA. My question is, draw a circuit that allows the 'black box' to be powered with a single 9V battery.

I will gladly receive circuits, and if any are better (that is, simpler) than the one I have in mind, I will present them in these pages. Lead times will mean they can't appear till around July, unfortunately.



The above diagram was meant to be published with the March 'What?' answer, to show clearly just how the answer was reached. My apologies for this lapse. (Milli - Production Ed.)

NOTES & ERRATA

12V/240V INVERTER

(CDI, January 1990): The circuit shown on page 93 has transistor Q2 shown inverted. The collector of Q2 should connect to the bases of Q5 and Q6, the 1nF capacitor leading to the base of Q1 and the 1.5k resistor leading to +12V, while the emitter of Q2 should connect to the emitter of Q1 and – 12V.

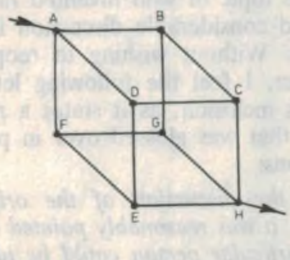
VK POWERMATE 25

(January 1990): In the wiring diagram on page 86, the wire from the PCB terminal second from the top is shown wrongly connecting to the base of Q2; it should connect to the emitter and R3. The bases of Q5, Q6 and Q7 are also shown connected together, but not to anywhere else; they should also be connected to the bases of Q2, Q3 and Q4, and of course to the PCB terminal fifth from the bottom.

6M FM RECEIVER

(January/March 1990): The value of capacitor C14 should be 4.7nF, for the correct 5kHz low pass cutoff. The 1.5nF value in the parts list should be changed accordingly. The parts list should also list a 680uH RF inductor. Note that resistor R8 is a 1k resistor (not 10k), and that the perspex cursor is 65mm long, not 75mm as suggested by the drawing. Also the 'Band A' antenna input socket is only 35mm from the side of the rear panel, while the EXT input socket is about 89mm from the transformer end – see the rear panel photograph. These dimensions were inadvertently transposed in the text.

Answer to last month's What??



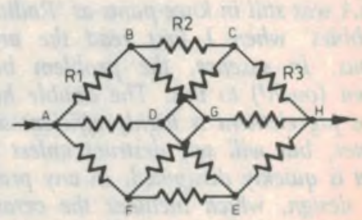
The answer to last months What?? concerning the resistance between diagonally opposite corners of a cube of 12, one-ohm resistors is 5/6 ohm. The solution supplied by the contributor of this question is as follows, although I did it a different way, which I'll also describe:

STEP 1. Take the resistor network forming the edges of the cube ABCDEFGH in (a) and redraw the network as shown in (b).

STEP 2. Because all resistors have the same value, the junctions B, D and F will be at the same potential. Thus they can be joined together without affecting the currents flowing in each resistor. Similarly, the junctions C, E and G can be joined together without changing any currents.

STEP 3. The left section (between A and the now joined B, D and F junctions) and the right (C, E and G to H) parts of the circuit each consist of three resistors in parallel, and the centre section has six resistors in parallel. If each resistor is 1 ohm, the resistance between points A to H is 1/3 + 1/6 + 1/3, which equals 5/6 ohms.

My method uses Ohm's law, and starts by assuming the current into the cube equals 3A. Thus, the current in R1 equals 1 amp, as this current will divide equally into three parts – giving a voltage drop across R1 of 1V. The current arriving at point B will divide equally giving 0.5A in R2, with 0.5V across R2. As the current out of the cube must equal the current in, the current in R3 equals 1 amp, and VR3 equals 1V. The total potential between points A and H equals 2.5V (sum of VR1, VR2 and VR3), and as the current is 3A, the total resistance is 2.5V/3A (V/I), giving 5/6 ohm. Thanks Mr Fowler, a good question and no, I didn't peek at your answer first!



EA marketplace EA marketplace

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SPECTRUM
Communications News & Comment

POCKET MODEM IS CELLULAR COMPATIBLE

Fancy being able to send a fax from the beach at Bondi, or using your laptop computer to call up a bulletin board from your car, to while away the hours spent in traffic jams?

Melbourne-based Dataplex has just the thing for you, because its 'Worldport 2496' portable fax and data modem is now compatible with Uniden cellular mobile telephones. About the size of a pack of cancer sticks, it operates at up to 2400bps for data (V.22, V.22bis, V.21), and at up to 9600bps for Group III fax.

Of course the modem is also claimed to work with any standard phone as well, making it *very* flexible indeed. Further details on the modem itself from Dataplex on (03) 735 3333, and on the Uniden cellular phones from Uniden Australia on (02) 599 3355.

BROADCASTING AREA MAPS

A new publication giving maps and descriptions of the service areas for all commercial television and radio stations in Australia has been released by the Department of Transport and Communications (DOTC). The publication is expected to be of interest to the broadcast industry, advertising firms, educational bodies and so on.

Copies of *Commercial Television and Radio Service Area Maps* can be obtained at any Commonwealth Government Bookshop for $34.95, or by mail order from the Australian Government Publishing Service, GPO Box 84, Canberra ACT 2601. Credit card orders can be telephoned to (008) 02 6148 or faxed to (062) 95 7295.

MORE PUBLIC RADIO STATIONS

A total of 27 new licences for public radio stations are to be made available over the next three years, according to Minister for Transport and Communications Ralph Willis. The Minister was announcing a revised public radio planning program, designed to better meet the needs of remote and isolated communities – with priority to Aboriginal communities.

"Giving a higher profile to the needs of Aboriginal, remote or underserved communities reflects the policies of the Public Broadcasting Association of Australia, which were conveyed to me during the consultation process in reviewing the program", he said.

At present there are some 78 public radio stations operating throughout the country, with a further 22 invitations for issue of a licence. The new program is expected to result in a significant further expansion of public broadcasting, with its diversity of program choices.

FIXED CELLULAR PHONES FOR REMOTE LOCATIONS

Telecom Australia is currently testing the use of fixed cellular phone installations to provide faster and more economical telephone service to people in remote locations which would normally make this very difficult to provide.

Trial installations have been made to a timber mill in Putty, 150km north-west of Newcastle in NSW, and to an isolated farm in South Jerry Plains, near Singleton NSW. The latter is more than 33km from the nearest normal phone service, and also has no mains power – requiring a solar panel with battery backup.

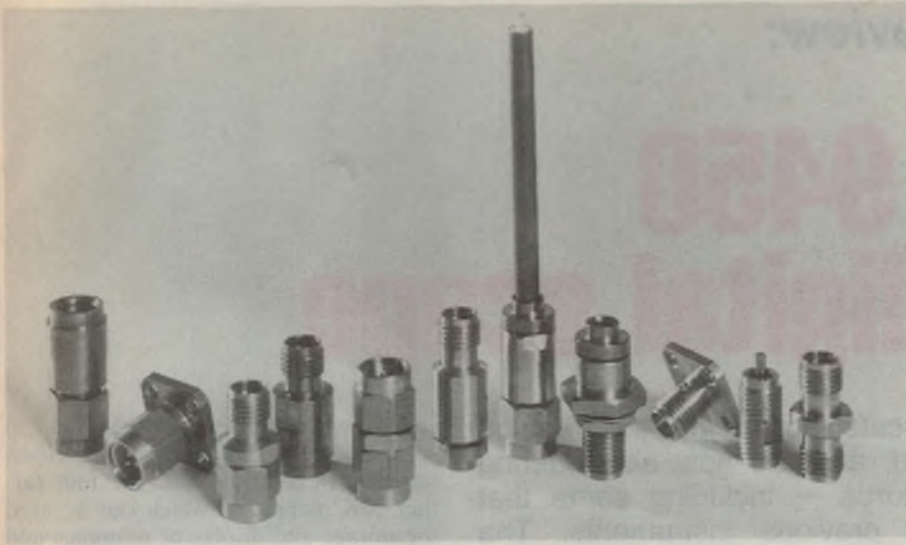
The system uses a transceiver at the nearest telephone exchange, linked into the normal network.

Telecom is committed to making access to the PSTN available to all Australians, and plans to use this system to help achieve that goal.

WRIST WATCH PAGER RELEASED

A joint venture between the UK arms of Motorola and Timex has created the wrist watch pager – combining a multi-function LCD watch with a numeric display VHF paging receiver.

The watch weighs barely 60 grams, and includes a time-stamp display and message-store facility. Although battery life is presently limited to a less-than-useful 40 days (due to the need for the pager to listen for messages), research is being done to extend this by improved power-saving measures.



IMPROVED MICROWAVE CONNECTORS

Huber + Suhner has extended its PC3.5 series of compact, low loss coaxial connectors for applications up to 34GHz. There are now 18 different types in the range.

In the past, PC3.5 connectors have been widely used in laboratories for R&D work, but they now offer a thicker wall and higher mechanical stability, and are claimed to be suitable for general microwave applications. The connectors essentially have air as the dielectric, with a support bead for inner contact centering and captivation. The centre contacts are of beryllium copper, with stainless steel for the bodies and gold-plated brass for the cable entry parts.

Suhner's PC3.5 series conform to IEC standards. Further details are available from Huber + Suhner (Aust), PO Box 372, Narrabeen 2101 or phone (02) 913 1544.

Test Equipment Review:

LeCroy's 9450 350MHz digital scope

Digital storage scopes are fast catching up with their analog predecessors in terms of speed, and are now also offering many more functions and features – including some that were simply unavailable with previous instruments. The LeCroy 9450 is a good example of the 'new breed' of DSO.

by JIM ROWE

Like many of our readers, I imagine, we've been intrigued by articles and advertisements in overseas magazines describing the latest digital sampling oscilloscopes in glowing terms. Some of the features and functions available on these instruments have seemed almost mind-boggling – although at the same time, a certain amount of ambiguity and 'optimism' seems to have been evident in some of the claims made for them.

Because of this, a few weeks ago we were very interested to check out one of the latest instruments from leading US-based DSO maker LeCroy Corporation. The opportunity arose when LeCroy's Australian representative Scientific Devices was able to make available a sample of the firm's high performance model 9450, for about a week.

The 9450 is a dual-channel instrument with an input bandwidth of no less than 350MHz, and a maximum real-time sampling rate of 400 megasamples/second for capturing and analysing single-shot events. For dealing with repetitive waveforms it also offers random interleaved sampling at an equivalent 10 gigasamples/second. A to D conversion of the input signals is performed by 12-bit flash converters, with averaging to give low noise 8-bit resolution.

Coupled with this basic speed performance, the 9450 offers very deep sample memory: 50K words per channel of non-volatile memory, each of which can be segmented into as many as 200 segments for storing multiple waveform samples. In addition there are four further 50K memories, which can be used for storage and display of reference and processed waveforms.

And speaking of waveform processing, the 9450 has built-in number crunching functions to perform digital addition, subtraction, inversion and summation averaging on captured waveforms. This is quite apart from its ability to make a full set of automatic measurements on all main waveform parameters: maximum and minimum voltage levels, arithmetic mean, standard deviation, RMS value and period for repetitive signals, and pulse width, rise and fall times, and delay times for pulses.

As if these facilities aren't enough, it also offers features such as automatic setup for 'no-hassle' initial capture of signals; a special 'FASTGLITCH' triggering system which allows triggering on glitches and spikes narrower than 2.5ns; a very wide range of flexible triggering options; automatic self-calibration, ensuring DC accuracy within +/–2% and time accuracy within 20ps RMS; automatic date- and time-stamping of all captured waveforms; the ability to make 'hard' copies of waveforms and parameter measurement listings at the press of a button, via a printer or plotter; and easy menu-driven operation.

