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**LOUIS CHALLIS
REVIEWS SONY'S
NEW DTC-55 DIGITAL
AUDIO TAPE DECK**



Registered by Australia Post - Publication No. NBP 0240

Wide Band Receivers...



has broken the barriers with its new line of wideband receivers built to go the distance. Introducing the IC-R1 handheld receiver, the IC-R72 HF receiver and the IC-R100 multipurpose receiver.

The smallest wideband handheld available today, the IC-R1 continuously covers 100kHz - 1300MHz (Specifications Guaranteed 2-905MHz) with AM, FM and Wide FM modes. This tiny receiver measures just 241mmW x 94mmH x 229mmD.

Easy operation is a snap with the IC-R1's Dual Frequency Selection (direct keyboard and rotary tuning). 100 memories and a 24-hour clock completes the world's smallest full-featured handheld receiver.

Install the IC-R100 at home or in your car. Listening pleasure is guaranteed with continuous coverage from 100kHz-1856MHz

(Specification Guaranteed 500kHz - 1800MHz) in AM, FM and wide FM modes. Monitor VHF air and marine bands, emergency services, government as well as amateur stations. 121 fully programmable memory channels, multiple scanning system, an automatic noise limiter, built-in preamplifier and attenuator, clock with timer, and built-in backup lithium battery make the IC-R100 the perfect package for mobile or base operation.

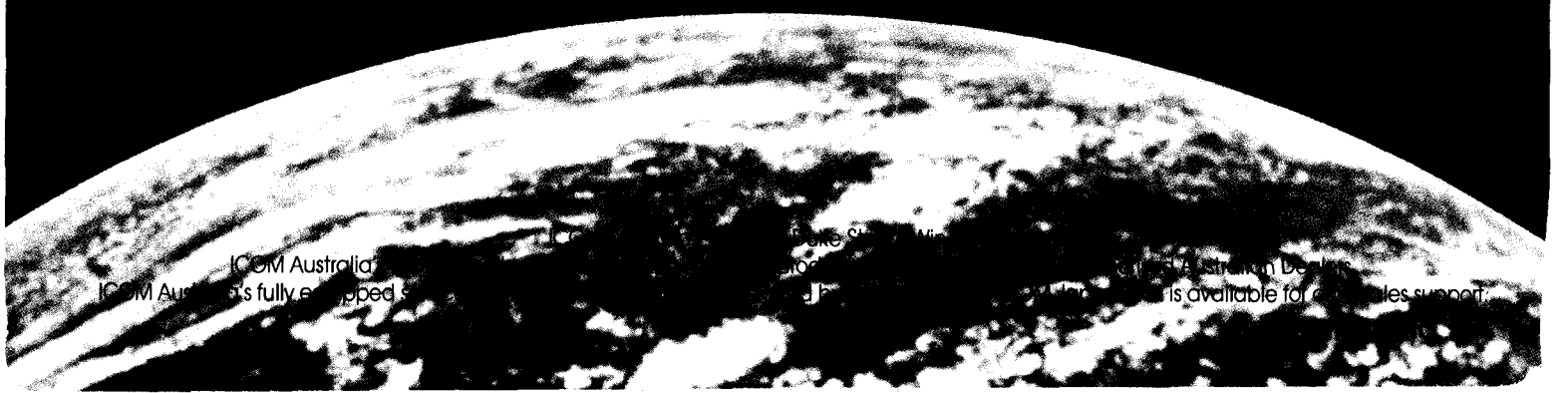
The IC-R72 continuously receives 100kHz - 30MHz in SSB, AM and CW modes with very high sensitivity. An optional UI-8 provides FM reception. Additional features include: Noise blanker, five scanning systems, AC/DC operation, internal backup battery, built-in clock and ICOM's DDS System. The IC-R72 boasts a 100dB wide dynamic range while an easy-to-access keyboard provides convenient programming versatility. The easy to operate

IC-R72 is superb for short wave listeners.

The IC-R1, IC-R72 and IC-R100 join ICOM's current line of professional quality receivers... the IC-R71A, IC-R7000 and IC-R9000. ICOM... expanding the horizons to bring you better technology, today. See the complete line of quality ICOM receivers at your local authorized ICOM dealer today.

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First in Communications

...That Go The Distance.



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ICOM Australia's fully equipped service

ICOM Australia's fully equipped service is available for all ICOM products support.

Electronics Australia

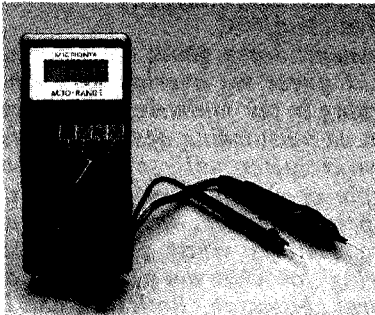
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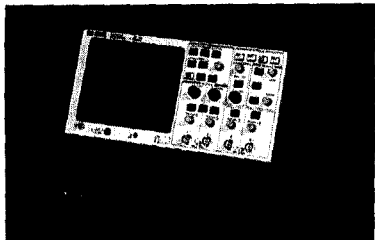
AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Digital multimeter with a voice of its own



This month sees the release of Tandy's latest handheld digital multimeter. It may look like any other DMM, but there's a difference: this one talks. See page 34.

H-P's new 100MHz 'analog' digital scope



As reported last month, Hewlett-Packard has just released a new competitively priced 100MHz digital scope which 'drives' just like a traditional analog model, yet offers all the latest facilities. Jim Rowe was able to try out an advance sample — see his report starting on page 88.

On the cover

Our new Logic Pulser probe makes an ideal companion to the Logic Probe we described in the August 1990 issue, for troubleshooting in digital circuitry. It's compact, low in cost and easy to build, too. See our story, starting on page 62. (Picture by Peter Beatty)

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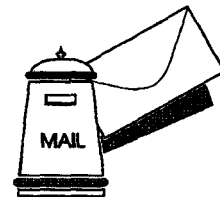
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LETTERS TO THE EDITOR



'Basic Electronics' series

Throughout my working life as a chartered professional engineer in the field of radio and electronics, I have always been interested in the sources of information available to those anxious to learn something about electronics but not really knowing where to start.

In this regard, it has been my experience that such people have often found some texts too elementary and thus not entirely suitable for leading on to more advanced study. Alternately, others appear rather too complex from the outset and thus tend to put would-be students off.

Without doubt, the most satisfactory solution to this dilemma has been the series of articles on 'Basic Electronics' written by Peter Phillips and published in *EA*. In this respect, I would like to congratulate the author on the accuracy and clarity with which he has presented the information, and the staff of *EA* for publishing it in such a readable form.

I strongly recommend a study of these instructive articles to all high school and university students wishing to add a sound basic knowledge of electronics to their chosen field of study.

Keep up the good work! Is it too early to suggest that, at a later date, the whole series might be put together in text-book form?

Winston T. Muscio,
Leumeah, NSW.

Comment: Thanks for the kind words, Winston. And no, it's not too early to suggest that it be published later in book form. We already have plans along these lines.

Transceiver only for hams

I applaud Dick Smith Electronics' research and development department for their latest efforts with the two metre transceiver. I hope it will be a great success for them. However, the one thing that does distress me everytime I see an article published in a magazine of a transmitter capable of operating within the amateur bands is the total omission of an appropriate warning cautioning the would-be builder that in order to use the transceiver a licence is required and the penalties for failing to do so are quite

severe. I also believe a prominent label should be displayed on the box of every kit sold. Or is it that neither *Electronics Australia* or Dick Smith care?

I would just like to know what it is that none of the magazines carry out what I consider to be a moral obligation.

Ian Glanville (VK3AQU)
Myrtleford, VIC.

Comment: Sorry about the omission, Ian. I guess we overlooked such a warning in our enthusiasm to present such an outstanding design. Hopefully your letter will serve to warn people of the need to gain the appropriate licence, though. I'm not sure exactly what you mean by 'caring', or what you perceive as our 'moral obligation.' Both DSE and EA are keen to promote amateur radio, as I believe we continue to demonstrate. Sometimes it seems that at least some hams are doing their best to discourage newcomers and turn the hobby into a secret society.

Encouraging youth

I am replying to the letter 'Encouraging Youth' in the February 1991 issue of *EA*. I am 12 years old and my life is basically electronics. *EA* is my favourite magazine and I get it every month via subscription.

I totally agree with what Patricia Tong said, and I know for a fact that not many young people consider electronics as a hobby — or as Patricia said — a way to make a living. I know that nobody I have met has even thought about it. It is people like Patricia and *EA* that actually do something about it. I like to watch 'Beyond 2000', but it only makes matter worse. Children think "no way - too hard!" Others might be more interested but just don't know what to do about it.

I definitely agree with people like Patricia who will stir up such a problem and a magazine like *EA* which will publish it. I have no doubt that *EA* is the best electronics magazine on the market today. Keep up the good work.

Sam Howlett,
Churchlands, WA.

Comment: Thanks for your comments too, Sam. I'm sure you're right, too — not just about youngsters being put

off from tackling electronics as either a hobby or a vocation, but about the world needing people like yourself to provide the next generation of engineers and technicians. We certainly intend to continue trying to interest young people like yourself in this fascinating field.

Why be a ham?

This letter concerns amateur radio, and specifically the regulations regarding it. About a year ago I sent away to the WIA asking for information. For a modest fee they sent me a load of material. More recently I sent away to the DoTC for their pamphlets concerning the regulations and so forth. I read through them and uncovered this:

DOC71

9. An amateur station shall not be used:

c) to transmit material relating to industrial, commercial, political, social or religious matters.

I don't know about anyone else, but I'm b — d if I'm going to learn a load of garbage that I may not use, go and sit an exam to determine if I know it, fork out money for a licence, possibly fees to a couple of clubs, give the government another excuse to keep a file on me, buy or build a transmitter, receiver, power supply and aerial (all up maybe a thousand dollars), mount (and find a place to mount) this aerial, only to be censored on talking about anything of any real interest (i.e., politics, society and religion).

However, I can buy a modem (\$500), register my copy of Telix (\$70?), snake a telephone extension up the hall and set the whole caboodle up for much less hassle, and still retain the (God given?) right to speak about whatever I bloody well choose. Really is there a comparison?

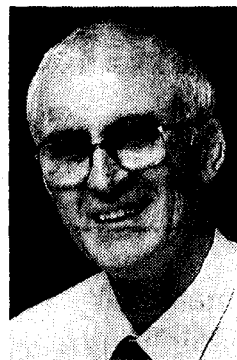
Patrick Zachariah,
Epping, NSW.

Comment: It depends on your interests, Patrick. Many people have found the experimental, technical side of ham radio to be highly satisfying and rewarding — even though that side of the hobby does seem on the decline. Still, your comments should give ham radio proponents a good idea of the challenges they face, in 'selling' their hobby.

DROP US A LINE!

Feel free to send us a letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it — but we reserve the right to edit those that are over long.

EDITORIAL VIEWPOINT



When will we get serious about scientific and technical education?

I don't know about you, but I keep on reading and hearing stories about deteriorating conditions in our colleges of Technical and Further Education. Demoralised and underpaid teachers, dated and irrelevant courses, inadequate equipment and resource material, almost no real communication between 'head office' and the colleges, overstaffed and inefficient head office departments, falling enrolments and so on — hardly a week seems to go by without a further worrying instalment.

Yet at much the same time, in the Sydney newspapers at least, I've seen large advertisements inviting applications for dozens of high-level administrative positions within the TAFE system. All offering *very* impressive salaries, well above those of the actual TAFE teachers.

The clear inference one gets from all of this is that somehow our TAFE system has become bogged down in its own inefficiency, and has lost the plot. Instead of directing its energies towards improving performance at the vital day-to-day teaching level, all the real attention seems to be going into building an even bigger bureaucracy.

In other words, we seem to be racing towards a system that will be top-heavy with administrative 'chiefs', all adding so much to the overheads that there'll be no money left over to pay for any 'indians' or equipment for actual teaching.

All this at a time when it is generally acknowledged that in the next few years, Australia will be in desperate need of many *more* skilled scientific and technical people. So we should be putting much *more* effort into lifting the morale and performance of our technical colleges, not less.

Which prompts the question: when is Australia *really* going to get serious about scientific and technical education?

Of course we aren't the only country with this problem; Britain and the USA are in much the same boat, judging from stories I've seen. But that doesn't make the problem less serious. Time is running out, and it's getting to the stage where the required remedies will be more and more drastic — or less and less likely to take place, whichever view you take.

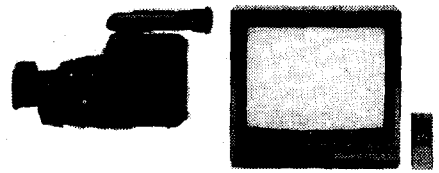
Perhaps we should take urgent lessons from Germany, which has always placed heavy emphasis on the education of its scientists and skilled technologists. Teachers in West Germany have very high status, and are apparently paid much more than their equivalents in Australia. And I believe that almost everyone in Germany who doesn't have a university degree has skill qualifications from a technical college or institute.

This has certainly paid off, with the country continuing to play a leading role in European technology — despite the complications produced by its recent unification. In fact West Germany is reputed to be the world's largest exporter, even ahead of Japan.

It seems to me that if we're not to slip right down into the status of a technological banana republic, it's about time we became serious about technical education too. And I *don't* mean simply building a bigger educational bureaucracy!

Jim Rowe

What's New in VIDEO and AUDIO



Yamaha A-V amplifier

The new Yamaha RX-V1050 AM/FM stereo receiver features the firm's 'Cinema DSP technology', and incorporates Dolby Laboratories' Digital Pro Logic/Enhanced surround sound decoding — which has now been implemented by Yamaha in a single LSI chip.

This provides 90dB of dynamic range with crosstalk at -46.5dB, significantly lower than the previous analog system.

Yamaha's own Digital Sound Field Processing 'Cinema DSP' provides four further available surround sound modes: concert video, mono movie, rock concert and concert hall.



The RX-V1050 provides three front channels (left, right and centre), each with a rated output of 110W RMS into eight ohms, plus two rear channels rated at 30W RMS each.

Rated THD for full output on the front channels is .015%, with .08% for the rear channels.

Frequency response for all channels is 20Hz-20kHz +/- 0.3dB for the main amps, and +/-1.5dB for the CD and other medium-level inputs. Signal to noise ratio for the medium-level inputs is 93dB, and for the phono (MM) inputs 86dB.

The unit has provision for eight audio and four video inputs. The inbuilt AM/FM tuner uses direct PLL tuning and has provision for 40 preset tuned memory channels, plus a 13-segment 'signal quality' indicator.

Other features include a built-in low pass remote control unit with 'learning' capabilities.

Dimensions of the RX-V1050 are 435 x 172 x 469mm, with a weight of 18.6kg. Further information is available from Yamaha dealers.

NiCad dischargers, free info brochure

Sydney video services firm Filmland Cinema Services is now able to supply Discharger units specifically designed for the NiCad battery packs used in the majority of portable video camcorders, by Keene Electronics. Controlled discharging ensures that NiCad batteries are fully 'cycled', to maintain their full rated capacity.

The units are designed to discharge at a gentle 130mA rate (C/10), with automatic cut off to ensure a full discharge of the useable portion of the battery's capacity, without over discharge. The battery can then be fully charged prior to use. Different cutoff voltage levels can be set, according to the number of cells in the pack. Cost of each Discharger is \$65.00.

FCS can also supply an information free brochure produced by Keen Electronics, entitled 'Understand your NiCads'.

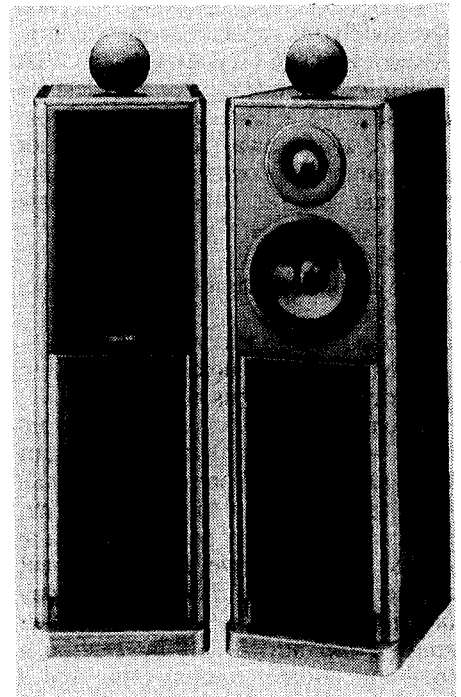
Further information is available from Filmland Cinema Services, PO Box 101, Strawberry Hills 2012; phone (02) 698 1470.

External 'bitstream' DAC

Most CD players already have their digital to analog conversion section built-in, but some models provide for an external converter to allow improving the sound quality as technology develops.

Those with early generation CD players who are enthusiastic to try the new low-bit conversion technology now have the opportunity with Deltec's PDM-1 series II external DAC unit. This can only be used with a player fitted with a direct digital output, but many of the more 'serious' CD players are in this category. The digital input is via a phono socket while audio outputs are also via phono sockets and are fixed at a nominal 2.5 volts.

The Deltec PDM-1 Series II is covered by a 12-month warranty and has a recommended retail price of \$2295. Trade and retail enquiries should be directed to Kedcorp Pty Ltd on (02) 708 4388.



Air column speakers from Onkyo

Onkyo has released its 'flagship' line of speakers, the Scepter 3001 Super Labyrinth Bass System.

The Scepter 3001 uses the 'labyrinth' system which was initially patented over 40 years ago, based on a loaded air column to 'tune' a speaker for optimum performance.

Onkyo claims this provides powerful, accurate and yet subtle low bass response, extending down to 40Hz. Previously this response was only achieved with much larger systems, the company claims.

The Scepter 3001 uses a 25cm (10") specially hardened Deltaolefin-cone subwoofer, which Onkyo claims produces the speed and transient ability to reproduce tight clean extended bass.

The directly radiating 20cm (8") pure cross-carbon woofer handles low and mid bass notes, while the mid range is covered by an exclusive 5cm (2") oval diaphragm configuration.

The high frequencies are delivered by an externally seated 1" dome tweeter, mounted on top of the Scepter 3001 to

provide wider dispersion characteristics and prevent unwanted mutual interference with the baffle board.

The Scepter 3001 offers medium sensitivity (88dB/watt/metre) and is designed for amplifiers from 60 up to 250 watts RMS. Frequency response is quoted at 20Hz to beyond 50kHz +/-4dB.

Finished in hand rubbed solid walnut with extremely thick baffle boards and rolled edges, the Scepter 3001 is designed to compliment the most discerning audio environments. Covered by a five year parts and labour warranty, it has a recommended retail price of \$8999 and is available at selected Onkyo dealers.

Novel colour TV released by Philips

Featuring a sleek futuristic design in black with startling Monza Red visor trim, the Philips 14 GR 1220 'Discoverer' portable remote control colour TV is styled in the shape of a space helmet, complete with a movable tinted visor and two telescopic antennae.

The limited edition 14" TV has a dark glass screen, for high picture quality and music power output of two watts. A digital display system operates on screen, so you can keep track of the adjustments made to functions including programming, volume, picture and timer.

Up to 40 pre-selections can be programmed into the Discoverer which also includes a sleep timer.

A lightweight space-save, the Italian designed Discoverer weighs in at 11.6 kilos and measures 53 x 43 x 52.5cm. It has a recommended retail price of \$699.



New 'top of the range' Technics cassette deck

Technics new 'top of the range' single deck cassette recorder RS-B965 uses the latest technology to give what is claimed to be the best sound possible.

It is a three-head machine, allowing the gap width in record and play heads to be set to the optimum for each function (on most decks the width is set on a compromise figure between the record and playback optimum distances).



In addition, the machine has real-time monitoring so the user can listen to and therefore adjust what is going on the tape as it is recording.

The RS-B965 has a superior quartz direct drive capstan drive motor, for constant speed while the closed loop dual-capstan gives excellent tape to head contact and tape control.

Recording bias level can also be adjusted to achieve optimum sound, depending on which brand of tape is used.

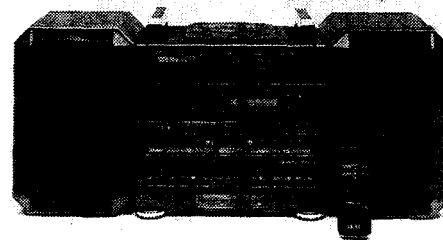
Other features of the deck include three noise reduction systems and an isolated chassis designed to help prevent electromagnetic switching distortion being picked up in the recording and playback modes within the tape deck. The Linear Magne-Field Class AA circuitry and the Phase Compensation Circuit (PCC), also give improved stereo imaging.

Technics RS-B965 is a sleek, black unit with large insulating feet. Recommended retail price of \$899.

Portable hifi systems include CD player

Akai has introduced two new portable CD hifi systems that are the flagships of their portable range. The PJ-W705CD system comprises a digital AM/FM stereo tuner with PLL tuning, five band graphic equaliser with dual 12 watts (RMS) power amp (144W PMPO), double cassette deck, 16 track programmable twice oversampling CD player, cordless remote control and two way detachable bass reflex speakers.

With its pedestal feet and octagonal shaped speakers, the PJ-W705CD is designed for music listeners who value good sound and exemplary good looks.



Although comparatively large in size, it has two sturdy supporting carry handles and is easily transportable.

The smaller PJ-W305CD portable offers five watts per channel and can deliver peaks of around 60 watts. A five band graphic equaliser provides individual tone control. Additionally, a loudness switch provides bass and treble boost to enrich listening at lower levels.

The PJ-W305CD also features an Extended Dynamic Sound System (EDSS), a form of bass enhancement which Akai claims provides a more 'dynamic' sound by producing enhanced bass boost.

Both the PJ-W705CD and PJ-W305CD operate from either DC or AC and are covered by a one year warranty. They have a recommended retail price of \$599 and \$499 respectively.

Stylish hifi system from Onkyo

Onkyo claims its new 'Liverpool 100' hifi system represents a new trend in component system design.

The Liverpool 100 system comprises a stereo tuner-amplifier, compact disc player, double auto reverse cassette deck, RI remote control capability and optional speakers and stands.

The tuner amplifier (R-100) offers 45 watts output and provides six audio inputs for phono, CD, tuner, auxiliary, tape in/out, and also two video sound inputs. Onkyo has used a motor drive volume control, claiming it to be superior to competitive semiconductor types.

The in-built AM/FM quartz synthesised stereo tuner offers 30 station presets, with a 'jump' function to skip over non-preset stations. Other tuner features include convenient battery backup in case of power failure or disconnection from the mains supply), auto tuning and auto mute. The compact disc player (C-100) offers an 18-bit eight timers oversampling digital filter and three modes of replay, disc — normal selection, memory — up to 20 selections in any desired order, or reshuffle — selections are completely at random.

The auto reverse double cassette deck (K-100R) offers the flexibility of both Dolby B and C and an HX Pro headroom extension system. ■



SONY'S DTC-55 DIGITAL AUDIO TAPE DECK

After an agonisingly long development and drawn-out legal wrangles with the software industry, DAT recorders have finally made it onto the consumer market. Louis Challis has been testing the first sample of Sony's new DTC-55 deck to reach Australia, and here's what he found.

Quietly, and with a minimum of fanfare, Sony Australia has released its first DAT recorder deck for unrestricted sale on the local consumer market. Now that may not seem to be such a momentous event to most readers, but it is now almost four years since Sony and other major Japanese companies released the first of these extraordinary recorders on the Japanese market, and they have shown something more than 'reluctance' to release them in other countries.

Why the delay, you ask? Well, it's taken three years for all the DAT manufacturers to thrash out with the recording companies a mutually acceptable policy and system for electronic protection against multiple sequential digital copying from CDs.

But the wait has brought benefits. When the first DAT recorders went on sale in Japan, they sold for between A\$2500 and \$3000. In contrast, the new DTC-55 has a recommended retail price of \$1599, and incorporates a number of new technical advances and 'user friendly' features.

Now most technically-aware purchasers would not refer to the Serial Copy Management System (SCMS for short) built into the DTC-55 and all other new DAT machines as a user friendly feature. But to be realistic, few normal users or purchasers are likely to be aware of its presence, and then only if they should attempt to 'break the copyright rules'.

The real breakthrough in the deck is the addition of a 'long play' recording mode, which gives you twice the recording time from your expensive DAT tapes — at the expense of a narrower 15kHz bandwidth and more importantly, only a purely nominal reduction in the dynamic range of the long play recordings.

When Sony released the DTC-1000ES

(its first digital tape deck) four years ago, it set in motion the second phase of the digital revolution which started only nine years ago with the introduction of CDs. The Sony DTC-1000ES was a heavyweight at 12kg, but although DTC-55 weighs only 7.5kg, it could never really be described as a 'lightweight'.

If you had purchased the DTC-1000ES in Hong Kong or Japan, you would have been disappointed to find that it incorporated a 'Digital Copy Prohibit' function which positively precludes the copying of CDs via the digital input (but not of course via the analog inputs).

But enough of comparisons with other digital records, for the DTC-55 is almost beyond comparison when it comes to technical superlatives. For a start it uses the first of a new generation 'one bit' digital linear converter system, which Sony describes as its 'High Density Linear Converter System'. This uses a 45-bit noise shaping digital filter which uses a direct digital synchronisation stage to reduce time base errors and subsequent 'jitter'. The deck also incorporates other new technology, including a multi-stage feed forward circuit to improve error correction, plus a new 'state of the art' digital servo IC which obviates the thermal drift and aging effects of components, which the previous generations of DAT decks apparently displayed.

The dynamics of the deck are further enhanced and significantly speeded up through the incorporation of a four motor transport, which almost halves the time required for loading or unloading a DAT cassette, when compared with the DTC-1000ES for example. In fact it really burns along during AMS searching or rewinding of a cassette. The high speed music search is particularly fast and is 200 times the normal playing speed.

Other convenient features which were introduced into the first generation DAT decks include music scan, threeway repeat, 10-key direct access for track selection and 60 track programmability.

The deck incorporates the ability to both generate or detect various subcode-activated interactive control functions. These include the 'Start ID', 'Skip ID' and 'End ID' functions. In addition Sony has now incorporated a digital fader, which conveniently allows you to almost professionally fade in or fade out at the beginning or end of a recording.

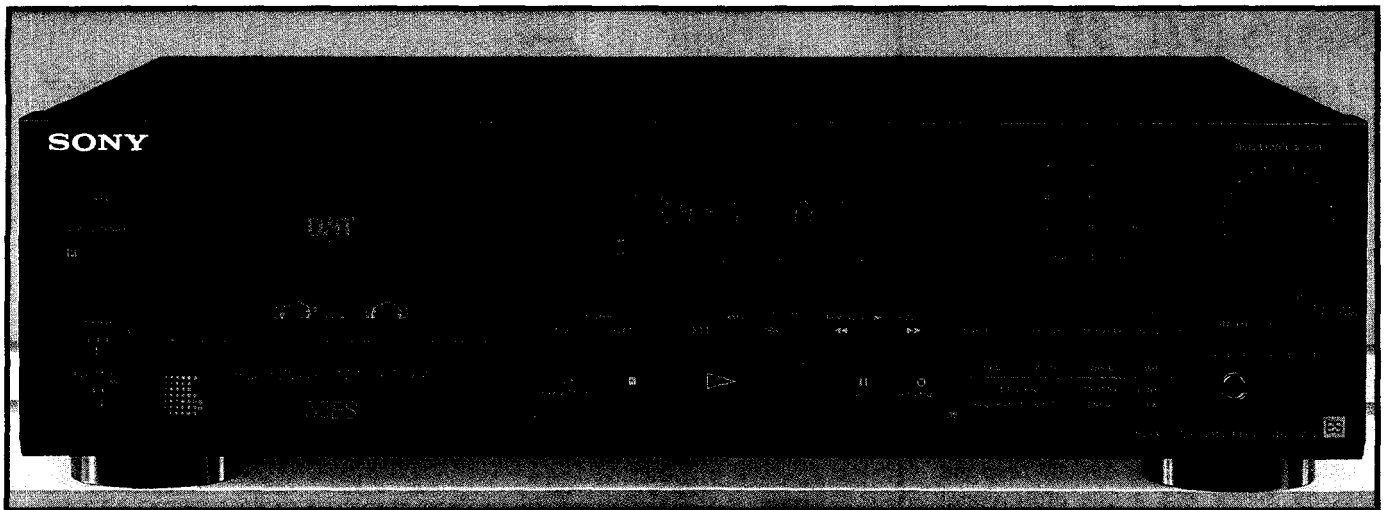
Following the trend started in the DTC-1000ES, the Start ID (which marks the beginning of each selection), can be entered either automatically or manually.

The Skip and End ID's are only entered manually. The purpose of the Skip ID is to stop playing and to fast forward to the next start ID code. The End ID stops the deck automatically, and is particularly convenient for marking the end of a partially recorded tape so that you can start recording again at that point.

The next feature that everyone will love, is that your program numbers can either be recorded on the tape at the time of the initial recording or later as a final renumbering process — without affecting the main recording. This is because the ID numbers are part of an entirely different subcode segment of the recorded tracks (see diagram).

This was no easy matter to achieve, especially when you realise that the digital data is being transferred to the tape at base frequency of a few megahertz, so as to achieve an astounding data density of 114Mbit/inch².

This is achieved using a two head system with the tape contacting the recording drum over a 90° arc, for smooth and stable recording.



The controls

The control layout on the DTC-55 front panel is simple, logical and provided you have a reasonable light level, you'll be able to read the lettering (or symbols) on the switches. On the extreme left of the front panel is the large power on/off pushbutton, below which is the switch for the timer off, Record/Play in the middle and a switch for record mode (Long/Standard) at the bottom.

To the right is the cassette well, which is different to other DAT players in that here the DAT transport is laid back at an angle so that you can not only see the cassette, but more importantly, the amount of tape on each of the spools, as well as identifying labels.

The other functional controls are laid out in two bands below the multi-function display window. These include firstly the open/close button, which takes three seconds to open or close the cassette well, and engage or disengage the tape from the cassette.

Next is the stop pushbutton, the double width play pushbutton, the record button, the pause buttons and the record mute — which provides a simple means of adding a four second section of blank track to the tape. These all use the now familiar graphical symbols.

To the right of these controls are eight wide but thin pushbuttons for recording, deleting or modifying the subcodes for Start, End, Skip and program number.

The second row of controls provide mode control for the counter, in terms of running time, absolute time, elapsed time or total remaining time, whilst the Reset button returns the timer to '0' minutes '00' seconds.

Adjacent to this are two pushbuttons for the Automatic Music Search (AMS) forward and reverse. Next are two conventional fast forward and fast reverse buttons besides which is the fader button.

The last three buttons are the Repeat button, the Skip Play button which activates the skip ID code function, and lastly the Margin Reset button which resets the digital display showing the margin of the peak signal recorded, relative to the 0dB upper recording peak signal threshold of the deck.

The other switch controls are the 10 direct 'numeric' select buttons (0-9), plus the Clear and Music Scan buttons at the right hand side of the display console.

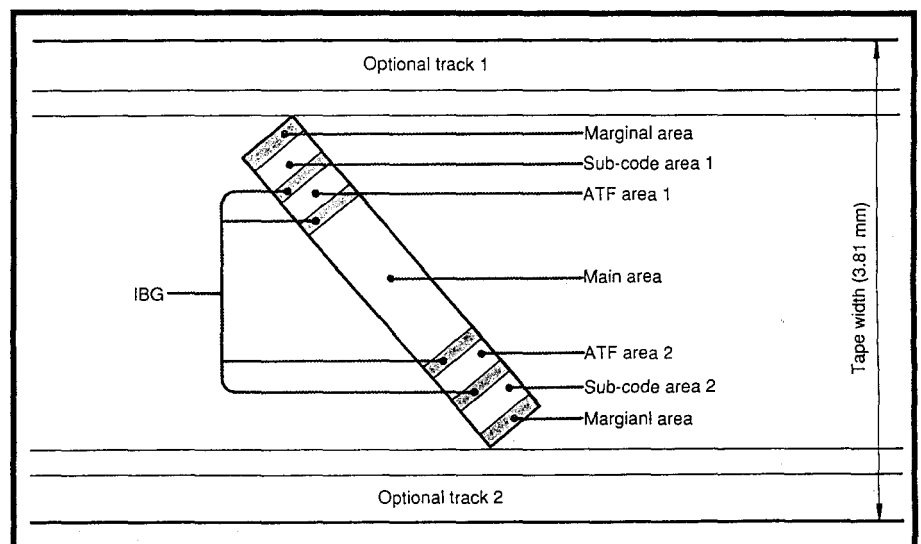
Last but not least, there is a large double rotary control for the gain adjustment of both channels, below which is the input selector for analog, optical digital or coaxial digital input. At the lower right-hand corner is the standard tip-ring-and-sleeve socket for 32 ohm headphones and a coupled small rotary volume control.

The DTC-55 display window is remarkable in that it visually alerts you to almost everything that you could ever wish to know about what the deck is doing, as well as about almost all of the control

switches and functions which I've described above.

Amongst the more novel are the two separate 60dB bar-graph level displays of the two record or play back signals, with mean peak levels plus absolute short-term peaks being held for long enough to be identified. This display may also be used to provide 'a frequency map' of record frequencies, by simultaneously pressing the Fader and Counter Mode buttons. The Margin Display facility is both novel and sensible, as it provides 'head room' information during recordings. It constantly monitors the peak analog input signal level and updates the indicated level each time that margin reduces, until reset.

The display also tells you what the sampling frequency is, which input has been selected, whether you have a long play or standard play in use, and if the Rehearsal mode is activated. This function is particularly important as it allows you to more accurately rewrite the Start



In addition to the main central area of each scanned track on the DAT tape used to store the actual digitised audio, there are areas used to store subcode information and automatic track finding/following ID information.

Sony's DTC-55

ID signal during replay when compared with the point at which it is located during the original recording. The signal can be moved forward or backwards in increments of 0.3 seconds, while you are checking the original or current starting point for that ID signal.

All of the main controls on the front panel are duplicated on the remote control, which is compatible with the latest generation of Sony CD players incorporating either digital, or digital and optical outputs. With this remote control you can synchronise the replay and recording from a Sony CD player directly onto the DTC-55 player, like a true professional and with a minimum of fuss or bother.

(Having tried the other way, I can personally vouch for the user friendly advantages of this capability — I don't want to face the other option again.)

This synchro recording capability is really the 'ants pants', at least for the first recording. But be warned! The tape now carries a copy inhibit code (SCMS) and should you try to copy it, the DISPLAY tells you curtly 'PROH' (which stands for prohibit) and lets you know that you can't get away with it. The controls lock up until the offending pre-recorded cassette signal is removed from the digital input.

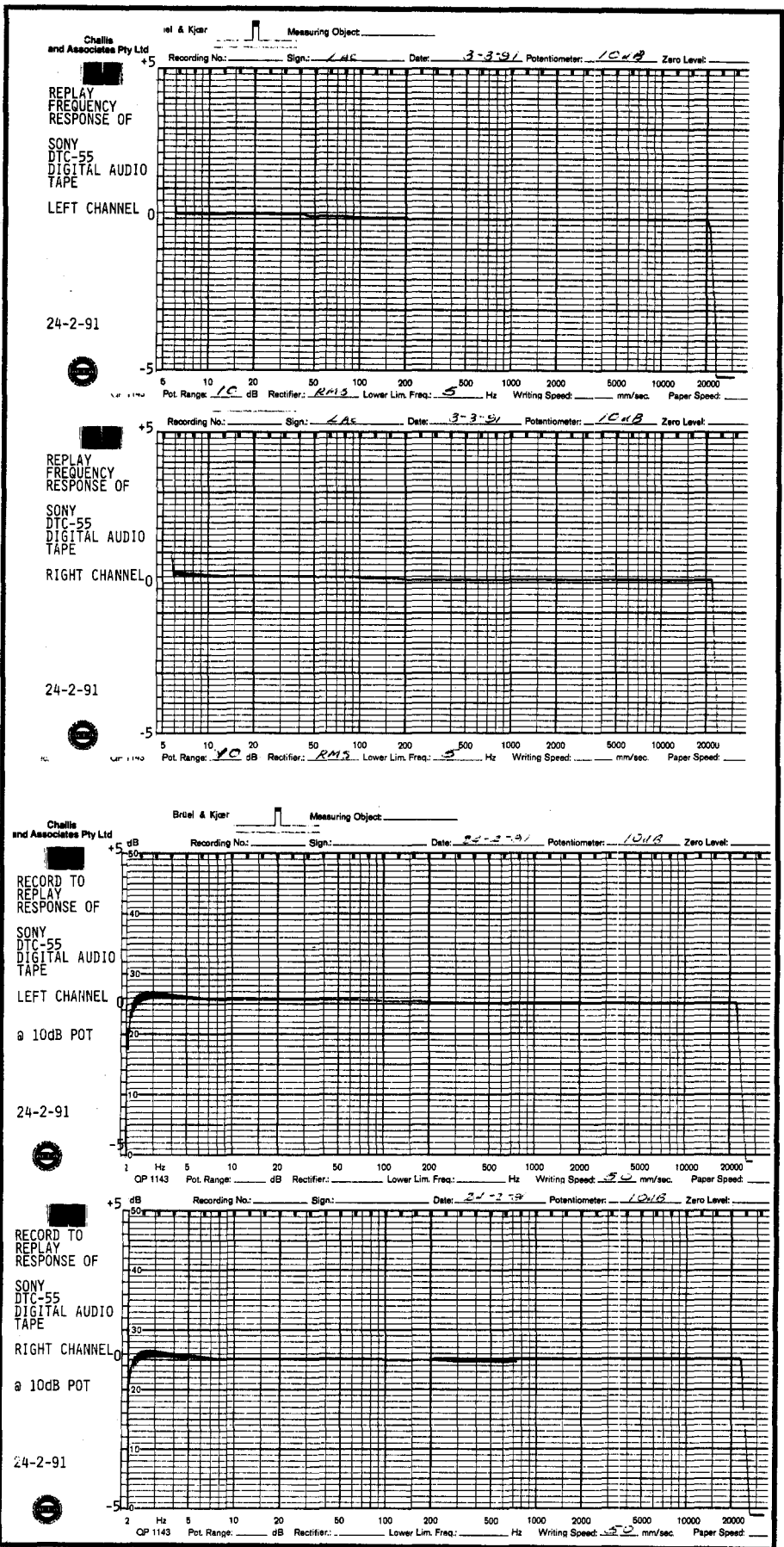
The rear panel provides the expected four coaxial analog inputs and outputs, plus a coaxial 75 ohm digital input and digital output, as well as an optical input and optical output.