In short, it's a very impressive instrument, by anyone's standards.

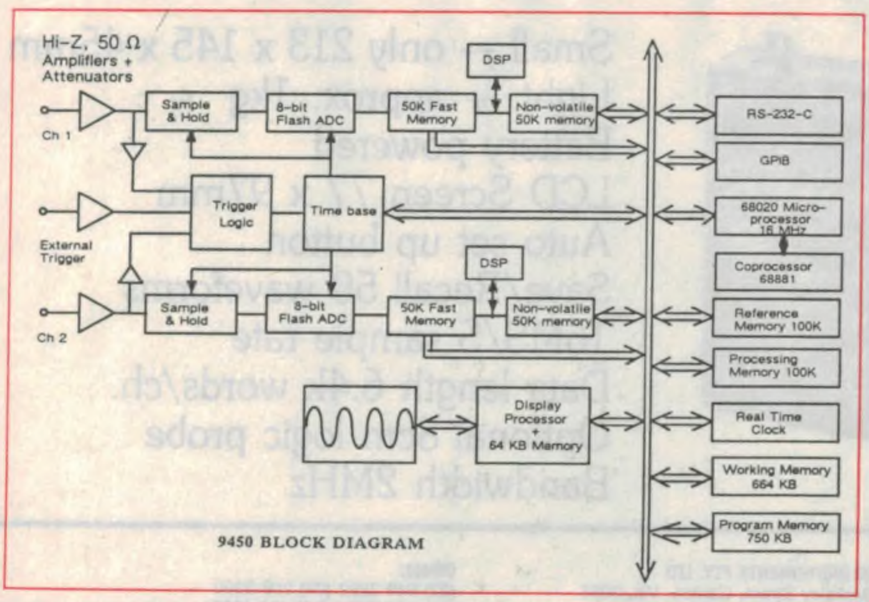
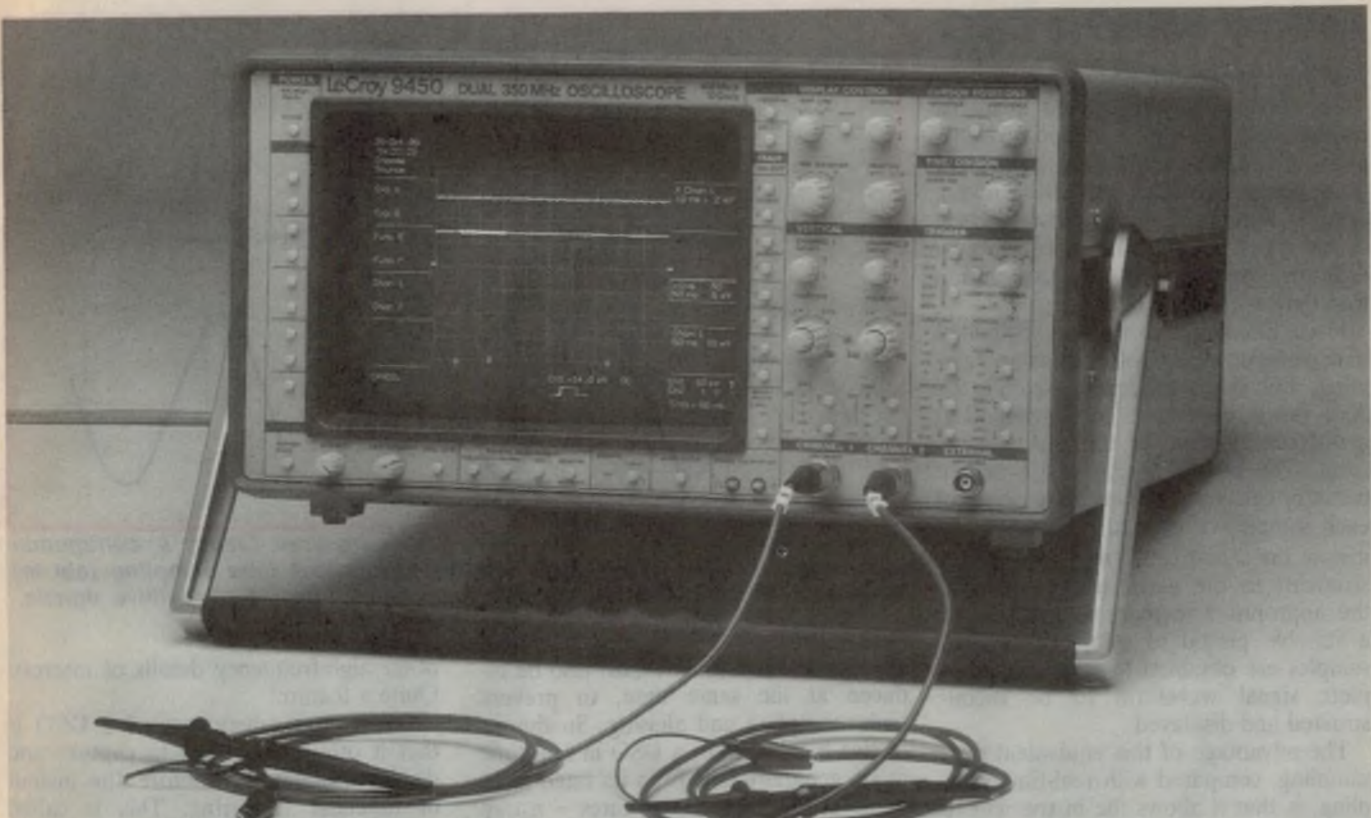


Fig.1: Internal architecture of the LeCroy 9450. After the input circuitry and ADC's, it's essentially a microcomputer system.

Back to basics

But exactly what do those impressive specs really mean? Most of us are probably still a little unsure of DSO specs, and often the manufacturers don't seem too eager to help clarify the situation. So before we go any further, it might be a good idea to explain a few DSO basics, using the 9450 as a good example.

The internal architecture of the 9450 is shown in the accompanying block diagram (Fig.1), taken from its operating



Unlike some DSO's, the 9450 looks like and operates in much the same way as a conventional analog scope.

manual. As you can see, each input channel is processed by an amplifier/attenuator, and then fed via a sample/-hold circuit to a flash analog-to-digital converter. This produces a series of 8-bit digital words, each corresponding to the amplitude of a signal sample.

From the ADC's, the samples for each channel pass to a 50K word fast memory. The fast memories are each coupled to the internal microcomputer data bus, as well as to digital signal processing (DSP) circuitry and a further 50K words of non-volatile memory.

As with analog scopes, there is also a timebase system with associated triggering logic circuitry, capable of triggering from either input channel or from an external trigger input. The timebase is also interfaced with the data bus, to allow it to be controlled by and communicate with the CPU. From here on, virtually all of the instrument is digital; in fact it's essentially a microcomputer system, with a specialised user interface. The front-panel controls take the place of the usual keyboard, while the display screen replaces the usual video monitor.

As you can see, attached to the internal data bus are the 68020 microprocessor, a 68882 maths co-processor, further working memory, a real-time clock, an RS-232C serial port for interfacing to a printer or plotter, and a GPIB/IEEE 488 port for remote programming. Also attached is the display processor, with 64KB of display memory, and the front-panel controls (not shown).

The 5" x 7" video display of the 9450 is not the usual raster-scan type, incidentally. It is of the faster and more precise vector-plotting type, as used on professional graphics terminals.

It should be clear from the block diagram that all signals fed into the instrument must pass through the input amplifiers and attenuators. The bandwidth of these therefore plays a major role – although not the only role – in determining its speed performance.

In the case of the 9450, it is the input circuitry which determines the instrument's *rated bandwidth* of 350MHz. However the *effective bandwidth* is also determined by the rate at which the instrument takes its digital samples; and this depends upon the mode of operation.

Like many other DSO's, the 9450 offers two basic modes: *real time* sampling and *equivalent time* sampling, in this case of the 'random interleaved' type.

Real time sampling is similar to the sampling used for digitisation of audio signals for compact discs. The incoming signal is effectively 'chopped' up into a series of thin slices, each one immediately after the other, and these are passed through the ADC for conversion into the equivalent digital codes.

As with any other kind of real-time sampling, Nyquist's theorem applies: for any kind of reconstruction of the original waveform, without aliasing, the sampling rate must be more than twice the maximum signal frequency. Or looking at it the other way around, the maximum bandwidth will be less than half the sampling rate.

In the case of the 9450, the maximum sampling rate is 400 megasamples/second, which gives a maximum theoretical bandwidth of just under 200MHz. However even this is unrealistic where an oscilloscope is concerned, because here we're generally not just interested in reconstructing a signal in terms of amplitude – we're also interested in its *wave shape*.

Generally speaking, in order to reconstruct the wave shape reasonably faithfully the maximum signal bandwidth must be limited to about *one tenth* of the maximum sampling rate. So for the 9450 in real-time sampling mode, the effective signal bandwidth is limited by the sampling rate to about 40MHz.

Incidentally real-time sampling is the *only* mode that can be used for non-repetitive or 'one-shot' signals. Hence 40MHz is the effective bandwidth of the

9450 for this type of measurement.

The other operating mode available on the 9450, but only for *repetitive* signals, is random interleaved equivalent time sampling. This involves taking samples not from a single pulse or cycle of the signal waveform, but from many different cycles – on the assumption that they are all identical.

Here the samples are not sequential and contiguous, as with real-time sampling, but taken randomly (see Fig.2). As a result, each tends to correspond to a different portion of the signal waveform. The DSO's trigger and timebase circuitry calculates the effective phase of each sample, relative to the zero crossings of the signal, and this allows the instrument to file each sample value in the appropriate memory address. After a suitable period of sampling, enough samples are obtained to allow the complete signal waveform to be reconstructed and displayed.

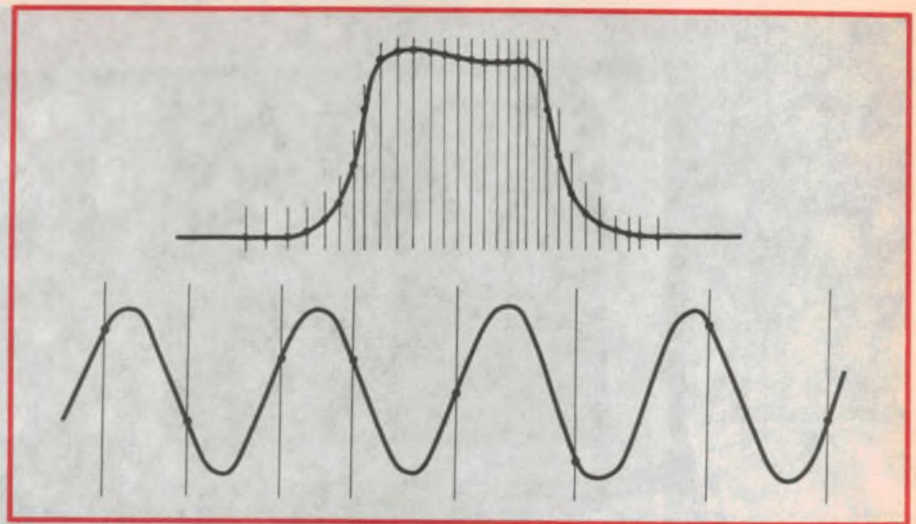


Fig.2: At top is real-time sampling, which involves taking a contiguous sequence of signal samples. In contrast equivalent time sampling (above) involves non-contiguous samples, and can only be used for repetitive signals.