Inside the cabinet the Sony design team have repeated many of the sophisticated advances, in terms of component reduction from the first generation of DAT decks, that they similarly achieved with the second and third generation CD players. There is still an awe inspiring array of components, but to me they look considerably less daunting than they did in the DTC-1000ES. This weight and size reduction is particularly noticeable in the power supplies and transformers — which are considerably smaller, more efficient, and have now been incorporated inside the cabinet, with no reduction in terms of the measurable signal to noise performance, nor in respect of hum immunity.

On test

The first real test of this recorder was to see how well it could record analog and digital signals and how well it could live up to its description of being 'state of the art'.

In theory with a digital recorder like this, the type of tape that you use should make no difference, But I decided to find out if this was really true and whether some tapes are better than others.



At top are the replay frequency response plots for the left and right channels of the DTC-55, while below are the overall record replay response plots.

Measured Performance of Sony DTC-55 (Digital Audio Tape Deck)

Serial No: SO 10800043-1

1. Frequency Response		5Hz to 22kHz	+0.2dB				
		.8Hz to 22.05kHz	+/-3dB				
2. Linearity @ 1kHz		Nominal Level	Left Output	Right Output			
		0dB	0.0	0.0			
		-1.0	-1.0	-1.0			
		-3.0	-3.0	-3.0			
		-6.0	-6.0	-6.0			
		-10.0	-10.0	-10.0			
		-20.0	-20.0	-20.0			
		-30.0	-30.0	-30.0			
		-40.0	-40.1	-40.1			
		-50.0	-49.9	-49.9			
		-60.0	-59.9	-59.9			
		-70.0	-69.5	-69.4			
		-80.0	-79.4	-79.3			
		-90.0	-88.9	-88.8			
3. Channel Separation		Frequency	Right into Left	Left into Right			
			dB	dB			
		100Hz	81	82			
		1kHz	81	82			
		10kHz	77	75			
		20kHz	75	71			
4. Distortion @ 1kHz		Level	2nd	3rd	4th	5th	THD%
		0	108.4	109.2	-	114.8	0.0017
		-10	109.0	103.7	105.0	108.9	0.0019
		-20	100.0	99.5	90.7	91.4	0.0069
		-30	83.8	84.1	88.9	84.0	0.025
		-40	-	79.2	-	77.6	0.028
		-50	-	66.9	70.8	63.8	0.13
		-60	64.8	60.3	63.4	56.8	0.34
		-70	-	44.9	55.5	50.2	1.12
		-80	45.6	41.6	42.4	43.8	2.67
		-90	-	32.2	33.2	28.3	7.90
5. Signal to Noise Ratio		Test Tape	A-weighted	Unweighted			
			S/N	S/N			
		BASF DAT-90	92.7	89.6			
		Fuji R-60	92.9	89.4			
		JVC R-90 XD	92.3	89.8			
		Sony DT-60	93.0	89.7			
		TDK DAR-60	92.7	89.6			
6. Frequency Accuracy		(19.999kHz)	-.01Hz for 20kHz test signal				
7. Output Impedance		Headphone Amplifier output impedance 220 ohms					

The choice of tape made absolutely no difference in terms of measured frequency response, and as you can see, the analog record to replay frequency response from 5Hz to 22kHz is +0.2dB/-0dB and the low frequency response is -3dB at 0.8Hz, which can really be described as 'instrumentation recorder'

performance. The replay frequency response is precisely the same as the record to replay response from 5Hz to 22kHz, being +0.2dB high at 5Hz and exhibiting the same shape of response.

A comparison of these two sets of data makes it appear that the replay amplifier is the most critical factor in determining

either the replay or record to replay response. Changing to the 'long play' mode shifts the upper 3dB point down to 15kHz, whilst the bottom end remains unchanged (because it's the replay amplifier that is the controlling factor).

As my testing revealed, the measured signal to noise ratio is to a very small degree dependent on which tape you use and of the five tapes (from different manufacturers) which I tried, the Sony DT-60 just pipped the Fuji-R60 by 0.1dB to achieve a 93dB(A) weighted signal to noise ratio — whilst the JVC R-90XD tape achieved a still outstanding 92.3dB figure at the other end of the group. But I must be fair to the Fuji tape, and acknowledge that there may have been +/-0.05dB setting error in my recordings; so that it may well have been equally as good as the Sony tape.

The record to replay linearity is exceptionally good, being within +/-0.1dB all the way down to -60dB and then deviating slowly by up to 1dB high at the -90dB point. The distortion figures were something of a surprise, being considerably lower than I would have expected based on the dozens of CD players which I have tested and whose characteristics I have come to regard as the 'yardstick' of comparison.

Even at -60dB the distortion products are so low that they were particularly hard to see amongst the noise, even if a long-term two minute multiple averaging time was set on my FFT analyser. The distortion only gets to 1% at -70dB, is still only 2.7% at -80dB and is only 8% at -90dB. These performance figures are particularly gratifying, especially when you take into account the price of this DAT deck.

When I switched to the long play mode, I found to my surprise that the signal to noise ratio was still 91.8dB(A) — within a dB of the signal to noise ratio of the normal play mode. When I viewed this result, I became concerned. I began to think that my measurements were wrong and that I must have been viewing some sort of system malfunction.

Now this is a 12-bit system in the long play mode and I believed that it should theoretically only provide a 72dB S/N figure. When I did some research to find out why there was a discrepancy, I discovered that Sony had 'cheated' by introducing a compander into the record/replay chain. This provides a performance which is to all intents and purposes the same as for the 'standard mode'. By this means the deck provides double the recording time and the only real penalty is a small reduction of bandwidth at the top end of the audible spectrum.

I tried to measure the wow and flutter,

Sony's DTC-55

but apart from looking at the shape of the narrow bandwidth FFT envelope, which confirmed that the wow and flutter deviations are extremely low, I could not measure anything useful with my conventional wow and flutter meter.

Tests with music

The real test of a DAT recorder or DAT deck like this, is firstly to replay digital pre-recorded tapes and secondly to evaluate its recording capabilities.

The digital pre-recorded tapes proved at my first attempt to be a trifle elusive. Sony was kind enough to lend me one, another came from overseas just as I was completing the review and a third was kindly donated by Hagameyer, who are the agents for the competing JVC product.

Now as it transpires the Hagameyer tape entitled 'Cinemagic' with Dave Grusin from GRP Records, is unquestionably the best of the three, and provided substantive proof of just how good this DAT medium really is.

As I discovered, not only was the music good but the fidelity was absolutely outstanding and frankly, equal or superior to, any CD player or CD disc that I have yet heard.

Prior to receiving the pre-recorded DAT, I had manufactured some pre-recorded DATs using the 'CD Synchro' capabilities of the deck in conjunction with a Sony CDP-555 ESD CD player, which Sony was kind enough to provide.

I had already asked Sony Classical for some appropriate material to use for this purpose, and having voiced my admiration of Isaac Stern's latest disc called 'Humoresque', they sent volumes 1 and 2 of 'Isaac Stern's Early Concerto Recordings' SM3K/5955 and SM3K/45956.

Although these discs are primarily analog material, they are unquestionably some of the most exquisite violin recordings I have ever heard, and will undoubtedly remain amongst my favourite discs.

I recorded these onto DATs using the direct digital recording capability from the CDP 555 ESD to the DTC-55. Then I set the CD to play and the DAT to play the same material, with a few seconds difference between the CD and the DAT deck so that I could switch from one to the other and inter-compare the same passages on an A-B basis.

Neither I, nor my assistants could tell the difference between source (the original CDs) or the copy. I would not have the temerity to suggest that one sounded better than the other, because I

could not tell the difference. Although eminently happy with these results, I proceeded to record conversations, some live piano playing in my living room using a pair of external capacitor microphones and separate power supply to feed into the auxiliary inputs of the deck.

As I soon discovered, with a pair of professional microphones the quality of sound produced by this deck is absolutely superb, and the quality of signal was unrivalled.

Even if I had not used DATs before (and I have), I must admit that the DTC-55 is an outstanding deck, which offers the user unrivalled flexibility and a performance to match.

Whilst the vaunted DCC system may offer DAT a run for its money, it has not yet arrived. And as my testing has shown, it has a potent adversary which can withstand the comparison and give as good as it gets. The next two years should prove to be very interesting in respect of who 'gets the guernsey', as it would appear that DAT is currently in an almost impregnable position.

The Sony DTC-55 measures 430 x 115 x 330mm and comes complete with cordless remote control. Further information is available from Sony dealers. ■

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EA1

Farewell to one of the world's great electronics innovators:

Sayanara, Takayanagi-San

In the April 1988 issue of *EA*, Jim Rowe outlined the achievements of a Japanese electronics pioneer — Kenjiro Takayanagi, who among other things developed a television system that relied upon electronic scanning. Now, with Mr Takayanagi's passing, Barrie Smith concludes the tale of this extraordinary man.

Five weeks after his death, the English-language *Japan Times* devoted two pages to Kenjiro Takayanagi's life achievements. Writer Mike Millard opened the article by repeating a frequently heard assertion that 'The Japanese never invent anything. They only develop the creative work of others for commercial uses.'

Takayanagi himself believed otherwise. In 1985, during an interview with the English *Financial Times*, he disputed the contention that the Japanese lack the spirit of invention.

"In the good old days," he said, "maybe one genius working on his own might come up with something totally new, but even then you had to put a lot of effort into being so lucky. Now, in this information age, there is no chance really of being first. We need a collective approach, of several people of the right scientific background, co-operating to one end."

Throughout his life he remained proud of television — despite its often poor entertainment values.

Takayanagi felt that television should be 'our servant, not our master', and had written an article in 1924 foreseeing the day when every house in Japan would serve as a 'human eye' travelling around the world.

"I always believed," he continued in the interview, "from the beginning, that television would be a mainstream of electronics, and it has been: witness the computer, which was derived from the pulse of television, and the electron microscope and so on."

Takayanagi was born on Jan 20, 1899, and when he died he had 122 patents to his name. His working life, after he graduated from what is now Tokyo Institute of Technology in 1921,

was inspired by something he at first called 'wireless distant electric vision', though he later picked up the term 'television' from a French cartoon.

Another inspiration for Takayanagi was the American inventor Thomas Edison. Years later, when Takayanagi received a prestigious award from the Society of Motion Picture and Television Engineers in the US — the first Japanese to be so honoured — his words would recall Edison's influence on his early career:



Kenjiro Takayanagi with a member of his family.

"I respected and worshipped Edison as a great genius for invention. It was Mr Edison who inspired me as early as 1924 that mechanical television had its limits and that a totally electronic approach was essential — from transmission to reception. Because I admired him so much I put his portrait on my wall and looked at him every day."

Throughout his working life he closely studied global developments in his 'wireless distant electric vision' technology, and was aware of the work of most of the other researchers.

In 1923, Kenjiro Takayanagi in Tokyo and Vladimir Zworykin in Camden, New Jersey both commenced research into an electronic method of capturing an image — as opposed to Baird's spinning disc method. Each was unaware of the other's work.

Then, in 1933, Takayanagi received some shocking news — a clipping from the *New York Times* that indicated Dr Zworykin had invented a revolutionary pick-up tube that could display outdoor scenery on a Braun tube just like a camera.

Later, Takayanagi would write "To my surprise, I found the iconoscope used the same accumulating device for which I had been granted a (Japanese) patent. There was a person at a great distance who was thinking the same thing that I was!"

Takayanagi felt he had to meet Zworykin, and went immediately to the United States to do so. "Although it was the first time we met," Takayanagi wrote, "we talked like longtime friends."

Zworykin was to find, however, that much of the ground he was covering had already been crossed. He applied for two Japanese patents, one for a

Braun tube and one for a pick-up tube, and was refused because patents had already been issued — to Kenjiro Takayanagi.

"The name 'Takayanagi' was thus engraved in the mind of Dr Zworykin and we came to respect each other as scientists," Takayanagi would write.

Takayanagi was a professor at Hamamatsu Higher Technical School from 1924 to 1937, when he moved to NHK as general manager of the national television broadcasting project, set up to broadcast the 1940 Olympics from Tokyo — something that never happened, of course, because of the war.

Takayanagi related: "I and my associates moved to the Technical Research Institute of NHK in August 1937 and undertook a variety of experiments in preparation for TV broadcasting of the Tokyo Olympic Games in 1940."

"In May 1939 an experimental TV broadcasting station was set up in the Technical Research Institute of NHK. Test pictures were broadcast at 441 scanning lines and 25 pictures per second, using the interlaced scanning system. In this experimental broadcasting system high definition TV broadcasting experiments could be carried out periodically. I feel proud of this experimental TV broadcasting station, which was built and operated by Japanese alone."

In 1944, Takayanagi was taken into the military as a naval engineer to work on radar, and after the war, in 1946, he joined JVC as head of television research. He stayed with the company until his retirement in 1979, although he served as a consultant until his death.

Near the end of Takayanagi's life, he was honoured by the SMPTE in 1988 and joined the ranks of two men he greatly admired — Vladimir Zworykin and Thomas Edison.

To attend the ceremony he had just flown to New York in a matter of hours, and was watching the Olympics live from Seoul on television. Takayanagi observed that the earth had become much smaller, and expressed a growing concern for its future. He declared that the problems created by rising carbon dioxide levels and damage to the ozone layers surrounding the earth had become so serious that some 'measures must be taken before the human race perishes.' With this in mind he recommended that a joint Japan-US research and development institute commence work on these issues.

Unfortunately, all of the pioneer's

Obituary Notice: July 24, 1990

Mr Kenjiro Takayanagi, the Supreme Advisor of the Victor Company of Japan Ltd (JVC), age 91, on Monday, July 23 died from pneumonia while at the Yokusuka Kyosai Hospital in Kanagawa Prefecture.

Having contributed greatly to JVC's reputation since joining the company in 1946, Mr Takayanagi became the company's supreme advisor in 1973. Prior to that, he served as JVC's representative director and vice president for three years. In addition to other prominent posts Mr Takayanagi held in his 44-year career with JVC, he established in 1984 the Takayanagi Foundation for Electronic Science and Technology with the primary purpose of helping researchers engaged in R&D of the field.

In 1981, Mr Takayanagi received the Order of Cultural Merit for his achievements in electronic engineering research. He was also the recipient of the First Order of Sacred Treasure in 1989, which recognised his distinguished services in the field of R&D of television, VTR systems and electronics engineering.

original equipment was destroyed by bombing in the war. When NHK opened its Tokyo Broadcast Museum in 1956, there was no original Japanese TV equipment for display. So, today's demonstration of early TV uses modern mock-ups of Takayanagi's technology.

Paradoxically, the only piece of 'television' equipment in the exhibition is an old Baird 'Televisor' — a television set employing technology precisely contrary to the method espoused by Takayanagi, Edison and Zworykin. ■

Some notable dates:

- 1862 Abbe Caselli, an Italian-born priest, sent shadowy pictures over a telegraph line. He was supported by Napoleon, but his method was not commercially successful.
- 1884 The German, Paul Nipkow proposed a complete television system. It featured a rotating disc perforated by tiny apertures arranged in a spiral — and intended to be used at the transmitting and receiving ends.
- 1897 Ferdinand Braun in Germany perfected the cathode ray tube that bears his name. Its immediate use was for the study of electrical wave forms.
- 1907 Boris Rosing in Russia experimented with a television system, trying to use a Braun tube for a receiver.
- 1908 A.A. Campbell-Swinton, a Scot, predicted the principles of television — using magnetically deflected cathode ray tubes at both ends of the system. The transmitting end would rely on a mosaic of photo electric elements.
- 1919 Vladimir Zworykin, who had worked under Rosing, left Russia and arrived in the US, where he was first hired by Westinghouse.
- 1924 Kenjiro Takayanagi conceived and invented pick-up tube and cathode ray tube for TV.
- 1925 In April, John Logie Baird of Scotland succeeded in a public experiment with mechanical television.
- 1926 Takayanagi succeeded in projecting a Japanese katakana character on his new picture tube, called a 'kinescope'. He found that three sets of signals could be combined into one channel.
- 1928 Takayanagi received a man's image on a cathode ray tube.
- 1930 Vladimir Zworykin invented the principle of the camera tube.
- 1930 Takayanagi commenced trial production of a cathode ray tube with a large and bright screen.
- 1931 RCA installed a television transmitter at the Empire State Building.
- 1934 Takayanagi visited Zworykin at the research institute of RCA in Camden, New Jersey.
- 1936 November saw the BBC begin the world's first regular 'high definition' TV broadcasts — in Baird's 240-line and EMI's 405-line systems.
- 1939 NHK sets up an experimental TV broadcasting station in Tokyo.
- 1944 Takayanagi entered Japanese Navy as an engineer to work on a radar system.
- 1946 Takayanagi joined JVC as the head of television research department.
- 1956 The '45-45 system' of groove cutting for stereo disc recording technology developed by Takayanagi.
- 1959 Takayanagi developed the world's first two-head VTR.
- 1960 Takayanagi developed the two-headed colour VTR for broadcast use.
- 1970 Takayanagi developed the four-channel stereo audio system — CD4

Silicon Valley NEWSLETTER



Valley's chip industry is running dry!

Relentless Japanese competition, economic recession, and the lack of low cost investment capital, have all affected the health of the semiconductor industry in Silicon Valley. But none is as potentially devastating as a major new problem facing more than 100 chip makers in Silicon Valley: water!

The expected implementation of more severe water use restrictions in the drought-stricken San Francisco Bay area (and California in general), may force most chip makers to curtail chip production.

Unless the latter part of February and March were to bring unusually high levels of precipitation this was predicted to be the driest year in Valley history, or at least since records were first kept 145 years ago. The record low rainfall this year comes after four previous years of below normal rainfall. At the current rate of overall use versus new supply, California's water supply will be completely depleted in less than two years.

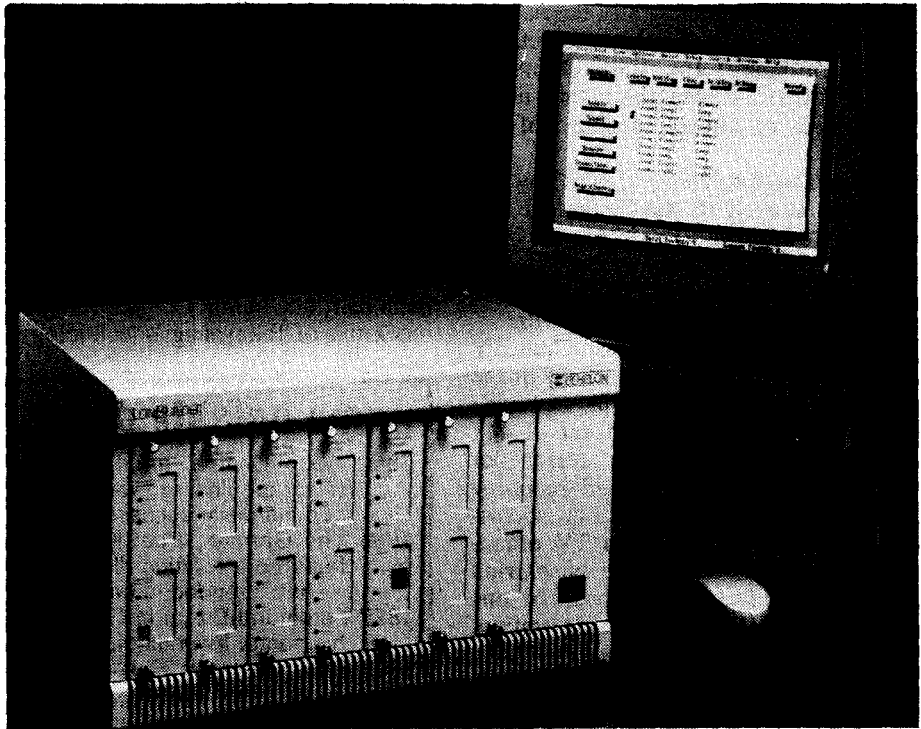
Water is a critical component in the chip making process. Nearly every step in the 15-25 step chip making process involves the use of ultra-pure water for cleaning off acid and other excess chemical deposits on the wafer surface.

Since 1987, when the current drought period began, chip makers in the valley have already reduced water use by 20-30%. These reductions have been relatively painless. But companies in Santa Clara County now face additional mandatory reductions of 30-45%.

For Advanced Micro Devices and many of the area's other large chip makers, these cuts mean they will have to curtail production and lay off hundreds of workers.

"There are some things we can do to gain incremental savings, but if we have to make a substantial further reduction, we might have to curtail our production and cut our workforce," said AMD spokesman John Greenagel. He added AMD's use of water has been cut by 50% since 1987.

During the past two years, the in-



The 'LonBullder' developer's workbench has been developed by Echelon Corp of Palo Alto to help engineers design low cost intelligent control systems for household appliances. Echelon recently announced an inexpensive but highly flexible 'intelligent' networking system which can link microprocessors in thousands of everyday appliances.

dustry in the valley has been spared much of the rationing programs that have already been imposed on residents. But this year it seems all but certain mandatory cuts will be implemented against commercial users as well.

Firm puts tape recorder on a chip

Imagine a dishwasher that listens and talks back to the user, letting them know what routine or other maintenance is needed to keep it operating at maximum efficiency? Or a cellular phone that fits in a shirt pocket with a built-in answering machine.. Those are just two applications for a revolutionary new chip launched by Information Storage Devices, a San Jose-based semiconductor start-up.

ISD has introduced what amounts to a

tape recorder-on-a-chip. In a telling demonstration, company officials hooked the chip up to a small battery, a microphone and speaker and recorded and played back 20 seconds worth of voice messages.

Because of its low cost and simple integration into existing systems, the chip has the potential of giving a broad range of appliances, industrial equipment and other machines the ability to listen and speak.

Today, many tape recorders use conventional memory chips in place of tape. But those chips can only store sounds that have been converted by an expensive analog-to-digital chip.

The ISD chip is the first to store sound in analog format which takes up only 1/8th the space of digital memory cells. It can retain its information for 10 years, even with power interruption. To in-

crease the storage time, two or more of the chips can be linked. The company is also working on new versions that will feature longer storage capability.

The advantages of the ISD chip over conventional tape recorders is obvious. Besides the elimination of volatile tape, it requires no motor or amplifiers.

"It is dirt simple. You just hook a microphone and speaker to it and you are on the air," said ISD chairman Richard Simko, who invented the chip. The company has already begun shipping the product, which will cost US\$20 in volume quantity.

Simko said the chip is likely to find applications in the talking toy industry, and in aircraft to warn pilots something is wrong with their aircraft, so they can quickly take the most appropriate action.

Simko holds two patents on the technology, which will hold off potential copycat competitors. He started the company in 1987 with US\$2 million in venture capital.

Apple seeks RF link for computers

Hooking personal computers, particularly laptop and notebook systems up to various disk drives, printers, scanners, faxes and other peripheral systems makes for a messy bundle of wires coming together in a very small space.

Five or so years from now that may not be a problem, as computers may use short-range radio frequencies to send data and instructions to and from peripherals scattered about in the room or office.

A few weeks ago, Apple Computer became the latest company to ask the US Federal Communications Commission permission to set aside a certain radio bandwidth to be used later on by computers to talk to each other and their peripherals. Don't expect any wireless Apple systems any time soon. The FCC approval process takes years, and the technology is still in the early laboratory and prototype stages.

The transceivers which Apple and other computer makers are developing would operate on a frequency that gives them a range of about 150 feet.

Other companies developing wireless computer communications systems, include Motorola, which has also proposed a system with the FCC. Motorola's is more advanced than Apple's, using microwave communications technology. And IBM is reportedly working on advancing a wireless communications system developed for its

field service network with personal and other computers.

Apple's petition is asking the FCC to set aside a portion of the bandwidth between 1850 and 1990MHz for all computer companies to use for system communications.

Japan's hidden help in Gulf

How about all those smart weapons — US technology at its best! Or is it?

Although Patriot Missiles, laser-guided bombs and many other smart weapons were designed and manufactured by US companies, a significant portion of the technology they incorporate was imported from Japan.

According to some figures, up to 80% of the components aboard certain smart weapons are of Japanese origin. Among other things, a number of chips that are part of the Patriot Missile's highly complex on-board circuitry are made in Japan.

Some of the high-tech gear is entirely Japanese made, including night-view equipment, air-speed acceleration indicators, infrared missile homing devices, fighter cockpit displays, microwave weapons control and targeting systems, advanced communications systems, and submarine sensors.

In addition, Japanese-made semiconductors, gallium-arsenide chips and fibre-optics components were used in such systems as part of many of the best military systems used in the Gulf. So, despite claims, Japan in fact, made quite a contribution to the Allied war effort.

National scores a hit at 'chip fest'

It has been a while since National Semiconductor made any waves at the annual International Solid State Circuits Conference. But at this year's conference in San Francisco, National's 'Swordfish' graphics image processor was a hit in a field of many amazing new semiconductors.

The Swordfish was designed at National's laboratory in Israel. It is 64-bit based and operates at 100 million instructions per second. Rather than personal computers, the chip will be aimed at such fascinating new markets as colour fax machines, low cost video conferencing, speech and handwriting recognition. In the automotive market, the chip will enable brake systems to sense the distance to the car ahead and apply the brakes automatically if necessary.

Swordfish will be available in volume

by mid 1992 and different versions will cost between US\$150 and \$700 each.

Another eye-opener at the ISSCC was an advanced version of the Intel 80486 processor, operating at 100MIPS, making it the fastest chip on the market today. Intel officials said, however, they have no plans to bring the chip to market. Rather, the chip represents a major manufacturing breakthrough. One reason the chip will not be made available immediately is that in the current configuration, it produces so much electronic noise. Some observers said the chip is more like an FM radio station.

One chip that will be incorporated into computers within the next year is a new 'lightning' SRAM circuit from IBM which features a data retrieval delay of just four nanoseconds — 1/16th that of the fastest SRAMs on the market today. The chip sends and receives data at eight million bits per second.

As expected, four of the major Japanese DRAM vendors — Fujitsu, Toshiba, Mitsubishi and Matsushita — showed off their designs for the next-generation 64 megabit DRAM chip. None of the chips are expected to reach the market until 1994.

Last transistor inventor dies

On the 6th February, the last surviving member of the team of three scientists credited with the invention of the transistor passed away. After William Shockley's death last year and Walter Brattain's death in 1987, John Bardeen died of a heart attack at the Boston hospital where he was being treated for an unrelated ailment. He was 82.

Along with Shockley and Brattain, Bardeen helped build the world's first transistor in 1947, an achievement for which he received one of his two Nobel Prizes in Physics.

Unlike the outspoken and controversial Shockley, Bardeen was soft-spoken. He was once quoted saying that at the time of their work on the transistor at Bell Laboratories, "I knew the transistor was important, but I never foresaw the revolution in electronics it would bring."

After he left Bell Labs, Bardeen joined the University of Illinois faculty where his research in low-temperature superconductivity led him to become the first man to receive two Nobel Prizes in the same field. Bardeen considered the second prize his greatest achievement. "Superconductivity was more difficult to solve. It required some radically new concepts," he said. ■

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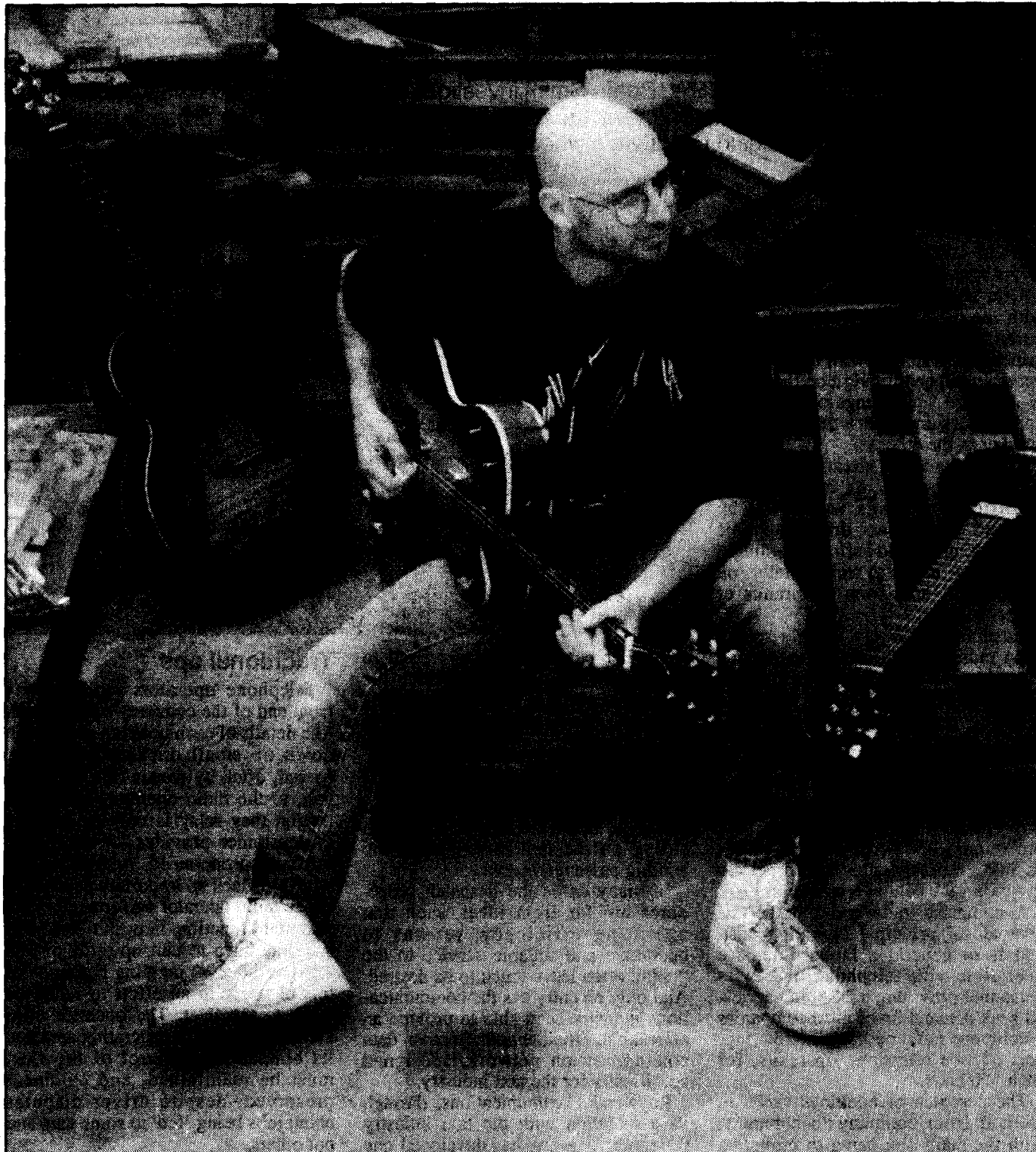
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Computer despatching for Sydney taxis

Sydney's Manly-Warringah taxi co-operative installed a computer despatching system in mid 1990 — the first such installation in NSW. Barrie Smith investigated, and thought the complexities of the subject sufficient to demand that he take up a taxi driver's licence — in the process thoroughly grasping the story from behind the driver's wheel.

Many of us have been passengers in taxis and listened in fascination, awe and often amusement at the role of radio in the base operator/driver relationship.

This writer has often sympathised with the driver's burden of having to listen sympathetically to his fare's gripes and grumbles with one ear, and yet maintain careful vigil on the heavily distorted squawkings of his base's operator, issuing from a tinny 5 or 6cm speaker in the other.

But without this stream of strident voice data, 60% or more of the work/jobs/bookings would not be awarded to the taxi driver, and his daily takings would suffer accordingly — forcing them to rely totally on picking up fares from taxi ranks or street 'hails'.

Australian taxis are heavily reliant upon radio communication to provide their unique role in servicing the travelling public. With the exception of some large depot-managed companies, most taxis are owner-operated, but work together as members under a common banner as 'The XXX Taxi Company'. Their fleets may be as small as 10 cars — or as large as a thousand plus, with each member paying a monthly subscription per car to support the common operation.

Running the 'radio room' is the taxi companies' principal operating cost, and is in general a labour-intensive operation with telephone and radio personnel providing a 24-hour service. At peak demand times most companies require one radio operator and the support of two telephone operators, for each 100 taxis.

The despatch of bookings varies in method from company to company, with the main aim being to provide a fair and equitable distribution of work to the members — together with the need to select the most suitable taxi for each radio job called.



Smaller companies have tended to use a plotting method, in which the general location of each vacant taxi is recorded in manually controlled area lists, or by means of magnetic tags on a location board. Larger companies, who have a large number of physical taxi ranks generally allocate each radio job to the first car which is vacant and sitting on the taxi rank nearest the waiting passenger's area.

In many cases the despatch procedures are far from ideal, such that operating efficiency, returns to operators, and reliable service to the public, often leave much to be desired. And only recently has the communications industry been able to provide an affordable, efficient and effective data communication network, designed specifically for the taxi industry.

Raywood Communications, through its association with the taxi industry for some 15 years, has developed one such system. It now provides the only fully operational computer despatch system, currently installed in four Australian states.

Traditional ops

Telephone operators represent the front end of the company's operations. The details of each booking are written down on small docketts which are passed, often by means of a conveyor belt, to the radio operator. The information they relay is only as good as the customer provides — streets are often mispronounced, or pick up instructions lack an important detail.

The radio operator performs a vitally important function. In peak times he or she may have to call upwards of 200 jobs per hour — juggling hundreds of bits of paper in an effort to relay the work to the fleet. The operator must know intimately the operating area and its boundaries. Control of the fleet must be maintained, and calmness preserved, despite driver disputes about jobs being 'fed' to some cars and not others.

Over the past four years Raywood has developed its despatch system to provide an integrated turn-key system, benefiting the company, owners,

drivers and the public. In the process, flexibility is integrated for any future industry amalgamation and industry rationalisation.

The new way

The control room is the heart of the system. One or maybe more high speed, real time, multi-user, multi-processors support a team of telephone operators. This system interfaces with the radio network to transmit and receive data communication with the fleet.

Each taxi is equipped with an intelligent mobile data terminal. This communicates directly with the control room via an existing radio transmitter installation. In general, there is no dependence on voice links, but a voice channel is provided for driver queries.

The in-cab installation features a four line by 40-character LCD display, backlit for night work; a 12 button, backlit keyboard for accessing the menu driven functions available to the driver; and a data modem for digital communication with the radio network.

How it works

Raywood director Lindsay Dowsey oversaw the Manly-Warringah installation. He explained that the customer calls in from the home phone, the call being placed in the cab company's normal queuing system at the switchboard. In the Manly installation there are six terminals, plus the supervisor's and a voice query operator's; these are all equipped with a keyboard, screen and a headset. The supervisor can take work as well.

The incoming line number shows up in order of reception at the top of the operator's terminal screen. A button is pushed, and the call is answered. As the operator takes the details he or she keys in the information using only key words or macros — such as 'nb' for Neutral Bay, or 'n' for Narrabeen to indicate a phrase or a key word.

If it's a regular customer, the operator need only key in a word or letter, and the screen will display all the job details — pickup address, name, destination. Then the number of passengers is keyed in, so that the need for a four- or five-seater taxi is known. Then a button is pressed and the job is sent out.

Once the outgoing job is in the system, the computer selects the first car 'plotted' and vacant in the pickup area.

The Sydney area is divided up into 70 areas, with provision for another 30

to be added. The driver 'plots in' his position by tapping one or more of his terminal keys — '1' is for Manly area, '60' is Sydney CBD; he may also request that he receive only bookings that pertain to one single area.

Additionally, each plotted area has 'adjacent areas', so that if there is no car in the particular area the computer offers the work as a 'cover job' to all the other cars in nearby areas.

The job details are transmitted in compressed form to reduce 'on air' time, and displayed on the taxi's LCD dashboard-mounted terminal.

The company has three transmitting channels — Manly uses two for data, plus one for voice — a 'query channel' for the driver to request any more information he may need about the job.

It may happen in one out of 50 calls that the driver, even with all the information on the screen, may still not be quite sure about a difficult street or flat number, or he may report the passenger has lost patience and left the

pickup point. The information is verified before it's sent, e.g., street combinations that don't exist. The map page and cross references are also transmitted, so the driver has no need to check his directory.