The advantage of this equivalent-time sampling, compared with real-time sampling, is that it allows the instrument to act as if it were sampling at a much higher rate. For example the 9450 has an effective sampling rate of no less than 10 gigasamples/second in this mode, compared with 400MS/s in real-time mode – an apparent speedup factor of 25 times. The only penalty is that a complete set of samples for a displayed waveform takes roughly 25 times as long to assemble (although in practice this is rarely even noticeable, as sampling is still generally taking place at 400MS/s).

With an effective sampling rate of 10GS/s, the *sampling bandwidth* of the 9450 in equivalent-time sampling mode is roughly 1GHz. But of course the bandwidth of the input circuitry is only 350MHz, so in this mode the effective signal bandwidth becomes 350MHz and the instrument is input bandwidth limited.

So for repetitive signals, where equivalent-time sampling can be used, the effective bandwidth of the 9450 increases from about 40MHz to 350MHz. Get the idea?

Actually things aren't quite this easy. At lower timebase sweep rate settings in real-time sampling mode, a DSO generally can't sample at full speed; it ends up with too many samples for the memory, resulting in overflow. So the sampling speed must generally be reduced, to bring down the number of samples within the memory's capacity.

When this is done, the input bandwidth of the instrument must also be reduced at the same time, to prevent under-sampling and aliasing. So the effective bandwidth of a DSO in real-time mode generally falls from its rated maximum at the lower sweep rates – a trap for the unwary. The lower sampling rate also results in lower horizontal (time) resolution.

With many instruments this bandwidth reduction takes place at relatively high sweep rates, because they only provide a memory depth of say 1K or 5K words. This can be a problem, as it can make glitches 'invisible' on all but the highest sweep rates.

Happily this isn't a significant problem with the 9450, because it provides those very deep 50K-word sample memories. This allows it to maintain the full 400MS/s sampling rate at all timebase sweep speeds from 10ns/div down to 10us/div. The sampling rate and effective bandwidth are only reduced below this speed, falling to 20MS/s (about 2MHz) at 300us/div, and 2MS/s (200kHz) at 3ms/div.

Needless to say, when you're using such low sweep speeds you're looking at low frequency signals, so the bandwidth reduction generally isn't a problem.

Because the very deep memories of the 9450 can store so many samples (50,000) per waveform, this has a further advantage in terms of horizontal resolution. Normally you can't see all the stored information, of course – the display resolution is only 4096 x 4096 pixels. But it's all there, in memory. So most of the time you can *expand* any stored waveform horizontally by up to 1000 times, allowing you to examine it in detail for glitches, spikes and any other high-frequency details of interest. Quite a feature!

One of the advantages of a DSO is that it offers the ability to capture and display signal events *before* the instant of timebase triggering. This is called 'pre-triggering', rather than the 'post-triggering' found on conventional analog scopes.

With post-triggering, a DSO operated in much the same way as an analog scope. Sampling of the signal begins only when the desired triggering condition occurs, and stops when there are enough samples taken to capture and display the waveform. The waveform displayed is therefore of the signal *after* the instant on triggering.

In contrast, pre-triggering is achieved by having the sampling process take place continuously before triggering, with samples of the signal waveform being stored and over-written into the memory (but not displayed). Then when the desired triggering condition occurs, this is arranged to *stop* the sampling process. The memory contents are then displayed, showing the signal waveforms which were last sampled *before* triggering took place.

Actually most modern DSO's allow you to select either pre- or post-triggering, or a combination of the two. The latter is achieved by sampling continuously, but also allowing further sampling after the trigger point, and for a programmable time. The captured and displayed data thus represents the signal both before and after triggering, with the trigger instant somewhere along the waveform – usually identified by a small cursor line or arrow.

The LeCroy 9450 is very flexible in

this regard. It allows pre-triggering adjustable from 0% to 100% of the displayed screen width, in 0.2% increments, and post-triggering delay time adjustable in .02 division increments up to 10,000 divisions.

Like most high-performance DSO's the 9450 also provides a very wide range of 'conventional' triggering modes and facilities. For example triggering can be taken from either of the input channels, from the external trigger input (either direct or with a /10 frequency division), or from the AC line; it can be made on either a positive or negative slope; and the coupling can be either DC, AC, HF (to 500MHz), LF reject or HF reject. There's also a choice of auto triggering, repeated trigger, single shot, or sequence (where multiple events are stored sequentially in different memory segments).

But that's only part of the story. The 9450 also provides a number of 'complex' trigger modes, for dealing with tricky situations and complex signals. It can be arranged to trigger only on very narrow pulses (FASTGLITCH – for pulses less than 2.5ns wide), or alternatively only on pulses *wider* than 2.5ns. Or it can be set to trigger only on signal *gaps* smaller than 10ns, or larger than 25ns. It can also be set to delay effective triggering after the actual triggering event, for either a programmable period (25ns to 20s) – called 'holdoff by time' – or by counting signal periods or events (0 to 10^9 events) – called 'holdoff by events'.

Further adding to the flexibility are a variety of multi-source triggering modes, which allow logical operations to be carried out between various triggering sources, in order to define the desired trigger condition. For example you can specify that triggering only takes place when the signals in channel 1, channel 2 and the external trigger input have a particular combination of voltage or logic levels – defined in terms of high (H), low (L) and 'don't care' (X).

Similarly you can set the 9450 to trigger on a condition from one of these three sources, but only when the other two present a certain combination of conditions (state qualified). Or it can trigger after a particular combination of conditions on all three sources, but only after a programmable time or number of subsequent events from one of the sources (time/event qualified).

These facilities give the 9450 the ability to perform many of the functions of a logic analyser.

Trying it out

Checking out the sample 9450 turned out to be a lot easier than we anticipated. Partly this is due to the fact that unlike some DSO's, it does have at least a reasonable number of front-panel controls that are reminiscent of familar analog instruments: vertical gain and position controls for each of the two input channels, and timebase speed and horizontal position controls. Most of the triggering controls also look reasonably familiar.

Mind you, this apparent familiarity is something of an illusion. Most of the controls are either pushbuttons or optically-encoded rotary shafts, sensed by the 9450's internal microcomputer. It then performs the desired function. But at least the end result is much the same!

The other factor which makes the 9450 so easy to drive is that there is so much information displayed on the screen. Quite apart from the menus which are used for programming in such things as fancy triggering recipes, and setting the real-time clock and calendar, the actual display graticule area of the screen is generally almost surrounded by text and graphics showing you almost every aspect of instrument status.

Down the right-hand side, for example, there's an area which shows you which traces you're currently viewing: channel 1, channel 2, expanded versions of each, memory channels C or D, or 'function' (processed) memory channels E or F. The legend for each trace includes data on the vertical sensitivity and effective sweep speed, and there is also a separate legend showing the time per major graticule division.

The programming menus appear down the left-hand side of the screen, with selection via the adjacent column of buttons. At the top left-hand corner appears the date and time.

But in some ways the most interesting things appear in the lower centre of the screen, immediately below the graticule area. At the very least you get a little graphics display showing the triggering mode in operation, with figures showing any significant level or timing criteria being used. However when you call for parameter measurements, this area displays a full listing of all relevant values – many of them to 4 or 5 significant figures. Ah, the joy of having a scope with such intelligence and accuracy!

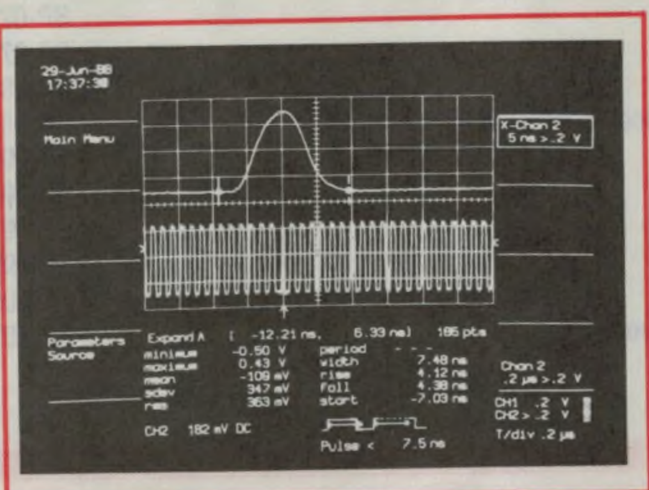
In fact that's the overall impression you get, after having used the 9450 for a while. Not only is it surprisingly easy to drive, but the operation is so unambiguous and the measurements so precise and repeatable. What enormous strides scope technology has made, since the old days of 'unsynchable' timebases, drifting deflection amplifiers and uncalibrated attenuators!

The 9450 is basically a complete measurement system in a portable case, with the facilities and accuracy of a DVM and digital counter as well as those of a 350MHz DSO.

Of course with all of that performance and those facilities, the 9450 doesn't come cheaply. In fact you'll need somewhat more than $25,000 in your piggybank to afford one – so it's the kind of instrument that can probably only be justified in a commercial, industrial or research environment.

Still, it's nice to dream, isn't it? It was also very educational to get our hands on a LeCroy 9450 for at least a short time, to see what the new breed of DSO's is really like. Using an ordinary 'steam driven' analog scope is never going to be the same again...

But if *you're* one of the lucky ones, able to afford and justify one of these beauties, you can find out more from LeCroy distributor Scientific Devices (Aust.), of 2 Jacks Road, South Oakleigh 3167 or phone (03) 579 3622.



A typical display produced by the 9450, showing the comprehensive signal parameter information it provides.

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NEW PRODUCTS

Programmable pen recorders

Rikadenki Kogyo's HR Series recorders are fully programmable units for up to 24 channels with menu-driven displays for fast set-ups. On the HR-3300 and HR4300 series each channel can be independently programmed for DC voltages or temperatures (thermocouples or RTD's).

The HR2300 series are desktop units featuring a recording and storage bandwidth from DC to 20kHz. Units are available with a plug-in card to store user program settings. The HR1300 series is a vertical format version of the HR2300 series and is suitable for continuous recording over prolonged periods.

All units feature alarm option, parallel and serial interfaces, data logging functions and chart annotation capability.

For further information, contact your local Elmeasco Instruments office.

Weatherproof pH monitor

AIC's latest microprocessor based pH monitor is suitable for pH measurement with alarms, controls and recording in hostile locations. The instrument is housed in an IP65 weatherproof enclosure. Calibration and other programmable functions are accessible from the touch keypads located on the face of the instrument.

The instrument features two

control/alarm setpoint relays, isolated 4 to 20mA recorder output and an optional RS232 or RS485 serial output. The instrument is Australian made and is part of a growing family of intelligent microprocessor based instruments which include temperature, pressure, weight and other specialised measurements.

For further information, contact Amalgamated Instrument, 7/21 Tepko Road, Terrey Hills 2084 or phone (02) 450 1744.

Low cost digitised sound

An Australian company, Silicon Sound, has developed a system for storing solid state sound which is said to reproduce to a high quality. The company itself will digitise the messages, or there is a low cost unit which allows anyone to digitise their own messages from a cassette tape.

There are two devices available, the Informatic which reproduces a message of up to two minutes, and the Audiomatic which can be triggered to reproduce any of five twelve-second messages.

These devices can be triggered to give warnings, information in different languages, or details about a certain aspect of equipment in response to a phone call.

For further information, contact Silicon Sound, PO Box 353, Edgecliff 2027 or phone (02) 713 4264.

Surface mount headers

The new SMH low profile header range is designed to provide an excellent solder fillet when using surface mount techniques. Elimination of through-holes permits increased signal density while surface mount technology allows both sides of the printed circuit to be utilised for maximum component loading.

The SMH Series caters for 17 contact sizes ranging from 6 to 64 positions and can be screw mounted or press fitted to the PCB. It is designed with retainer-ejector latches which accommodate female socket connectors with or without strain reliefs. Engaged latching header provides a stable connection, with little chance of unintentional disengagement due to vibration.

The contact area can be plated with either 15 or 30 micro-inches of gold over nickel, with the contact transition area supported by a high temperature plastic header which eliminates potential stress points.

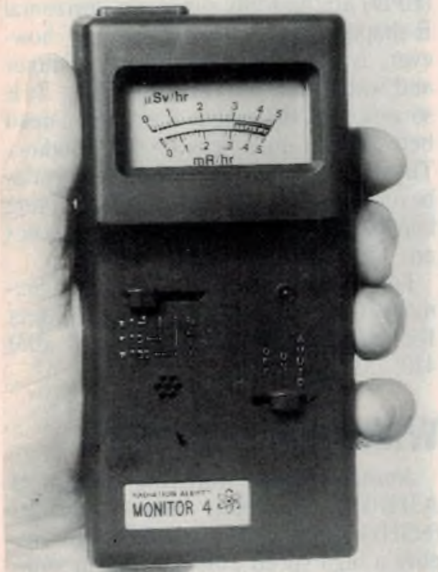
For further information, contact George Brown Group, 456 Spencer Street, West Melbourne 3003 or phone (03) 329 7853.

Soldering fume extractor

The Weller Fume Extractor accessory is a nozzle designed to fit a wide range of Weller irons and stations, connecting to an independent exhaust system. The nozzle draws the smoke and particles away, millimetres from the point of soldering, from the tip. This is claimed to ensure that the fumes are collected before they are disbursed.

The range includes a temperature controlled soldering station, an iron fitted with an integrated fume tube, and add-on fume tubes to suit existing standard irons.

For further information, contact Cooper Tools, 519 Nurigong Street, Albury 2640 or phone (060) 21 5511.



Radiation monitor

The SE International Radiation Monitor 4 is now available for hire from Tech-Rentals. Monitor 4 is capable of detecting Alpha, Beta, Gamma and X radiation from a wide variety of sources and is expected to find applications in the medical, industrial and research fields.

The unit, which is handheld and battery operated, measures radiation in three ranges: 0-0.5, 0-5 and 0-50mR/hr. An LED and a small inbuilt loudspeaker also provide indication of radiation presence by activating at a rate proportional to the signal strength.

A halogen quenched GM tube with a thin mica window is used as the instrument's detector and although particularly sensitive to Cesium 137, Monitor 4 will also detect Cobalt 60, Phosphorus 32, Strontium 90, Radium, Plutonium and Uranium. The sensitivity of the unit is typically 2.5MeV for Alpha, 50KeV for Beta and 10Kev for both Gamma and X-rays.

For further information, contact your nearest Tech-Rentals office.

Echo simulator

Echosimulator HXOS IV is a multi-purpose instrument designed to test and calibrate any kind of echosounders and sonars.

Once it has been connected to the sonar or echosounder under test, the operator selects the operating frequency and the measuring unit. After receiving a pulse from the sonar, HXOS IV sends back the return-pulse with a delay which depends upon the simulated depth. In this way the operator may easily compare the simulated depth with the sonar's response, and check its correct functionality.

Additional checks may be performed on the sonar's receiver sensitivity and on the pulse transmitted power.

For further information, contact RF Devices, 9 Lyn Parade, Lurnea 2170 or phone (02) 607 8811.

Cable detector

Tech-Rentals now has the Radiodetection RD400 Cable Locator available for hire. The locator is claimed to detect cables and pipes easily in congested areas and also provide the operator with information on their depth.

The unit comprises a handheld receiver and transmitter, both of rugged design and construction. The receiver can be operated in four modes, two of which, Power and Radio, allow independent operation with the receiver responding to the presence of 50Hz, signals and re-radiated radio signals respectively. In the 8kHz and 32kHz modes, the receiver is used in conjunction with the transmitter to detect signals on those two frequencies.

A large scale analog meter provides a visual indication of signal strength and cable depth. A complementary inbuilt loudspeaker gives an output which can identify both signal source and strength.

For further information, contact your nearest Tech-Rentals office.

Thick paste applicator

The new EFD DispensGun is said to make application of thick fluids, such as solder and brazing pastes, greases and silicones, easy and without typical hand fatigue.

The rugged metal tool has a propri-

tary pull-back feature that provides a clean cut-off and prevents oozing or dripping of the fluid after making a deposit. It also has interchangeable adaptors to accept 5, 10 and 30cc barrels.

For further information, contact Electronic Development Sales, 11-13 Orion Road, Lane Cove 2066 or phone (02) 418 6999.

Insulation resistance tester

The Musashi model DI-26 insulation tester is a multi-voltage tester measuring to 2000M at three test voltages – 250V, 500V and 1000V. The tester can also measure AC Voltages to 600V.

This low cost unit is disposable battery operated and includes a test prod and a carry case.

For further information, contact Macey's Electrical, 9 Foamcrest Avenue, Newport 2106 or phone (02) 997 8544.

Large plastic instrument case

Hobbyists and manufacturers alike should find Altronic's new desk mounting case very useful for the larger projects. The case has generous ventilation slots on both the top and bottom panels. Plenty of mounting posts are provided for PCB's, and reinforced mounting posts are included for securing transformers. Additional ventilation has also been provided for the mains transformer and power supply area.

The case has dimensions of 355 x 250 x 122mm.

For further information, contact Altronic Distributions, 174 Roe Street, Perth 6000 or phone (09) 328 2199.

New Products

Solid state modem switch

Theta-J has released the Solid State Telecom Switch TS117E, with Telecom Approval RA88/142, providing 3750V RMS optical isolation.

The switch is said to provide optimal function density for tip/ring interface circuits. It incorporates an optically isolated solid state relay for hookswitch, dial-pulse, or loop-start switching, with a loop current (off hook/on hook) detection.

The TS117E is sensitive to typical loop currents of 2mA, allowing the circuit designer the freedom to program the actual in-circuit triggering current by appropriate choice of input shunt resistance.

For further information, contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

Low profile transformer cores

With the new EFD ferrite cores from Siemens, transformers for power ratings 20 to 140W and pulse frequencies of 100 to 1000kHz can be manufactured with a considerably slimmer outline than with classical E shaped cores. They are claimed to be particularly suitable for the compact DC/DC converters needed for power supplies in digital switching centres and computers, amongst other applications.

The new ferrite cores, manufactured to an economic flat transformer design (EFD) are basically similar to horizontal E-shaped cores. The difference however, is that the middle leg is slimmer and wider than the two outer ones. It is so arranged that space has been gained between the outer legs for the winding. Thus the winding no longer protrudes beyond the ferrite core. The mounting heights for transformers with EFD cores are 8 to 12.5mm.

For further information, contact Siemens Components, 544 Church Street Richmond 3121 or phone (03) 420 7313.

Wideband amplifier

Anritsu's ultra wideband amplifiers A3H1001 (10GHz) and A3H1002 (6GHz) exhibit low noise, and can amplify a high speed pulse waveform without distortion, so they can be used to improve the sensitivity, S/N and code error rates in preamplifiers for OEM converters for ultra-high-speed optical telecommunications at more than 10Gbit/s.

If they are used as a distribution amplifier or a preamplifier for general measuring instruments such as a spectrum analyser or oscilloscope, the sensitivity and S/N can also be improved, according to Anritsu. The amplifiers are thus very useful for high level systems in the development of optical communications, ultra-high-frequency semiconductors, low noise EMI measurement systems, and applications for signal processing.

For further information, contact Alcatel STC Australia, 58 Queensbridge Street, South Melbourne 3205 or phone (03) 615 6677.

Components Feature:

3D stacked-capacitor cell ready for 64Mb DRAMs

Fujitsu researchers have come up with a semiconductor design technology that could push the firm into world leadership in memory chips. The claimed breakthrough relates to an improved version of the three-dimensional stacked capacitor cell, which the company has to date employed for its one and four-megabit DRAM chips.

The immediate goal for Fujitsu memory researchers is to confirm the feasibility of applying the 'second generation of 3D stacked capacitor cells' to such upscale memories as 16 and 64-megabit DRAMs.

At Fujitsu, the volume production of one megabit DRAMs using the stacked capacitor cell design is under way, and such manufacturing will soon extend to four-megabit DRAMs. The three-dimensional stacked capacitor cell provides a quantum leap from conventional memory cells that have had limits to the integration of memories using them. The new cell, in this sense, foretells how much the level of such integration will be increased in the 1990s.

The potential of the Fujitsu three-dimensional storage cell is substantial. In fact, a test-made 64-megabit DRAM cell attracted considerable attention from overseas semiconductor researchers and engineers when it was announced at an international electron device meeting in San Francisco in late 1988.

Background

The DRAM needs a certain minimum level of storage capacitance for its cell in order to attain stable read operation. But as integrated bit density proceeds, the entire storage capacitor area tends to diminish, making it hard to obtain a constantly sufficient level of capacitance.

A 64-megabit DRAM, for example, requires a storage capacitor area of 4um² for every 2um² of cell area. No less important for the makers of these DRAMs is mass-producibility for the memories. In developing a new generation of 3D stacked capacitor cells, Fujitsu attached much importance to attaining this dual goal.

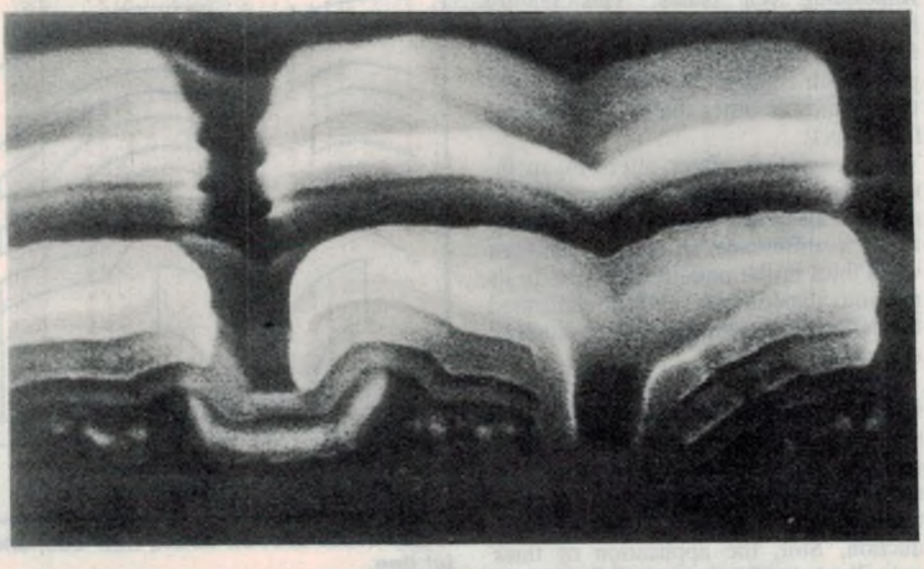
Most semiconductor manufacturers depended on the standard two-dimensional planar structure for the cells of their four-kilobit through one-megabit DRAMs. But Fujitsu and other top semiconductor suppliers have recently pursued an alternative standardised cell structure that would work more effectively with higher-integration memory chips. Among them, the stacked cell structure is fast coming into the sunlight.

As a leading factor behind the ongoing switch to the stacked cell design, Masao Taguchi, manager of the DRAM Development Section of Fujitsu's MOS Memory Division, cites the possibility that the planar structure will not function well enough for four-megabit or higher-integration DRAMs. Specifically, the capacitor insulator of two-dimensional planar-structured cells has grown thin, as the memories using such cells gained more integration in their past generations. Simply said, the chance is slim that the two dimensional planar structure will provide sufficient cell performance for future DRAMs.