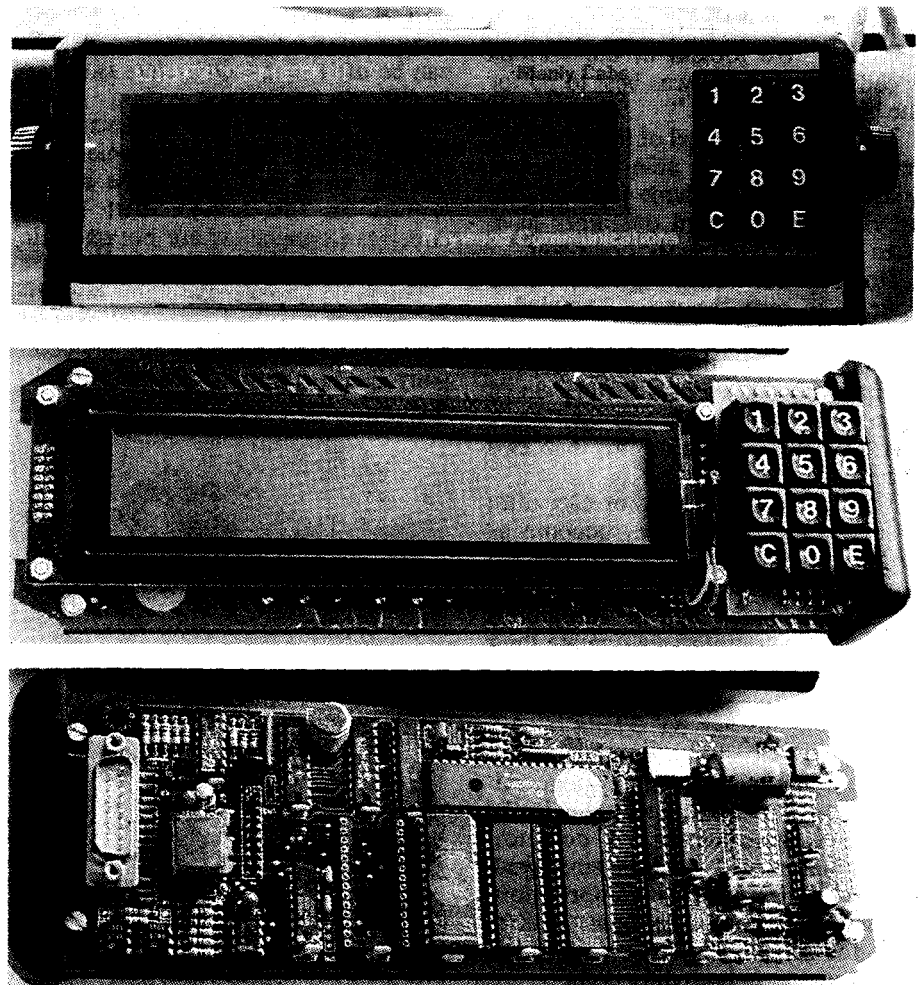
Also, with voice no longer being used to transmit street names, there is no confusion over mis-pronunciations. The text is in front of the driver.

The main aim of the system is speed. Less time is spent on the phone with the customer, and less time wasted in despatching the job, so the taxi driver receives the information faster.

In some cases no more than four key strokes need be made for the job to be sent out, e.g., pick ups at clubs and hotels. The average phone call may be less than 20 seconds.

Lindsay Dowsey explains:

"The installation uses a standard 'AT' type keyboard, which is easy to service, and easily purchased from any computer shop. The screens are EGA — we drive them with our own design



Three shots of the Raywood Communications in-cab terminal. At top the complete unit is shown mounted on the dashboard, while centre and below show the display/keyboard PCB and control circuitry PCB respectively.

Taxis by Computer

board. The computer itself has 20 or 30 parallel processors installed. We've always done this with every installation in the past — using a dedicated processor for each function."

"In this installation we have two '386 machines, which carry the street directory, do the searches, and store the client information. This can operate for two or three months without any back up required."

"Each operator is given a pair of processors linked up to both the '386 machines. And our own proprietary bus, which operates in parallel."

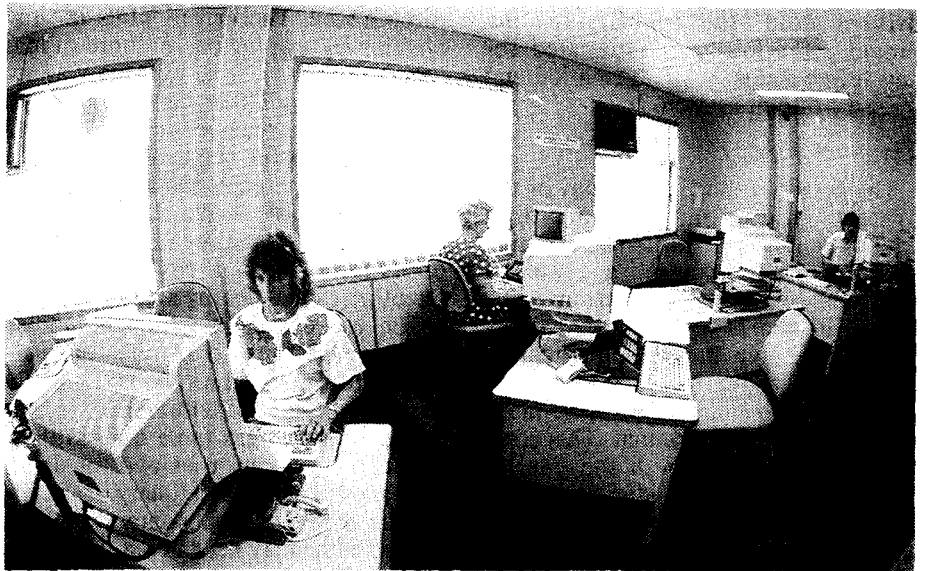
Raywood's engineers looked at networking, and decided it was just too slow for the purpose. So they designed their own boards around a shared memory device. In this way multiple functions can be provided in two directions. The software is written in 'C' language, basing it on MS-DOS at the present time. Each machine has a 110MB hard drive. If one fails the other can cut in. Clock speed is 33MHz: "We looked at the various speeds and found it was best to go for the highest available."

The experience level of the operators requires that they be able to type, and possess a pleasant phone manner. The previous switchboard operators have been re-trained to use the computer.

Dowsey continues: "What we've done is to take the street knowledge and experience of 10 radio dispatchers and put that into the database. We've compressed the street directory down from 3.5MB to 1MB, and any street can be found with no more than two access actions."

Thus a keyboard operator can, after a few hours experience, become as good as a highly experienced dispatcher. The screen displays the key codes, which can be summoned up. And the operators can create their own. For example, they may only need to type in 'tnt', and the client's full details will appear on screen — address, contact phone number, usual destinations, method of payment. Already there are 1050 key codes in the system. In transmission, a compression factor of 5 to 1 is employed, using 'recursive data compression' techniques. This was necessary to cope with the sometimes heavy data traffic load, running in both directions.

Raywood's first installation was in Melbourne at West Suburban Taxis in December 1988 — then the Gold



This is the interior of Manly-Warringah's control room. There are a total of eight VDU operators and work stations.

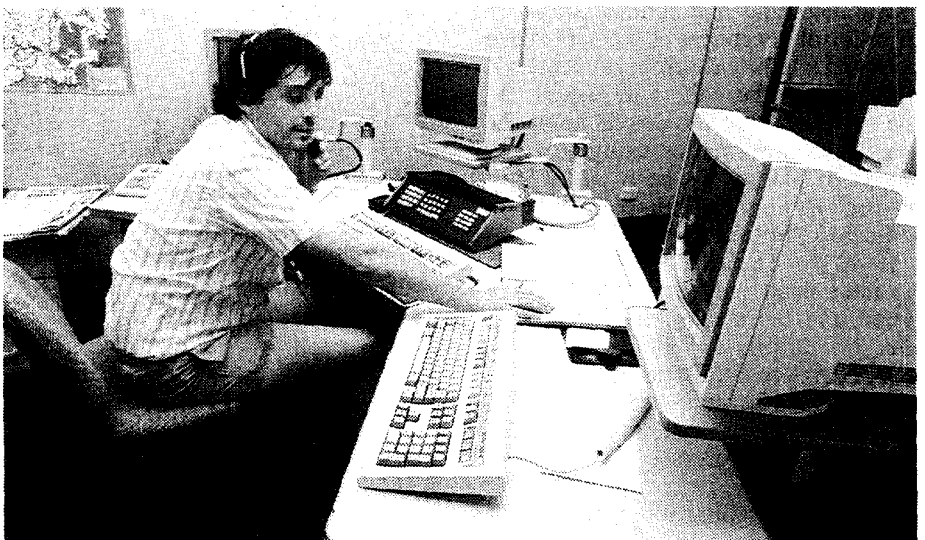
Coast, then Cairns, then Darwin. More recently, others were commissioned in Melbourne at Sandown Taxis and Black Cabs. Mr Dowsey revealed the cost of installation is \$2-4000 per car, and existing voice transmitter systems can be used. But each system is slightly different in design:

"A lot of the overseas systems won't work here. Some companies say 'here's our system, use it the way it works in the USA'. But many American companies are not as radio orientated as we are."

The Gold Coast installation was different in that it had only 130 cars — but a lot of traffic. Each day the company handles up to 7000 radio bookings. The company's area ranges from

just south of Brisbane nearly to Murwillumbah, but each booking is frequently a very short run, often going only a few blocks. In radio days they had 12 operator positions — on busy nights 12 would man phones, plus at least three working the radio itself.

Says Dowsey: "And they'd be working pretty hard. The operators' desks were completely covered with paper, mainly 'cover jobs' because they couldn't get them accepted by the cars. So all those bits of paper sat on the desk for a while — even up to an hour, or indefinitely if the bit of paper fell off the desk. By the time the driver got to the job it became 'old', and the customer had probably walked down the street and hailed a passing taxi."



A slightly worried looking Supervisor at his post, which has a more complex computer array than the VDU operators. One channel of the system is still used for voice communication between the cabs and control room.



Looking over the shoulder of a VDU operator, showing the various keyboards and displays involved in making sure your taxi arrives. Four key strokes are often sufficient to input job details.

"But (with Raywood's system) they now have three channels to cover this area, so the computer selects the appropriate channel for the area. The driver doesn't need to select the channel. With computer despatching the job is more likely to be a 'live one' (recent)."

In Manly's case the fleet consists of 200 cars, dealing with 4-5000 radio jobs a day — in addition to rank hirings and street hails. The area has difficult topography. The problem is the general coverage, the extensive size of the area, and the hilly country.

Being a relatively small company the Department of Transport & Communications initially allotted only a

limited number of channels, with no consideration being given to the geographical problems. For example, in Sydney's Western suburbs two channels will cover every area needed because of the relatively flat landscape. Manly has three, in far more mountainous country.

Dowsey continues: "We've re-assigned some of the channels to fix up the 'dead spots'. These were a problem even in radio days."

Some bookings can call for a taxi to pick up a customer in the city and deliver him or her to the top of the Peninsula at Palm Beach — a distance of 45km — or for a journey within a suburb that may only run a

kilometre or two. With the new installation Manly's experience has been that a 'best case' — from initial phone call to arrival of the taxi — is three minutes.

On the horizon

Lindsay Dowsey mentioned that Raywood has "had some enquiries from Hong Kong and other Asian countries — also from Italy — and it looks as though Auckland may be taking an installation."

"The next stage, depending on co-operation with various authorities, will be a method of determining vehicle location — so the driver has no need to plot in his location. The computer will actually know this, and be aware when the car is vacant.

"This stage may call for satellite relay, or a triangulation method. There have been suggestions that the customer may be able to dial directly into the system. We feel that regular customers could probably do that — but the problem is that typified by the TV commercial with the budgerigar tapping away at a keyboard, to have the house cat picked up by a freight forwarder. You really rely on the customer pushing the right buttons. And you're relying on blind faith. We feel you need the contact."

He further explained that "many companies use the recorded message system to take down details of the booking. But many people often don't understand it's a recorded voice, and talk over it, not waiting for the breaks for their input."

"And it often happens that the customers may be unsure of their exact location. We are very particular about 'trapping' this situation, while the customer is still on the phone to verify details."

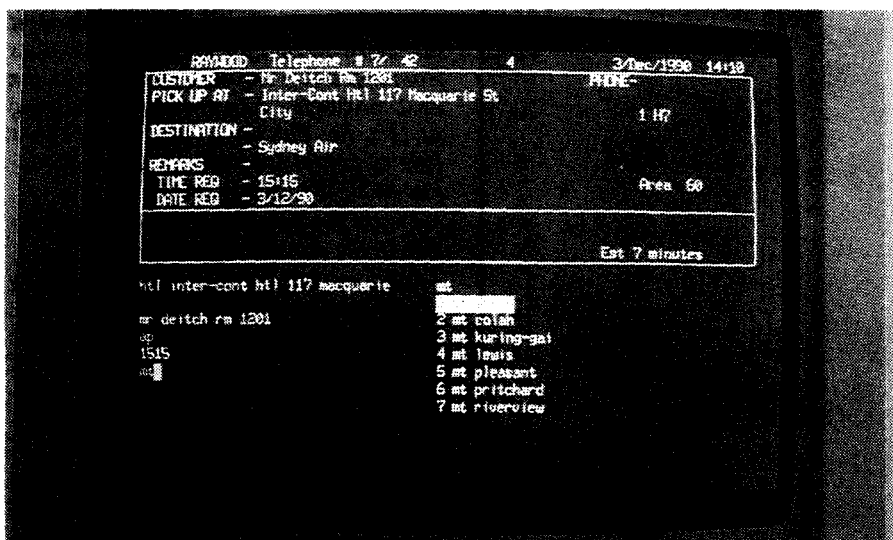
"Another problem is that often the customer wants to have a chat. Sometimes, after giving all the details to the operator they ramble on about all sorts of things, then apologise by saying 'Sorry, can't talk any more — the taxi's here!'"

How it's going

Manly-Warringah Taxis are very happy with the new installation. There have been a couple of difficult areas, but these were also a source of problems with the old radio system.

Says Dowsey: "I think the drivers enjoy it. It means now that they can work a 12 hour shift with less exhaustion. When you're driving a taxi,

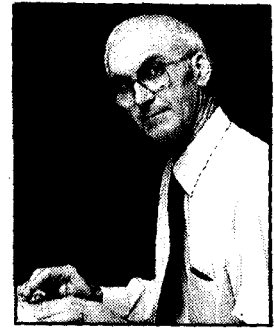
Continued on page 107



The screen display seen by the VDU operator. Note 'mt' has been keyed in — short hand for 'mount'. The system then provides seven choices to the operator, speeding up the input process considerably.

FORUM

Conducted by Jim Rowe



Readers respond to my January explanation of AM...

In the January column I attempted to explain how sidebands are generated when we modulate the amplitude of a RF carrier, and a number of readers have written in with helpful comments on the subject — plus a few criticisms regarding my explanation.

By and large, most of the people who wrote in to comment on the subject of amplitude modulation seemed to be reasonably happy with my explanation, although with various reservations concerning both the approach I took and some of the finer details. So I think you'll find their comments make interesting reading.

John Neate of Blackwood in South Australia offered the following comments in his letter:

I sympathise with your efforts to clarify amplitude modulation for Peter Fox (and no doubt many others). While I agree with almost all you say, the problem remains that there comes a point where you have to say 'It turns out that...' (or worse still, 'It can be shown that...') — and that may be where you part com-

pany with the reader who doesn't want to take anything for granted that he (or she) cannot see for themselves.

One point of actual disagreement with your argument is where you suggest that changing the amplitude introduces new frequencies because the rate of change of the waveform has changed ('some parts of the sinewave will end up with a higher rate of change than before, corresponding to a higher frequency'). After all, if you just increase the amplitude of a sine wave, some parts will 'end up' with a higher rate of change than before, but that doesn't mean there has been an increase in frequency.

I think there is much to be said for tackling the problem the other way around. Instead of starting with the waveform, start with a spectrum. Imag-

ine a 1MHz sinewave, then add to it a bit of 1.000001MHz sinewave. What would the waveform look like?

Being almost the same frequency, they will drift in and out of phase. When they are in phase, we have a bigger sinewave; when they are out of phase we have a smaller sinewave. Lo! we have amplitude modulation, just by adding two sinewaves.

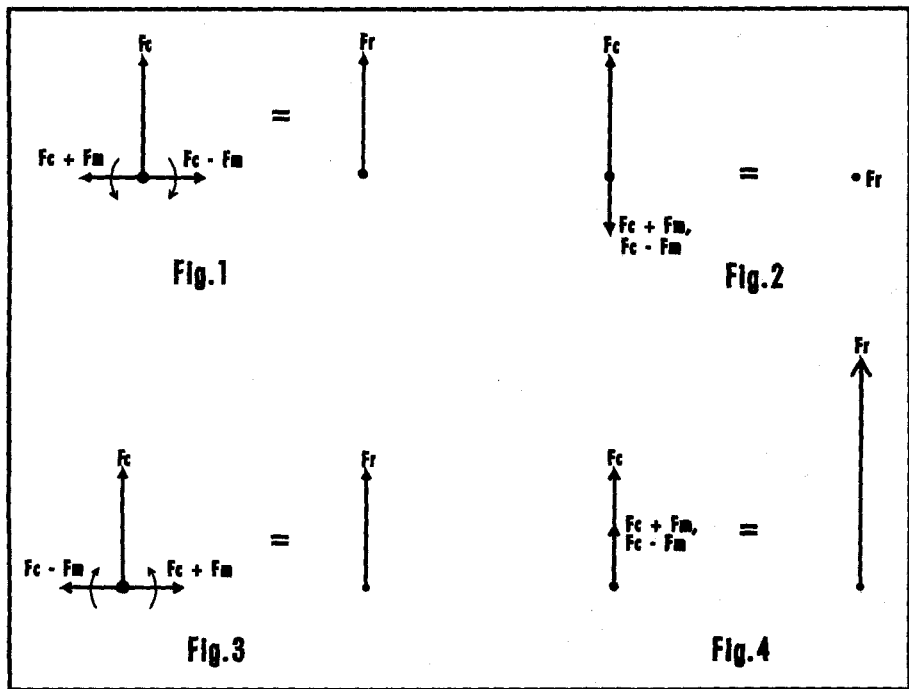
But this is not quite the same as our normal idea of AM, because our wave will be varying in phase as well as amplitude, as can be seen by drawing a vector diagram. So add in another sinewave at 0.999999MHz; this too will drift in and out of phase with the original waveform, increasing the change in amplitude of the resultant, but cancelling the change of phase. Again this is confirmed by adding the appropriate vector to the diagram.

Thus we have produced exactly the phenomenon of amplitude modulation by combining three sinewaves of fixed amplitude. In this particular example it takes one second for the mixture to pass from maximum through minimum to the next maximum; i.e., we are modulating at 1Hz. Set the sidebands 500Hz either side of centre frequency and we modulate at 500Hz, and so on.

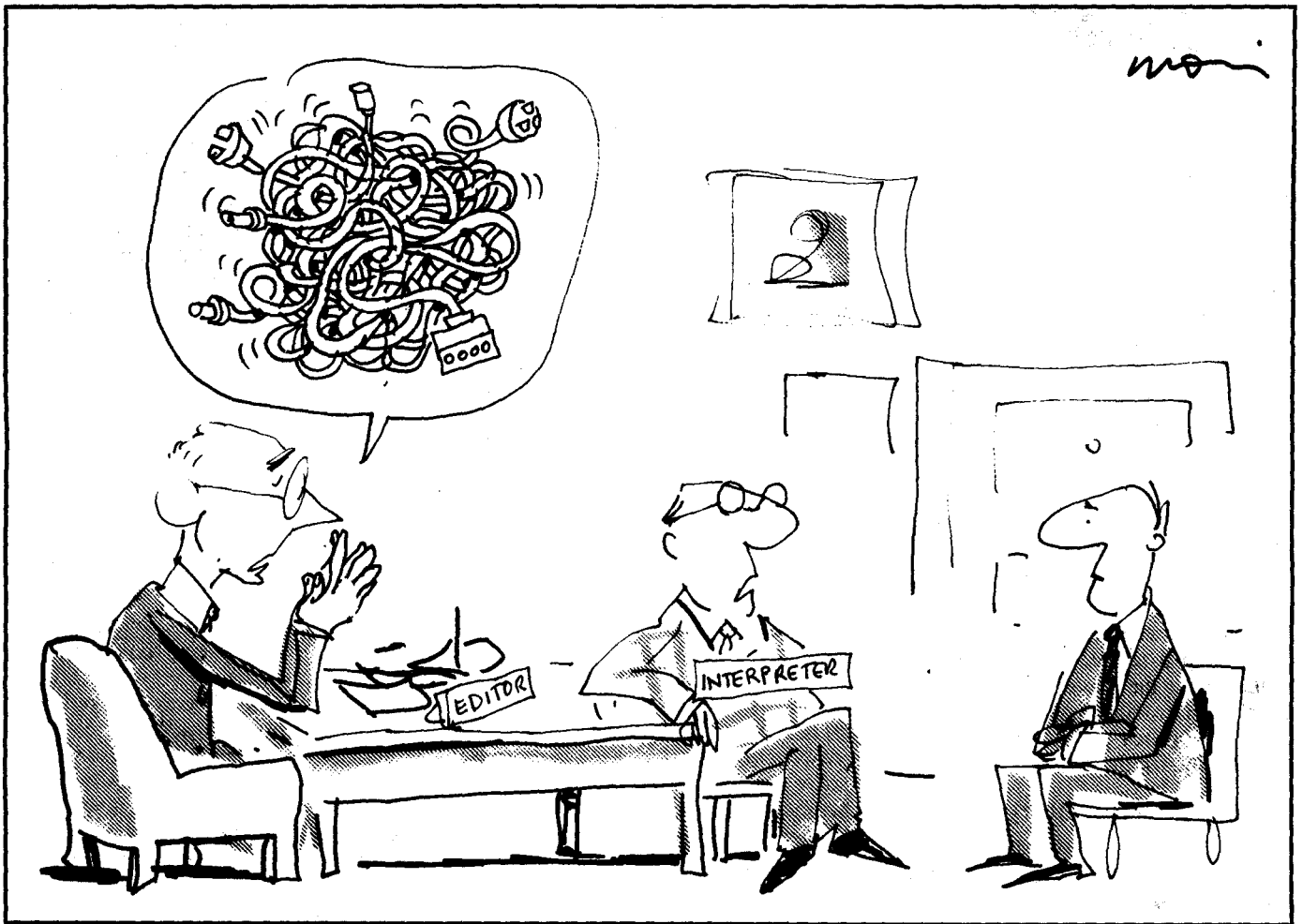
I trust you find this a helpful contribution to the discussion.

I did indeed, John, and I'm sure many of the readers will find it helpful as well. Your approach of taking a single sinewave and describing the effect of adding another is a good one, and undoubtedly helps to demonstrate the duality of the situation.

You're also quite right to challenge my explanation of the mechanism behind the generation of sidebands as due to variations in the sinewave's rate of change, because looking back over it again, it does seem rather poorly expressed.



The four phasor diagrams used by correspondent Stephen Sloan to help show how a varying resultant F_r is produced by a steady carrier plus sidebands.



I guess what I was trying to say was that if you have a signal of a single frequency, its waveform will be a pure sine wave. But any deviation from that pure sine waveform will inevitably involve the creation of additional frequency components, as we know from the way distortion in audio amplifiers causes the generation of signal harmonics, and intermodulation products — all additional signals, at other frequencies.

With a single-frequency signal, distortion of the sine wave produces additional signals which are harmonic multiples of the original frequency. A square wave is an extreme example of this, corresponding to a mixture of the original sine wave with a large number of its odd-order harmonics — $3f_0$, $5f_0$, $7f_0$, $9f_0$ and so on.

Perhaps it is hard to make the jump from this to what happens when we modulate the amplitude of a sine wave with another sine wave, but what I was trying to suggest was that the very process of varying the original signal's amplitude also produces additional signal components, simply because it produces a kind of 'cyclic distortion' of the sine wave, in the process of making it vary in amplitude. And if this variation in amplitude

itself takes place in a sine wave fashion — the 'purest' kind of modulation, in a sense — it's probably not too surprising that the process then generates only two additional signal components, one above and the other below it in frequency. Nor is it all that surprising that these two additional signals are separated from the original signal by an amount equal to the frequency of modulation.

This is the kind of idea I was trying to express, anyway. But I agree with John Neate that I hadn't expressed it particularly well..

Let's pass on to the next letter, though. This came from Stephen Sloan, also from South Australia but in this case from Craigmare. Here's what Stephen had to say:

While I agree with your explanation on needing sidebands to convey information, your explanation of why we observe a varying carrier on a CRO screen while in fact the carrier doesn't actually change in amplitude, might confuse some people.

The waveform is due to the addition of the sidebands and the carrier, with the resulting amplitude waveform displayed on the screen. If we look at Fig.1, this

shows a phasor diagram of the carrier and the two sidebands, with the carrier frequency as the reference phasor at one point in time. As the carrier is the reference, the lower sideband will be rotating slower than the carrier and the upper sideband rotating faster. Therefore at the next instant in time the upper and lower sidebands will be as Fig.2. As the sidebands are both opposite in amplitude to the carrier, they both subtract from the carrier amplitude to produce the decrease in amplitude we see on the CRO.

Fig.3 is the next instant in time, and the same as in Fig.1, while in Fig.4 the two sidebands add to the carrier amplitude and result in an increase in the signal on the CRO screen, over that of the unmodulated CW signal.

I hope this explanation will be of some help, as I have come across many people who don't understand this principle. The explanation can be taken further to explain the demodulation process. When the IF signal is detected, the carrier is mixed with the sidebands and the original AF signal is produced as the difference between the two. All of the RF signals are then filtered out and only the AF signal is left.

The reason the detector produces the sum and difference signals is that it is a nonlinear device. It doesn't cut the waveform in half, as explained in some textbooks.

Thanks for your comments too, Stephen, and I'm sure that your introduction of the phasor diagrams will again help clarify the concepts for quite a few readers. I tossed up whether to introduce them in my original explanation, but decided to try putting over the ideas without them. This was because I wasn't too sure how many readers would grasp the significance of a phasor or vector, without a fair amount of explanation.

Perhaps I would have done better to leave them in — they certainly do demonstrate the equivalence between three fixed-amplitude components, and the varying-amplitude resultant signal we see on a scope. Provided that you realise why the lower frequency sideband phasor rotates 'backwards', and the higher frequency phasor 'forwards', relative to that for the carrier...

Remaining difficulty

Also I suspect that Peter Fox and quite a few other people probably still find it difficult to see where those two sideband signals actually 'come from', since we start off with a single RF carrier and nominally only vary its amplitude. It was this problem that I sensed in Peter's original question, and it was in an attempt to tackle that particular aspect that I took the approach I did.

In other words, it's fairly easy to show how the addition of two sidebands to a carrier produces a resultant that varies in amplitude, but rather harder to show why varying the amplitude of a carrier in sinusoidal fashion automatically generates the two sidebands.

Incidentally your explanation of demodulation worries me a little, I have to confess. A modulated signal is already a mixture of the carrier plus sidebands, so a detector hardly needs to 'mix' them together. You do of course need to introduce a nonlinear mechanism, to cause an audio component to be generated, as you go on to point out.

By the way, there's nothing really wrong with the 'cutting the waveform in half' way of explaining diode detector operation. Passing only half the waveform (or thereabouts) is after all an example of nonlinear circuit operation. Here again we're really just talking about two different ways of visualising

the same basic mechanism; they're both legitimate concepts.

And so to the next letter, which comes from a reader who has contributed to Forum on previous occasions: Mr Hugh Harrison, of Brighton in Victoria.

Mr Harrison also isn't happy about my attempt at an explanation of AM, as you'll see, because he feels I could have done a lot better by bringing in the relevant maths. In fact, he believes that we should put a good deal more maths into EA as a whole:

I feel I must take issue with you over your January treatment of amplitude modulation.

In my letter published in June 1988, I was critical of your avoidance of virtually all mathematics in all EA articles; but you did not respond to that point. I repeat my view that electrical and electronic phenomena call for mathematical explanations, probably more than any other technical subject. And this is basically because no-one can see, taste or smell an electron, or indeed, an electric current. We can only observe their effects. The science (or is it an art?) of mathematics enables us to create quantitative models to help understand their behaviour.

Therefore, I feel you have made such a fetish of avoiding maths in EA articles, that you do a considerable disservice to the great majority of your readers. Even in the rare occasion when you indulge in some simple arithmetic, it is buried in an ordinary line of print without proper maths typesetting. I recollect that, way back, you justified your policy by saying that maths might tend to put off younger or inexperienced readers.

That can hardly apply today, when considering that nearly all youngsters aiming for HSC (now VCE), and certainly those interested in technical subjects like electronics, will study some general maths and some algebra, geometry and trigonometry. These, alone, even without calculus, are enough to shed light on many electronic matters.

So, coming back to amplitude modulation, your explanation occupies about 1200 words (equal to over three full columns). I have little fault to find with the accuracy of your explanation, but it is all qualitative and depends on people accepting your assertions at face value — I bet you have some readers arguing the point in due course.

I have attempted an alternative explanation, supported by the relatively simple maths entailed, which I enclose. It takes about half the space of your story. Mine, being quantitative, demonstrates the two sidebands incontrovertibly.

Possibly, a reason for avoiding maths in the past, which you haven't voiced, is difficulty in preparing and printing an article with maths formulas in it. With all that done by a computer these days, such a reason is no longer valid. I have prepared the attachment on an Apple Macintosh, using a word-processing program. That program has a special facility for typing maths formulae, but I have done what I think you will acknowledge is a reasonable job just by ordinary word-processing, using an occasional symbol from another font where necessary and utilising the facility of grafting in a graphic. If the little amount of that sort of typesetting isn't met by in-house expertise, it could easily be covered at moderate cost by using an outside specialist as the occasion warranted.

In the past and when in its former glory, we have both admired Wireless World. Take a look at some back numbers and see how liberally maths were sprinkled wherever they could promote understanding. I read into their presentation an intelligent editorial policy of favouring maths but keeping their presentation to a fairly standard format and relegating the more complex maths to appendices so as not to interrupt the main flow of the text. That's a good way of satisfying the more ardent followers of the subject while leaving the majority to take it mainly 'as read'.

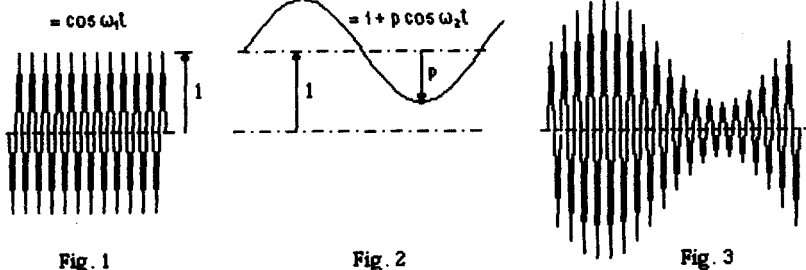
I suggest that the inclusion of some relevant maths in various articles would indeed lift the tone of EA and help to give it an even higher standing amongst the technical community.

Thanks for your comments too, Mr Harrison — despite what appears to be something of a back-hander in your second last paragraph. It certainly looks as if you don't regard EA's current editorial policy as being particularly intelligent. Perhaps you're right in that respect; no doubt I'm a little too close to the subject to be capable of much objectivity. In any case, magazine editors are notorious egotists who rarely accept any criticism as valid.

But there are a few of your other points with which I in turn would like to 'take issue'. First, I don't really agree that we avoid virtually all maths in EA articles. If you look through many of the articles in Bryan Maher's 'Basics of Radio Transmission and Reception' series, you'll find some basic maths; there's also some in the later chapters of Peter Phillips' new 'Basic Electronics' series. These even have a separate panel summarising the maths formulas used, *a la Wireless World!*

I certainly agree that we don't gener-

AMPLITUDE MODULATION OF A CARRIER



A sine-wave alternating electrical quantity (voltage or current) can be described mathematically by the expression: $A \cos(2\pi ft) = A \cos \omega t$, where A is the maximum amplitude and f , or ω , denotes the frequency.

To consider amplitude modulation of a carrier, it is convenient to take the normal (unmodulated) amplitude of the carrier as unity, [Fig. 1],

so let carrier = $\cos(2\pi f_1 t) = \cos \omega_1 t$

and assume an audio signal = $p \cos \omega_2 t$, where $0 \leq p \leq 1$

If the carrier has its normal amplitude in the absence of modulation this implies that there must be a d.c. component in the audio signal equal to the normal amplitude of the carrier so that the total modulating signal is $1 + p \cos \omega_2 t$. [Fig. 2]

This means that when $p = 1$, the most negative excursions of the a.c. audio signal will reduce the carrier amplitude just to zero and this condition is termed 100% modulation.

$$\begin{aligned} \text{So complete signal} &= \cos \omega_1 t \times (1 + p \cos \omega_2 t) && \text{[Fig. 3]} \\ &= \cos \omega_1 t + p \cos \omega_1 t \cos \omega_2 t \end{aligned}$$

which, by trigonometry,

$$\begin{aligned} &= \cos \omega_1 t + p/2 [\cos(\omega_1 + \omega_2)t + \cos(\omega_1 - \omega_2)t] \\ &= \cos \omega_1 t + p/2 [\cos(\omega_1 + \omega_2)t + \cos(\omega_1 - \omega_2)t] \end{aligned}$$

From which we see that the carrier remains constant in amplitude (expressed here as unity) and that there are two sidebands at frequencies of $\omega_2/2\pi = f_2$ above and below the carrier frequency f_1 .

When $p = 1$, which is described as 100% modulation, each sideband has a relative amplitude of $1/2$ and the power in each sideband is therefore $1/4$ of that in the carrier.

Hugh Harrison's alternative explanation of amplitude modulation, using the appropriate maths — which he chides me for not using in my explanation.

ally put much maths into our articles, and that's a long-standing EA tradition. We've always tried to give our highest priority towards helping readers grasp the basic physical concepts involved in device and circuit operation, on the basis that there are usually dozens of textbooks which already cover the maths side at considerable length.

This is an editorial policy that I inherited, if you like, but as it happens it's not one with which I have ever had any serious disagreement. Perhaps that's because during my own progression through high school and university, I struck a great many teachers and lecturers (not to for-

get textbooks) who all seemed to think that maths was sufficient explanation for just about anything.

'Don't worry about understanding what's actually going on', was often their approach, 'just memorise the maths and regurgitate it back to us in the exams'.

Well, I for one always had great difficulty with this approach, and I'm sure I wasn't the only one. To me, the maths is important, but certainly NOT sufficient for a full and satisfying understanding of electronic or other scientific phenomena. I find it best to try getting a sound qualitative physical understanding *first*, and

then pick up the maths to quantify everything. In fact that's the only way I ever seem to be able to remember the maths. If I try to learn it first, in rote fashion and before I grasp what it is that the maths is actually describing, the result is usually a disaster.

Frankly, if I couldn't have both forms of knowledge but had to choose from either one or the other, I'd much rather have the sound qualitative understanding, any day. And I'm pretty sure that I'm not alone in this.

The funny thing is that getting a good qualitative understanding of many electronic phenomena still seems to be just as hard as it ever was; in fact to my mind it's much harder than finding a mathematical 'explanation'. There are still umpteen books available to provide the latter, but often very few places to find the former.

Hindering or helping?

So to be honest, Mr Harrison, I really can't see that we're 'doing a considerable disservice to the great majority' of EA readers, by putting our main emphasis on qualitative explanations. Quite the contrary; I think we're likely to be helping them *more* than if we simply regurgitated the same old mathematical 'explanations' that they can find in the textbooks.

Incidentally, since Mr Harrison makes a reference to the UK magazine *Wireless World*, to my mind one of the most interesting and memorable columns that magazine ever ran was written by M.G. Scroggie, under the *nom de plume* 'Cathode Ray'. The column was dedicated to discussing and clarifying basic concepts, and as I recall he placed great emphasis on qualitative understanding — even though the maths side was generally dealt with as well.

Continuing with Mr Harrison's letter, I agree that nowadays many readers would probably have sufficient algebra and trigonometry to follow his mathematical explanation — which I'm reproducing, to give them the chance. I guess where we part company is his apparent assumption that as well as taking up 'half the space' of my own explanation, it provides a more convincing and satisfying alternative.

To my mind, it's just a concise, quantitative way of showing that if nothing else, one thing a modulated carrier is *equivalent* to is a carrier of fixed amplitude together with two sidebands. Fair enough; it's not all that difficult to use mathematics to show that various things are equivalent to various other things. Probably if you shuffled the maths

FORUM

around a bit more, you could show various other equivalences as well. But does that necessarily show which events and phenomena occur in the real world, and help us in understanding *why* they occur?

For example in this case, the maths still doesn't explain how the sidebands come to be generated — 'where they come from', in other words. It simply shows that by describing the modulated carrier with one expression and shuffling it around, we get another expression which represents a carrier and sidebands...

Then there's Mr Harrison's statement that the maths 'explanation' demonstrates the two sidebands 'incontrovertibly'. I'm not sure I understand what he means by that, but it sounds a bit as if his criterion of a good explanation is one that stops all subsequent argument or discussion. Is that really the mark of a good explanation?