Three-dimensional capacitor cell structures made their debut as alternatives for the planar configuration, among them stacked and trench cells. The two cell structures each have merits and demerits.

The trench capacitor features an enhanced cell storage level, but it still has 'parasitic' transistors, such as trench-to-trench leak and trench surface metal-oxide transistor (MOS) structures, making it extremely complicated to fabricate the capacitor.

Despite its simplicity of fabrication, the stacked capacitor has been regarded



A scanning electron microscope (SEM) view of the new cell structure.

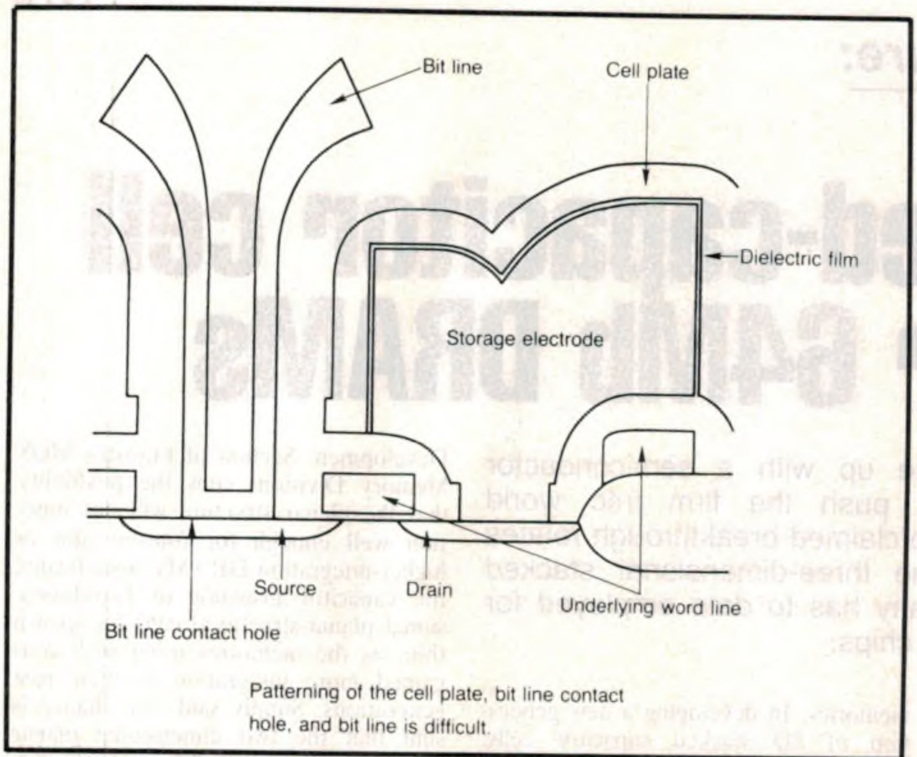


Fig.1: Cross-section of a 64Mb stacked capacitor cell using the conventional structure.

as less superior to the trench configuration in storing sufficient capacitance for 16 or 64-megabit DRAM cells. To overcome this problem, Fujitsu introduced a proprietary stacked cell design, called the fin structure.

Fin structure

The most outstanding feature of a three-dimensional design for stacked capacitor cells is that capacitance appears in between a storage electrode atop the neighbouring gate electrode and its corresponding cell plates. This feature leads to two clear three-dimensional effects, one generated by the sidewall of polysilicon constituting the storage electrode, and the other the so-called *curvature effect*.

The curvature effect refers to an increase in the surface area entailing a storage electrode curve, which comes from a difference in height between word lines in the underlying layer. In its previous experiments, Fujitsu confirmed that effects from the polysilicon sidewall are more significant.

Accordingly, Fujitsu found it very effective to use thick polysilicon in the storage electrode in order to attain a dual goal of keeping a certain electrode surface area and preventing a capacitance decline at the time of cell area reduction. Still, the application of thick polysilicon tends to cause difficulties in making the pattern of cell plate, bit-line contact holes, and bit lines.

To overcome these difficulties, Fujitsu researchers employed a technique that makes the storage electrode thin, but prevents its surface area from decreasing. The result of this methodology is what they call the 'fin' structure. (See Fig.1).

DRAM development manager Taguchi said that Fujitsu's fin structure would be the best among various 3D storage electrode structures. He compares a fin capacitor structure to a heat sink which, because of its fin structure, can have its total surface area multiplied and makes air flow smoothly along its surface.

Previous Fujitsu experiments show that a single-fin capacitor cell, for example, is capable of generating 1.7 times the capacitance of cells based on conventional structures and two-fin cells three times. "All said, the fin structure will soon emerge as the mainstream DRAM design method," according to Taguchi.

Fujitsu says that fin-structured memory cells experience no deterioration in the breakdown voltage of capacitor insulator films, in spite of the fact that both such films and cell plates are formed in ultrasmall caps. In addition, the reliability of such films stands on a par with those for use in conventional structures.

In other parts of their experiments on the trend-seting cell structure, Fujitsu researchers concluded that cell plate impurity concentration, as found in between fins, hits a sufficient level with the conventional vapour phase impurity diffusion process in the fin manufacturing process.

64M DRAM

For Fujitsu to successfully apply the new fin structure in volume-producing

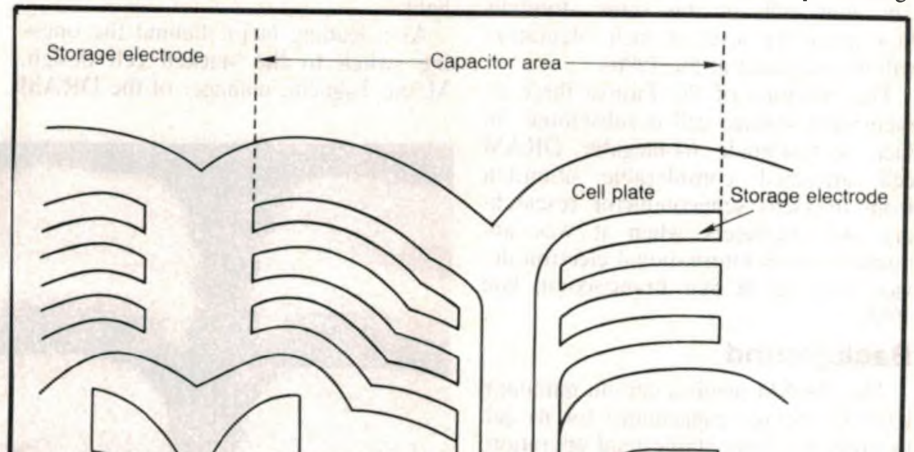


Fig.2: Cross-section of the new cell, showing the fin structure and underlying bit line.

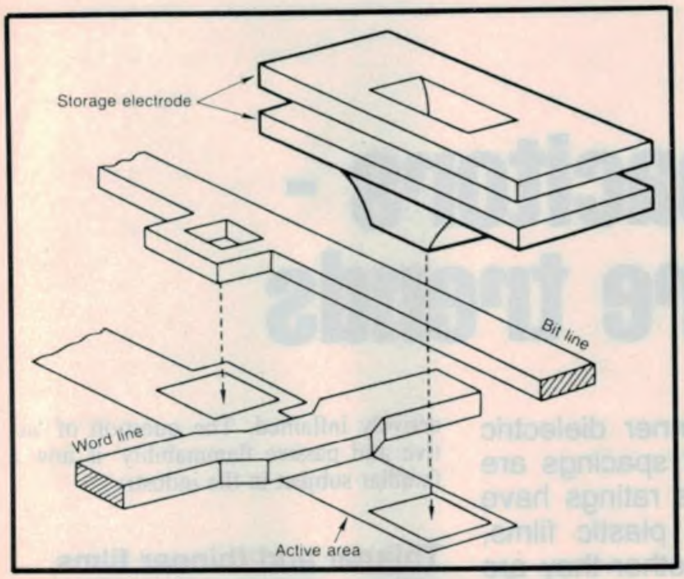


Fig.3: Schematic view of the new cell structure.

64-megabit DRAMs, it launched specific feasibility studies, which confirmed a number of advantages of such application.

Firstly, the new structure cell, when applied to 64-megabit DRAMs, ensures an improved level of scalability, because the cell needs no patterning of cell plate polysilicon layer in the array. Secondly, a larger storage electrode area can be obtained. This is because additional patterning in between storage electrodes (bit line contact holes, etc.) as required under the conventional method, is not necessary.

Coupling among mutually adjacent bit lines can also be decreased, because the cell plate acts as a shield plate. Such coupling was previously responsible for interference noise. (See Fig.2 for a $0.2um^2$ design rule cell.)

To verify the advantages of the new cell structure, Fujitsu test-made a $4.4um^2$ 16-megabit DRAM based on a $0.5um^2$ design rule (see Fig.3) and confirmed, among other things, that it ensures an efficient storage level of 27IF and a bit line-to-bit line coupling level of less than 1%.

The results are good enough to verify that the new Fujitsu fin-structured cell enables simplified processing, a high capacitance, and a heavily reduced noise level.

Further information regarding Fujitsu Microelectronics is available from Pacific Microelectronics, Unit A20/4 Central Avenue, Thornleigh 2120 or phone (02) 481 0065.

NOTES & ERRATA *From page 105*

COMPACT SUB-WOOFER ENCLOSURES

(September 1989): In the Jan 1990 Notes and Errata we noted that the current C3055 drivers available from Altronics stores were not suitable for the published cabinet designs. However, further investigation has shown that if the enclosures are re-tuned to about 42Hz (rather than the original 38Hz), the current speakers will produce acceptable results.

The single sub-woofer box should have its port length reduced to 70mm, while the double unit's ports should be changed to 62mm each. The resulting response is quite smooth, however the low-frequency roll-off point is raised to about 40Hz (–3dB) – the original arrangement's response extended down to around 35Hz.

In any case, Altronics informs us that a new driver with specifications to match the original unit will be available later in the year. (File: 1/SE/68).SE/68).

CHROMAVOX PROJECT: SAFETY WARNING

Since our publication of the Chromavox Sound/Light Display project in the February 1990 issue, a number of readers have contacted us expressing concern about the safety aspects of this project. The concern arise from the fact that virtually all of the circuitry of the project is 'floating' at mains potential.

Dick Smith Electronics, the developer of the project, spent a lot of time and effort to ensure the safety of this project when assembled from the firm's kit. Special components are used, such as control potentiometers and a control switch with plastic spindles; the project is also housed in a fully insulated plastic case. Note that because the project is proprietary, no other supplier is able to market a kit for it.

Electronics Australia is confident that when the project is assembled from a Dick Smith Electronics kit, according to the instructions supplied, and provided that the power is never applied to it except when the circuitry is fully enclosed within the case, the project will be completely safe.

However it must be stressed that operating the unit with the case OPEN is extremely dangerous, and could lead to a fatal electric shock. Such a shock could also occur if the circuit is not built into the specified case or if other components are used to substitute for any of the special insulated-shaft controls specified.

In the interests of safety, we warn readers to build this project ONLY from the DSE kit, and to follow all instructions carefully. In the event of a component failure it would also be best to make NO attempt at servicing, or component substitution, but rather return it for servicing to DSE.

Components Feature:

Plastic film capacitors - present & future trends

With the possibility of making thinner and thinner dielectric films, capacitors with smaller and smaller lead spacings are entering the market. The corresponding voltage ratings have gone up since the introduction of metallised plastic films, expanding their range of use. At this stage, whether they are of stacked or wound configuration does not seem to matter.

by WOLFGANG WESTERMANN

The main dielectrics of the film capacitor have been and remain paper, polyester (polyethylene terephthalate), polypropylene, polycarbonate and polystyrene (polystyrol). However, new plastic dielectrics have been and will continue to be developed, even if they only rarely achieve a technical or economic breakthrough.

The latest case of a successful dielectric is PPS (polyphenylene sulphide). It has a dielectric constant of 3.0 and a dielectric loss factor of 6×10^{-4} (at 1kHz/23°C). It therefore approximates and combines the advantages of polyester's high volumetric capacitance with the low dissipation factor of polypropylene. PPS also has a higher temperature rating than polycarbonate.

MP Capacitor

Metallised and resin-impregnated paper capacitors are now very widely used for power line RFI suppression, offering very high reliability, particularly in comparison to equivalent metallised polyester capacitors. This capacitor is the logical consequence of product and producer liability and the associated risks. Across-the-line capacitors made of metallised plastic film are destroyed by transients and catch fire, i.e., become actively inflamed. The question of 'active and passive flammability' is now a familiar subject in the industry.

Thinner and thinner films

Polyester is the dielectric material most suitable for the production of ultra-thin films. Whereas 25 years ago 6um was considered to be a 'thin film', in the mid 70's 2um and in 1978 1.5um were the minimum thicknesses available. It was only in 1986 that a further significant reduction could be made. In 1986, leading manufacturers launched films of 1.3 or 1.2um, reducing further to 1.0um in 1987.

Reducing the thickness of the dielectric material is the key to miniaturisation of capacitor construction. The degree of reduction in film thickness determines the reduction of volume per capacitance unit or the increase in capacitance per unit of volume. Ultra-thin films which were still considered impossible in the form of self-supporting films

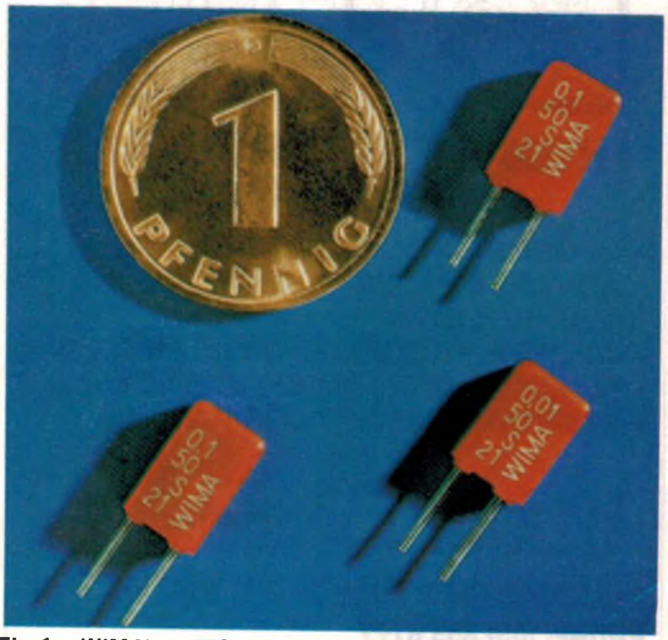


Fig.1: WIMA's MKS 02 series illustrates the modern miniature plastic film type, with 2.5mm lead spacing.

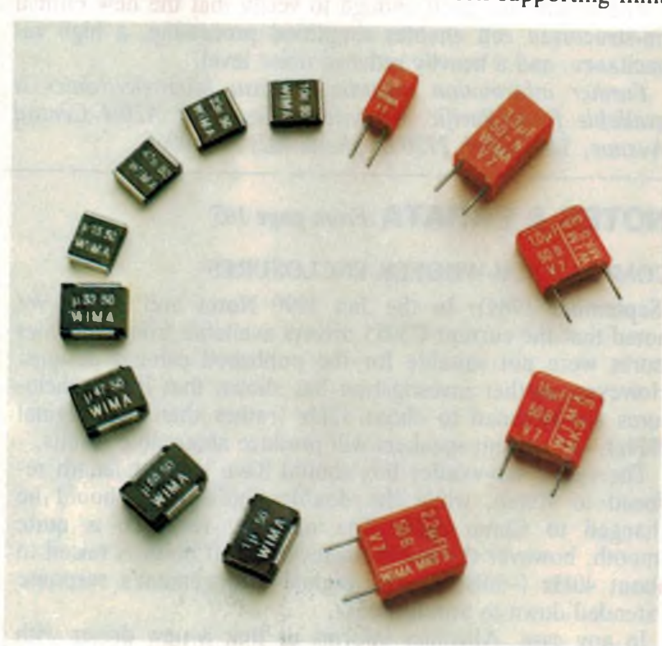


Fig.2: The MKS 01-SMD series come in values from 10nF to 1.0uF, with solder pad spacing of 5.7 or 7.3mm.

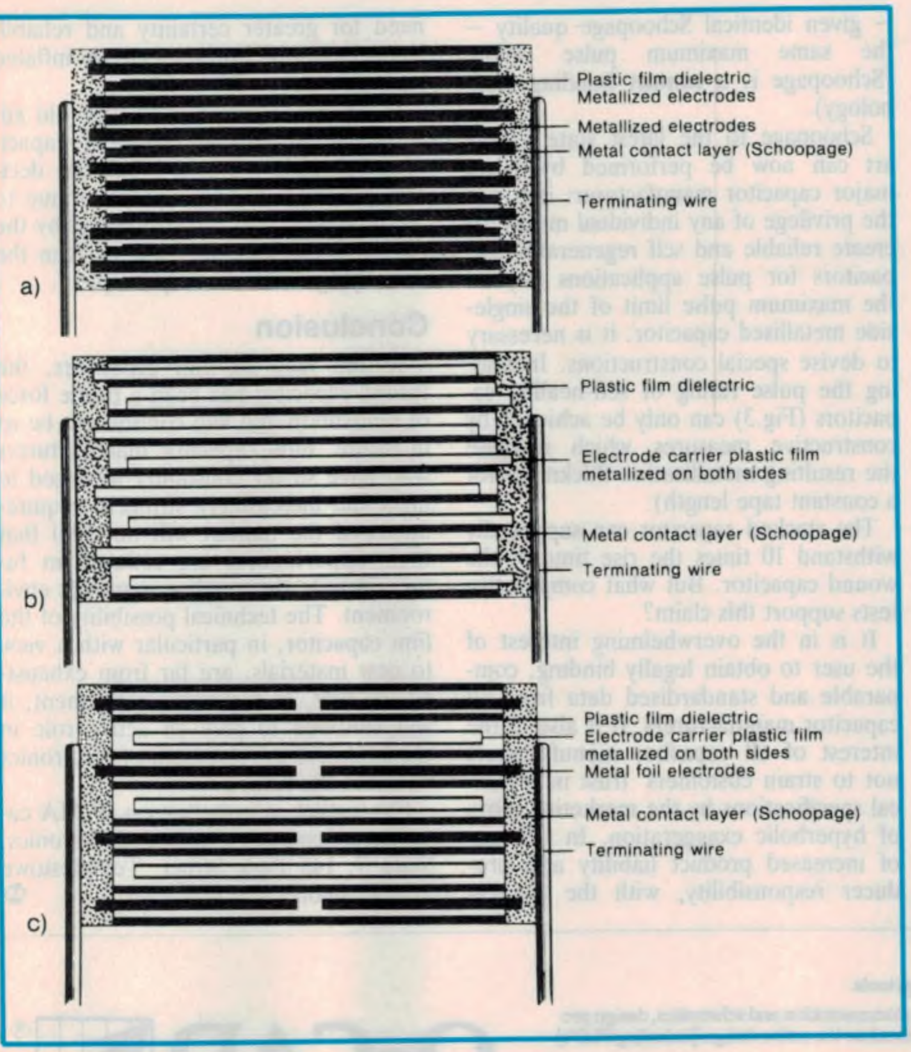


Fig.3: The construction of metallised plastic film capacitors can be adjusted to increase their pulse rating, by increasing metal thickness.

a few years ago have now become reality. However, development has still not stopped, and even thinner films are announced and can be anticipated as early as this year.

In all these stages, WIMA was always the first manufacturer to be able to mass produce and deliver usable products from the newly discovered films, thereby consistently demonstrating its outstanding potential for innovation as a wound capacitor manufacturer.

The most striking example of the miniaturised film capacitor is the WIMA MKS 02, an MKT capacitor with 2.5mm lead spacing (Fig.1). Film tapes only 2mm wide and as little as 1um thick are handled for this capacitor.

SMD film capacitors

The increasing importance of surface mount technology is generally familiar, as are the difficulties related to its introduction. However, these problems simply open the way for the metallised film capacitor in SMD design.

Wherever other SMD capacitor types suffer problems of inadequate electrical properties or mechanical difficulties in soldering, e.g., micro-cracks, solder deposits etc., the SMD film capacitor will be able to prove its worth. The one criterion is a reasonably priced and technically reliable component. In this respect, the important factors are the production process and the design.

WIMA supplies the MKS 01 SMD with the standard solder pad spacing of 5.7 or 7.3mm and a capacitance range of 0.01uF to 1.0uF (Fig.2). Naturally, both ranges are available in blister tape packaging for automatic insertion.

One remaining factor of uncertainty for the component manufacturer and user is the variety of soldering processes with insufficiently defined solder heat specifications. The introduction of standards will address this problem.

Wound or stacked?

This question is of a commercial rather than technical nature. Extracts from recognised specialist papers and patent literature show that the problem is much more complex and less clear-cut than certain stacked-capacitor manufacturers like to assert. The fact remains that the almost legendary differences between the processes are actually relatively small. The decisive factor is the know-how and resulting quality produced by the individual wound or stacked production factory.

This point is most convincingly demonstrated by the results of extensive comparative acceptance and inspection tests continuously performed by the most demanding component users.

In recent publications from the stack capacitor side, a fanfare of claims have been made that a new design has been found and that wound capacitors, by comparison with the 'new' stacked capacitors, are technically inferior in almost every parameter. For example, the sizes in the 250V and 400V voltage ranges have been almost 'halved'. It is also asserted that the 'clearly preferred modern' construction is the rectangular plastic case and that after massive research it is now possible to build PCM 5 capacitors with a capacitance comparable to that available on larger lead spacings with higher voltages.

On closer examination of this argument, the rectangular case favoured for capacitors relates to the radial lead capacitor which was developed as a plug-in component with the advance of printed circuit board technology. That was 25 years ago. The lead spacing of 5mm (PCM 5) is now some 20 years old.

The halving of capacitor size stems from the fact that the use of thinner films, provided that they have sufficient dielectric strength, means that capacitance values normally only attainable for voltage ranges above 250V with 7.5mm and 10mm lead spacing can now be attained in PCM 5.

It has also been claimed that stacked capacitors on 5mm lead spacing have an improved self-healing capacity. The backing for this claim is that the layers are stacked without high ply pressure, because they are stabilised by the Schoop contact layer. Analysis of this claim leads us to state that, as in the past, the MKT PCM 5 mother capacitor is stabilised by means of the tempering process.

All we can do is to carry out comparative tests on e.g. MKT 1.0 FPCM 5 capacitors of different makes and constructions, forcing the destruction of the component by slowly raising the applied direct voltage above the nominal voltage. It is interesting in this respect to note the dielectric strength up to the start of self-healing and regeneration when the voltage level is raised still higher. Many makes or types of capacitor are found to be astoundingly tough, whilst for others the first self-healing process is also the last, i.e., they break down like a film/foil capacitor.

A third claim made by proponents of the stacked capacitor is that the lower pulse rating of the metallised capacitor by comparison with the film/foil contruction is to a large exent compensated simply by the improved 'non-wound' construction.