Perhaps it is to an overworked school-teacher or a uni lecturer, whose life is no doubt easier if none of the students ever wants to discuss the subject or query any aspects of the 'explanation' they've been given. But to my mind, the definition of

a good explanation is surely one that assists the reader or listener to *understand* the concepts concerned. And as the dynamics of a two-way discussion generally seem to assist in this process (something Socrates demonstrated, a long time ago), surely that means that a good explanation should *stimulate* discussion, not choke it off.

I agree that maths-type explanations often *do* tend to produce little 'controversy'. No doubt that's largely because they are so concise, even elegant at times — at least, as far as they go. But here again, I suspect that *part* of the reason why many people don't argue with a maths 'explanation' is that they don't really understand it, and are unwilling to make a fool of themselves!

I can't argue with Mr Harrison's statement that maths can provide quantitative models to help in our understanding of electronic behaviour. It certainly can, when properly presented. But I guess I've seen so many examples where great slabs of maths are simply shoved at people, leaving them to wade through it all and find the implicit models.

My impression is that in practice, only a relatively small proportion of people ever do find and recognise the models; as far as the rest are concerned, they remain

buried in the forest of maths... It would be very interesting to hear from Peter Fox and other readers, with comments as to whether or not they found Mr Harrison's maths explanation helpful.

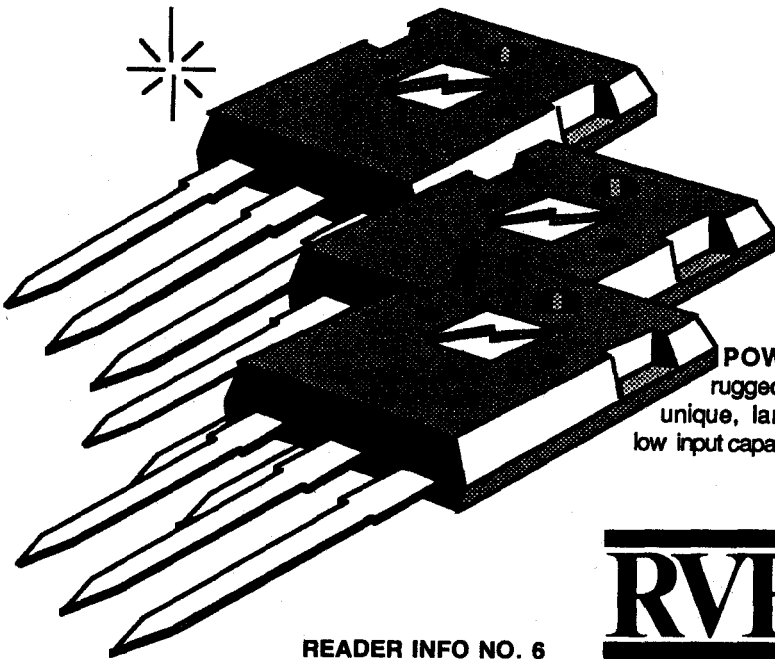
Incidentally, Mr Harrison says that my explanation depended on people accepting my assertions at face value. Fair enough — but how about some of his assertions in the maths explanation?

By the way typesetting of basic maths symbols is not really a problem nowadays. With our *Ventura* desktop publishing setup, we can call up virtually any symbol with relative ease. It's not all that difficult to set even calculus expressions, although these can be rather time consuming. No, it's more a matter of us simply not being convinced, at this stage, that more maths in *EA* is a good thing...

But again, I'd like to hear from other readers about this point, now that Hugh Harrison has raised it. Do you think we should provide more maths, or not? It's an interesting point, and I'm grateful to Mr Harrison for raising it.

That's about all we have space for, this month. There was one other letter in response to the January column, but as it actually deals with another subject (FM stereo), I'll try to deal with it next month. I hope you'll join me. ■

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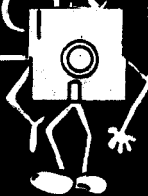
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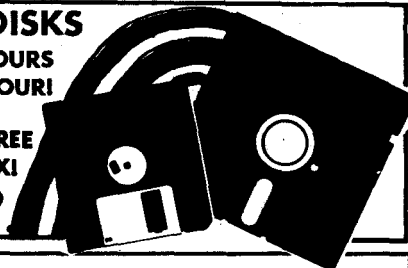
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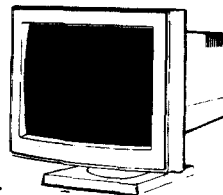
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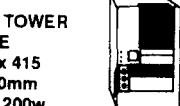
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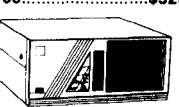
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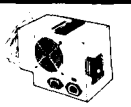


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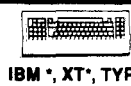
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 DC OUTPUT: +5/13A -5 0.5A +12V /4.5 -12 V 0.5A
 X11096.....\$109
 180W AT.....\$169
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- Buzzer warning when blackout
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- Maintenance-free & long life batteries


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 180W UPS.....\$299
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 X12020.....\$109

IBM COMPATIBLE EXTENDED KEYBOARD (101 KEYS)
 X12022.....\$109



101 KEY TRACKBALL KEYBOARD
 Keyboard & mouse in one
 X12030.....\$199.95

KEYBOARD STORAGE DRAWER

C21083.....\$84.95




MINI VACUUM CLEANER
 C21087.....\$17.95




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 C21089 84 KEY.....\$4.50
 C21088 101 KEY.....\$5.95

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100 x 5 1/4" ECLIPSE
 C16042.....\$11.95
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 C16040.....\$8.99
 120 x 3 1/2" LOCKABLE
 C16039.....\$21.95
 100 x 5 1/4" LOCKABLE
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 50 x 5 1/4" LOCKABLE
 C16025.....\$11.95
 120 x 5 1/4" LOCKABLE
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 RS232-4 WAY.....\$69
 RS232-X OVER.....\$69
 RS232-2 WAY AUTO.....\$69
 CENTRONICS 2 WAY.....\$49
 CENTRONICS X OVER.....\$69
 CENTRONICS 2way auto.....\$79
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 C21058.....\$89.00

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 2 FREE TELEPAINT DISKS!
 X19951.....\$119




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 "A Stationary Breakthrough"
 Use your finger instead of your mouse. Great for saving space. Ideal for laptops
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 Supports hundreds of applications.
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IBM PRINTER LEADS




· 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

COPY HOLDERS

COPY HOLDER (YU-H32)
 Adjustable arm
 Sliding Guide
 C21062.....\$39.95



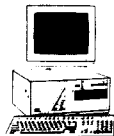
COPY HOLDER (YU-H33)
 Sliding Guide
 Flat Metal base
 C21060.....\$39.95



RITRON QUALITY RITRON POWER

RITRON

286-16

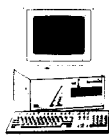


80286-12 CPU
 1 MEG RAM EXPANDABLE TO 4 MEG
 16Mhz LANDMARK SPEED TEST
 1.2M JAPANESE BRAND F.D.D
 42M HARD DISK DRIVE 28ms ACCESS
 101 EXTENDED "CLICK" KEYBOARD
 JAPANESE KEYBOARD SWITCHES
 MINI CASE & 200W POWER SUPPLY
 256K VGA CARD
 SUPA VGA COLOUR MONITOR (1024 x 768 res)
 SERIAL, PARALLEL, GAME PORT
 2 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 DOS 4.01. IBM COMPATIBLE
 SPREADSHEET, WORDPROCESSOR & DATABASE
 SOFTWARE INCLUDED.
ASSEMBLED & TESTED IN AUSTRALIA

\$1,795

RITRON

286-20



80286-16 CPU
 1 MEG RAM EXPANDABLE TO 4 MEG
 20Mhz LANDMARK SPEED TEST
 1.2M JAPANESE BRAND F.D.D
 42M HARD DISK DRIVE 28ms ACCESS
 101 EXTENDED "CLICK" KEYBOARD
 JAPANESE KEYBOARD SWITCHES
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RITRON

386SX-21

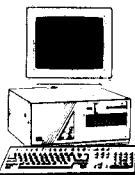


80386SX-16 CPU
 42 MEG 28ms HARD MEMORY
 1.2 MEG 5 1/4" DISK DRIVE
 1MEG RAM
 16 BIT 256K VGA CARD
 SUPA VGA COLOUR MONITOR (1024 x 768 Resolution)
 SERIAL, PARALLEL, JOYSTICK PORTS
 MINI CASE & 200W POWER SUPPLY
 101 KEYBOARD
 WITH DOS 4.01
 IBM COMPATIBLE
 3 YEAR AUSTRALIA PARTS & LABOUR WARRANTY
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RITRON

386SX-27

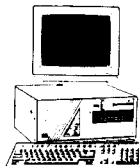


80386SX-20 CPU
 1 MEG RAM
 27Mhz LANDMARK SPEED TEST
 1.2M JAPANESE F.F.D
 42M HARD DISK DRIVE, 28ms ACCESS
 101 EXTENDED "CLICK" KEYBOARD
 MINI CASE & 200W POWER SUPPLY
 256K VGA CARD
 SUPA VGA COLOUR MONITOR (1024 x 768 Resolution)
 SERIAL, PARALLEL, GAMES PORTS
 3 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 DOS 4.01. IBM COMPATIBLE
 SPREADSHEET, WORDPROCESSOR & DATABASE
 SOFTWARE INCLUDED.
ASSEMBLED & TESTED IN AUSTRALIA.

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RITRON EXECUTIVE

386-32

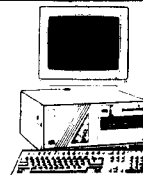


80386-25 CPU
 NO CACHE 1 MEG RAM
 32Mhz LANDMARK SPEED TEST
 42 MEG HARD DISK 28ms ACCESS TIME
 1.2M JAPANESE F.D.D
 101 EXTENDED "CLICK" KEYBOARD
 SERIAL, PARALLEL, GAMES PORTS
 256K VGA CARD
 SUPA VGA COLOUR MONITOR (1024 x 768 Resolution)
 MINI CASE & 200W POWER SUPPLY
 DOS 4.01. IBM COMPATIBLE
 3 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 SPREADSHEET, WORDPROCESSOR & DATABASE
 SOFTWARE INCLUDED.
ASSEMBLED & TESTED IN AUSTRALIA.

\$3,195

RITRON EXECUTIVE

386-41



80386-25 CPU
 CACHE ON BOARD MEMORY
 1 MEG RAM
 41Mhz LANDMARK SPEED TEST
 42 MEG HARD DISK 28ms ACCESS TIME
 1.2M JAPANESE BRAND F.D.D
 101 EXTENDED "CLICK" KEYBOARD
 SERIAL PARALLEL GAMES PORTS
 SUPA VGA COLOUR MONITOR (1024 x 768 Resolution)
 MINI CASE & 200W POWER SUPPLY
 256K VGA CARD (256 COLOURS)
 DOS 4.01 IBM COMPATIBLE
 3 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 SPREADSHEET, WORDPROCESSOR & DATABASE
 SOFTWARE INCLUDED.
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RITRON EXECUTIVE

386-56



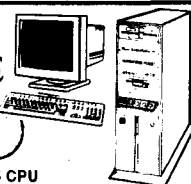
80386-33 CPU
 32K/64K CACHE ON BOARD MEMORY
 1 MEG RAM
 56Mhz LANDMARK SPEED TEST
 85 MEG HARD DISK 18ms ACCESS TIME
 1.2M JAPANESE BRAND F.D.D
 101 EXTENDED "CLICK" KEYBOARD
 SERIAL, PARALLEL, GAMES PORTS
 SUPA VGA COLOUR MONITOR (1024 x 768 Resolution)
 512K VA CARD DOS 4.01
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 & DATABASE SOFTWARE INCLUDED.
ASSEMBLED & TESTED IN AUSTRALIA.

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200 MEG DRIVES
 AVAILABLE \$4,495

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486-115



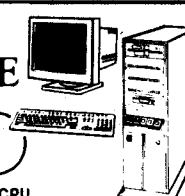
80486-25 CPU
 ON BOARD CACHE. 4 MEG OF RAM
 115Mhz LANDMARK SPEED TEST
 85 MEG HARD DISK 12ms ACCESS TIME
 1.2M JAPANESE BRAND F.D.D
 3.5" 1.44M JAPANESE BRAND F.D.D
 101 EXTENDED "CLICK" KEYBOARD
 SERIAL, PARALLEL, GAMES PORTS
 512K VGA CARD
 VGA COLOUR MONITOR (1024 x 768 Resolution)
 DOS 4.01 IBM COMPATIBLE
 TOWER CASE & 220W POWER SUPPLY
 3 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 SPREADSHEET, WORDPROCESSOR & DATABASE
 SOFTWARE.

\$5,995

WITH 200 MEG DRIVE (12ms)
\$6,995

RITRON EXECUTIVE

486-157



80486-33 CPU
 ON BOARD CACHE. 4 MEG OF RAM
 157Mhz LANDMARK SPEED TEST
 200 MEG HARD DISK 14ms ACCESS TIME
 1.2M JAPANESE BRAND F.D.D
 3.5" 1.44M JAPANESE BRAND F.D.D
 101 EXTENDED "CLICK" KEYBOARD
 SERIAL, PARALLEL, GAMES PORTS
 1 MEG VGA CARD
 VGA COLOUR MONITOR (1024 x 768 Resolution)
 DOS 4.01 IBM COMPATIBLE
 TOWER CASE & 220W POWER SUPPLY
 3 YEAR "AUSTRALIAN" PARTS & LABOUR WARRANTY
 SPREADSHEET, WORDPROCESSOR & DATABASE SOFTWARE.
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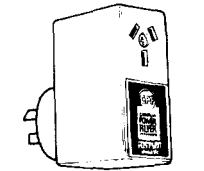
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PLEASE QUOTE THIS ADVERTISEMENT FOR THESE GREAT PRICES!



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

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket.
Indicators: Tricolour LED's for TD, RD, RTS, DSR, CD, TC, RC, DTR, (E)TC.
Jumper Wires: 20 tinned end pieces.
Power: Interface power.
Enclosure: Black, high impact plastic.
Dimensions: 85 x 95 x 30mm
X15700 **\$99.95**

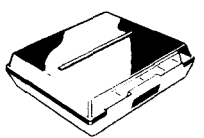
CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR
The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment.

The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

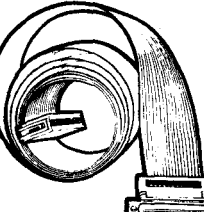
SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4500 amps for 20ms/second pulses
Maximum clamping voltage: 275V differential mode.
Cat. X10088 **\$69.95**



ENCLOSED PRINTER STAND
Keeps your printer and print-outs neat and orderly.
Transparent cover makes it easy to check on paper supply.
Paper can be fed from the centre or the rear according to the design of the printer.
Removable drawer which allows paper to be changed without moving the printer.
Retractable rear basket makes print-out collection fast and convenient.
Suitable for most printers.
\$69.95

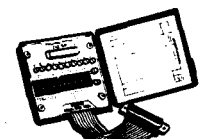


DATALIFE DL-600 DATA CARTRIDGE
Stores up to 120 M/Byte
C12614 **\$59.00**



5 1/4" FLOPPY DISK DRIVE EXTENSION CABLE
IBM compatible
DB37 Male to 34 way edge connector
Length 0.5 metres
P19045 **\$99.95**

3 1/2" FLOPPY DISK DRIVE EXTENSION CABLE
IBM compatible
DB37 Male to 34 IDC connector
Length 0.5 metres
P19046 **\$99.95**



DISK NOTCHER
Converts 5 1/4" single sided floppy disks to double sided, by placing an appropriate notch in the floppy disk jacket.
C21070..... **\$5.00**



KEYBOARD EXTENSION LEAD
5 Pin Din plug and socket
P19038..... **\$9.95**



DELUXE PRINTER STAND
Restores order to your work area without occupying extra space.
Feeds and reloads paper under the printer automatically.
Adjustable paper deflectors ensure smooth flow of paper.
Made of moulded plastic.
Suitable for most printers.
C21058 (80 column) **\$69.95**



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**



SURGE BUSTER
6 PROTECTED POWER OUTLETS
Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc

SPECIFICATIONS:
Electrical rating: 240V AC, 50Hz, 10A
3 x Metal Oxide Varistors (MOV)
Maximum clamping voltage: each MOV: 710 volts at 50 amps
Response time: Less than 25 Nanoseconds.
X10086..... **\$69.95**



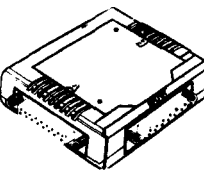
THE BUTTON SPIKE PROTECTOR
Surges and spikes are caused not only by lightning strikes and load switching but also by other equipment being switched on and off, such as fluorescent lights, electric motors, fridge freezers, air conditioners, etc.

For effective protection such spikes must be stopped before they reach your equipment. Simply plug The Button into an outlet and it will protect all equipment plugged into adjacent outlets on the same branch circuit. The Button employs unique metal oxide varistor technology and will dissipate 150 joules of electrical energy (nearly twice that of comparable surge arresters.)

SPECIFICATIONS:
Voltage: 240V Nominal
Total Energy Rating: 150 joules
Response Time: 10ns
Protection Level: 350V peak
\$42.95



ROD'S COMPUTER TIPS!
Are you having trouble reading 5 1/4" disks which have been around your children or non-computer people? This is a common fingerprint problem. Arm yourself with a bottle of methylated spirits and cotton wool balls. Hold the disk that wont read up to the light and try and spot the fingerprint, grease or foreign matter. You do this by looking in the "window" at the media and slowly turning the disk with your fingers in the middle hole. Be very careful not to crease the disk. You might have to clean both sides of the disk at the problem position(s), but normally you can recover your software by this procedure. Having young children I am very aware of this problem!!!
Regards Rod Irving.

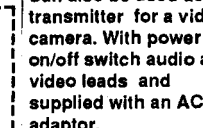


POCKET AUTO AB SWITCHES
Pocket size, auto-scanning
Allows 2 PCs to share one printer
Serial model:
MS-201 - Host-powered
X19150..... **\$79.95**
Parallel model: MP-201
Protocol transparent
X19155..... **\$89.95**

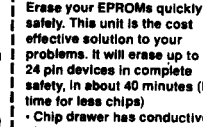


VIDEO / AUDIO TRANSMITTER
A small compact unit that allows transmission of video & audio signals (RF) to any TV set or VCR within range of 30 metres. Ideal for watching videos in the bedroom or kitchen without having to move the entire VCR or having long extension leads running through the house.

Can also be used as a transmitter for a video camera. With power on/off switch audio and video leads and supplied with an AC adaptor.
A16150 Normally... **\$95.95**
NOW ONLY... **\$84.95**



UV EPROM ERASER
Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)
Chip drawer has conductive foam pad
Main power has
High UV intensity at chip surface ensures EPROMs are thoroughly erased
Without timer
X14950..... **\$99**
With built-in timer
X14955..... **\$169**



DUST COVER
Keep your computer and accessories free of dust and grime while not in use
XT Cover Set
C21066..... **\$14.95**
AT Cover Set
C21068..... **\$16.95**



HEAD CLEANER DISKS
It only takes a minute amount of dust, dirt or magnetic oxide particles on your drive heads to cause problems: errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.
3 1/2"
C12560..... **\$6.95**
5 1/4"
C12555..... **\$6.95**

HAVE THE CUTEST MOUSE IN THE HOUSE WITH THESE GREAT NEW PRODUCTS!



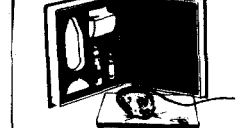
MOUSE COVER
Be the first in your office to have a mouse that every one will want use. This cute little mouse cover puts a bit of fun and colour onto your desk while keeping your mouse free of dust!
C21069..... **\$7.95**



MOUSE CLEANING KIT
Keep dust and dirt from damaging your mouse with this handy mouse cleaning kit. This special rounded tool will find its way into all the hard to get at places. The kit also comes with cleaning fluid and 5 soft cloths to keep your mouse spotless!
C21071..... **\$9.95**



MOUSE KIT
Everything you need to keep your mouse happy! You get a mouse pad, a mouse holder, a cleaning kit (previously described) and a cute little mouse cover.
C21072..... **\$16.95**

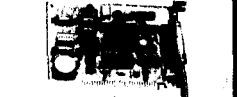


MOUSE GIFT SET
Here it is! The ultimate mouse kit. You get all of the above products, the cute little mouse cover, the mouse cleaning kit, the mouse house and mouse pad all in a handy black case.
C21074..... **\$19.95**



COMPUTER CLEANING KIT
To gain optimum performance and prevent damage to valuable disks, this cleaning kit has all you need to keep your computer in top notch performance. Anti-static cleaning pads, cleaning swabs, cleaning solution, 5 1/4" & 3 1/2" cleaning diskettes.
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XT HD CONTROLLER **\$129**
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TANDY'S NEW TALKING DMM

This month, Tandy is releasing an innovative new measuring instrument — a compact handheld digital multimeter that announces its readings in audible speech, as well as presenting them visually on a standard liquid-crystal display. David Botto had the opportunity to try out an advance sample of the 'Voice Meter', and here's what he found...

The idea of a talking multimeter has always interested me. It sounds easy: simply make use of the digital signals that drive the display of a standard digital multimeter. Apply these signals, via suitable interfacing circuitry, to a speech synthesiser IC complete with programmed speech ROMS. This will produce audio signals which can then be amplified and fed into a loudspeaker.

Of course, it's one thing to theorise how a talking multimeter might be built. However, it's quite a different proposition to actually produce a compact working model that can be sold commercially at a reasonable cost. But Tandy has done just that, with its new model 22-164 Micronta Voice Meter digital multimeter.

The Voice Meter DMM is a hand-held autoranging instrument with a 3000-count (3-2/3) LCD readout. If you normally use a DMM with a 3-1/2 digit readout (1000 counts), then you'll find the Voice Meter's 3000-count readout a big help, particularly when low voltages must be accurately measured.

The Voice Meter is housed in a gray plastic case measuring approximately 180 x 75 x 40mm and is powered by four type 'AA' 1.5 volt batteries. A six position rotary switch selects the various functions, including a diode check. The three position power switch has off/on and continuity test functions.

At first sight the Voice Meter appears to be an ordinary hand-held DMM. (See photograph). Values measured are displayed on an easy-to-read high contrast LCD display with digits 10mm high. The difference is that at the touch of a button (built into the DMM's positive test probe), the Voice Meter speaks both the measurement value and function. For example when a 15 ohm 5% tolerance resistor was measured the voice said 'Fifteen point one three ohms'. A measured DC voltage produced the spoken message 'Two point six seven three volts DC'. The voice is clear and has good volume.

A battery annunciator on the LCD display alerts the user when the batteries are low. If you then try to use the voice function the meter voice tells you 'Replace Batteries'.

The voice feature is not a gimmick, but an extremely useful function. When you've a TV, VCR or video camera for repair on your bench, it's often difficult to keep the test probes firmly contacting hard-to-access test points and at the same time look at a DMM read-out. This is where the Voice Meter scores; there's no need to look at the readout — the electronic voice tells you the measurement value in clear, authoritative tones.

The same thing applies any time you need to make measurements in among the hard-to-get-at places that seem to be proliferating in modern pieces of electronic equipment. Here you'll find that with the Voice Meter you can easily

make several measurements in the same time it would normally take to make just one.

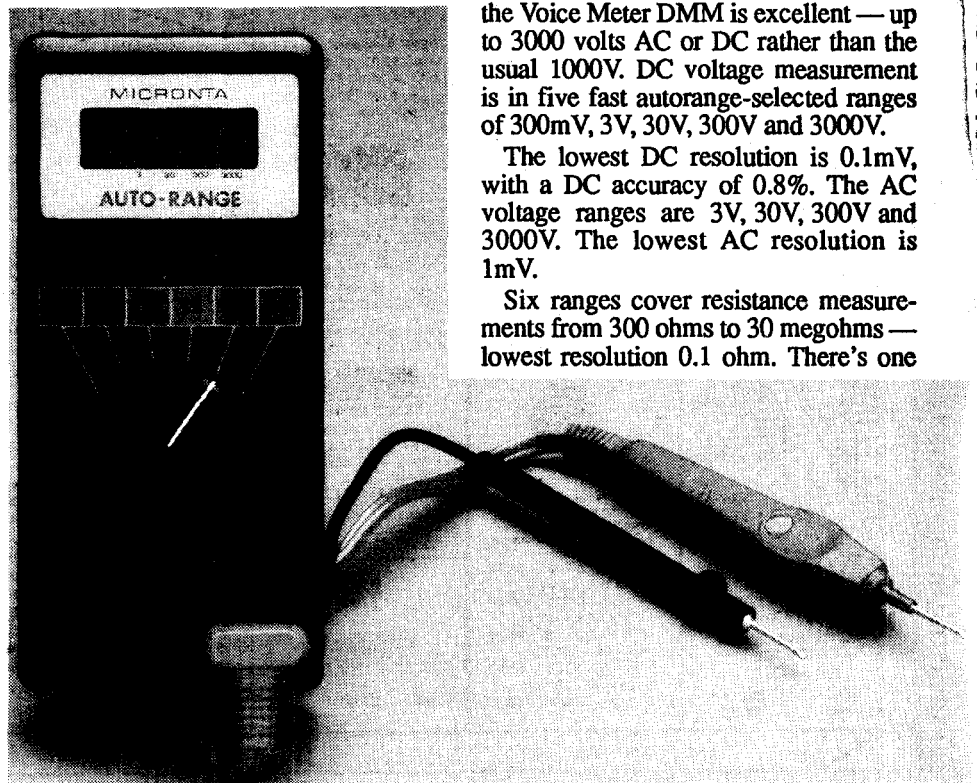
Of course a DMM with a 'display freeze' function will hold measured values, but you still have to turn your head continually to see the headings. This results in extra effort — plus neck and shoulder strain that you can well do without.

For the TV/video service technician who works in the field, the Micronta Voice Meter DMM is ideal. When crawling around the floor — the outside service tech's favourite position — it's often not easy to see a DMM readout. Here the Voice Meter is a real boon. And if you ever have to fit or service in-car equipment and need to make those nasty under-the-dashboard measurements, the Voice Meter really comes into its own.

The voltage measurement coverage of the Voice Meter DMM is excellent — up to 3000 volts AC or DC rather than the usual 1000V. DC voltage measurement is in five fast autorange-selected ranges of 300mV, 3V, 30V, 300V and 3000V.

The lowest DC resolution is 0.1mV, with a DC accuracy of 0.8%. The AC voltage ranges are 3V, 30V, 300V and 3000V. The lowest AC resolution is 1mV.

Six ranges cover resistance measurements from 300 ohms to 30 megohms — lowest resolution 0.1 ohm. There's one



range of 300 milliamps for DC and AC current. The lowest current resolution is 0.1mA.

Summing up

I would have preferred to see the voice on/off switch on the body of the multimeter, rather than contained within the positive test probe. Having the switch within the probe means that if the probe were damaged or an internal break occurs in the lead(s), then you'd have to get an exact replacement from Tandy. However, I must admit that having the button on the probe does make for easier voice on/off switching.

I'm enthusiastic about the Micronta Voice Meter DMM and believe that it's a big step forward in multimeter development — a voice function may soon be a standard feature in many DMMs.

The Micronta Voice Meter digital multimeter is planned for release early in May. At \$179.95 the Voice Multimeter is excellent value for money. It's a piece of technology that a few years ago would have cost thousands of dollars to produce and would have probably been housed in a large box on wheels!

The Voice Meter is one of those instruments that is going to make life a lot easier for the long-suffering service technician. But it should really carry a warning: should you find yourself talking back to the voice DMM, then you'll know you urgently need that holiday you keep promising yourself!

My thanks to Ahmed Parekh of Inter-Tan UK Ltd, for his help. ■

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INDIA'S SURGE IN TECHNOLOGY - 1

To many Australians, India is a land of ancient temples and millions of people barely surviving in rural poverty, still using very low level technology. But the reality is different, as the author explains in this first of two articles. Today's India has a thriving hi-tech manufacturing industry, and its electronics industry is growing at a dramatic rate in order to meet the surging demand for domestic, commercial and industrial equipment.

by **THOMAS E. KING, VK2ATJ**

When 35 year old Squadron Leader Rakesh Sharma was catapulted into space atop a 300-ton Soviet rocket in April 1984, not only did he enter the history books as India's first man in space but he also gave India the honour of becoming the 13th nation in the world to send an explorer into the cosmos.

It was an epoch-making event, highlighting two decades of Indo-Soviet collaboration in space science — besides revealing the growth in scope and sophistication achieved by Indian scientists in space technology.

Scenes of the Soyuz T-11 three stage rocket blasting off from the Baikonur Cosmodrome in Kazakhstan and the subsequent docking with the orbiting Salyut 7 Soviet space station were processed by technicians in a hi-tech Indian city, transmitted across the Indian subcontinent by a satellite transponder used by Doordarshan (the Government's TV broadcasting body) and received throughout the country by hundreds of thousands of locally manufactured black-and-white and colour receivers. In addition, an audio commentary was broadcast to millions of radio receivers, all of which had been designed and manufactured in India.

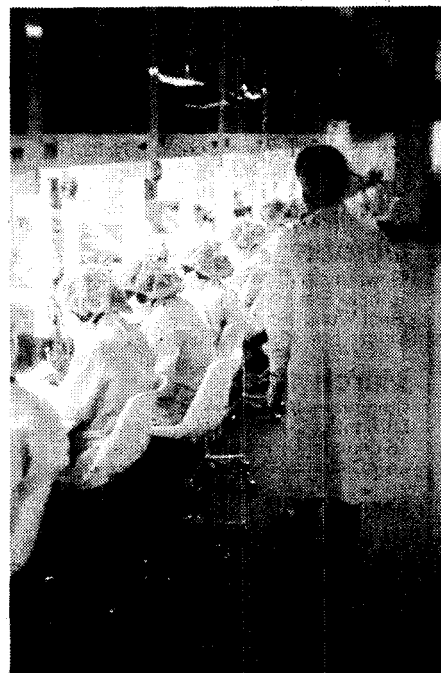
A highly trained, Indian-born space explorer; use of a satellite for domestic communications; a sophisticated state-of-the-art electronics industry in a technologically minded metropolis; these examples of advanced industrial technology do not fit into the stereotyped scene that many Australians still hold of India.

More frequent are visions of a land of dazzling-rich maharajas, tourist-seducing snake charmers, wandering sacred cows, endless backward vil-

lages and poor farmers with their dusty bullocks tilling a desert-like land.

These views are reinforced when we see TV news reports of swirling flood waters covering mud houses and drought-stricken villagers being given relief aid. Also when we read of the World Bank figure of an average per capita income of \$420 a year, a 36% literacy rate, an average life expectancy of 54 years and a natural yearly increase of over 2.2% (which means the equivalent population of Australia or Texas is born every year).

While such events and scenes are real, and the statistics are undeniably true in this 75% rural country, 40% the size of Australia, rarely do we come to



Strict computer component manufacturing standards are maintained in the clean room of Modular Electronics, in Madras.

know of the prospering state-of-the-industrial-art in this economic giant. Good news, it seems, doesn't always make the news!

At the time of independence just over four decades ago, India was dependent upon imports even for razor blades and pins. Today the country which has a gross national product nearing \$300 billion is the world's 16th largest producer of steel. Using that metal manufacturers produce a tremendous variety of items ranging from aircraft carriers, refrigerators, railway coaches and engines and jet planes to colour TV chassis, laser alignment systems, computers and printers and modern styled automobiles. And that doesn't include submarines, nuclear power stations or intermediate range ballistic missiles!

Not all items are such high-profile products. There have been considerable spinoffs from research and development, in hi-tech ventures to improve the rural lives of the three quarters of India's 830 million strong population who live in villages. Technology, for instance, has been used to increase mechanised farming, further enhancing the 'green revolution'; to develop inexpensive cooking devices; and to improve the domestic rail network so agricultural produce can be rapidly sent to major markets.

Enormous technological strides have taken place over the past few decades, particularly in the fields of engineering and electronics. Industrial production is currently expanding at 8% per annum, while the country's overall economic growth is an impressive 5%.

The engineering industry plays a pivotal role in India's economy — representing over 30% of the output from all industry, nearly a third of the employment and around three quarters

of all foreign collaborations. Coupled with other industrial sectors, this has put India among the top 10 most industrialised nations in the world. Guaranteed growth in the burgeoning electronics segment of the giant engineering industry ensures a continued prestigious 'top 10' ranking.

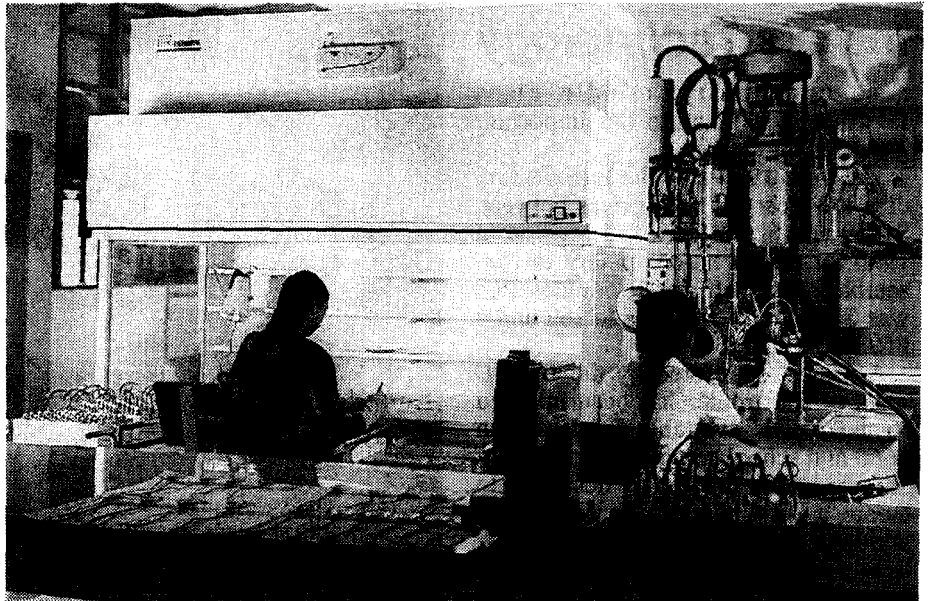
The embrace of high technology and the growing sophistication of the electronics industry in the 42 year old Republic has had a skyrocketing economic impact. Latest available figures reveal that the total aggregate output of electronics during 1988 was worth \$4.2 billion (\$6.3 billion estimated in 1990), compared to \$885 million in 1980. A third of this was in the production of consumer electronics items, while the manufacture of electronic components (including hundreds of products such as black and white picture tubes, semiconductors, plastic film capacitors and carbon film resistors) was worth \$668 million in the year ended 1988. The overall growth achieved in the electronics industry during 1988 was a remarkable 33.5% — and that was on a significant base figure from 1987.

Exports of Indian manufactured consumer electronics items (though faced with increased competition especially from Southeast and East Asian countries) have also registered good growth. They went up to \$13 million in 1988, compared to \$2 million in 1984. A selection of just a few electronic items made in India for export include data processing equipment, pre-recorded video cassettes, metal film and wire wound resistors, PC board subassemblies, signal transistors and both black and white and colour TVs. Electronic components are still the number one export item in the \$207 million export consumer electronics market.

These growth patterns are presented to simply provide a background to some high technology electronic success stories from India which don't make front page headlines in Australia, Europe or the USA.

Success stories

Looking at the lucrative world market for software support systems, who would have envisaged, even a few years ago, that software programmed in India would be sold to and used in the USA. Yet this was a major accomplishment for India's electronic industry when Hinditron began producing computer programs for sale



Women in traditional saris operating sophisticated argon arc-welding equipment in BHEL's semiconductor plant reveal the two worlds of industry in India.

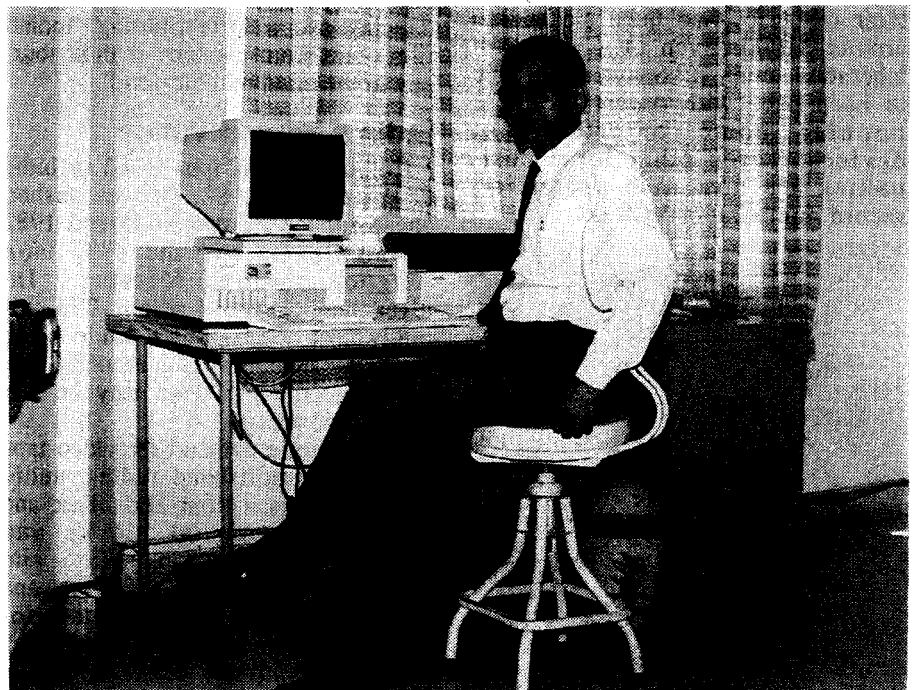
through America's Digital Equipment Corporation.

All-India software exports last year were \$116 million. While the export figure is plotted to be \$1 billion in 1995, it pales in comparison to the 1990 world software market of \$162.5 billion.

Another Indian company scored a coup with its launch of a 'super computer' on the American market.

Sold in partnership with an American firm, the Indian-made 'mini Tata' computer can be expanded by a factor of six by simply plugging in additional modules. In the USA, NASA and Chevron plus the Indian Oil and Natural Gas Commission have shown interest in this revolutionary computer.

On the home front, around 30 companies are selling personal computers to an increasingly affluent Indian busi-



Modular Electronics is a leader in disc drive manufacturing and third largest PC maker in India. Mr T. Vasu, general manager Operations, shows the company's IBM compatible 'Tandom' computer which is made in Madras.

India's Technology

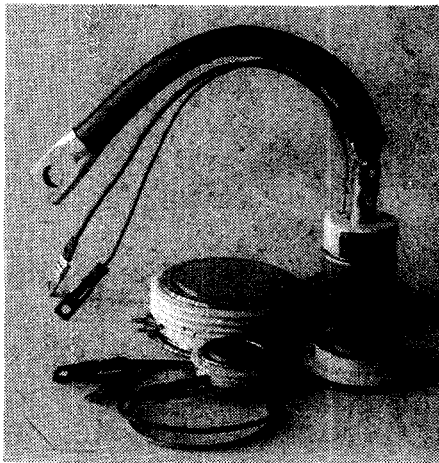
ness community, middle class families as well as to the important government market.

The year 1989 saw the introduction of a low cost PC with prices between \$1660 and \$2660. In a full page ad in 1990 for NOVA kit computers, an 'assemble-it-yourself in 30 minutes PC' was \$1130, a PC/AT was \$2260 and a PC/386 was \$4130.

A project sponsored by the Department of Electronics has been initiated to make PCs available for less than \$660 and school computer for half that amount. This project is designed to create a mass market for computers, and increase their applications in business and education. Meanwhile the India-based Centre for Development of Advanced Techniques has completed a project for computer graphics in various Indian languages.

On the component scene, recent achievements have been the manufacture of hybrid microcircuits to international quality and standards, the indigenisation of colour TV receiver components and success in CMOS technology at the two micron level.

A major status symbol among status-conscious middle class Indian families (estimated to number between 180 and 200 million) is the video cassette recorder. In early 1983 these were selling for around \$3250. Seven years later the price had been slashed to around \$1000. Even in a joint collaboration setup, BP Sanyo is not able to keep pace with orders for these popular home entertainment devices. Three other local companies are now also producing record numbers of VCRs.



BHEL's control equipment division in Bangalore produces a wide range of semiconductor devices.



Highly trained staff at Modular Electronics use a variety of test and measurement instruments in performing quality control tests on semiconductor devices. Some of the instruments were custom built within the company.

The video craze has even filtered down to less affluent Indians, who can board long distance video equipped coaches and watch 'all singing, all dancing and a little fighting' Indian film epics from the start of their journey to the mind numbing end!

India's Silicon Valley

Colour TV was introduced in India at the end of 1982. (It was pushed ahead for the New Delhi-hosted 1982 Asian Games and the 1983 Non Aligned Nations Meeting.) Indigenously produced colour TVs currently cost around \$650, while black and white models start at around \$150. (On a good night there may be 150 million viewers!)

The surge in demand for video tape recorders, multi-band radios, audio tape recorders, colour and black and white TVs, digital clocks and electronic watches, amplifiers and speaker systems, video TV games and headphones has meant a boom for India's homegrown consumer electronics industry. R&D is rapidly accelerating, while production is at breakneck speed throughout India. Although overshadowed in population by such giants as Bombay, New Delhi,

Calcutta and Madras (significant electronic producers in their own right) one city in South India has such a high concentration of electronic manufacturing facilities that it has been dubbed India's 'Silicon Valley'.

Bangalore, the capital of the south state of Karnataka, is well known to tourists for its beautiful parks, wide avenues and impressive buildings. Before India gained its independence in 1947, Bangalore was a summer resort. British administrators found the city's salubrious climate the ideal escape from the blazing summer heat of the plains. But after independence the Indian Government had different ideas for Bangalore.

In 1956 the government set up its first electronics manufacturing venture in the green, garden city. Everything produced had an instant market as the field and stationary communications equipment was destined for the Indian Navy, Army and Air Force.

Because of the enormous investment involved and the sensitive nature and vital importance of the equipment being produced, Bangalore had been carefully chosen as the ideal location for a number of reasons.

Being situated in the south central

part of India, Bangalore was not accessible by air or sea in case of enemy attack. The British had already built roads and railway lines, which connected the city to Madras to the east and Bombay to the north, so infrastructure was established. Additionally, skilled and semi-skilled labour was readily available from the universities and schools in the southern region. And finally Bangalore's cool 900-metre elevation meant less need for air conditioning and fewer problems with dust.

Consumer electronics manufacturing installations began appearing in the city around 1965, as electronic components were made available to the private sector. Bangalore's success story continued and in recent years the capital has developed into a vast industrial centre, which contains some giant projects and facilities of national importance.

In and around Bangalore are scores of defence and aerospace research organisations, and companies like the Hindustan Machine Tool Factory, the Bharat Electronics Factory, the Indian Telephone Industries Factory and dozens of other manufacturing setups where VHF and UHF communications equipment, colour and black and white

TVs and TV tubes, cassette recorders, semiconductors, electronic watches, meteorological transmitting and monitoring equipment, PSI computer test equipment, specialised industrial controls and even some classified military items are produced.

One of the industrial giants of India is Bharat Heavy Electricals Ltd (BHEL), the largest engineering and manufacturing organisation in the country. Ranked among the top 10 organisations in the world producing power plant equipment, the massive company is credited with providing more than 80% of the power plant equipment commissioned in India.

Some 75,000 people, including nearly 15,000 engineers and trained technicians are employed in the Delhi-headquartered operations, which has 10 manufacturing divisions.

Two of these, the Electroporcelains Division (manufacturing porcelain insulators and bushings for use in transmission lines) and the Control Equipment Division (making an extensive range of electronic and mechanical control equipment) are located in Bangalore.

Bharat was one of the earlier entries on the industrial front in Bangalore. One by one, others established a new venture or relocated to the city. And then the boom hit.

Within the last five years, Bangalore has not only worked its way into the mainstream of big business but according to many authorities, India's fifth largest metropolis is well on the way to becoming an international success story as the country's premier science city.

Texas Instruments set up shop in the green city in 1986. Other multinationals have joined in the excitement including Digital Equipment Corporation, Motorola, National Cash Register and Tektronix, all from the USA; Groupe Bull of France; Macmillan of the UK; Sony of Japan and Gridlays through their software division, Index from Australia. Hewlett Packard is currently investing over \$22 million in its Bangalore facility, while 3M's \$8 million manufacturing centre in the city was opened early last year.

The latter factory is surrounded by an Indian giant, Tata Electronics, the multi-national Philips and 55 other players in a hi-tech complex called Electronic City, on the outskirts of Bangalore. This is a Karnataka State Government showpiece which was set up in 1980, 18km from the city on a

337-acre plot. When it is fully occupied a few years from now, it is expected to employ around 12,000 professionals. A software park is being built nearby and another Electronic City is rising in the princely city of Mysore, a few hours drive from Bangalore.

Such ambitious plans will require highly trained personnel. There's no shortage of such people in India and indeed in Bangalore. (India has the third largest pool of trained manpower in the world.) The incessant demand for technologically qualified people has, over the years, sparked the founding of many institutes. Currently there are over 40 engineering colleges and polytechnics in Bangalore, the highest concentration of such institutions to be found anywhere in the vast country.

Each year thousands graduate; most have little trouble in finding well paid (by Indian standards), satisfying positions in 'Silicon Valley'. Their skills are used in such widely dispersed fields as gas turbines and aircraft systems to fibre optics and computer programs for the Indian space programme, an agency which has been responsible for a number of man-made 'birds'.

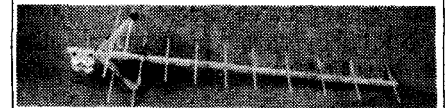
(To be continued)

Hi-tech India Comes to Australia

India's surge in engineering-based exports has resulted in the country's decision to sponsor about 70 Indian companies to participate in Australia's International Engineering Exhibition in Melbourne. Set for May 13-17, AIEE '91 will be spread over 18,000 sq. metres of display space in the Melbourne Royal Exhibition Building. Some 350 manufacturers from 12 countries are expected to show their best engineering efforts.

India's contribution, the largest delegation of any foreign nation, is intended to raise its profile as a highly industrialised nation. A broad range of engineering products will be exhibited in 1500 sq. metres of display area; including motor vehicle parts, machine and hand tools, diesel engines, electrical machinery and switch gears, wires and cables, and scientific, surgical and medical equipment.

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When I Think Back...

by Neville Williams

Readers have their say: Superregen receivers, trans-Atlantic radio, etc.

Thanks to a reader from Balwyn, Victoria, we have the opportunity to understand, perhaps for the first time, how an old-time super-regenerative receiver really worked. Again, a retired Queensland radio operator shares with other readers a visit to the deserted wind-blown foreshore where Marconi planned to receive the first ever trans-Atlantic wireless signals.

In the August 1990 issue, in the second of two articles about Major Edwin Howard Armstrong, I referred to his invention of the superregenerative receiver and mentioned, *inter alia*, that there had always been a great deal of uncertainty as to how it actually worked.

Regenerative receivers, TRFs and superhets have all lent themselves to a fairly straightforward 'mental image' kind of explanation, but not so the 'superregen' receiver — or, more specifically, the superregenerative detector.

For hobbyists and professionals alike, it has always been something of an enigma.

I referred in the article to an 'accepted if rather superficial', explanation of how the circuit worked but, since then, have come across a rather better one in Morgan E. McMahon's book *A Flick of the Switch* (Vintage Radio, 1975). Whether it's sufficiently explicit, in isolation, I leave you to judge:

The superregenerative circuit is by far the most sensitive of all one-tube receiver circuits. The circuit breaks into and out of self-oscillation at random times, making a hiss in the headphones. When a signal (even a very weak one) is present, the circuit breaks into self-oscillation in coordination with the signal, hence the signal is heard in the headset. It has disadvantages because it is not very selective and it bothers nearby receivers by radiating its own signal.

Fortunately, I also mentioned an engineering-level paper on the subject by Hikosaburo Ataka (of the Meidi College of Technology, Tobata, Japan) published in the *Proceedings of the IRE (USA)* for

August 1935 — an issue to which I had no ready access. But Mr Alan M. Fowler of Balwyn, Victoria did and he kindly made a copy available to me, which I was most happy to peruse.

It is a thoroughly professional document containing some 44 pages of text, and providing a detailed mathematical, graphical and practical analysis of superregenerative detectors. At first reading, however, I despaired of being able to communicate its contents in a concise form or, much less, isolate the vital clue needed to unravel the logic of the circuit.

But gradually, the picture cleared and, like Rex Harrison in *My Fair Lady*, I found myself exclaiming 'I think you've got it ... I think you've got it!' So, read on:

Superregen detector

As with their ordinary regenerative counterpart, superregenerative detectors rely on the fact that the inherent RF losses of the associated tuning circuits can be offset by the provision of positive RF feedback from the output to the input of the stage; in other words by the use of so-called 'regeneration' or 'reaction'.

In ordinary regenerative detectors, the amount of feedback needs to be critically adjusted by the operator to bring them to the threshold of self-oscillation, with the residual RF circuit resistance either near-zero for best reception of amplitude modulated signals, or slightly negative to produce active oscillation and thereby a heterodyne beat for the reception of CW transmissions.

In a superregenerative detector, there is no user-operated reaction control, the RF feedback (or regeneration) circuitry

being configured to promote RF oscillation whenever the voltages applied internally to the detector so permit. That statement calls for further explanation.

In addition to its normal signal and supply voltages, a superregenerative detector is subject to an additional input — a cyclic supersonic wave generated by a separate 'quenching' oscillator or a self-generated 'blocking' voltage resulting from the use in the 'grid-leak' circuit of R/C components exhibiting an unusually long time constant.

As the terminology rather implies, the purpose of this extra input is periodically to 'quench' or 'block' the self-oscillation of the detector so that, instead of being continuous, the oscillation occurs in distinct pulses or 'packets' at the intended supersonic repetition rate — i.e., at a selected frequency above the audio range.

The arrangement was patented by Armstrong, circa 1923 and greeted with considerable interest by professionals and amateurs alike, who were attracted by the term 'super' and the prospect of reduced dependence on the unpleasantly critical reaction (regeneration) control.

As it turned out, superregen receivers proved to be even less predictable or acceptable in their behaviour than their regenerative counterparts — in large degree because very few seemed to understand why or how they were supposed to work!

As we indicated in the earlier article, do-it-yourself articles about superregen receivers published in *The Australasian Wireless Review* during 1923 provided a classic example of the (technically) blind leading the blind!

What really happens

For those able to cope with his graphs and mathematics, Ataka offers a lengthy and detailed analysis of quenching action and so on, with due acknowledgment to earlier papers by E.O. Hulbert (*Proc. IRE USA*, August 1923) and H.O. Roosenstein (*Hochfrequenz und Electroakustic*, Bd42, s85, 1933).

Priorities aside, the essential clue to the basic operation lies in Ataka's Fig.38, reproduced herewith. It crams quite a few concepts into one drastically simplified diagram but, more to the point, it conveys what he is trying to communicate.

Plotted on a time scale (left to right) it indicates the behaviour of a superregenerative detector, during one cycle of supersonic quenching voltage — which is assumed arbitrarily to be sinusoidal in form, as distinct from a more angular shape.

At the extreme left, the quenching voltage is at reference zero and the tuned circuits are passive, maintained so by their inherent RF losses.

When the quench voltage approaches a level shown arbitrarily as E_m , the gain of the detector rises, the positive output/input feedback becomes effective, the apparent tuned circuit resistance reverts to negative and the stage begins to oscillate, as indicated by the 'oscillatory voltage' envelope.

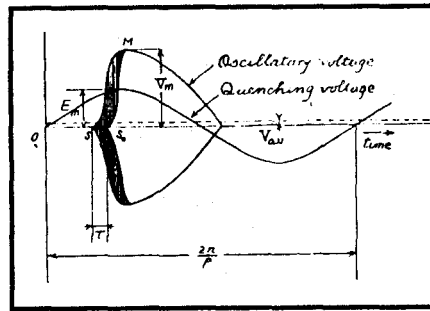
(To be more explicit, Ataka's draftsman should perhaps have filled the envelope with a closely spaced RF waveform).

The oscillation passes through a maximum amplitude V_m , as shown, then tapers off to nothing as the quench voltage cycles through reference zero into the negative region, progressively reducing the gain of the detector and therefore its ability to counteract the losses in the associated tuned circuits.

It follows that the instantaneous output current of a superregenerative detector will cycle in response to the supersonic quench frequency, with a superimposed 'packet' or 'envelope' of oscillations at the resonant frequency of the associated tuned circuits — one burst for each quench or blocking cycle.

(One might further suggest that, if the end result is visualised as an RF carrier grossly over-modulated at a supersonic rate, an array of other by-product frequencies would also be present).

As it happens, the low-pass RF choke and capacitor normally found in the output circuit of any detector could be expected to prevent the supersonic, the oscillatory and any other RF by-



Ataka's Fig.38 provides the essential clue to the operation of a superregen detector. The quench signal initiates and quenches packets of RF oscillation. Extraneous noise and/or signal advances the trigger point (shaded) affecting the duration of the oscillatory burst and superimposing a resultant audio component on the anode current and voltage (dotted line, V_{av}).

products from reaching the audio system, reducing the detector output voltage and current to an average mean value, able to be read on a meter and free from significant audio components.

What's the purpose?

To many readers, what I have said thus far will simply have re-stated the obvious. But what's the purpose of it all? How does such a configuration detect incoming signals, to apparent advantage over a normal detector and why the loud rushing noise experienced between signals? This is where Ataka's article comes into its own.

His research indicated that, having achieved peak amplitude, shown as V_m in his Fig.38, the packets of oscillation are thereafter substantially uniform in their amplitude, shape and rate of decay.

He postulates further that, in the absence of extraneous phenomena, the oscillatory packets would always commence at the same relative point on the time scale, shown as S_0 and equivalent (arbitrarily) to quench voltage E_m . On this assumption, the mean anode current after low-pass filtering would be constant.

However, Ataka says, practical circuits behave quite differently. As the quench or blocking voltage approaches the level which enables the oscillatory burst, the detector becomes extraordinarily sensitive to any extraneous energy effectively reinforcing the quenching voltage. This includes any noise source as, for example, particle noise within the detector itself — 'shot effect' in the case of a thermionic valve.

Effectively adding to the quench voltage, the noise voltage tends to trigger the oscillatory burst earlier than would

otherwise be the case — by time interval 'T' in Fig.38, at point 'S' instead of 'S₀'. As a result, the oscillatory burst is supplemented by the shaded area, resulting in a variation in the mean anode current and voltage, as suggested by the dotted line 'V_{av}'.

Because 'shot' and other wide-band noise contains audio components, these will inevitably modulate the 'advance' interval 'T', the duration of individual oscillatory packets and therefore the mean value of the anode current and voltage. In other words, the anode current and voltage will tend to vary with the signal and/or noise envelope.

This is the source of the noise, in the absence of any other signal, and its prominence is indicative of the huge energy gain between the tiny disturbances capable of triggering the oscillation in the turn-on region and the end effect on the detector anode current.

In the presence of a weak amplitude modulated input signal, the oscillatory packets are triggered partly by the signal and partly by the noise, so that the recovered audio is a mix of the two. With stronger signals, the triggering effect of the noise diminishes and the signal/noise ratio of the recovered audio progressively improves, as with any other detector.

Optimising performance

Over the years, articles on superregenerative detectors have emphasised the need to experiment with various aspects of the circuit, backed up by empirically determined guidelines for the amplitude and frequency of the quench signal, etc. The emphasis has traditionally been on 'what', rather than 'why'.

Throughout the paper, Ataka sheds a fair amount of light on the 'why' factor and, for the occasional engineer who still needs to know, it would be well worthwhile getting hold of a copy of the original paper.

One other vital clue to the basic operation is supplied by a diagram, reproduced herewith, namely Ataka's Fig.39. It follows from the broad statement that the sensitivity of a superregenerative detector depends on maximising the shift in anode current (V_{av} in Fig.38) for a given level of input signal.

While it obviously involves the configuration of the oscillatory circuit itself, Fig.39 concentrates on the relative amplitude and frequency of the quenching voltage.

Diagram (a) suggests a situation where the 'advance' region is prominent but the quench frequency is much too low,

WHEN I THINK BACK

resulting in a relatively small shift in the mean anode current and voltage.

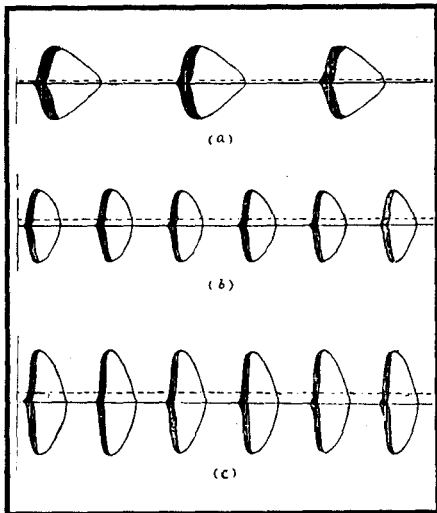
Diagram (b) suggests a significantly higher quench frequency, producing a somewhat greater variation in the anode current.

Diagram (c) shows the same quench frequency but, as well, a greater quench amplitude, yielding much improved sensitivity.

Yet another diagram (not reproduced) shows the sensitivity peaking with a quench frequency (typically) around 200kHz, with much less prominent sensitivity peaks at about twice and three times this figure.

As I said earlier, there is much more in the paper for those who need to know, including an explanation of the circuit's chronic lack of selectivity, which he attributes to the by-product frequencies resulting from the quenching action. But what has been said will hopefully provide a coherent answer to the question about how it really works. That it was foremost in Ataka's mind is suggested by his 'Conclusion'. I quote:

The amplification by super-regeneration is performed by the building-up of free oscillation which is initiated by the impulse of the signal. When the effective resistance of the oscillatory circuit in the receiver is brought to be sufficiently negative to start the oscillation, the



The sensitivity of a superregen detector depends on the magnitude of the anode current/voltage change. In (a) the quench frequency is too low; (b) suffers because the quench signal is still of insufficient amplitude; (c) is closer to optimum, as indicated by the greater displacement of the dotted line.

receiver becomes very sensitive for the impressed electromotive forces. The slightest impulse is sufficient to start the oscillation.

Without pursuing the matter, I would expect that, given the need to do so, Ataka's analysis could be adapted to solid-state devices.

Queensland reader

So much for an interesting but now substantially outdated piece of technology. From W.A. ('Blue') Easterling, VK4BBL of Burleigh Waters, Qld, comes a letter thanking me for past articles and in particular for one in the October 1990 issue entitled: 'From Sparks and Arcs to Solid State'.

'Blue' says that he, too, has seen it all — from sparks to satellite — remarking that there were still a few spark-equipped ships running as late as 1954. That he has been around personally is attested by a string of amateur call signs dating back to 1947 or thereabouts: VK4BBL, -2ABL, -9WE, -4BL, -2BJ.

Blue also says that, around 1928, his father — with assistance — assembled a 4-valve TRF receiver, complete with outdoor aerial, horn loudspeaker, trickle charger and B-battery eliminator. It proved a boon to the family during the depression years that followed, silenced only once when the power was cut off because of an unpaid account. They were even able to sample broadcast band DX, with regular reception from Montreal, Canada.

Around 1936 he acquired a pair of headphones for one shilling (10c), which led to the construction of his own crystal set, followed by a 2-valve regenerative Reinartz receiver with plug-in coils, which rewarded him with short-wave signals from Schenectady, NY, on about 9MHz.

Then came war service, a part-time course with the Marconi School, a first-class COCP (Commercial Operator's Certificate of Proficiency) in 1950, followed by 32 years with OTC in the coastal radio service. Looking back over the latter period, he says:

In La Perouse in 1950, most of the staff were old-timers who graduated in spark and then had the grind of learning CW after the 1927 Convention so that they could validate their tickets. From them I heard much of the early radio history, first-hand.

Peter Gillon had been at sea the night that the Titanic went down; too far away to help, but he heard the whole horrendous episode. Even then, nearly 40 years on, the old chaps were still shaken by the tragedy. They are all silent keys now, but

OTC Archives managed to record much of their reminiscences.

The above observation is a perfect example of how old timers carry — perchance to the grave — rich fragments of electronics history. How neatly their recollections would have slotted into Stephen Rapley's 'Bright Sparks' sessions, broadcast over ABC National radio in mid 1989.

Prompted by past articles in this present 'Think Back' series, Blue Easterling goes on to mention that he also has to hand 'a mine of information' from a former Marconi engineer closely associated with Marconi's pioneering efforts — in the form of a much treasured book entitled *Wireless Over 30 Years* by R.N. Vyvyan.

In fact, I have yet to deal specifically with Marconi, but his name has been mentioned on several occasions; it could scarcely be otherwise in a series concerned with the history of wireless communication. Vyvyan's 'warts and all' account of events certainly follows naturally on the biography of another of Marconi's engineering associates, Professor J.A. Fleming, in the April 1990 issue. I quote from Blue's letter, with minor abbreviations:

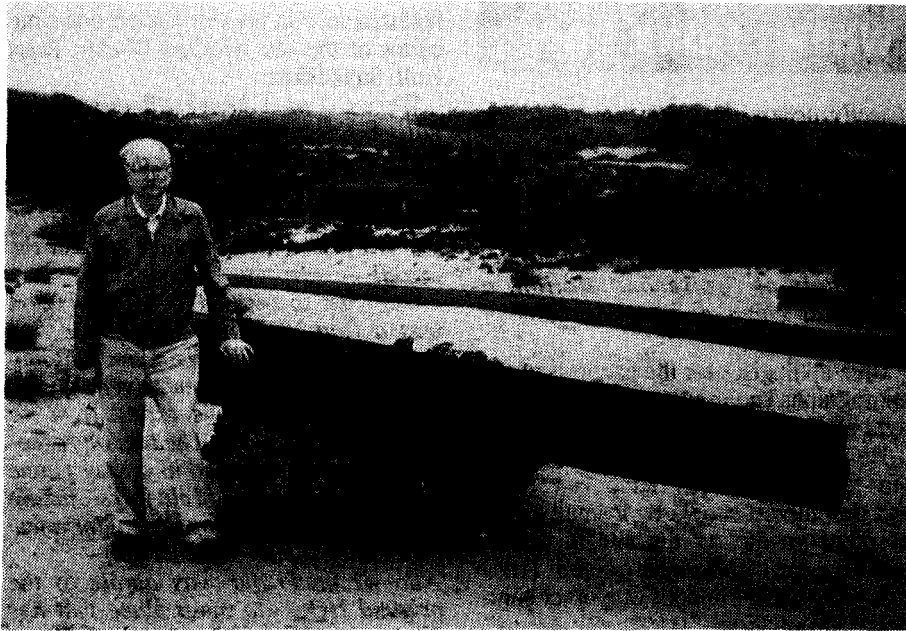
Last year I visited two ham friends of my VK9 days. Ned WIRAN took me all over New England, USA, and we visited the old Marconi site at South Walfleet on Cape Cod. This was the first Marconi station in the Americas, and was intended to receive the first transatlantic signals. The purpose was kept secret at the time; had the tests failed, the company would have suffered some derision and also, I think, some drop in share values.

The station planned for South Walfleet was identical with that erected at Poldhu, where Vyvyan had assisted Dr Fleming for a time with the procurement and commissioning of the various plant items.

In February 1901 Vyvyan was selected as the construction engineer for the Cape Cod station, and shown the plans for the aerial systems to be installed at each station. They were formidable looking arrays calling for a ring of 20 masts, each 200ft (60m) high in a 200ft diameter circle.

Made from wooden beams, bolted together, the purpose of the masts was to support an inverted cone of some 400 wires, insulated at the top but joined together at the base, right over the transmitter building.

Vyvyan considered the structures to be fundamentally unstable, with each mast guyed to the next but only to ground in a



After the best part of a century, bits and pieces of Marconi's pioneering wireless station remain on the sandy foreshore of Cape Cod. Pictured with this hunk of timber, steel and concrete is W.A (call me 'Blue') Easterling, himself an old-timer from the 'sparks to satellite' era and now retired after 32 years with OTC in the Australian Coastal Radio Service.

radial direction, away from the centre of the system. It would be a case of 'one down, all down', he said, but his objections were overruled. He sailed with Marconi for site selection and construction and, by late June, 1901, the buildings and masts at South Walfleet, Cape Cod were up.

In August, with no more than a stiff breeze blowing, the tops of the masts on the windward side at Cape Cod were bending to such a degree that Vivyan cabled London for permission to dismantle the top sections. Pity the poor riggers who actually did the job!

At Poldhu, as the masts were nearing completion, a gale on September 17, blew them down. Three weeks later, the masts at Cape Cod met the same fate, with one mast penetrating the roof of the transmitter room and another missing Vyvyan by just 3ft (1m).

Marconi was in a proper bind. Rapid improvisation saw the so-called triatic fan array erected at Poldhu at 150ft (45m), involving 54 wires at 1-metre spacing and joined at the bottom. Tests were run with Crookhaven, Ireland, with good results.

Marconi then headed for Newfoundland, a separate British colony at the time, arriving at St Johns on December 5. The local authorities were most helpful, making a room available at Signal Hill.

On December 9, Marconi cabled Poldhu to commence tests from 3pm to

6pm each day and these started on December 11.

At Signal Hill, a balloon carrying the antenna broke away on the first ascent. Next day a kite aerial was sent aloft to 400ft (121m) but its climbing and diving altered the capacitance so much that the associated tuned circuits were all out of kilter.

Marconi took them out of circuit and the first 'SSS' signals were heard on Thursday 12th with just the aerial, a sen-

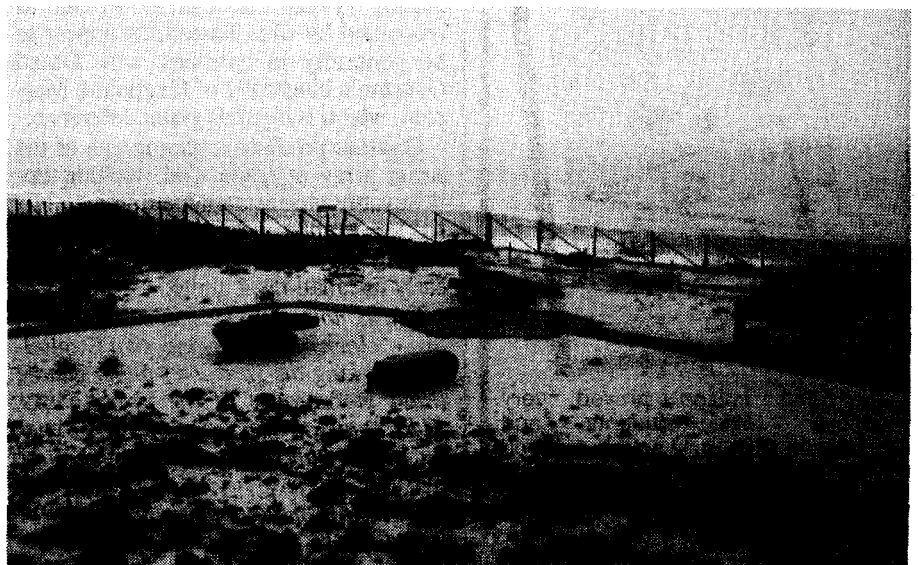
sitive self-restoring coherer of Italian navy design, a headphone and ground. It caused a worldwide sensation, although not without a few sceptics. But the experiments at Signal Hill came to an abrupt halt when the Anglo-American Telegraph Company served notice that it had a monopoly in Newfoundland of all telegraphic communications. Marconi was duly shown the door!

The Canadian government thereupon invited him to that country, with a promise of assistance by way of funding and real estate. The new station was built at Glace Bay on Cape Breton Island and it was there that the main experimental work was done that led to a regular commercial service.

The South Walfleet station on Cape Cod had meanwhile been rebuilt with four towers, each 210ft (64m) high, similar to Glace Bay and Poldhu, and the first signals were exchanged with Glace Bay. The first official message, sent from the USA for relay to Poldhu on January 18, 1903, was from President Teddy Roosevelt to King Edward VII.

Four years of experimental work followed, with a full commercial USA/UK service beginning in early February, 1908. But South Walfleet has long since been abandoned, with the site now under the control of the National Parks and Wildlife Service.

Cape Cod is, in fact, a huge sandpit and geologically unstable. The Atlantic has been eating away at it since the events at the turn of the century and half the original transmitting site has gone. The safety fence in my photographs runs



In 1901, Guglielmo Marconi and engineer R.N. Vyvyan gazed from this point out over the 3000km-odd of ocean that separated them from Poldhu, in Cornwall, UK. Half the original transmitting site — beyond the barrier fence — has been eroded by wave action.



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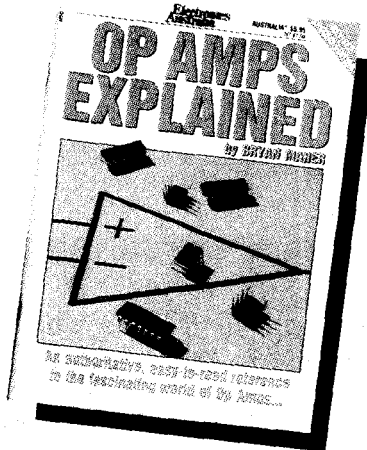
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WHEN I THINK BACK

directly across the centre of where the transmitting building once stood.

There is still a fair amount of debris from the two stations: rusting steel, chunks of timber, concrete anchorings, etc. A large shelter shed houses a display of models of the second station, a memorial cairn and various bits of memorabilia.

Blue apologises for the haziness of the photographs enclosed, by reason of poor light and an approaching cyclone.

He is most appreciative, however, of the kindness of his American hosts and the interest shown by a small group of other visitors to the site in details which he had memorised from Vyvyan's book. He adds one other snippet of information:

The transmitter used at Stn. Walfleet was 20kW, designed by Fleming and comprised of two spark transmitters in series, inductively coupled. Keying the monster was a problem.

Initially he tried breaking the primary of the 2000/200V transformer with a big key and a water resistance, but finally put an iron-cored inductor in series with the primary and used a key (or relay contacts) to short it. Key up and the voltage drop reduced the 2000V to a value that would not actuate the spark gap; key down and the full voltage was restored. Not conducive to high speed keying... I wonder what they used when they went into full commercial service?

As seen through the eyes of an engineer, Vyvyan's account of events, as recounted by Blue Easterling, appear to be generally in harmony with David Gunstan's biography of Guglielmo Marconi, which is my own prime reference.

Gunstan provides a photograph of the aerial array at Cape Cod, looking unbelievably unsubstantial and vulnerable. No less graphic is his description of the keying arrangements of one of those early installations. I quote:

It was not until December 16 (1902), at 7 o'clock in the morning, that Guglielmo, working the yard-long pump handle (read metre-long) of the sending key, tried again to raise Cornwall. "Better put your hands over your ears", he warned his staff, and started to call Poldhu with three dots — the Morse for 'S'. Crash! crash! crash! went the sparks, again and again."

Blue says that he rounded off his trip to the USA, wearing his proverbial VK-amateur hat, with a visit to the former shipping grounds of one of the first men

featured in this present series: one-time editor of the old *Wireless Weekly*, Ross Hull. Says Blue:

We went to a hamfest/fleamarket at Willimantic Ct, where I was quite at home. It was the same junk that I've seen at hamfests here, and one would almost suspect that someone charters a 707 to carry it from place to place around the world!

Our visit to ARRL HQ at Newington was a flop. Arriving in the rain, we slogged our way into the main building and inspected the museum (very good). People came and went and took no notice of us whatever. The lass on reception was more involved in a long phone conversation with the 'ole folks', taking time off only to accept payment for a few publications (plus 8% state tax).

So we made our way across to the original HQ — to me a place that has always been the Holy of Holies. It was barred and bolted; NO VISITORS! It was being refurbished, I discovered, with entirely commercial gear of an unknown brand — not even as supplied by regular QST advertisers; nothing homebrew, despite the workshop facilities and staff. It was a great let-down after having come so far.

Last but not least was Blue's closing par, which should grab readers who combine an interest in technical history with amateur radio:

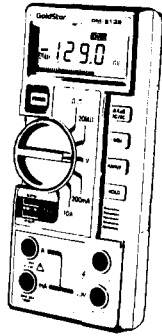
I came back by train to Los Angeles where I was the guest of Jerry, N6AV; went out into the Yucca Desert and stayed overnight with W6BA, who has an antenna farm that would rival OTC's Doonside.

On the day before I left, I was shown the gear of the late Don Wallace, now in the possession of Jan N6AW, who was his technician. It was like Aladdin's cave: stuff going back to before WW1; receivers that we used to drool over in 1930's magazines; much homebrew as well.

I met Don in Port Morseby around 1965 and found him a most affable man. He, too, had a huge antenna set-up at Rolling Hills near Long Beach; none of this end-fed 67ft of wire in the ceiling, like me!

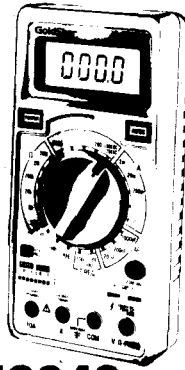
Thanks, Blue, for an interesting letter and the chance to share your trip down memory lane. Thanks also for your kind remarks about the historical articles. As your contribution has demonstrated, no one contributor has a monopoly of information about a particular subject. Snippets of information about the past are tucked away in bookshelves and drawers all over the nation, just waiting to be re-discovered. ■

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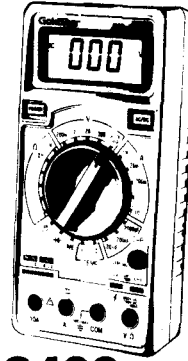
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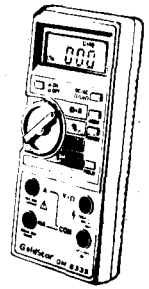
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NEWS HIGHLIGHTS

US RESEARCHERS DEVELOP NEW FLAT CRT

Researchers at SRI International in California are reported to have developed an extremely thin optical display panel which uses electrons to excite a fluorescing phosphor screen, like a conventional cathode-ray tube, but does not use an electron gun or high voltage electric field.

Instead the panel uses a large number of tiny electron emitters, positioned less than a millimetre behind the phosphor screen.

Each electron emitter is a tiny conical formation, fabricated using similar technology to that used in making semiconductor devices. This allows the emission of electrons from the cones in response to a relatively low intensity electric field, directly and without the use of heating.