No capacitor manufacturer can escape the physical fact that with single-side metallised capacitors, the pulse stressing limit for this system of contact bonding is defined by the length of the contact layer and quality of the contact bonding by the Schoop metal spraying process. Single-side metallised wound and stacked capacitors have the same contact bonding principle and consequently – given identical Schoopage quality – the same maximum pulse rating. (Schoopage is a contact bonding technology).

Schoopage to the latest state of the art can now be performed by every major capacitor manufacturer: it is not the privilege of any individual make. To create reliable and self regenerating capacitors for pulse applications beyond the maximum pulse limit of the single-side metallised capacitor, it is necessary to devise special constructions. Increasing the pulse rating of self-healing capacitors (Fig.3) can only be achieved by constructive measures which increase the resulting metallisation thickness (for a constant tape length).

The stacked capacitor can supposedly withstand 10 times the rise time of the wound capacitor. But what comparative tests support this claim?

It is in the overwhelming interest of the user to obtain legally binding, comparable and standardised data from all capacitor manufacturers. It is also in the interest of all capacitor manufacturers not to strain customers' trust in technical specifications by the marketing ploys of hyperbolic exaggeration. In this age of increased product liability and producer responsibility, with the ensuing need for greater certainty and reliability, it is no time for subjectively inflated statistics.

In future, for good or ill, the 'old adversaries', wound and stacked capacitors, will continue to coexist. The decisive factor for the user will continue to be the quality and range supplied by the capacitor manufacturer, rather than the underlying construction principle.

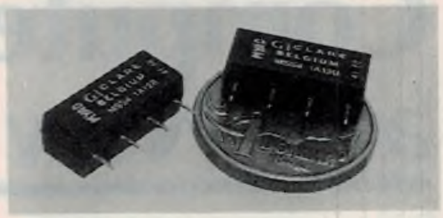
Conclusion

In the field of film capacitors, the wound capacitor has been a prime force of innovation and will continue to be so in future. Film capacitor manufacturers who have so far constantly managed to meet the increasingly stringent requirements of the market will not find that their opportunities are reduced in future, despite the tougher economic environment. The technical possibility of the film capacitor, in particular with a view to new materials, are far from exhausted, so that, as a passive component, it will continue to play an active role in the explosive development of electronics well into the future.

For further information on WIMA capacitors, contact Adilam Electronics, Suite 7, 145 Park Street, Templestowe 3106 or phone (03) 846 2511.

Components Feature:

New Releases



Coaxial switches

Dow-Key Microwave has introduced a series of electromechanical coaxial switches, with improved RF performance at microwave frequencies: VSWR less than 1.5:1, and insertion loss of 0.5dB.

The 461 series multiposition switches provide isolation of 60dB at 18GHz. The nominal actuator current for 28V DC is 140mA. Options include indicator circuitry, 12 or 28V DC normally open actuators, TTL or CMOS logic circuits and failsafe operation.

The 401-184 SPDT fast electromechanical switch has 5ms switching time and isolation of 50dB at 26.5GHz. Options include either failsafe or latching actuators.

The 421-101 coaxial switch features two inputs and three outputs, with SMA connectors for installation ease. Power is supplied through a subminiature 9-pin 'D' type plug. Switch speed is 10ms with options including latching type actuator and 50 ohm internal terminations. Isolation is 85dB at 18GHz and the performance is said to be excellent up to 24GHz.

For further information contact PJL Associates, 1a Windsor Place, Windsor 3181 or phone (03) 529 4061.

Minature PCB relays

Potter & Brumfield has extended its RK series of relays to include two pole units – for the models incorporating DC coils.

DC coil units are now available in a range of nominal voltages from 5 to 110V DC in two form A (DPST-NO) and two form C (DPDT) contact arrangements. Other contact arrangements available are form A (SPST-NO), form B (SPST-NC) and form C (SPDT).

AC coil units are available in nominal voltages from 6 to 240V AC with SPST and SPDT contact arrangements.

Units can be obtained with either an unsealed, plastic dust cover or an immersion cleanable, plastic sealed case.

For further information, contact Tecnico Electronics, 11 Waltham Street, Artarmon 2064 or phone (02) 439 2200.

PCB mounting BNC connectors

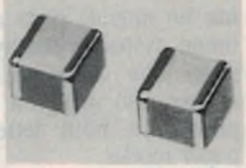
Belling Lee (UK) has extended its range of high quality BNC connectors with a new right-angled PCB mounting socket, which features low profile mounting.

Ideal for high-frequency PCB designs in instrumentation, broadcasting and aerospace applications, the new socket eliminates the need for hard wiring, and has a mounting height of only 17.45mm.

The right-angle BNC connectors are rated at 500V or 1A maximum and are manufactured in nickel plated brass. Contact resistance is 2 milliohms,, while insulation resistance is 5 gigohms. Nominal impedance is 50 ohms.

For further information, contact Tecnico Electronics, 11 Waltham Street, Artarmon 2064 or phone (02) 439 2200.

GHz range SMD capacitors



Murata Manufacturing has released the GRH-700 series SMD capacitors, with a solder coated termination suitable for reflow applications and hand soldering. Due to the miniature size and leadless construction, inductance is negligible and suitable for frequencies over 1GHz.

The GRH-700 series is offered with a stable NPO temperature coefficient (30ppm/°C), in a capacitance range of 0.5pF - 1000pF. They have a typical Q of 10^3 – 10^2 from 200 – 500MHz (10pF). Series resonant frequency is typically from 10GHz (3pF) to 300MHz (1000pF).

The GRH-700 series meets MIL-C-55681B with respect to thermal shock, moisture resistance, solderability, vibration, barometric pressure, temperature cycling, immersion and salt spray. The capacitors are available on tape and reel, or in bulk to suit both small and large users of the product.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

Mercury wetted SIP relay

C P Clare has released the MSS4 single-in-line (SIP) relay. It features an all position mounting mercury switch in a miniature form A (normally open) contact configuration.

The relay offers life-long stable contact resistance, high sensitivity, low input power and reliable switching from low levels to 30 watts. The miniature epoxy molded SIP package (19.5 x 8.2 x 6.75mm) with four in-line pins spaced 5.08mm is suitable for automatic and high density board mounting.

The nominal input power is as low as 178mW (5V coil) with operating times of less than 1.5ms. Standard coil voltages are 5, 12 and 24V DC with an optional diode.

For further information, contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

SMD inductors up to 1000uH

Siemens has now increased the inductance values of its surface mounting RF chokes to 1000uH by adding the new SIMID-03 series.

RF chokes in SMD style have a wide range of applications. They protect logic control circuits in automotive and industrial electronic equipment against high-frequency interference. The chokes are likewise used to suppress high-frequency interference for tuner IC's in entertainment electronic devices and to separate bands of different frequencies in filter circuits. They can also be found in satellite communication systems and cordless telephones.

Until recently, Siemens has supplied SIMID series 01 and 02 SMD chokes in size 1210. with inductance values ranging from 0.01 to 100uH. The new SIMID series 03 (size 1812) increases these values to 1000uH. Both SIMID 02 and SIMID 03 types, however, have the advantage of higher current ratings and lower ohmic values, some of which have been more than doubled and halved respectively.

For further information, contact Siemens Components, 544 Church Street, Richmond 3121 or phone (03) 420 7716.

Computer News and New Products

Epson's new 386SX-based PC

With 386 PC's currently the fastest growing sector of the market, Epson Australia has just released the latest addition to its PC family – the 16MHz PC AX3s.

Providing high speed 32-bit multi-tasking performance, the new PC AX3s offer the user an attractive and cost-efficient alternative to the current selection of 80286-based systems. Running at either 8 or 16MHz, it features a standard 3.5" 1.44MB floppy disk drive and is also available with a choice of either 40MB or 100MB hard drives.

Main board memory is a standard 1MB expandable up to 14MB on a single dedicated memory board, to cater for sophisticated and memory-hungry applications.

And just as importantly, the user's investment in existing software, AT-compatible boards and peripherals is preserved because the 386SX chip, although 32-bit internally, uses a 16-bit data bus. Full MS-DOS compatibility allows a wide variety of software to be run, including programmes written specifically for 80286 and 80386 processors. Users can make the most of the latest 386-based multi-tasking system enhancers, windowing environments and OS/2 software to gain the maximum performance from their system. A choice of either 3.5" or 5.25" optional floppy disk drives is also available.

In addition to the standard parallel and serial ports, the PC AX3s incorporate a built in PS/2 – compatible mouse port (with mouse). Five full-sized expansion slots are then available to allow the PC to be customised to the user's requirements.

For further information, contact your closest Epson Sales Office or dealer.

Enhanced bubble jet printer

Canon's advanced Bubble Jet Printer, the BJ130, is now capable of printing a variety of fonts. LePrint software, for example, can enable a word processing package using the BJ130 to print various fonts including, Clarendon, Helvetica, Garamond, Souvenir, Zaps Chancery Light, Letter Gothic, LCD, Old English, Park Avenue and Times Roman.

Bubble jet technology is claimed to be a vast advance on traditional ink jet printing. It gives superior print quality, has no moving parts and the ink membrane system virtually eliminates clogging. The difference in output technology also makes it easier to use the printer in both letter and computer paper modes.

The BJ130's broad range of fonts, seven different pictures for internal courier character expansion, reverse, shading, bold sub-and superscript and up to four typefaces per line capabilities, have now been greatly extended with the availability of enhancement programs.

For further information, contact Canon Australia, 1 Thomas Holt Drive, North Ryde 2113 or phone (02) 887 0166.

Low profile 3-1/2" hard drives

MiniScribe Corporation has announced a new product family which includes the industry's first 1" high 80 megabyte (MB) drive.

The 1" high, 3-1/2" hard drives, known as the 7000 series, are available with 40 or 80MB formatted capacities (40MB per platter) and AT or SCSI embedded interfaces.

The 7000 series features access time of less than 19 milliseconds, disk caching, high shock rating, and low power consumption, making the drives well

suited for use in battery-operated laptop and portable computers, as well as desktop systems.

A higher performance member of the product family features 120MB capacity and 16 millisecond access time. It is scheduled for release during the third quarter of 1990.

For further information, contact MiniScribe, Block 12, Lorong Baker Batu 04-11, Kolan Ayer Industrial Park, Singapore 1334 or phone (65) 745 3121.

Low cost frame grabber

The Dindima Group has released a locally designed and manufactured low cost frame grabber. The Arlunya FG.302 TV frame grabber PCB occupies a single slot of the IBM PC or AT bus. Its function is to store one field of a TV frame in 256 x 256 pixel resolution (7 bits grey scale per pixel), and to transfer the image data to the computer memory under DMA.

The FG.302 works with any VGA display with a transfer rate of 8 images per second or more. Images can be stored as a file on diskette or hard disk. File size of an image is 51.2K bytes.

The FG.302 accepts video input from most black and white cameras including CCIR and RS170. This enables images from a video camera to be displayed almost live on the computer VGA screen without the need for a second monitor.

The FG.302 is ideal for OEMs with specific applications in mind. Other applications include computer image database, surveillance systems, desktop publishing, image analysis, inspection systems, etc.

For further information, contact the Dindima Group, PO Box 106, Vermont 3133 or phone (03) 873 4455.

Transputer autorouter for CADSTAR

The new CADSTAR Transputer Autorouter is said to bring the power and flexibility of Racal-Redac's 'Bloodhound' autorouter within the reach of users running the CADSTAR PCB design system on IBM AT, 386 or compatible machines.

The package consists of a T800 transputer running the Helios operating system, and the Racal-Redac Advanced Autorouter. The transputer card can be 'plugged in' to an existing PC-AT or compatible, bringing with it true 32-bit workstation processing power. However as the Helios operating system is transparent, the user is kept in the familar DOS environment.