The phosphor screen is divided into an array of pixel dots, with transparent addressing electrode lines as used in LCD panels. Between 10 and 100 emitter cones are positioned behind each pixel element, to ensure sufficient emission of exciting electrons.

The new display panel is seen as a possible future replacement for both CRTs and LCD panels, offering the compactness and low voltage operation of the latter combined with high efficiency and freedom from electromagnetic radiation.

At the same time, the cost could be significantly lower than either existing technology. However as with other proposed new display technologies, it remains to be seen if this one will prove to be easy to manufacture.

SOFTWARE PUBLISHERS FORM ASSOCIATION

A number of pioneering Australian PC software package developers have recently collaborated to form the Australian Software Publishers Association (ASPA), to promote the local software publishing industry and its products.

"The time is ripe for an organisation such as this", said Steven Goschnick, interim chairman of ASPA and a

partner in Melbourne firm Solid Software.

"The installed PC base in Australia has reached a level whereby developers of inexpensive PC packages, such as our members, can thrive selling locally developed programs to the local market, before looking at overseas markets."

Phillip Bertolus, managing director of Program Development Systems, said "We are convinced that the 1990s will see the development, sale and export of locally developed packaged software become a significant Australian activity."

The founding members of ASPA are

Program Development Systems, developer of MX-Pascal, Freeway and the Murrumbeena Network System; Leprechaun Software, developer of Virus Buster Advanced; Solid Software, developer of Seetree, Lot-tocheck and Octadial; 'Soft As It Gets', developer of programmer's editor ED; and Procon Technology, developer of the programmable logic controller software PLC.

SCIENTIFIC-ATLANTA BUYS PLESSEY B-MAC SERVICES

Scientific-Atlanta has expanded its services and repair operations for satel-

'SCHOOL OF THE FUTURE' OPERATING IN SA

A 'School of the Future' has been set up in Adelaide's Technology Park complex, to provide South Australia's school students with access to the latest high technology manufacturing practices and techniques.

An initiative of the SA Education Department, the school is the first of its kind in Australia and one of only a few in the world. Half of the School's funding is provided by the SA Government, with the remaining funding from joint developments with industry. Major sponsors include Apple Australia, Computer Corporation of Australia, ETSA and Telecom.

Essentially the School is a resource shared by all of South Australia's existing schools, allowing both students and teachers to gain 'hands on' experience with computer control of machines, basic robotic systems and similar hi-tech developments.

It also has programmes to encourage young inventors, and runs a 'Girls and Technology' programme which supports teachers in developing programmes which are more accessible and enjoyable for girls.

School manager Kevin Richardson says the School is now also in the process of establishing micro-electronics manufacturing and advanced computing facilities, to complement the existing CAM and multi-media facilities.



lite transmission equipment by purchasing the Plessey B-MAC Service Centre, including the 57 field service centres authorised by Plessey.

The field service centres cover outback areas of NSW, Queensland, Victoria, Tasmania, Northern Territory, Western Australia, South Australia as well as Norfolk Island, New Zealand and Papua New Guinea.

Overall Scientific-Atlanta now provides the outback service and repair facility for more than 20,000 satellite television receivers in the 'outback TV' network and private business networks.

The company has purchased the Plessey assets in this field and has also taken over the obligation for warranty repair.

Prior to the purchase, Plessey serviced three of the B-MAC products: the 2001 'outback unit', the 2002 re-transmission units, and the 2003 commercial re-transmission unit.

Scientific-Atlanta will now support all of these models at its Frenchs Forest electronics technical facility in Sydney, with service enquiries for outback TV repairs to continue to be directed to the 57 field service centres.

Already the company services the B-MAC satellite transmission equipment at TV studios as well as the commercial products of Sky Channel and others.

LIST OF AUST-JAPAN TECHNOLOGY OPPORTUNITIES

Australian companies interested in international technology tie-ups with Japan are the subject of a survey by the Japan External Trade Organisation (JETRO).

JETRO has compiled a list of 313 different technologies and products from Japanese companies interested in tie-ups with overseas firms, by way of technology transfer and introduction, joint R&D, or other joint ventures.

The hi-tech related areas covered in this special project include chemicals, metal products, machineries and parts, electronics and components, communication equipment, robotics and factory automation, measuring and testing equipment and other technologies and equipment.

Companies responding to the JETRO survey will receive detailed information on the requested Japanese technology participant. Once having received this information, the interested Australian party is requested to ap-

proach the Japanese company directly with their proposal.

Any companies interested in receiving technology exchange offers from Japanese firms should contact Mr Greg McCarthy, Assistant Director, JETRO Sydney on (02) 241 1181.

EARLY DELIVERY OF NEC CALL DIVERTERS

NEC Australia delivered its first 200 wholly Australian designed and developed rack mounted call diverters to Telecom — one month ahead of schedule. The diverters are part of a five year Telecom Australia contract, worth \$8 million over the next 18 months.

General Manager of NEC's Line Transmission Equipment Division, Mr Peter Taylor said the call diverter had been conceived in response to Telecom Australia's requirements and totally designed, developed and manufactured

SINGAPORE STARTS INMARSAT-C SERVICE

Singapore Telecom has begun providing Inmarsat-C satellite communications services through its Singapore land earth station at Sentosa.

in his LTE Division at NEC's Mulgrave factory. The call diverter is a fully contained, exchange-based double Eurocard which diverts calls from subscribers to pre-determined numbers.

"The call diverter effectively brings a mini-PABX to the subscriber's home," Mr Taylor said. The call diverter has three modes of operation — direct, divert or delay. In direct mode, incoming calls received by the call diverter are connected through to the subscriber. The divert mode diverts incoming calls are initially connected through to the subscriber; if unanswered, they are diverted to a pre-programmed number.



NEWS HIGHLIGHTS

Inmarsat-C is a new two-way global mobile satellite communications system that uses very small, low cost user terminals.

The Sentosa station is the second station to provide commercial Inmarsat-C services in the Pacific area. The first was the station in Perth, Western Australia, which began operations earlier this year.

"This station will be the first in the Pacific area to provide on stage text messaging and direct access to customers worldwide," said Tan Tian Seng of Singapore Telecom.

Inmarsat-C service is also operational in the Atlantic Ocean (East) region, through stations at Pleumeur Bodou, France, and Blaavand, Denmark. Service in the Indian Ocean region, virtually completing global coverage was expected to start in April.

Inmarsat-C mobile terminals — 11 different models from nine manufacturers are now available — are so small and simple that they can be fitted to any vessel or vehicle, and some versions can be carried by hand or in a brief case.

ABB BURSARIES ENCOURAGE MORE WOMEN ENGINEERS

In a move to attract more young women into the engineering profession, four NSW schoolgirls have been awarded bursaries with a total value of \$12,000 to study engineering at Sydney University. The bursaries have been sponsored by ABB Asea Brown Boveri Pty Ltd.

The four winners, selected from 88 applications from 76 schools are: Yin Yin Chung, Parramatta; Teresa Neale, Nowra North; Amanda Russell, Medowie near Newcastle; and Vinoli Thampapallai, West Pymble. Each will receive \$1000.

A further \$1000 will go to their school and another \$1000 to their parents. The bursaries will be renewable when each pupil completes Year 12 this year. Then they will receive another \$1000 each towards their university course.

In sponsoring the bursaries, ABB, Australia's largest electro-technical and rolling stock manufacturer, which employs 6000 people in manufacturing plants throughout Australia, wants to see more women electrical engineers by the year 2000.

It is estimated Australia will require 95,000 engineers by that year.

Managing Director Ian Imrie said, "ABB is competing against the law schools, banking, stockbroking and other professions for the brightest talents."

Next year, the company will expand the Awards programme to target 500 schools in NSW.

The company is also negotiating interstate to introduce a pilot project of engineering bursaries similar to those awarded in NSW.

ABB also sponsored the 1991 Chancellor's Scholarships in Engineering, awarded to 26 scholars who will study engineering over the next five years at Sydney University.



NEWS BRIEFS

- **Priority Electronics** has been appointed exclusive distributor for the Advantech range of data acquisition cards. The company has also signed a distributor agreement with Laboratory Technologies who produce the Labtech Notebook package.
- **Memorex Telex** is to become a major sales distributor and service provider for all Vitalink's Token-Ring and SNA products in Australia and New Zealand.
- **Canon Australia** has a new managing director, Mr K. Miyagi, who was previously a senior general manager at Canon, Tokyo. He has held a number of planning, marketing and sales management posts in Japan and Europe.
- **Amtex Electronics** has appointed John Pearson to be responsible for its Victorian branch. He will provide sales and technical support for the company's range of power supplies, displays and industrial board level computer products.
- **IRH Components** is now the exclusive distributor in Australia and New Zealand of Johnson Controls' range of sealed lead-acid batteries.
- Two new key appointments have been made at **CITRI**, the Collaborative Information Technology Research Institute. Mr John Cromie is now managing director. He was formerly general manager of Hewlett-Packard's Australian software operation. Professor Ron Sacks-Davis, formerly head of the Department of Computer Science at RMIT, is the new research director.
- Sydney component distributor **Semtech** of Lane Cove is now stocking the full range of Philips electronic components, having discontinued the National Semiconductor range.
- **Utilux** has appointed Allan McGilvray as human resources manager to cover personnel administration, training and industrial relations. Allan was previously personnel manager for ICI at Botany.
- **Promark Electronics** will distribute and represent ZyMOS products throughout Australia. ZyMOS products centre around highly integrated 'PC on a chip' solutions, based on 286 and 386 architecture.
- Under a recently signed agreement, **Anitech** will become the Australian distributor for GP Industrial Electronics. It will provide full technical and after sales support for the UK company's range of device programmers.
- Mr Michael Bonacci has been appointed managing director of the radio communications arm of **GEC Plessey Telecommunications**. Previously he was general manager of the Novatel cellular division of Air International.

US FIRM DEVELOPS RETINA ID UNIT

EyeDentify, Inc of Beaverton, Oregon has developed the Ibox 90, an advanced handheld retinal reading system that brings the best biometric identification capability to computer terminals and database access controls.

The Ibox 90 is a portable and rugged retinal identification instrument made possible by new microcontroller technology, innovative analog circuit design and novel software pattern matching algorithms. Packaged into a small, lightweight, handheld device it communicates with a computer through a standard RS-232C serial port. Price is US\$1995 for single units.

When linked to a personal computer, this unit provides fast identification and authentication of users. Using the unique blood vessel pattern of each human retina, EyeDentify's retinal reading technology is claimed to positively identify any enrolled individual. By aligning the eye to a visual target in the Ibox 90, the user takes an eye reading, which is digitised and processed. The host computer sends the enrolment 'eye signature' to the Ibox 90 for verification, and the unit then transmits the results back to the host.

EyeDentify has been engaged in the development and manufacture of retinal reading systems since 1976. Additional information about the Ibox 90



and other retinal reading systems may be obtained by contacting the firm at PO Box 3827, Portland, OR 97208.

SANYO NICADS IN WINNING GLIDERS

Sanyo Australia was a sponsor of the Australian team which competed at the World Championships for Electric Powered Model Aircraft. The world championships were hosted by the Austrian Aero Club at Freistadt, Austria. The competition is for gliders which have been fitted with an electric motor and a folding propeller, so they

can climb to a height from which the competition tasks can be carried out.

Sanyo assisted the Australian team's challenge by supplying it with 162 of its new 1000mA SCR nickel-cadmium cells, the same as those used by the winning Austrian team which narrowly beat the USA.

The motors used in the Australian team's model gliders produce over 750 watts (one horsepower), and the Sanyo cells supply current in excess of 50 amps. According to the team's Mike Farren, the fact that cells can produce this level of performance, flight after

flight, indicates the high level of advanced technology reached by companies such as Sanyo.

A combination of high performance electric motors and batteries enables models weighing 3kg to climb at more than 10 metres a second. A 10-second burst of power will take a competition model to a height of more than 100 metres.

Sanyo Australia's Wally Fabiszewski said the sponsorship reflected Sanyo Japan's intense interest in encouraging use of environmentally friendly electric power.



TRAINING LINK BETWEEN HP, BOX HILL TAFE

Located in Melbourne's Eastern suburbs, Box Hill College of TAFE is the largest provider of Electronics courses in Victoria's TAFE system.

The Electronics Engineering Department offers state funded courses in the Associate Diploma of Engineering (Electronics or Computer Systems) and the Certificate in Basic Electronics. These courses form the majority of teaching activity and the department also offers an extensive range of industry-based short courses.

The college and the Electronics Engineering Department have formed close links with industry for the development of courses designed for Award Restructuring and also general training.

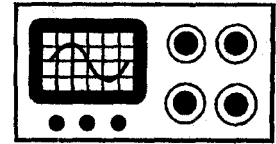
Hewlett Packard has entered into a partnership in Technical Training with the Department which allows for employees of the company to attend week-long training seminars at the college. Seminars cater for the industry's

needs and can be delivered on the company's site or at the College. This close link with Hewlett Packard is also reflected in the state of the art equipment used in the department's day to day teaching activities, and also in the funding of Bursaries for Women.

Training is presently being provided for companies in South Australia, ACT, NSW, Queensland and Victoria. This training ranges from the Certificate of Basic Electronics through to LAN courses based on Ethernet and Token Ring (using Novell or 3COM), Digital Signal Processing fibre-optics, BASIC and Advanced MS or PC-DOS, Introduction to Unix, Programmable Logic Controllers and virtually any other electrical or electronics training courses. All staff in the Department have worked in industry and this experience translates to a 'hands on' practically orientated approach to training.

For further information about courses offered at the College, or to discuss your special needs, contact Mr John Italiano, Head of The Electronics Engineering Department on (03) 895 1332 or fax (03) 899 5234.

THE SERVICEMAN



Breezing around the Pacific, fixing cranky computers

No, I haven't actually been doing that myself — more's the pity. While I've been confined to my familiar workshop, slaving away over equally familiar colour TV sets, one of this month's contributors has been having all the fun in exotic places and with exotic equipment. I also have an intriguing 'oddball' story from the early 1960s, from another contributor.

How often have you had to check your passport before answering a service call? Or arrange export and import licences for the spares you'll take with you?

This month's lead story is one of those 'out of the ordinary' tales that I appealed for several months ago. It's about service problems with a minicomputer in a bank, on one of the Pacific Islands, and it comes from contributor D.H., of Port Vila in Vanuatu.

D.H.'s story makes me profoundly dissatisfied with my lot. I mean, can you imagine flying around the South Pacific answering service calls? Lazing on palm-fringed tropic beaches while waiting for the next flight back to the workshop?

But enough of that dreaming... Here is the story, much as D.H. told it:

I work as a computer technician in

Port Vila, Vanuatu. In the past I have worked in other Pacific Islands, including six years in Honiara, Solomon Islands, for another branch of my current employer.

This story starts on a Wednesday a few weeks ago, when the Honiara technician rang me to say he had a problem with the minicomputer at a bank in Honiara. He had replaced a cartridge tape drive (a common job in these dusty locations), and afterwards the system would not boot up.

He had tried replacing some circuit boards, including restoring the original tape drive, but he still had the same fault. He initially contacted me to enquire about the availability of some spare PCBs which were missing from his stock. I was able to assist, except that the next flight to Honiara was not until Saturday.

The Vila branch of the bank (which provides software support for the Honiara branch) was going to send a bank officer up on the plane, with some system tapes (in case the disc data was corrupted) and he would carry the spare parts.

But it seemed pointless to send a person who could not offer any technical help. So, when the problem was no nearer being resolved by Thursday, it was agreed that I should go, carrying as many spares as possible. I could then make sure to bring the parts back with me on the Sunday flight, so as not to jeopardise my own support commitments in Vila.

Friday was spent in preparation, ensuring that all the parts were good. This was done by removing the parts I would take with me from our internal office system and replacing them with parts from my stock.

This way, I could be sure that the PCBs I took with me were well 'burned in', and hopefully would still be good after travelling to Honiara.

I did have one glitch on the office system, as a result of confusing some switch settings on a PCB. This resulted in the system failing to boot, even with the original PCBs restored. After checking the installation manual, I found that I had the SCSI bus ID address switches set incorrectly; with the correct settings, the system booted up without fault.

Once I had my parts selected, I had to make arrangements with Customs in Vila and Honiara for temporary export from Vanuatu and importation into Solomon Islands.

Then it was a matter of collecting my tickets and some Solomon Islands dollars, pack the parts and manuals, and catch the plane on Saturday morning.

It was a pleasant flight on the Solomon Airlines Boeing 737-200 in BELAMA (Business) class, and two hours later I was back in the Solomon Islands, after an absence of more than four years.

A representative of the Bank met me in the Customs Hall and with his help we breezed through customs with no problems.

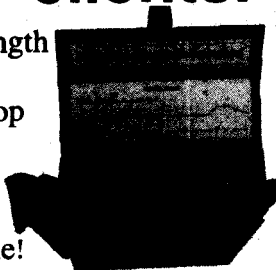
Honiara weather was, as usual, hot and humid. Like being wrapped in a warm, wet blanket! I was rushed off to town and into the bank, a 10-minute drive from the airport. The computer room was a cool change from outside and I got straight onto the problem with Bob, the Honiara technician.

Briefly, we exchanged all the relevant PCBs with the good stock I had brought, including the tape drive and its controller; even the first disc drive. We were able to boot from the tape

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drive, but could not access any disc drives in the system.

This computer uses a SCSI bus for its storage devices, such as streaming tapes and disc drives. The various SCSI devices are daisy-chained onto a long ribbon cable, which snakes through the computer cabinet, with IDC connectors crimped onto it at strategic locations.

After the SCSI host board in the computer, the first connection is not used. The second has the tape drive connected, next is the disc drive control board then the cable goes to the rear of the box to provide an external connection for other SCSI devices, in this case a high capacity disc drive.

Our problem appeared to be that we could access the tape drive on the SCSI line, but not the disc drives.

A check of the schematic showed there were no unique terms (control lines) for the discs, so we made a check on the cable. It looked good, but a continuity check showed that some terms were not available at the disc controller connector.

This was verified by connecting the disc controller to the connector used for the tape drive — at last the internal discs were accessible. And much to the relief of the bank personnel, the disc data appeared to be intact.

It had taken four hours to get to this stage, and it was going to take another four hours to repair the cable. We did not have a spare cable, so we had no choice but to repair the existing one.

Initially, the breaks appeared to be only on the exit side of the connector for the tape drive, so we tried adding a jumper over the top of the connector. But this did not prove successful. We had to open the back of the connector, remove a section of the broken wire and install a replacement.

While repairing this one, we could not avoid placing strain on adjacent wires — and so made further breaks. We also discovered that due to strain, the connector at the disc drive controller also had broken wires that required replacement.

Once we had this problem resolved, we found that the second disc drive was not accessible. We changed the disc controller, without any luck, so we checked the A and B drive cables and found the B cable faulty.

This was probably due to broken wires, the connector having been removed several times.

This was quickly replaced, but then the first drive would not come up again. "Now What?!", we cried in despair. So we swapped the B cable again and

everything worked. We were able to find a new B cable, so we were able to leave everything in full working order.

On the Sunday, the bank staff came in to catch up on the three days work that they had missed.

I packed up all my parts, which hadn't been needed after all, then bought a few local souvenirs and headed for the airport for my 1pm departure for home and family in Port Vila.

On thinking back over the job, I realised that the problem must have happened when the tape drive was first changed. And being such a common, easy job, it had not occurred to anyone that it could be anything so simple as a broken wire. This sort of trouble is easy to overlook when a technician is on his own and unable to bounce ideas off a fellow tech.

There was in fact a postscript to this story. Bob rang me on the Monday morning to say there was still a small problem. I countered immediately by saying "The tape drive doesn't work!", and he agreed.

I had realised on my way home that we hadn't checked the tape drive, once we had access to the discs, as it is normally only used for security backups.

I had suspected that the connection at that point might not be good, because the cable has to do a 180° turn at the tape drive connector and this tended to pull our temporary wires away from the pins.

We decided that it would have to stay that way until a new cable could be installed, and the bank could use a separate disc drive for temporary backup.

A new cable was installed a only few days later, and since then no news has been good news. But I'm getting a spare SCSI cable for my own parts stock, 'just in case'.

Well, D.H., I think our readers would have found that a fascinating tale. I know I did. It was as much for the exotic location of the job as for the list of woes you encountered.

The story harks back to many of our recent tales — mechanics rather than electronics.

It seems that even the most sophisticated equipment suffers more mechanical breakdowns than electronic failures.

Anyway, we have to thank D.H. for showing us that not all problems occur in suburbia. Some people at least get to work away from gray skies and pollution!

Exotic gear

Now on to our next contributor, and a tale concerning even more exotic equipment.

This story comes from B.H. (no relation to D.H.), of Heathmont in Victoria.

B.H. sounds as though he is one of my vintage, and his story certainly is. It could have been told a great many years ago, and yet the lesson to be learned from it is just as valid today as it ever was in the past. Here's how B.H. tells his story:

Some 30-odd years ago I worked in the mechanical research department of a large Australian machine tool manufacturer. The company was also an agent for several overseas firms, including one British manufacturer of an 'electronic' spark cutting die forming machine.

It transpired that one of these rather expensive machines had been imported for a client, who subsequently refused to accept it because it would not function continuously.

They found that they could only operate it for about two hours, before the vertical die-former head shaft would spring into its uppermost position and remain there for as long as the machine was left turned on. The machine had to be turned off and left overnight, before it would deliver another two hours' work next morning.

The British company sent their expert to fix the machine, but after several days of effort he could not solve the problem. It seemed that the machine would have to be returned to the UK, with some very expensive egg left on many faces.

The client was threatening everything from legal action to the execution of all concerned, before cooler heads suggested that they had a couple of 'electronic whizz-kids' in their own mechanical research department.

The truth was that we were only electronic hobbyists, but as it turned out we had more commonsense than the British 'expert'.

We were presented with the machine which was very impressive indeed. The blank die, of hardened tool steel, was held in a vice on the bed of the machine. A brass template, in the shape of the hole to be formed in the die, was secured to a vertical shaft above the blank.

A very high DC voltage was applied between the template and the blank, then the template was lowered until yellow sparks formed between them. The sparks eroded the blank and slowly cut

THE SERVICEMAN

away the tool steel in an accurate copy of the brass pattern.

The exact arrangement of the machine is now somewhat hazy, after some 30 years, so I hope that any experts reading this will excuse my poor memory. In general terms, it was something like the sketch in Fig.1.

In tracking down the fault, we initially considered that the problem was contained in the electronic control equipment, possibly the amplifier or servo head. We had already eliminated the EHT supply and the oscillator, because both of these functions continued normally when the machine was in the fault condition.

We subsequently eliminated any faults in the servo head windings, which maintained virtually the identical DC resistance in both the working and not-working state.

This left only the amplifier as the likely culprit. And so began the task of finding the fault in what was a very well laid out and assembled push-pull amplifier (using push-pull 807 valves, if I remember rightly).

The amplifier circuit was very conventional and departed from a normal audio push-pull valve amplifier in just one respect — it had no output transformer. The transformer function was provided by the windings in the servo head itself.

For the initial attack we tried the usual substitution of all the valves. This produced no effect, so we turned the

chassis over and began our search among the smaller components.

The only noticeable damage under the chassis was a very slight discolouring of the yellow dot on the body of one of the half-megohm (500k) grid bias resistors. All the resistors in this amplifier carried the old style 'body, end, dot' type markings — which really dates this story!

Anyway, this discolouration led us to think of leaky coupling capacitors, particularly the one connected to the grid from the anode of the previous stage. Leakage in this cap was a common cause of distress in grid resistors, but this one was a good quality component and tests showed it to be in prime condition. We sweated all day over the under-chassis components of the amplifier, and finally had to admit that we couldn't find any obvious fault to make a fast or easy repair.

Next morning, my associate suggested that we should disconnect all the resistors, measure their values before operating the machine then do the same, very quickly, after the machine malfunctioned.

This seemed like a good idea, so we began with the push-pull output stage, simply because there were only a handful of resistors, and the layout made them very accessible.

We hit it in one! Murphy must have been late for work that morning. After the machine had malfunctioned, we found that the discoloured half-meg resistor had changed by nearly 300%. It read close to 1.5meg ohms. But why?

Actually, our fingers told us why. In

removing the dubious resistor, we had to be careful not to burn ourselves on the common cathode bias resistor. The bias resistor was only 3/8" (10mm) away from and parallel to the one that had gone faulty. The cathode bias resistor in a valve power amplifier dissipates a lot of power as heat, and it was this heat that had affected the grid resistor.

As a temporary test, we strung the cathode bias resistor well away from everything else, then cooled the grid resistor back to a normal value — after which the unit worked properly for several days.

I subsequently replaced both half-meg grid resistors with new ones, and relocated the cathode bias resistor onto the top of the chassis, using a bracket-mounted 20watt IRC wirewound unit. The amplifier was then replaced in its control cabinet and the machine was tested for several full eight-hour days of continuous operation.

I'm pleased to say that the machine functioned perfectly, much to the relief of the British manufacturer and all the other parties. The whole exercise taught me to locate these output stage cathode bias resistors well away from all other components, to prevent imbalance conditions occurring in amplifiers.

I wonder how many amps, both valve and solid state, are suffering deterioration in performance after operating for a few hours, with heat from power resistors altering component values. It also emphasises the need to undertake performance measurements on amplifiers AFTER they have been operating — i.e., heat stabilised — for several hours.

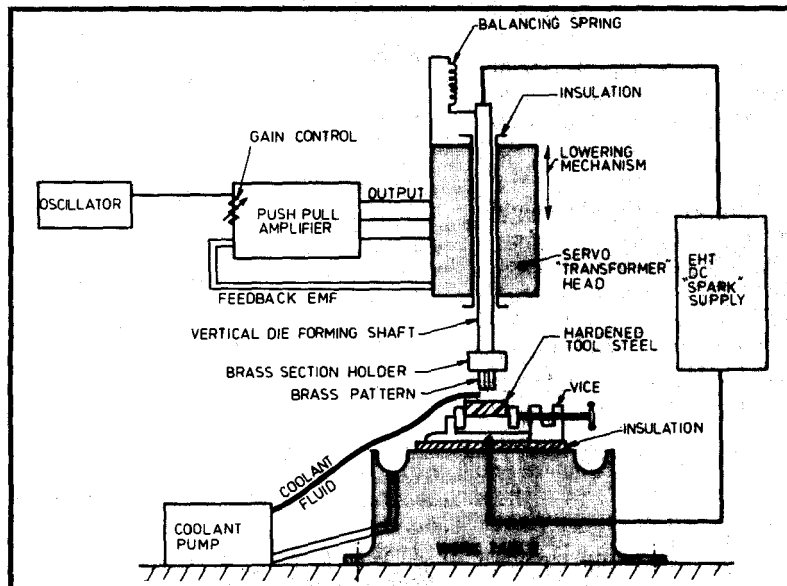


Fig.1: The general arrangement of an electronic spark cutting die forming machine, as provided by B.H. In operation the servo head lowered the brass pattern down against the tool steel blank.

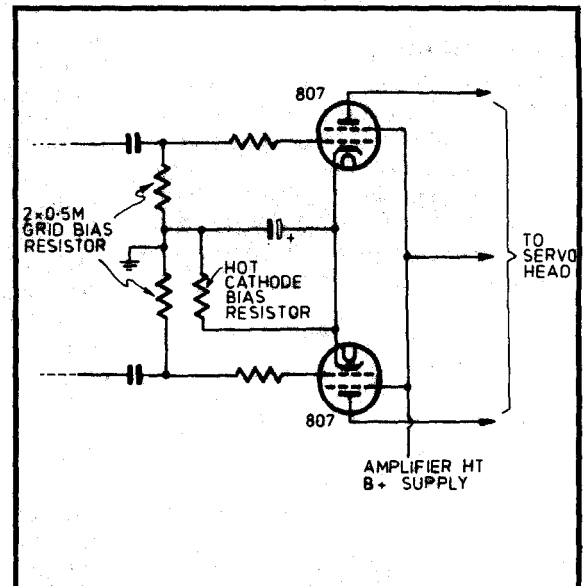


Fig.2: The output stage of the die former's servo amplifier. The cathode bias resistor became quite hot in operation, with drastic consequences.

Well, now! Wasn't that a blast from the past? I don't know about you, but I still have a soft spot for valves. (Even more so today, since I have just wrecked two expensive transistors trying to solve a problem in a complex switchmode power supply!)

Valves had a wonderful capacity to bounce back after the most hideous overloads. I've seen some valves still working after an overload melted the glass envelope!)

But back to B.H. and the die sinking machine.

High dissipation resistors still cause their share of problems, even in solid state devices. But these days, the problems manifest themselves more often as dry joints, with changed values being somewhat less common.

Nevertheless, as B.H. points out, there must be a lot of equipment not performing as it should due to heat induced problems. It pays well to examine circuitry around these heat-producing resistors.

Many faults can be spotted just by visual checking even if, like B.H.'s yellow dot, other tests are needed to confirm the trouble. Then again, I have just realised that cans of freezer spray have not been available for all that many years. I imagine that B.H. would have welcomed that modern service aid, when this story was being acted out.

Thanks for your story, B.H. It might be an old one, but it was interesting nonetheless. Other readers might care to note that old stories can still be used in these pages, provided that the theme can be related to modern problems.

Code cracking

Now, on to a more up-to-date matter.

In the December edition I told the story of a Philips television in which I had to replace component '3583'. I then went on to comment about this being a confusing way to number components.

Two readers have been kind enough to write in with an explanation of how the Philips system works.

They both agree with me that it is a complicated system, and add that it is quite useless without a key to unscramble the code.

It makes me wonder why the Europeans need to encode everything, thus requiring users to decode the material before it can be used!

It's rather like the arguments for and against little rectangles for circuit symbols, which raged in this magazine a year or two back. Without a key to explain the meanings of the rectangles,

one has almost no idea of what one is looking at.

But enough of that. Thanks to my correspondents, I am now able to explain what all the numbers mean. I hope you find the explanation useful.

The first figure in the four figure group relates to the circuit component. The code is:

- 1xxx Fuse etc.
- 2xxx Capacitors.
- 3xxx Resistors.
- 4xxx Circuit units (formerly Uxxx).
- 5xxx Inductors.
- 6xxx Diodes.
- 7xxx ICs or transistors.

The second figure in the four figure group gives the component location:

- x0xx Remote control logic.
- x1xx Audio, RF and IF circuits.
- x2xx Power supply.
- x3xx Synchronising circuits.
- x4xx Vertical scan circuits.
- x5xx Horizontal scan circuits.

(There seems to be a number missing here, for video and chroma circuits, but these are all that I have been given.)

Finally, the last two figures are the conventional component numbers.

So in the December story, '3583' was in fact a resistor (3) in the horizontal section (5), number 83.

Really, the Philips complications are only in the use of the first figure instead of the conventional letter prefix.

Most manufacturers already use a form of location code similar the the Philips system. They use a three-figure number for their components, where the first figure is common to all parts in that section of the circuit.

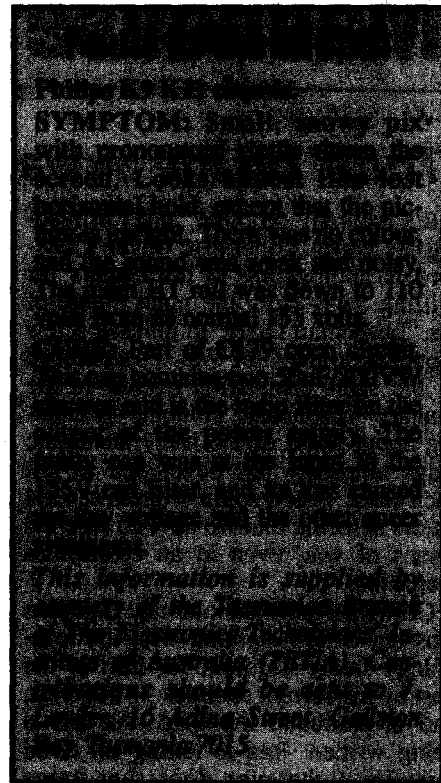
So Philips have taken an efficient and long standing system, and complicated it for their own inscrutable purposes. It may be that their own staff can manage the system, but for those of us who switch back and forth among brands, it's just another of those annoying peculiarities that make some brands less welcome than others.

An afterthought: If the Philips practice were carried to its logical conclusion, then certain well-known electrical equations would take on quite a new appearance. For instance, $T=RC$ would become $T=32$. And $XL=2(\pi)fL$ would be $X5=2(\pi)f5$. And so on!

My motto is 'If it ain't broke, don't fix it!' And if the old system has worked well for a great many years, then why change it just for the sake of changing it? It seems to me such a pointless exercise.

Well, that's all for this month. I hope you've enjoyed a brief sojourn in the South Pacific, and a journey back in

time to a less frantic era. I have no idea of what these pages will bring next month, but you can rest assured that it will be as interesting as these pages have been. ■



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Moffat's Madhouse...

by TOM MOFFAT



'Truth' on the airwaves

It's Saturday morning, and I'm reading the paper. Columnist Wayne Crawford is apologizing to his readers for drifting away from the main theme of his 'Tasmanian Diary' to unleash a few thoughts on the Gulf War. I succumbed to the same temptation myself in the January 'Madhouse' column, speculating about some of the nasty electronic ways humanity has developed to kill each other. That column brought several letters agreeing that we have to face the issues of war, even in an electronics magazine.

Crawford pointed out that Saddam Hussein is now fighting with the technology freely acquired for him in the past by his current enemies — the West, and in particular the USA. As this is being written, Iraq is letting off Scud missiles (whatever does that name mean??) capped with conventional explosive warheads. But said to be waiting in the wings are 'chemical warheads containing a mixture of mustard and cyanide gases'. Crawford himself refers to Hussein as 'a very nasty dictator', and the quote about chemical weapons comes from an American journalist named Thomas Friedman.

The big question here is, how much of this stuff can you believe? I can tell you right now that Wayne Crawford would never knowingly feed his readers any bullstuff; I've known him personally for over 15 years and he's got to be one of the straightest shooters in Australian journalism today.

But is Saddam really a 'nasty dictator'? Who says so? And as for Thomas Friedman, he is a Pulitzer Prize winner; that's to America as the Walkley Award is to Australia. So he must be pretty good. But is his stuff unconsciously coloured a little by the fact that he is a resident of the USA?

Don't think for one moment that I am a supporter of what Saddam Hussein is doing. I just don't know enough about the TRUTH of what's going on to know if I should support him, or condemn him, or just ignore him. We all know the old saying - 'Truth is the first casualty

of war' - and just looking around, I'd say we're getting precious little truth.

What we're getting is giant helpings of hype; newspaper stories about the Butcher of Baghdad; next week they'll have him eating his own children for breakfast. Or General Schwartzkopf, the US military commander, always pictured as big, overpowering, chomping a cigar, revelling in the glory of the latest kill.

Perhaps, in reality, Saddam is a gentle person who genuinely feels he is doing the best thing for his country. It's already been reported that Schwartzkopf loves opera and ballet, has a master's degree in civil engineering, and has an IQ near the genius level. Strange characteristics for a man depicted as a war-mongering dolt.

Who's right?

Which one of them is right? Are they both a little bit right? Are they both totally wrong? Is Bush right or wrong? Who's really running the show anyhow? All we can be certain of is that all these people are human players on the world stage; they get up every morning, sit on the loo, they eat breakfast, just like you and me. But their publicity machines would have you believe they are gods.

Our own newspapers and electronic media serve up what must now be seen as mostly wartime propaganda. (The promo for tomorrow's Hobart Mercury: 'Torturer Hussein — A former body-guard tells all') This whole mood of our times must influence the writings of even the most careful journalist. So isn't it convenient, then, that we have shortwave radios. We can jump outside our own country and listen to the world.

It would be a pretty good guess that just about every reader of EA owns, or has access to, a shortwave receiver. It is most fortunate that we are currently right up in the peak of the sunspot cycle, so stations from all over the world come booming in on the higher frequencies, day and night, with their own versions of what's been going on in the war.

Most international broadcasters are

departments of their respective governments, although some stations are run by 'contras' — liberation groups and the like. The *Voice of America* has the reputation of being a branch office of the CIA. One would expect to hear tirades from President Bush raving on about how he is going to destroy Iraq, but no, the VOA has been remarkably restrained. Their programming thrust still concentrates on various facets of life in America, and American music. News services of course cover the war in depth, but what is served up as 'truth' is prefaced by 'according to a government spokesman...'. It all seems pretty legitimate, so maybe that CIA image is wrong.

Baghdad Radio has reportedly been heard in Australia from time to time, in the 13MHz band. I've spent a lot of time snooping around for it, and one night, about 3am, I started poking around 15MHz instead and suddenly there it was! A broadcast, clear as a bell, using impeccably spoken English. So easy to listen to after all that searching!

Woman's view

The station was carrying what appeared to be a woman's view of the War, mainly featuring an interview with a woman described as 'a well-known Egyptian feminist'. She was talking about how things had improved for women since the 'liberation' of Kuwait. Liberation, for her, meant the military action taken by Saddam Hussein to throw out the former oppressive rulers of Kuwait. She saw the war now as an attempted invasion of Kuwait by American forces.

This woman said the entire Middle East was run by eight ruling families, all propped up by the United States for its own financial benefit. Go-gettem Baghdad Radio! This was the stuff I was expecting to hear, the story as seen from the other side. But come station identification time, "This program comes to you on Radio Australia..."

What is this — treason? A program giving comfort to the enemy, on the na-

tional broadcaster? Well, that's what it sounded like, and I must admit I was a bit startled to hear it. But it did explain why the signal was so strong and steady, and why the presenter's English was so good. But — was it right to run this stuff on *Radio Australia*?

Fiercely independent

Radio Australia has always tried to remain fiercely independent of the Australian government, and it's developed a world-wide reputation for impartiality. You may remember soon after the war started, *Radio Australia* got into a terrible stoush with Defence Minister Robert Ray, who wanted the station to run special programs and family messages for Australian personnel serving in the Persian Gulf. *Radio Australia* refused, saying it was not a government-run broadcasting service. But the money to operate *Radio Australia* still comes from the Australian taxpayers, and the government started making dire threats about funding cuts.

The dispute was finally settled when an arrangement was made for *Radio Australia* to officially sign off, and then the government could resume broadcasting its armed forces service through *Radio Australia* transmitters. To prove this was happening, photos were produced showing army announcers preparing programs in an army studio onto army tape recorders.

The question still stands: was *Radio Australia* right or wrong to broadcast that program that was biased so favourably toward Iraq, a country that Australia is supposedly at war with? I don't know the answer to that, but it does seem to show that *Radio Australia* is still determined to come up with both sides of the story, even in time of war.

RTTY broadcasts

Radio broadcasting through million-watt transmitters is really aimed at the masses of the world. But many countries, particularly those of the third world, operate radioteletype stations that broadcast their versions of the news. This stuff is picked up at listening posts around the world, edited, and included in the receiving countries news broadcasts as "according to the Japanese News Agency..." or whatever.

Electronics Australia readers who purchased the 'Listening Post II' kit for their computers (designed and sold by yours truly — plug, plug) are able to capture these radioteletype transmissions for themselves, unedited and straight from the horses' keyboards. As I remember, the Mid-East war started at

11 o'clock one morning, and within the hour I had the Listening Post fired up, scanning the known teletype bands.

My first score was not a teletype broadcast but a diplomatic transmitter in the Mid-East somewhere, running teletype at 110 bauds and frantically sending out lists of Arabic names, with their nationalities, dates of birth, and another date that was probably their passport expiry date. Almost all the nationalities were Egyptian; a few were Kuwaiti. I wonder where those people are now...

As for teletype news broadcasts, the Korean Central News Agency English service from Pyongyang continues to hurl rage and abuse at the Americans, as it has done for many years. The Mid-East war is like throwing a firecracker into a wasp's nest; KCNA are in a highly agitated mood. I haven't spent a lot of time monitoring them, but I suspect they might become a useful source of war reports from the Iraqi perspective, if things continue.

Iraq doesn't seem to have its own radioteletype press transmitter, but Kuwait had one before their troubles started. I wonder if it's still going? Or was it gobbled up by Iraq, like all the Kentucky Fried Chicken stores?

China neutral

A fact that hasn't received a lot of publicity in Australia is that China is trying to remain steadfastly neutral in the war. Their Xinhua teletype service in English carries articles critical of both sides, but I haven't seen them praise either side. In one interesting item they got stuck into UN Secretary-General Perez DeCuellar, for allowing the resolution that gave Bush the authority to attack Iraq in the first place.

Radio facsimile (another Listening Post II feature) carries weather maps most of the time, but there is also an extensive news service with Japanese facsimile newspapers transmitted from Tokyo. These have English labels at the top indicating that they are intended for Japanese ships at sea, but they're a bit heavy going for anyone who doesn't read Japanese. It would be interesting to know what they're saying to their target audience of Japanese nationals. The English-speaking teletype service from Japan seems to be fairly neutral in war matters.

There, then, are some suggested pathways to the truth. They skip over the top of the Australian media, who, try as they may, will still deliver their goods with the flavour of a country at war. We hear much from our own 'local experts', only to find out later that they've got their

own political drums to beat and their commentary is somewhat coloured, to say the least.

And then there's our politicians. Well, we've learned to take what they say with a grain of salt, haven't we?

So let's listen to what the world is saying, not just Australia or the USA or Baghdad. With a shortwave receiver our sources of information are greatly widened, although there's nothing to guarantee that any of them are 'the truth'. But with so much more information to sift through and digest, it's much more likely we'll be able to come up with an answer as to who's right and who's wrong in this war. Maybe with enough listening we'll discover that nobody's right, and the whole lot of them are sadly mistaken. ■

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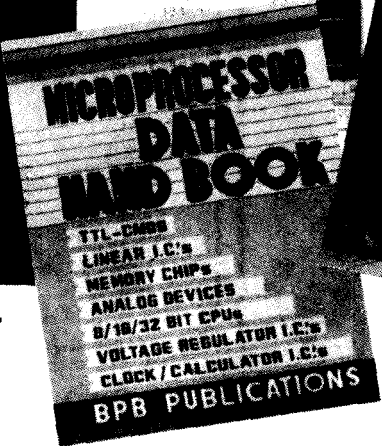
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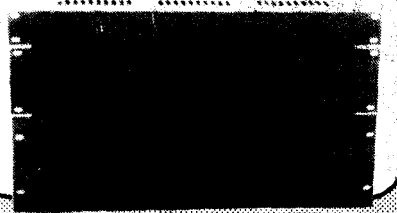
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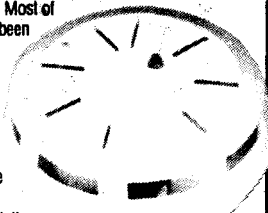


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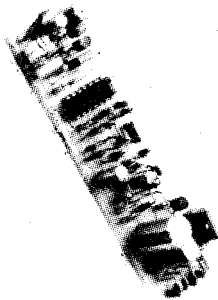
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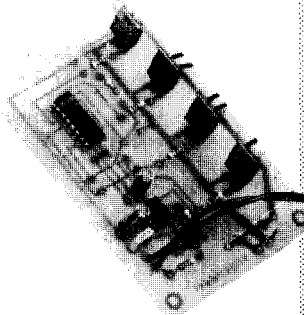
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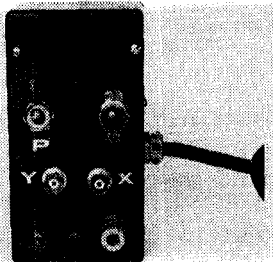
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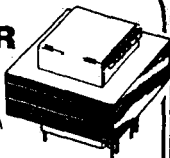
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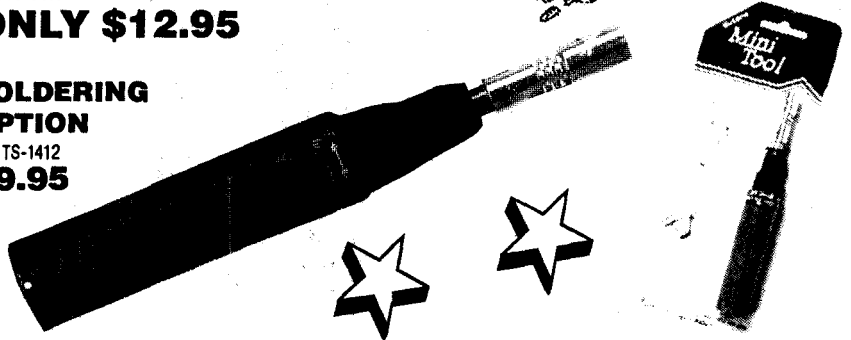
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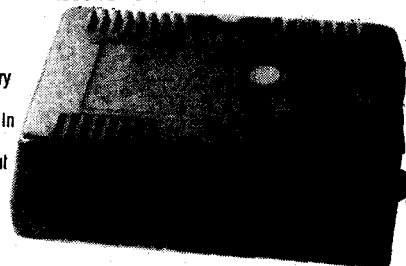
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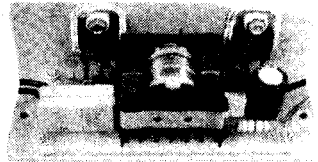
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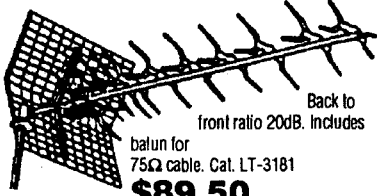
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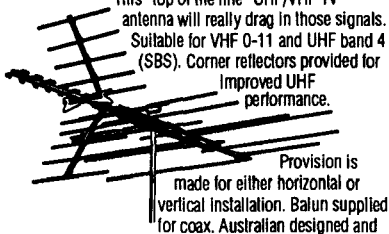
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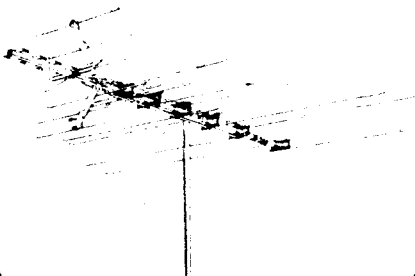
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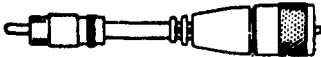
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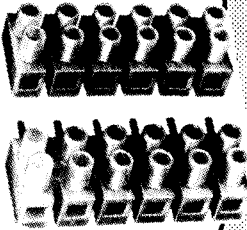


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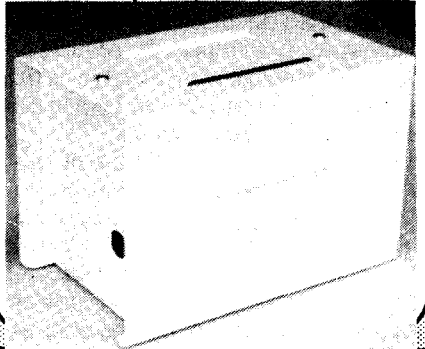


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Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Water reticulation control box

This reticulation control box uses cheap and easily obtainable parts. A cheap digital alarm clock is used as the timer. There is no limit on the number of stations.

Locate the supply negative on the clock and connect to the earth lead on the circuit (A). The lead (B) is connected to the clock's piezo speaker. The correct connection is the one which goes positive when the piezo is working. When the alarm is switched on, it causes transistor Q1 to switch on, pulling down the emitter of Q2. The 47µF capacitor C1 charges up, causing relay D to close momentarily. The relay contacts connect C2 (2200µF) across the supply allowing it to charge before the relay drops out. The charged capacitor then switches on Q3 and Q4. Relay RLY1 then switches on the first water valve solenoid and charges up the next capacitor C3 ready for the second valve to operate.

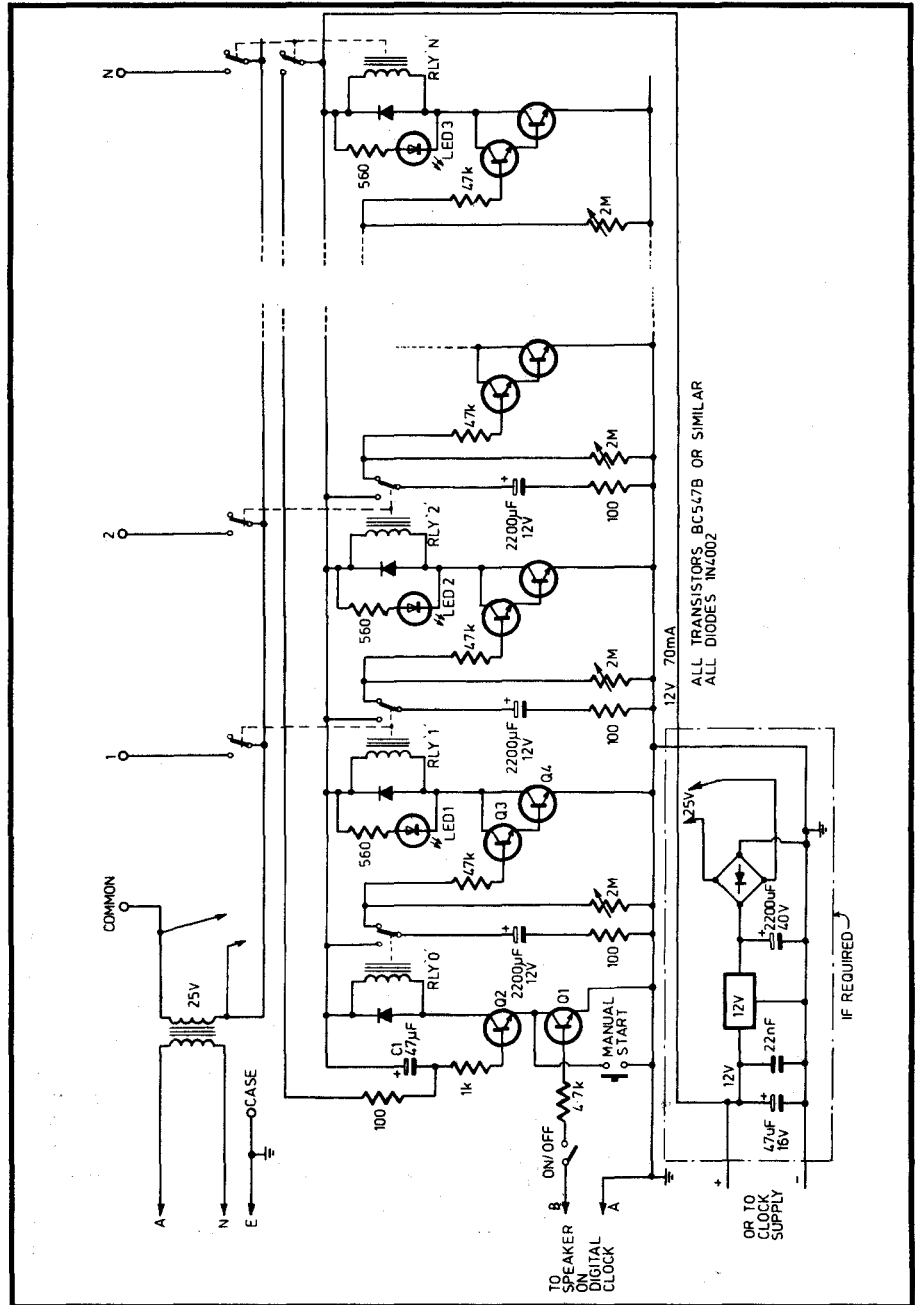
The length of time for each valve's operation is set by the 2M pot and can be varied between a few seconds and about 20 minutes. Contacts on the last relay are used to discharge the 47µF capacitor, ready to repeat the sequence. The LEDs indicate which valve is in operation. The sequence can be started manually by the press switch.

If individual manual operation of valves is required, set the relevant pot to the time required, turn all other pots to minimum and press the manual button.

I show a power supply in the circuit, but in most cases, the clock power supply is 12 volts, and will be able to give the necessary extra 70mA.

Stewart Farrant,
Yangebup, WA

\$40



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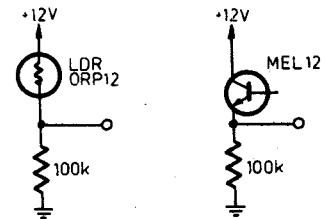
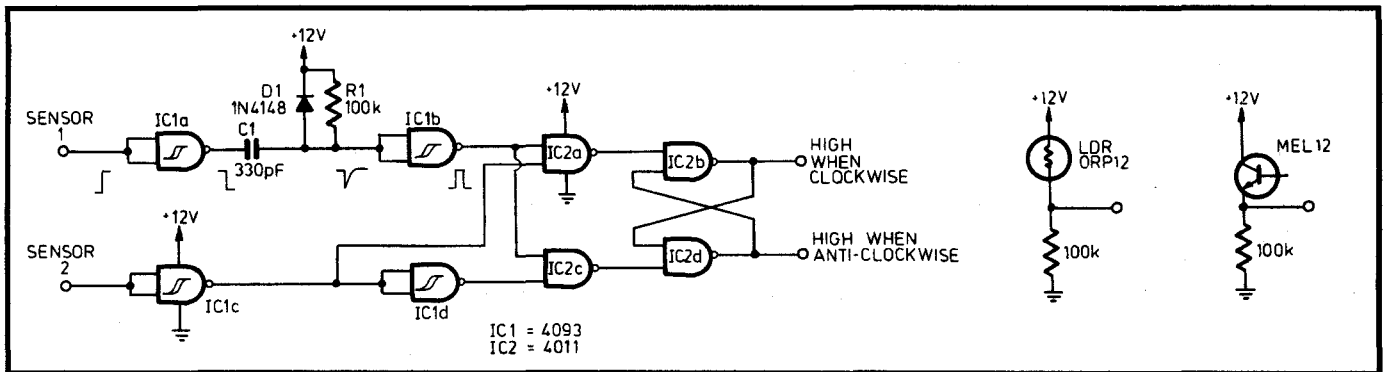
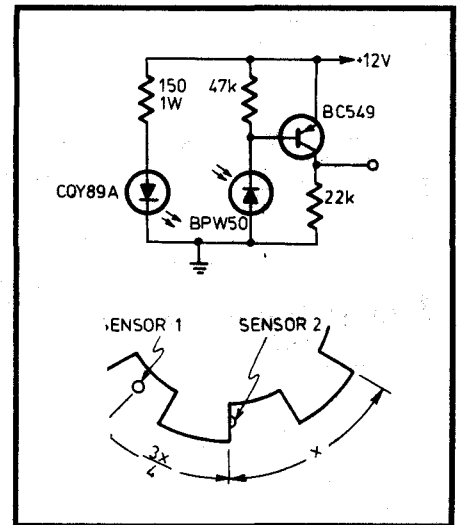
Simple optical shaft encoder

This circuit stemmed from the need to determine the direction of rotation of a shaft. The shaft has a toothed wheel mounted on it. If the pitch between teeth is X, then the two detectors and illumination sources should be mounted 3X/4 apart such that the teeth interrupt the beams of light. Three types of sensors are shown, including infra-red LED and diode. The MEL 12 phototransistor and the LDR may use an incandescent bulb or an orange or a red LED. The LDR has a fairly slow response and is only suitable for low rotational speeds. The rest of the circuit

consists of two quad NAND gates, a 4011 and a Schmitt trigger 4093. IC2b and 2d form an RS flip-flop which requires a low at the output to change state. The diodes R1 and C1 produce a brief negative-going spike when sensor 1 goes from low to high. This spike is squared up and inverted by IC1b and fed to gates 2a and 2c. The output of sensor 2 determines if the flip-flop is set or reset. When the shaft turns in a clockwise direction sensor 2 is low when sensor 1 goes from low to high. Conversely, for an anti-clockwise rotation, sensor 2 is high when sensor 1 goes from low to high.

Peter Van Schaik,
Inverell, NSW

\$35



Timer with memory

This circuit is designed to allow recharging of NiCad batteries for 15 hours. It makes certain that 15 hours of charging have occurred by allowing for power dips and blackouts.

Often power dips reset the timer and blackout times are lost. This timer charges for 15 hours when the power is on. It remembers how long it has already

run when power is returned after a dip or break.

Because CMOS chips only draw minute currents when they are not being clocked, the diode D1 and the 100uF capacitor C2 form a simple memory backup which will keep the 4020 running overnight. The 555 does not run when the power is off, so it does not clock the 4020 during a blackout.

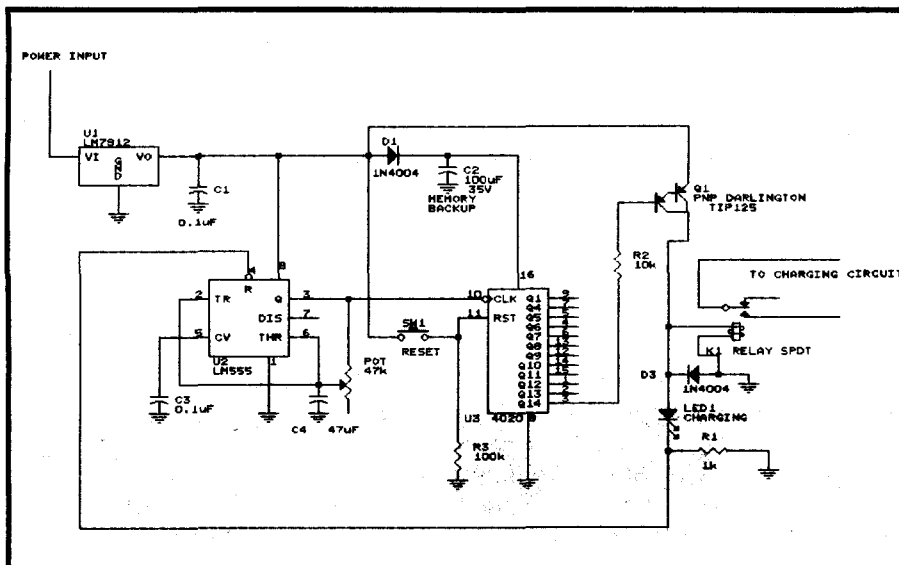
Start the clock by pressing the reset button. Resetting the 4020 pushes pin 3 low, which turns Q1 on. The relay then connects the battery to the charger. It also pulls pin 4 of the 555 high, allowing the oscillator to run and clock the 4020. The 47k pot is adjusted so that the 555 oscillates every 3.3 seconds. So after 16384 pulses (15 hours, 1 minute and 7 seconds later), pin 3 goes high and turns off the charger via Q1 and the relay K1. This stops the 555.

The circuit can obviously be used for other applications like swimming pool pumps.

Running times can also be halved by using successive outputs from the 4020; Q14 gives 15 hours, Q13 7.5, Q12 3.75 and so on.

Alex Eades,
Katooma, NSW.

\$40



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Electronics Australia, PO Box 199,
Alexandria, NSW 2155.

Construction Project:

Low cost dual mode Logic Pulser probe

Here's the design for an easy to build, low cost logic pulser probe — an ideal companion for the logic sensing probe we described in the August 1990 issue. It provides either a single pulse or a train of pulses, with sufficient current capability to 'force' most circuit lines into the opposite logic state. This makes it an excellent circuit stimulator for troubleshooting in either TTL or CMOS digital circuitry.

by REX CALLAGHAN and JIM ROWE

Test equipment suitable for fault finding in digital circuitry ranges from inexpensive logic probes, such as the one described in the August 1990 issue, to sophisticated logic analysers costing tens of thousands of dollars. At the lower end, a simple logic probe is often entirely adequate, particularly if the circuit being tested uses discrete gates, flipflops and counters rather than complex LSI, special function devices. Furthermore, the low cost of these probes places them within the reach of most hobbyists and small service organisations.

But often a circuit being tested will be completely inactive, being locked into a static state, and won't provide any changing signals for a logic probe to detect. This makes it very difficult to tell if any particular logic element is faulty, or merely lacks an input signal. In order to check logic paths with a probe, some means is therefore needed to provide a 'stimulus' signal for the circuitry.

The logic pulser fulfills this role, being designed to 'force' any selected signal line in the circuit briefly into its opposite logic state, so that the effect of this level change can be

checked at other points of interest. This allows you to check whether gates, inverters and other elements are working or not, by tracing the pulser's signal through them.

Commercial logic pulsers have been available for some years, but generally at a price which has tended to limit their appeal. The design presented here can be built at much lower cost, and should therefore allow anyone who needs one to take advantage of this handy troubleshooting tool.

The new pulser has been designed as a matching companion to the logic probe described in the August 1990 issue of *Electronics Australia*. It is housed in the same professional probe case and, like the logic probe, is suited to both TTL and CMOS circuitry. Of course it isn't limited to use with the August 1990 probe; in fact it should work equally well with other standard logic probes.

As explained above, the pulser's role is to inject a controlled pulse into digital logic circuits. For compatibility with the different logic families, the pulse amplitude and logic threshold have been made dependent upon the pulser's supply voltage (5-15V), which

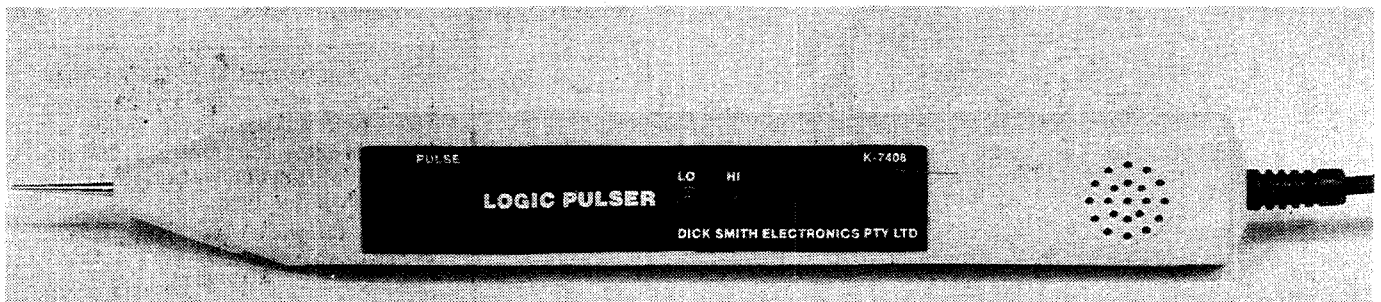
is derived from the circuit being tested. The pulse width depends upon the loading imposed by the logic circuitry.

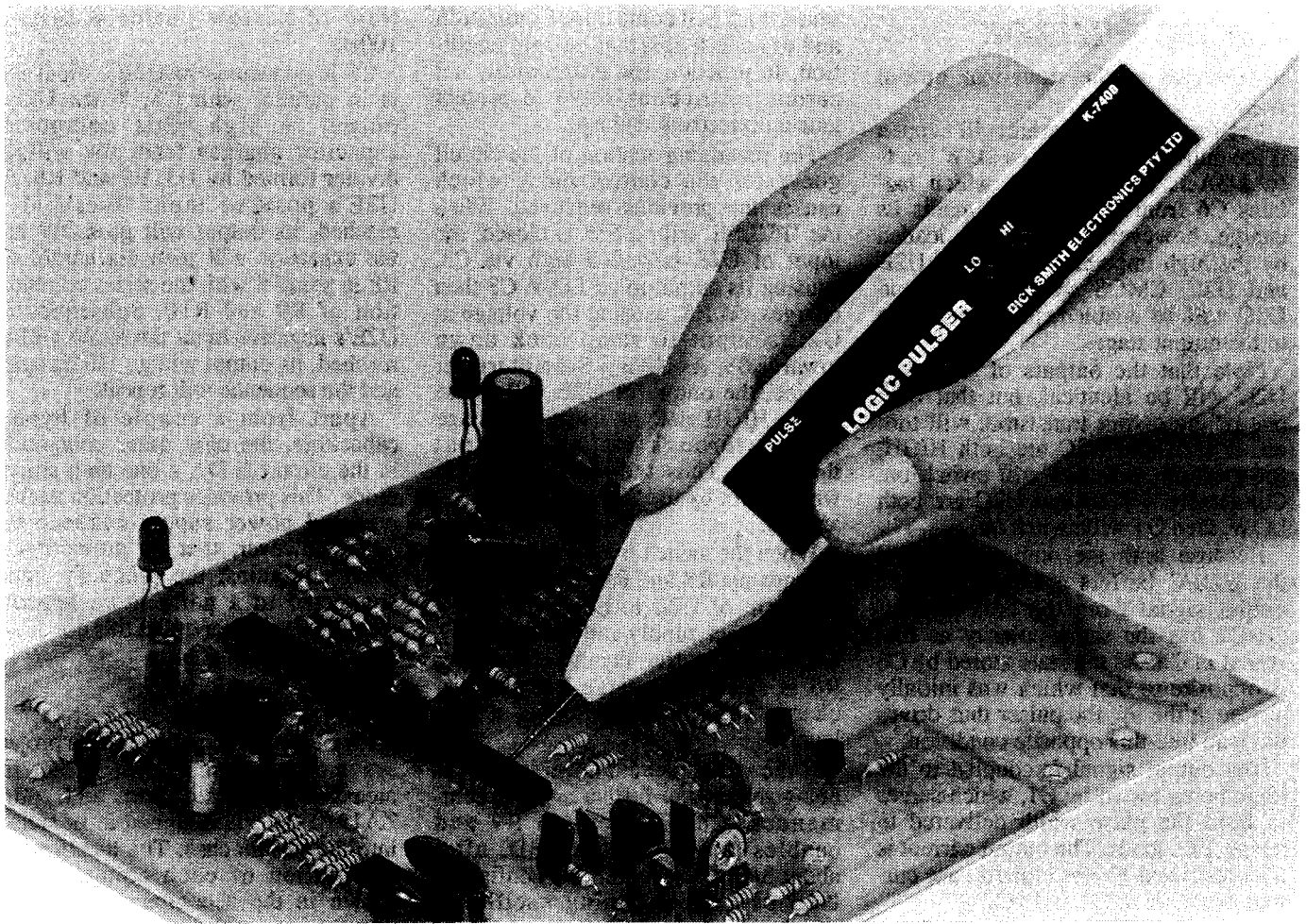
In operation, when the pulser is first connected to a digital circuit, its output is in a high impedance state and the internal circuitry 'memorizes' the existing state of the logic. The 'PULSE' button is then pressed, causing the generation of a brief pulse which drives the digital circuit into the *opposite* of that initial existing state. That is, if the circuit was initially in a HIGH state, it will be driven LOW briefly, and vice-versa.

The relatively high drive capability of the pulser is able to override the output state of most logic ICs, including high-current, TTL bus drivers. The pulser may have trouble driving a circuit having a number of active buffer outputs connected in parallel, but such circuits are rare.

The pulse width delivered to higher impedance loads, such as most CMOS circuits, is long enough to drive slow logic. When driving heavier TTL loads the pulse width is reduced, limiting the energy applied to gate outputs.

Incidentally the development of this pulser design took place at the R&D





Our new logic pulser probe is an ideal companion to the logic sensing probe described last year. With it you can temporarily force any selected point in the circuit to the opposite of its existing logic state, to test the operation of a gate, flipflop, or other logic element — or the integrity of a PCB track.

Department at Dick Smith Electronics, and as a result the PCB pattern and probe control panel artwork are proprietary to DSE. Other firms are therefore not able to supply them, but individual constructors are of course free to build up their own pulsers using the circuit, and etching their own PCB, etc.

But needless to say, DSE is marketing a complete kit for the project, with the designation K-7408 and priced at only \$24.95. So building an exact duplicate of the professional-looking pulser shown in the pictures will be particularly easy, if you take advantage of the kit.

The circuit

To see how all this is achieved, let's take a detailed tour of the pulser's circuit. We'll assume, for the moment, that the pulser has been powered-up for long enough that the various capacitors in the circuit have reached a stable condition.

The input of inverter U2E will be

pulled low by R8 and its output will be high. U3A, a CMOS switch, will be enabled, while switches U3B and U3C will be disabled because their control inputs have been inverted by U2D. Because no base current is available to output transistors Q1 and Q2, they will both be turned off and the pulser output will be in a high impedance state. R1 will ensure that C1 is kept discharged, thus the voltage level at the collectors of the output transistors will be the same as that at the pulser's tip (marked 'I/O' on the schematic).

The voltage at the tip is applied to comparator U1, which compares it with that at the junction of the resistive divider formed by R14 and R15. This divider sets the pulser's threshold voltage at approximately 45% of the supply voltage, less about 0.7V lost across D1. U1, therefore, determines whether the existing input voltage is interpreted as being a logic HIGH or LOW.

As U1 is configured as a non-inverting comparator, its output voltage, at pin 7, is simply a buffered replica of

the state at the pulser's tip. Note that resistor R13 is necessary to provide 'pull-up' current to U1's open-collector output stage.

The output of U1 is inverted by U2A and then again by U2F, which drives either of the two LEDs, D4 and D5. These LEDs are configured in a complementary manner and serve to indicate the state at the pulser's tip. If the pulser's tip is in a HIGH state, D4 will be lit, otherwise D5 will light. Thus the pulser provides a limited sensing probe capability, in addition to its main role.

This can be particularly handy when checking simple gates for example, as the main probe can be used to check the gate's output while the pulser is being used to both monitor and stimulate the gate inputs.

Returning to U2A, its output voltage charges C6 via the channel resistance of U3A. C6 is the pulser's 'memory', which stores an inverted version of the state at the tip. The voltage on C6 is inverted by U2B and U2C ready for

Logic Pulser

application to the transistor output stage.

Let's now consider what will happen if the output of U2E pulses LOW briefly. U3A is now disabled, which isolates C6 from U2A. C6 maintains its charge, however, as it is only loaded by the high impedance inputs of U2B and U2C. CMOS switches U3B and U3C will be enabled, providing drive to the output stage.

Note that the outputs of U2B and U2C will be identical, but that only one of the output transistors will turn on. If U2B and U2C are both HIGH, for example, only Q2 will switch on. Conversely if U2B and U2C are both LOW, then Q1 will switch on.

Because both the output stage and the U2B/C buffers are inverters, the output signal from the collectors of Q1/Q2 has the same polarity as that stored in C6. As the state stored by C6 is opposite to that which was initially sensed at the tip, the pulser thus drives the load into this opposite condition.

The output signal is coupled to the logic being tested by C1, which serves to limit the pulse width delivered to heavy TTL loads. The output current is also restricted by the limited base current available to Q1 and Q2.

Under heavy load conditions, these

transistors will come out of saturation and assume a constant current condition. In practice, the pulse width and current restrictions serve to protect gate outputs from damage.

The remaining section of the circuit generates the control pulse which causes the previous sequence. When the 'PULSE' button SW is closed, the input of U2E is pulled high via C3, causing its output to go LOW. C3 then charges via R8, causing the voltage at U2E's input to ramp back down towards 0V. As U2E is a Schmitt trigger device, the output of U2E will return to the HIGH state as its input voltage passes through its lower input threshold. Thus the maximum pulse width is set by the time constant of C3 and R8.

When the switch is released, C3 discharges via R6 and R7. As this causes the input of U2E to be driven below the negative supply rail momentarily, U2E could suffer damage. However R6 is sufficiently large that the discharge current is limited to a safe level.

If the switch is held down instead of being released, a further activity commences. C4 charges via R7 and enables CMOS switch U3D, after about 3/4 of a second. This configures U2E as a free-running oscillator, which causes the pulser to generate a

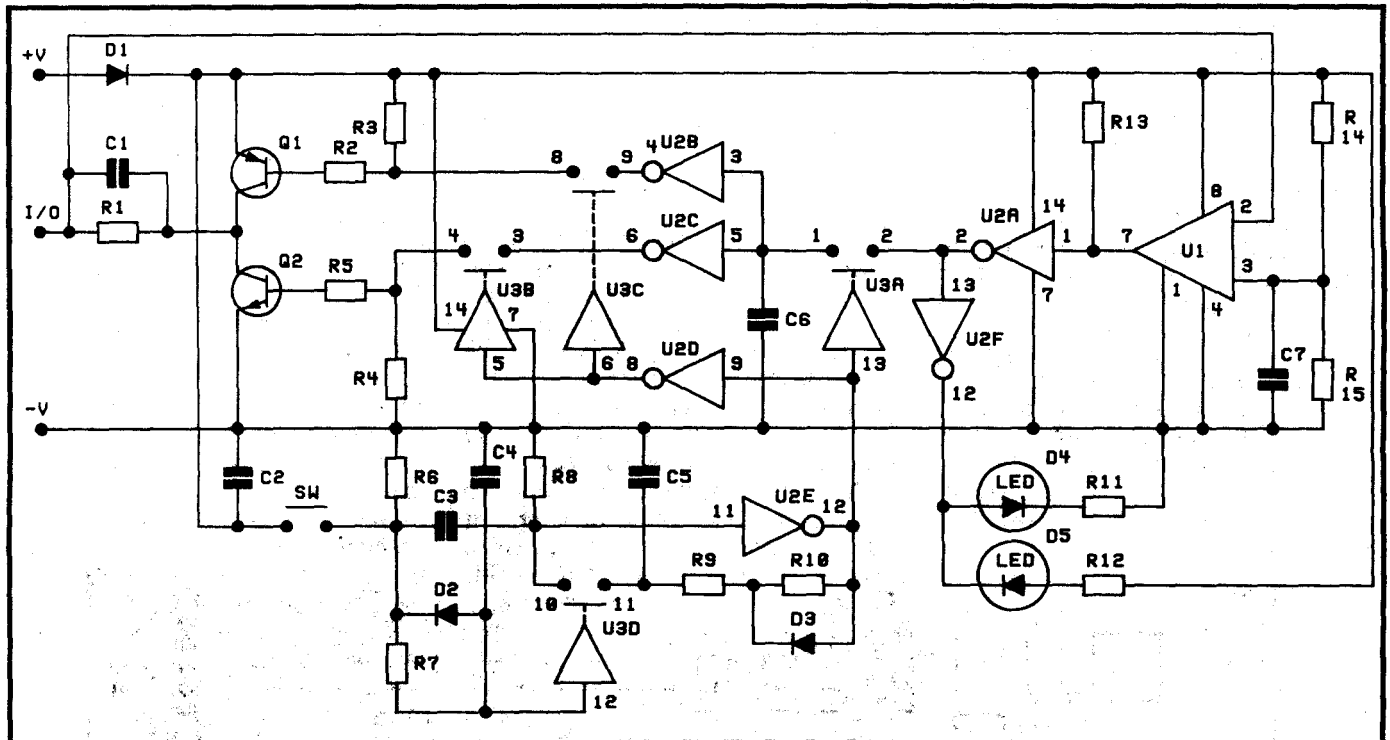
train of narrow pulses at around 100Hz.