The Autorouter complements the interactive placement and layout optimisation of CADSTAR PCB design, and is said to be capable of achieving 100% solutions for the majority of well-placed boards, including high technology designs with double-sided component mounting and fine-line multiple layers. It is design-rule driven, which means that quality is not compromised to achieve speed.

There are five routing modules in all: a single-pass mode for initial assessment of placement and routability; a memory routing routine, for efficient routing around memory chips; a multipass gridless, 'rip up and re-try' router, capable of working with up to 16 layers simultaneously; a smoothing module, which optimises manufacturability by minimising segments and vias, and ensuring even track distribution; and an automatic corner mitring routine which automatically inserts 45° corners to improve both manufacturability and speed performance.

A Router Monitor Control System (RMCS) allows the user to monitor progress, obtain analysis reports and change parameters between passes for efficient operation.

Further details are available from RCS Cadcentres, national distributor for Racal Redac EDA Software, at 731 Heidelberg Road, Alphington 3078 or phone (03) 499 6404.

PC-driven device programmer

Sprint is a PC-driven 'universal' IC device programmer said to boost productivity considerably.

Sprint has been developed for programming PLDs, EPLDs, EPROMs, EEPROMs, PROMs and Microcontrollers, and can be added to an IBM PC, XT or AT to be used as a complete development tool.

It supports a total of 1150 PROMs and PALs, GALs and RALs from just about every manufacturer, and is said to be the most complete programming system available.

Sprint is also entirely menu-driven, which means there is no learning curve to overcome before it is fully functional. It is used with logic design tools, such as LOG/iC, ABEL or CUPL, and can also accommodate the Texas Instruments TMS320 range of digital signal processors.

For further information, contact Dynamic Component Sales, 1/17 Heatherdale Road, Ringwood 3134 or phone (03) 873 4755.

Bar codes from PC

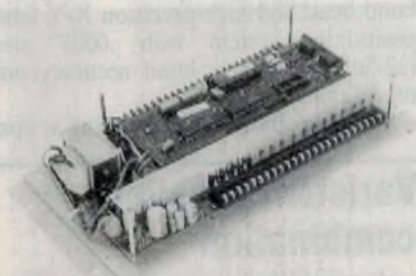
Canon Australia has developed a means of creating and printing bar code labels at a fraction of what it normally costs. The codes are created on a personal computer under DOS using a program written by Guian Young, an Adelaide-based Canon laser beam printer technician.

The program, which is priced at $400 per family of fonts, covers not just two, but all the major bar code standards and is designed exclusively for the Canon printer, which costs from $3995 depending on the model. However, the results are as good as those produced by dedicated bar code machines costing up to $20,000.

The Canon program is font-based and prints quite fast. The user can include a product description and special label design with the bar code symbol.

The program is likely to appeal not only to programmers but to groups using PCs such as accountants (who are now bar coding clients' files), pathology labs (for filing) and companies with database files. Bar codes can also be prepared by companies for labelling equipment for stock taking or auditing.

For further information, contact Canon Australia, 1 South Road, Thebarton 5031 or phone (08) 352 5366.



I/O controller for PCs

Computronics' Kolinker 1616B IO controller is suitable for a wide range of control applications from irrigation to automatic batch plant operation and so on. It has simple stand alone sequence control, sophisticated automatic manufacturing/testing systems and remote/distributed controllers with local intelligence.

All of its inputs and outputs are optically isolated. There are 16 inputs, 12 high capacity relay outputs capable of handling 10A and four high speed open-collector outputs for controlling high speed devices such as stepper motors and solid state relays. An optically isolated RS-232C input/output provides for control by an external computer and easy software operation.

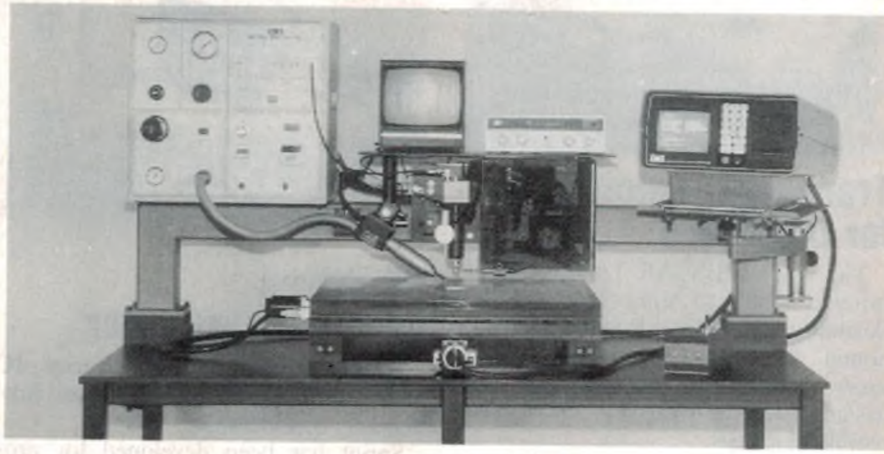
The PCB signal paths and onboard power supply are designed for maximum noise immunity to suit operation in all harsh environments.

For further information contact Computronics, 31 Kensington Street, East Perth 6004 or phone (09) 221 2121.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Large substrate outer lead bonder



US company IMI has just introduced a Model 1300E single point outer lead bonder for large substrate processing. The bonder was developed for the large substrate market, including glass panel displays and printed circuit boards.

The bonder is capable of ultrasonic, thermosonic or thermocompression single point lead bonding, directly to populated substrates up to 610 x 610 x 1.27mm. Substrate heating is accomplished by a custom heated work holder and/or a unique hot gas gun system. Included is a stationary, true Z motion bond head and high precision X-Y table positioning system with .0005″ step (12.5um) to insure bond accuracy and repeatability.

Set-up positioning and viewing is controlled by a 2-axis joystick and CCTV/stereo microscope system with an optical reticule to target the bond point. The machine control system is microprocessor driven with 3.5″ microfloppy data storage. The bonder can be equipped with custom workholders and optical systems.

Further information from International Micro Industries, 23 Olney Avenue, Cherry Hill NJ 08003 or phone (609) 424 3112.

Varistor/capacitor combination

A new high-capacitance varistor from Siemens protects not only the sensitive electronic equipment in automobiles against overvoltages, but also prevents EMI from impairing radio reception in the car. These features are made possible by the first component to combine a capacitor and a varistor in a single package.

The more electronic parts are used in automobiles, the more important becomes their protection against electromagnetic interference. The essential thing, on the one hand, is to prevent overvoltages resulting from automotive relay switching, a task that can be handled by a varistor. On the other hand, the suppression of EMI that disturbs radio reception, such as that produced by a windscreen wiper motor, requires the use of a capacitor.

Siemens has combined two components to form a compact single one: a multilayer ceramic capacitor and a multilayer varistor are connected in parallel and then encased in epoxy. The resulting high-capacitance varistor measures as little as 7.8 x 5.5 x 9mm, has capacitance values in the 0.5uF to the 1.5uF range, depending on type, and can absorb spikes up to 1J in energy.

Also available are high-capacity varistors capable of absorbing energy up to 15kJ and with a maximum current rating of 100kA.

For further information, contact Siemens Components, 544 Church Street, Richmond 3121 or phone (03) 420 7313.

32-segment LCD driver

Microchip Technology's AY04381 is a CMOS LSI circuit that drives a liquid crystal display, usually under microprocessor control. The part acts as a smart peripheral that drives up to 32 LCD segments.

It needs only three control lines due to its serial input construction. It latches the data to be displayed and relieves the microprocessor from the task of generating the required waveforms.

The AC frequency of the LCD waveforms can either be supplied by the user or generated by attaching a capacitor to the chip's LCDs' input, which controls the frequency of an internal oscillator.

The AY04381 also acts as a versatile peripheral, able to drive displays, motors, relays and solenoids within its output limitations. It is available in 40 lead dual-in-line ceramic and plastic packages.

For further information, contact Fairmont Marketing, 726 Plenty Road, Preston 3072 or phone (03) 471 0328.

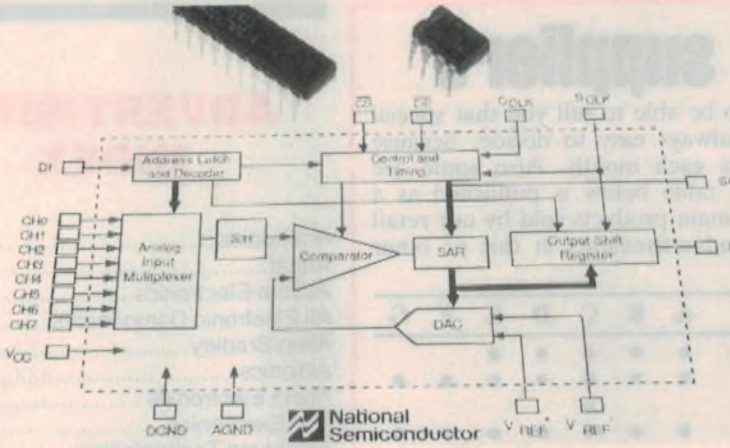
8-pin instrumentation amplifier

Precision Monolithics has introduced the AMP-02, a high performance 8-pin instrumentation amplifier. It requires only a single external resistor to set the gain, offers internal overvoltage protection, and features very high accuracy performance.

If no external resistor is used, the AMP-02 is set to a gain of +1, making it a complete unity-gain differential to single ended converter amplifier. It also has internal overvoltage protection that allows the device to withstand 60V overloads with the power on or off. The input offset voltage is under 100uV with temperature drift below 2uV/°C.

The AMP-02 has over 115dB of common-mode rejection. Since it utilizes a transimpedance input stage, it does not suffer a dramatic decrease in bandwidth as gain is increased. At G = 1, the bandwidth is 1.2MHz; at G = 1000, the bandwidth is 200kHz.

For further information, contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064, or phone (02) 439 8622.



ADCs with multiplexer, track-and-hold

National Semiconductor has announced a new family of 10-bit serial I/O analog-to-digital converters (ADCs) featuring on-board multiplexer and track-and-hold capabilities. The three devices in the family are ideally suited for engine monitoring and control applications, instrumentation and automatic-test equipment, and process-control systems.

The ADC1031, ADC1034 and ADC1038 have one, four and eight analog input channels respectively. All three A-to-D converters are guaranteed over industrial and military temperature ranges and completely tested for no missing codes. The devices also feature a low power consumption of 20 milliwatts and fast conversion times of 13.7 microseconds.

The fast and flexible serial interface of the ADC1031 series offers user-programmable left or right justified output data with a serial data-exchange rate of 10 microseconds. Digital I/O lines are TTL and CMOS compatible.

Further details are available from National Semiconductor distributors.

Visible-light laser diode

Toshiba has developed and will start marketing the world's shortest wavelength visible-light emitting laser diode. At room temperature, the TOLD9220 can constantly emit a visible red-light laser beam at a wavelength of 660 nanometers.

Because of its short wavelength, the perceived brightness of the beam emitted by the TOLD9220 is twice that of the company's current 670nm models at the same input power level. Red-light emitting laser diodes are used in the bar-code readers found in stores and factories, in laser pointers and measuring instruments, and are expected to be further used in laser beam printers and optical disk drives in the future.

Toshiba achieved a 660nm-wavelength device by adopting an active layer (light-emitting layer) made of indium-gallium-aluminium-phosphide (InGaA1P) compound, and by developing an optimal crystal growth method.

TOLD9220 also incorporates a selectively buried ridge waveguide laser (SBR), which makes light emission more effective.

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