C5 is connected to U2E's input and is in parallel with C3. When U2E's output is high, this composite capacitor charges from the voltage divider formed by D3, R9 and R8. As U2E's positive input threshold is reached, its output will go LOW and the capacitor will then discharge, via R8 in parallel with the series combination of R9 and R10. Subsequently, U2E's negative input threshold will be reached, its output will go HIGH again and the sequence will repeat.

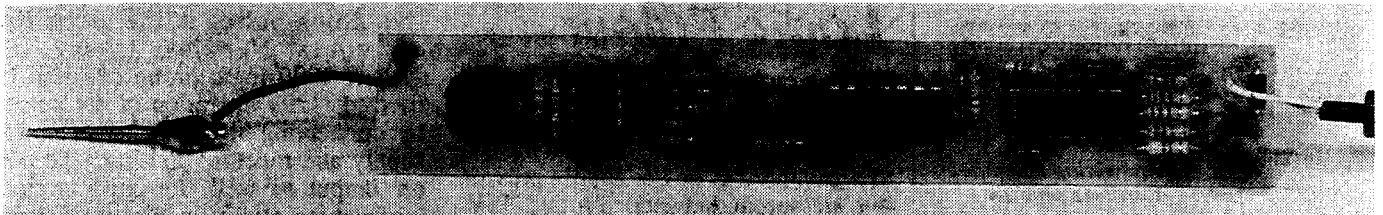
Apart from a couple of bypass capacitors, the only other component in the circuit is D1, a one amp silicon diode. This provides protection against reversed power supply connections. Note, however, that no protection is provided against the probe tip being connected to a point more negative than the 0V rail, and that this condition may damage U1.

Construction

All of the components for the project are mounted on a slim PC board measuring 134 x 21mm, and coded ZA1410. This is designed to fit snugly into the plastic case. The location and orientation of each component is shown in the accompanying overlay diagram.



The schematic of our new pulser probe. Comparator U1 senses the logic state at the I/O pin (connected to the probe tip), and sets up a charge in C6 corresponding to the opposite state. When pushbutton SW is pressed this reverse polarity signal is applied to the output stage Q1/Q2 briefly, producing the output pulse.



A view of the assembled pulser PCB board showing all the components in position. Use this shot with the diagram below to assist you in wiring up your own pulser board.

Because of the narrowness of the PCB, the copper tracks are all fairly thin, and it's a good idea to inspect the board for any etching defects before construction commences.

Begin construction by loading and soldering the resistors into the PCB, checking the value of each as it is fitted. Next fit the capacitors, ensuring that they sit as close to the board as possible so that they won't interfere with the case.

Now the semiconductors can be fitted, but leave the LEDs out for the moment. All of these semiconductors are polarity sensitive, and must be inserted exactly as shown in the component layout diagram. Note that the two transistors and the two larger ICs are different types which must be correctly located.

The LEDs should now be inserted, but don't solder them in fully as yet. These too must be correctly orientated, of course. Position them so that their bases are about 7mm above the PCB surface, and lightly solder *one* leg of each LED. Clip the LED leads, leaving at least 4mm protruding below the PCB.

Now fit the PCB to the bottom half of the case and then fit the top half of the case, allowing the LEDs to pass up through the slot in it. The LEDs should protrude through the slot as far as possible, with the case halves properly mated. Note that you may need to clip off one of the internal bracing spigots, in order to provide clearance for IC1 and the PCB.

If the case cannot be closed or if the LEDs are not protruding through the holes correctly, the LED heights can be adjusted by heating the single solder joint on each one and moving it up or down as necessary. Once a satisfactory fit has been achieved, the LEDs can be properly soldered and have any excess leads clipped.

The next step is to fit the push-button switch SW, which fits snugly against the top of the PCB. Note that the switch has four pins, which mate with four holes in the PCB.

As these are internally connected together in pairs, and are all evenly spaced in a square configuration, you need to check the orientation of the switch carefully before fitting it — otherwise it will in effect be permanently 'on'.

The correct switch orientation is visible in the photograph, with the small guide spigots on the side of the switch lined up along the long axis of the PCB.

If you have any doubts, though, check the switch connections with a multimeter before mounting it. The internally connected pairs of pins obviously connect to the linked pairs of pads on the PCB.

With the switch fitted, it can be used as a guide to cut the mating square clearance hole in the 'front half' of the probe case. Do this very carefully, by sitting the PCB in the rear half and then lining up the two so the exact hole location can be determined and

marked. Then cut it out carefully using a sharp hobby knife and/or a miniature file, using the PCB and rear case half to check on progress frequently as you near completion.

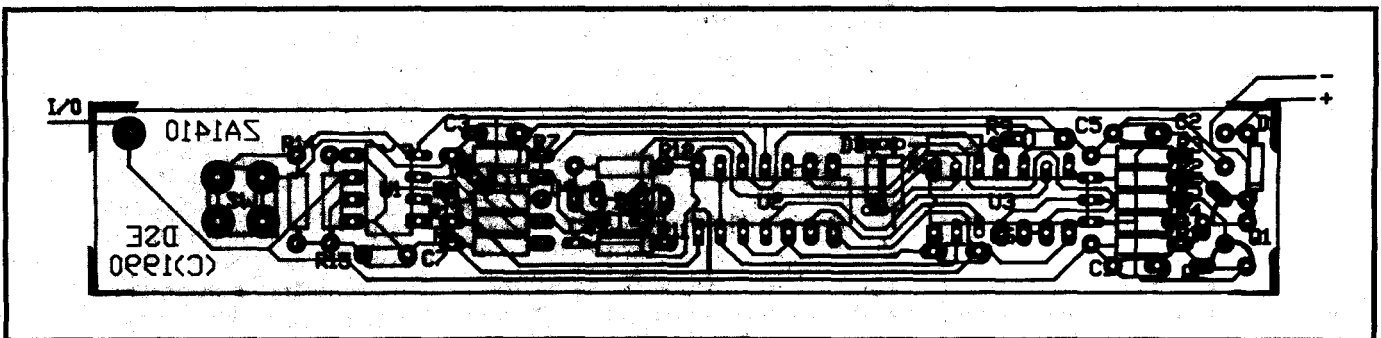
This done, prepare a 38mm length of insulated hookup wire and solder one end to the 'I/O' pad on the tip end of the PCB. Then wrap its other bared end around the short end of the tip, and solder the two together.

The remaining step is to prepare the 'inside' ends of the power cable wires, and then solder them to the '+' and '-' pads on the end of the PCB furthest from the tip. Take care to connect them the correct way around, of course — the one connected to the red clip goes to the '+' pad, and that connected to the black clip to the '-' pad.

Now that the PCB assembly is complete, take some time to inspect it carefully. Every solder joint should have a neat, shiny appearance and flow smoothly onto the PCB pads. Check for solder splashes and 'bridges', and ensure that all polarised components are correctly orientated — along with the supply cable leads.

If all appears well, the assembly can be fitted into the case and the case halves can be secured using three small PK screws. Note that the single screw used at the tip end of the case is shorter than the other two.

Finally, peel the backing paper off the panel label, line up the label with the switch and LEDs, and apply it to the top of the case.



And here's the PCB wiring overlay diagram, to give you further guidance in constructing your pulser.

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Logic Pulser

Testing it

To test the completed pulser, connect its positive and negative supply leads to a suitable DC power supply providing an output between 5V and 15V. Then touch the probe tip to each supply rail in turn, and observe the LEDs. These should indicate 'LO' and 'HI' respectively, for the negative and positive rails.

Now connect a 4.7k resistor to the negative supply rail, and touch the pulser's probe tip to the free end of the resistor. The 'LO' LED should again glow, but when you press the 'PULSE' button briefly, the 'HI' LED should glow very briefly to indicate that a positive pulse has been produced.

Holding down the PULSE button for about a second should cause the HI LED to flicker continuously, indicating the generation of a train of narrow pulses. If you have an oscilloscope, this can also be used to monitor the voltage at the probe tip, and observe the positive-going output pulse(s).

Assuming all seems well so far, swing the 4.7k resistor over to the positive supply rail, and repeat the same test. This time the HI LED should glow strongly, with the LO LED flickering either briefly or continuously in response to the PULSE button.

The 'scope should now show nega-

tive-going pulses at the probe tip, of course. Needless to say, the August 1990 logic probe can also be used to verify operation of the pulser, by connecting it to the same power supply and touching its tip to the pulser output as well. Its pulse stretching/latching facility will make it quite clear that output pulses have been generated. If you don't get the above results with these tests, it's time to open up the pulser and look for wiring errors. But if everything checks out OK, your pulser should be ready for business.

Using the pulser

A logic pulser and sensor probe are used in much the same way as a signal injector and tracer are in audio and RF circuits. The pulser injects a stimulus signal at some point and the progress of this signal is then traced through the circuitry using the logic probe. If at some point the stimulus signal disappears, then that area of the circuit warrants closer inspection.

One important point to note when using a pulser and probe is that they should always be powered from the same supply as the circuitry under test.

Failure to detect the signal from the pulser at a particular point can indicate a number of possible faults such as broken PCB tracks, dry solder joints, functional failures inside an IC and shorted tracks, gate inputs or gate outputs.

Broken tracks and poor joints are usually easy to confirm or eliminate as a cause, by probing for the signal right at the IC pins and at places along the PCB tracks. If a functional failure or short is suspected, it is always worthwhile to first verify that every IC connected to the particular point has valid supply voltages right at its supply pins. Shorts are usually difficult to isolate, without the use of more expensive test equipment such as a current tracing probe. While metallic shorts between PCB tracks can often be located by close visual inspection, internal IC shorts can totally confound, sometimes intermittently appearing as signals change on other lines, or disappearing when power is removed. If all else fails, it often becomes necessary to remove an IC and do some further testing, or replace it with another.

Whether you construct digital projects as a hobbyist or troubleshoot digital equipment professionally, this logic pulser should prove to be a valuable addition to your workbench.

PARTS LIST

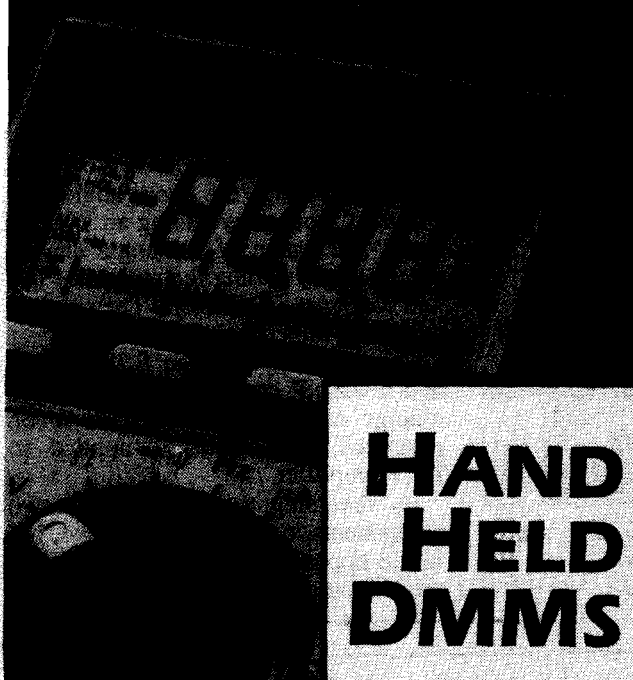
- 10 10m 1/4W resistor R2, R5
- 1 10m 1/4W resistor R6
- 2 10k 1/4W resistor R7, R12
- 2 2k 1/4W resistor R15
- 5 4.7k 1/4W resistor R1, R3, R4, R10, R14
- 1 10k 1/4W resistor R10
- 2 10k 1/4W resistor R8, R9
- 1 10k 1/4W resistor R7
- 1 0.01µF ceramic cap C3
- 5 0.1µF monolithic cap. C2, C4, C5, C6, C7
- 1 1µF monolithic cap C1
- 1 1N4002 diode D1
- 2 1N4148 diodes D2, D3
- 2 3mm red LED D4, D5
- 1 BC108 PNP transistor Q1
- 1 BC108 PNP transistor Q2
- 1 2N3858 JFET U1
- 1 2N3858 JFET U2
- 1 2N3858 JFET U3
- 1 2N3858 JFET U4
- 1 2N3858 JFET U5
- 1 2N3858 JFET U6
- 1 2N3858 JFET U7
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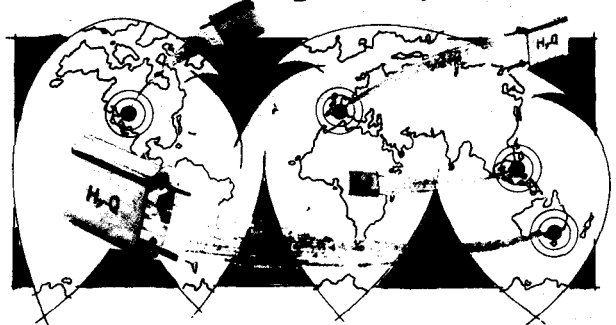
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READER INFO NO. 27

Construction Project

Simple CRO adaptor tests solid state devices

Cathode ray oscilloscopes have traditionally been used to display the voltage level of signals. But they can also be used to compare the frequency or phase of two signals by drawing Lissajous figures. Using the simple circuit described, and the Lissajous figure reference chart provided, the oscilloscope can become a very useful tool. It can identify unknown devices, check whether they are defective, and even identify their pin connections.

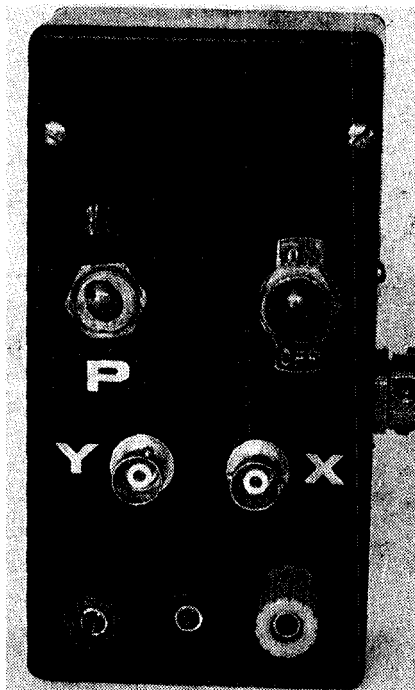
by **BEN TAKACH**

The cathode ray oscilloscope (CRO) is widely used in service work to detect the presence of signals, and to examine their shape.

CROs have also been used during the past decades as sensitive voltmeters. However, the popular, and more convenient, digital multimeters are now more likely to be used to measure levels of even feeble signals.

Another task, which one can conveniently carry out with a CRO, is the comparison of signal frequencies. Two signals of different frequency, fed to the X and Y deflection systems will produce a Lissajous figure. A frequency ratio of 1:1 will normally produce a circle, while a 2:1 ratio (the X frequency is twice the Y frequency) will form the figure '8'. The well known shape of the ABC TV logo is also a Lissajous figure, formed by a 1:3 frequency ratio. The higher the frequency ratio, the more complex is the displayed geometrical shape.

If the two applied frequencies are equal, then the ratio is 1:1, and only certain basic shapes can be produced.



The author's unit. The S/P switch (signal/power) is referred to as H/L (high/low gain) in the text.

These are straight lines, circles and ellipses. The actual shape depends on the phase difference of the signals fed to the X and Y amplifiers. Fig.1 illustrates the Lissajous figures produced by various phase differences. As the phase angle increases, the straight line becomes an ellipse, and then a circle when the phase change is 90°. A change of 180° returns to the straight line, but its direction has rotated 90°. The changing pattern continues, until the displays repeat after 360°.

We can change the phase angle of a given AC source by adding an RC network. The value of the angle can be calculated by adding the resistance (R) and reactance (X) vectors. Their sum is called the impedance (Z).

Fig.2 shows how an 8.2k resistor and a 0.22µF capacitor cause a phase change of 60°. In the circuit to be described, this signal is applied to the X amplifier.

By reversing the order of the two components, a further 30° change, but in the opposite direction, is applied to the Y input. This makes a total relative

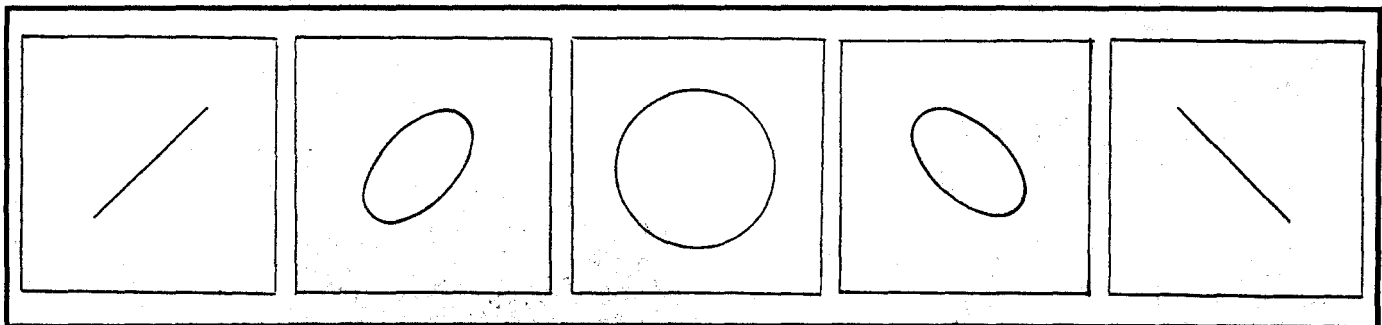
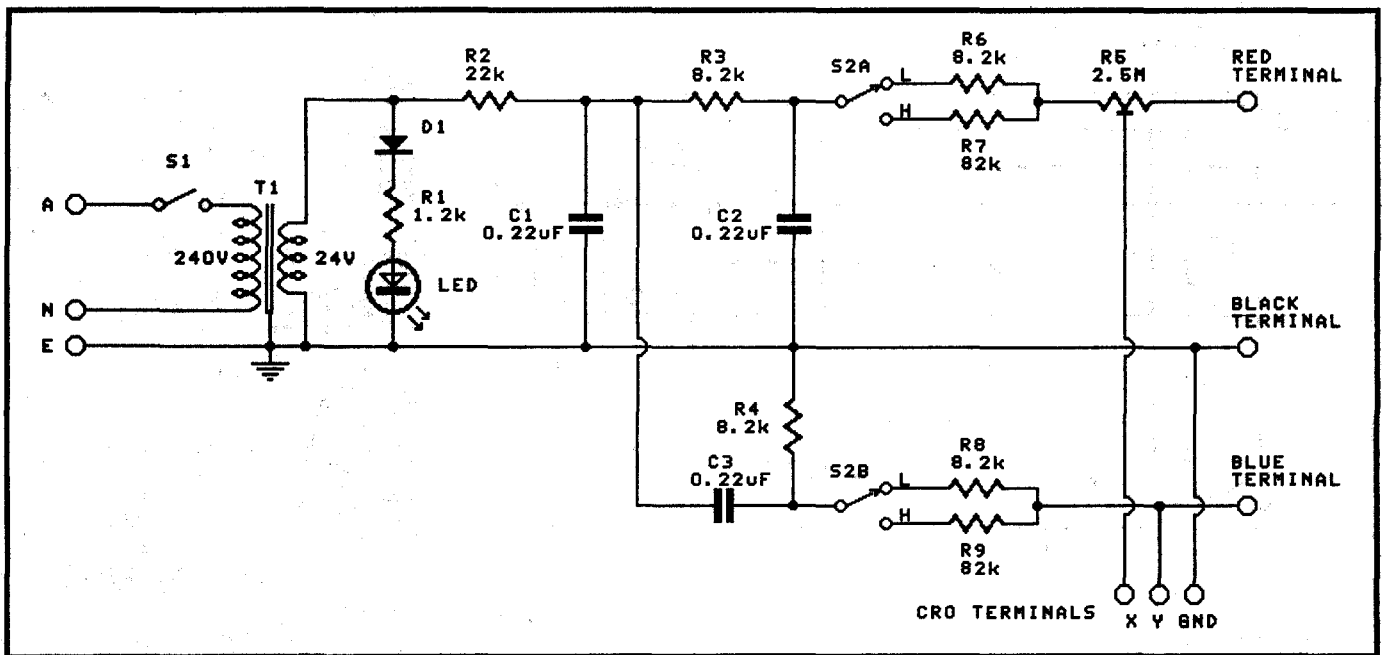


Fig. 1: With a frequency ratio of 1:1, different Lissajous figures will be drawn as the phase difference between X & Y changes. From left-to-right, the phase differences are 0, 45, 90, 135 and 180 degrees respectively..



The simple circuit for the CRO adaptor. The 90 degree phase difference between the signals applied to the X and Y CRO terminals is provided by R3/C2 and C3/R4. Switch S2 provides two levels of attenuation for the signal, while R5 allows a setup adjustment for the X amplifier gain.

phase change of 90° between the signals fed to the X and Y inputs.

The value of the reactance of the capacitor is given by the formula: $X_c = 1 / 2\pi fC$.

For a 0.22µF capacitor and a frequency of 50Hz, $X_c = 14.5k$.

Adding vectorially the resistance of

8.2k to the reactance of 14.5k, we end up with an impedance of 16.6k ohms.

The simple CRO adaptor described here applies these basic concepts so that we can test transistors, diodes, unijunctions, triacs, SCRs and zener diodes in a more or less dynamic mode.

The adaptor also allows us to identify unknown devices, and to determine the pin connections. Using commonsense and logic, one can determine the condition (in most cases) of solid state components in a circuit.

Naturally, due allowance has to be made for any resistances in parallel with the device under test. Unfortunately, I cannot claim credit for the designing the circuit.

It came to me, so to speak, third-hand. Martin Michaelis, a German radio amateur (DK1MM), published the details, which were picked up and reprinted in the *Practical Wireless* (1987/12).

It was then reprinted in the Hungarian magazine *Radiotechnika* (1990/1), where I spotted it.

The circuit is quite simple and does not contain any active components. I have modified it slightly to make it easier to use.

How it works

A 24V AC signal from the transformer (T1) is split into two components, which are phase-shifted by a total of 90° by R3/C2 AND C3/R4. When fed to the X and Y amplifiers,

they produce a circular pattern on the screen. The two signals are also applied to the device under test, connected to the red, black and blue terminals. Depending on the functioning of the device, it will modify the circular display in different ways.

The two pole change-over switch (S2A & S2B) is used to select a suitable sensitivity for low (L) or high (H) gain devices. For example, select 'L' for a power transistor which has a low gain, but 'H' for a signal transistor which has a high gain. The positioning of the switch is not critical.

The 2.5M attenuator (R5) on the X

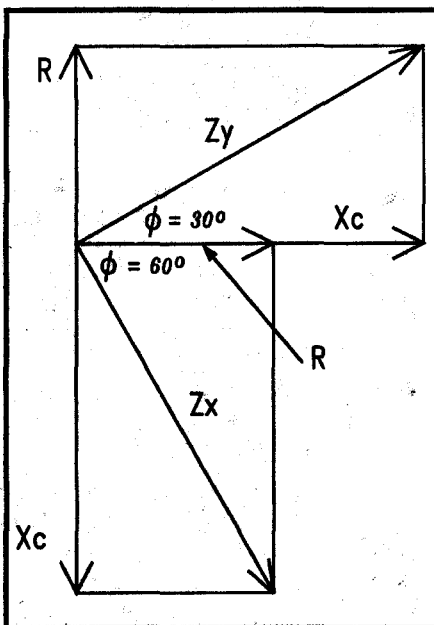


Fig.2: The use of a pair of RC circuits produces a phase shift between the signals fed to the X and Y amplifiers. Resistor R3 and capacitor C2 give the 60 degree shift for Zx, while R4 and C3 give the 30 degree shift for Zy. Zx and Zy then differ by 90 degrees.

EXCESSIVE REVERSE CURRENT			
TYPE	C-B	C-E	B-E
PNP			
NPN			

TYPE	A-G	A-C	G-C
UJT			

Chart 2. Some of the displays obtained when excessive reverse currents flow in the devices.

CRO Adaptor

TRANSISTORS							
TYPE	GOOD	SHORT CIRCUIT			OPEN CIRCUIT		
		C - B	C - E	B - E	C	B	E
PNP							
NPN							
PNP DARLINGTON							
NPN DARLINGTON							

CONNECTIONS: RED - COLLECTOR, BLACK - BASE, BLUE - EMITTER

SCR							
GOOD	GOOD, A & C REVERSED	SHORT CIRCUIT			OPEN CIRCUIT		
		A - G	A - C	G - C	A	G	C

CONNECTIONS: RED - ANODE, BLACK - GATE, BLUE - CATHODE

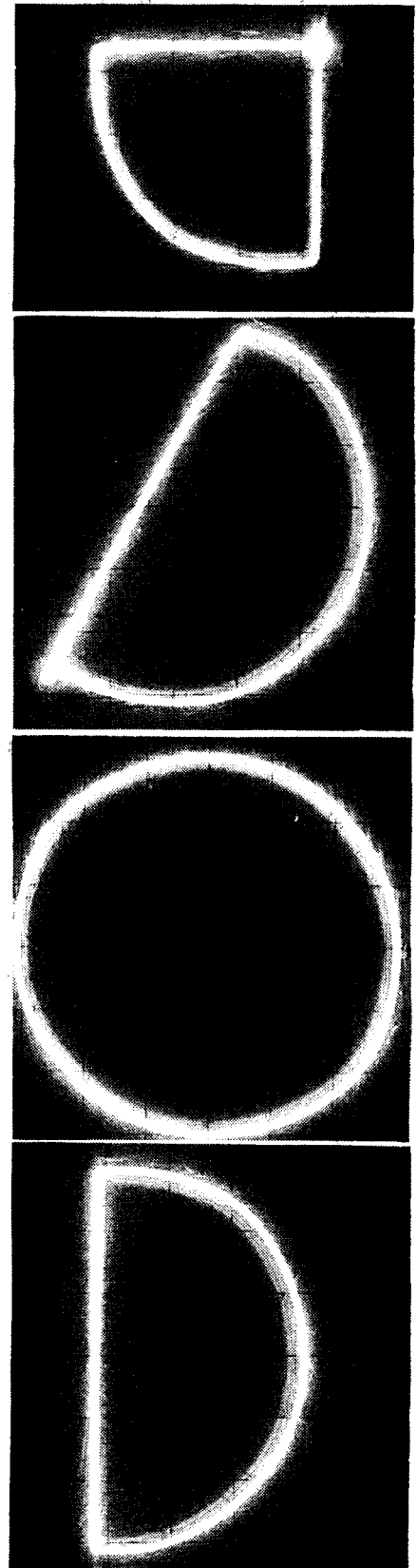
UNIUNION							
GOOD	GOOD	SHORT CIRCUIT			OPEN CIRCUIT		
		B2 - B1	B2 - E	B1 - E	B2	B1	E

CONNECTIONS: RED - BASE 2, BLACK - BASE 1, BLUE - EMITTER

DIODE AND ZENER DIODE					TRIAC		
DIODE GOOD	GOOD, REVERSE CONNECTED	ZENER DIODE GOOD	SHORTED	OPEN CIRCUIT	T1 - T2 CONNECTED	G ALSO CONNECTED	

CONNECTIONS: RED - CATHODE, BLACK - NOT USED, BLUE - ANODE

RED - TRIG 1, BLACK - GATE, BLUE - TRIG 2



At top is shown a correctly functioning PNP transistor; second — an NPN Darlington transistor with an open circuit base; third — a triac with both triggers connected; and last — a good SCR, but with anode and cathode connections reversed.

Chart 1: The CRO displays for good and bad devices. The diagrams on the left show correctly functioning components, while those on the right show the modified displays caused by short and open circuit faults in the components.

input is a trim-pot which allows a set-up adjustment to match the X-amplifier of the CRO to the adaptor. It might not even be needed.

However, without it, the size of the circle may be too large to fit on the screen, since, on most oscilloscopes, the attenuation range of the X amplifier is much smaller than that of the Y amplifier.

The main switch (S1) and the LED indicator (D1, R1 & LED) are non-essential components, especially if the mains power is taken from the equipment under test. However, the LED is a very useful indication that the circuit is activated.

Layout and wiring are not critical, nor is the size of the power rating of the transformer. What is important is that the connecting coaxial leads to the X and Y terminals of the CRO, and the test leads, should be kept as short as possible.

Naturally, the 24V input voltage will limit the unit's usefulness for testing zener diodes. The characteristic zener pattern will only be produced by zener diodes which are rated at less than 24V. Higher rated zeners will draw a conventional diode display on the screen.

Chart 1 shows the expected displays

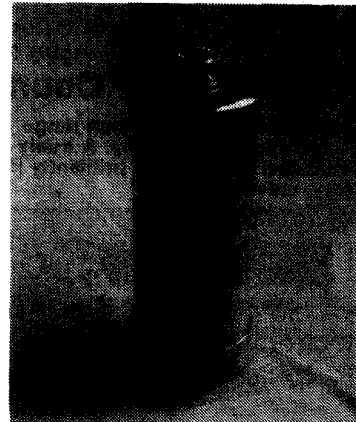
and the pin connections of several common devices. If the device under test is wrongly connected, then excessive reverse current can flow through it. Chart 2 show the distorted displays produced when such currents occur in PNP, NPN transistors and SCRs. Depending on the level of the reverse current, several different diagrams can be produced.

To use the CRO adaptor for a different device, simply compare the display of a new component with the display from the one you wish to check. The various patterns of each type of component are distinctly different.

This simple device has saved me many hours of frustrating searching for, and the unnecessary replacing of, suspect components. It overcomes the uncertainty of in-circuit testing.

I have used this unit when working on industrial PLC I/O cards. Since PLCs usually contain multiple I/O cards, simple comparison tests can be carried out. Any variation of the displayed Lissajous figure, from that of a known good card, will pinpoint the culprit.

Due to the simplicity of the circuit, a component lay-out drawing has not been provided. ■



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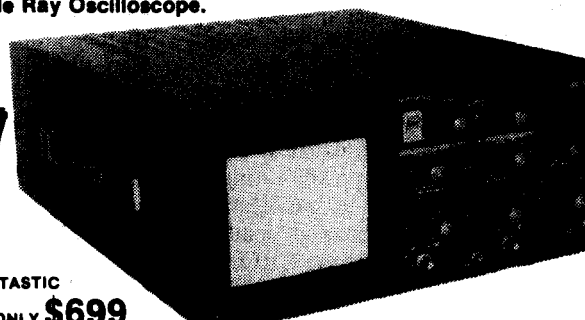
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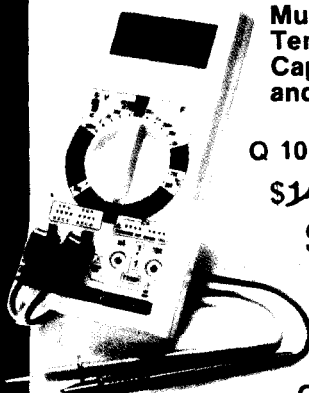
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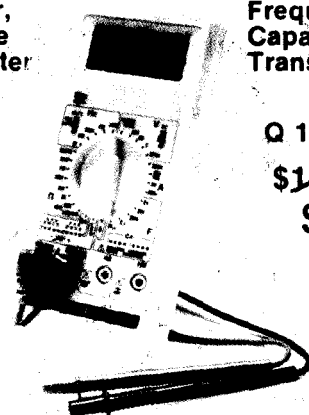
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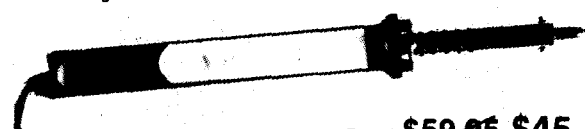


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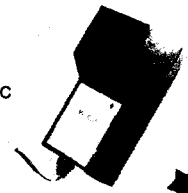
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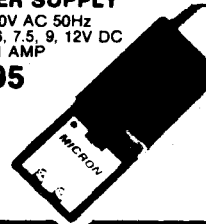
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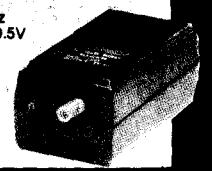
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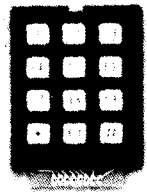
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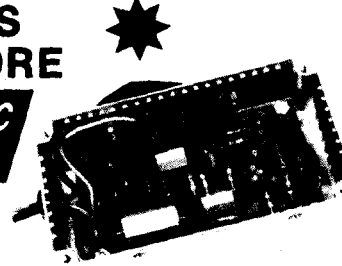
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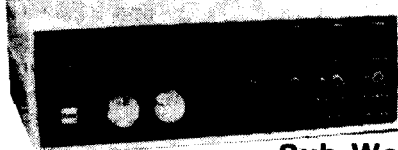


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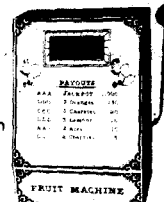
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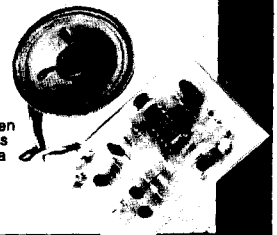
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Construction Project:

NEW CRO ADAPTOR FOR MONITORS - 2

In this second article describing our new digital CRO adaptor for video monitors, we present construction details for the PCB that contains the input amplifier and the graticule generator. Combine this board with that described in Part 1, and you'll start seeing a video display.

by PETER PHILLIPS

Last month we introduced our all new video-CRO adaptor project and described the construction and adjustments for the PCB that generates the TV sync signals. This board, referred to as PCB1 also has other sections of the circuit, and should be constructed before the board described in this article.

This month we describe PCB2, which includes the 12V dual polarity power supply, the input amplifier and the circuit that produces the calibrated grid. This board is the simplest part of the project, and the grid generator section can be made fully operational in readi-

ness for the final article. The case is also described, so you can have it ready to integrate all three boards when the final article is published.

About PCB2

This board contains the signal amplifier and the circuitry to generate a grid pattern which can be used to allow the frequency or the amplitude of a waveform to be measured.

It also has the power supply that produces the dual polarity 12V supply used by the amplifier on PCB2 and other circuitry on PCB3. We'll look first at the amplifier, which was surpris-

ingly difficult to design. Considering the rather tricky digital circuitry of PCB1 and PCB3 (when it is published), it would seem that a bit of analog design would be a welcome relief. As it turned out, getting an amplifier with a frequency response of 1MHz and a gain of over 130 proved very difficult. Initial attempts used transistors, but when it was decided to incorporate DC coupling, it seemed op-amps were the only way.

The final design is not perfect, but its relative simplicity and low cost were prime factors in my decision not to try for further improvements. When everything was first translated to a PCB, it also included two comparators associated with the circuit. However the switching transients from the comparators affected the operation of the amplifier, despite all efforts to isolate the supply lines and to provide lots of decoupling.

This meant a complete redesign of the PCB, and when Part 3 of this project is presented you'll notice that the comparators driven by the amplifier on PCB2 are located on PCB3. It was the best and simplest way to overcome that bane of all analog circuits: noise. Apart from switching noise, there is also noise generated by the op-amps themselves — explaining why there are two outputs from the amplifier, the x1 and the x5 output. In the original design, the only output was from IC104, but to minimise the effects of noise this was changed to give the present design by taking an output from IC103 and to call this the x1 output. This still allows a 50mV peak to peak signal to span one division of the grid, which is a good sensitivity anyway. For those times when extra sensitivity is

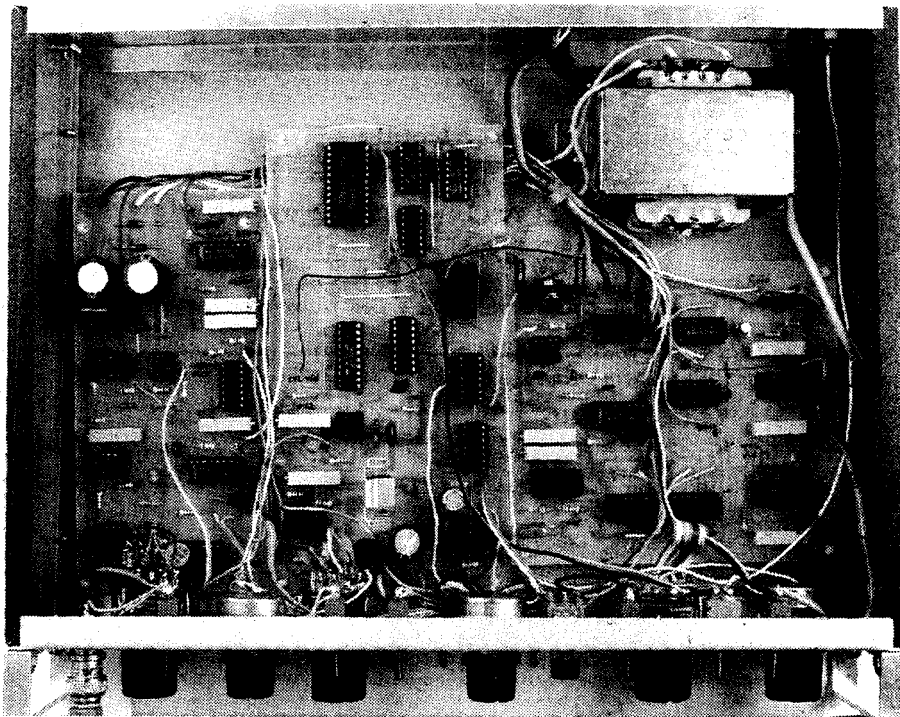
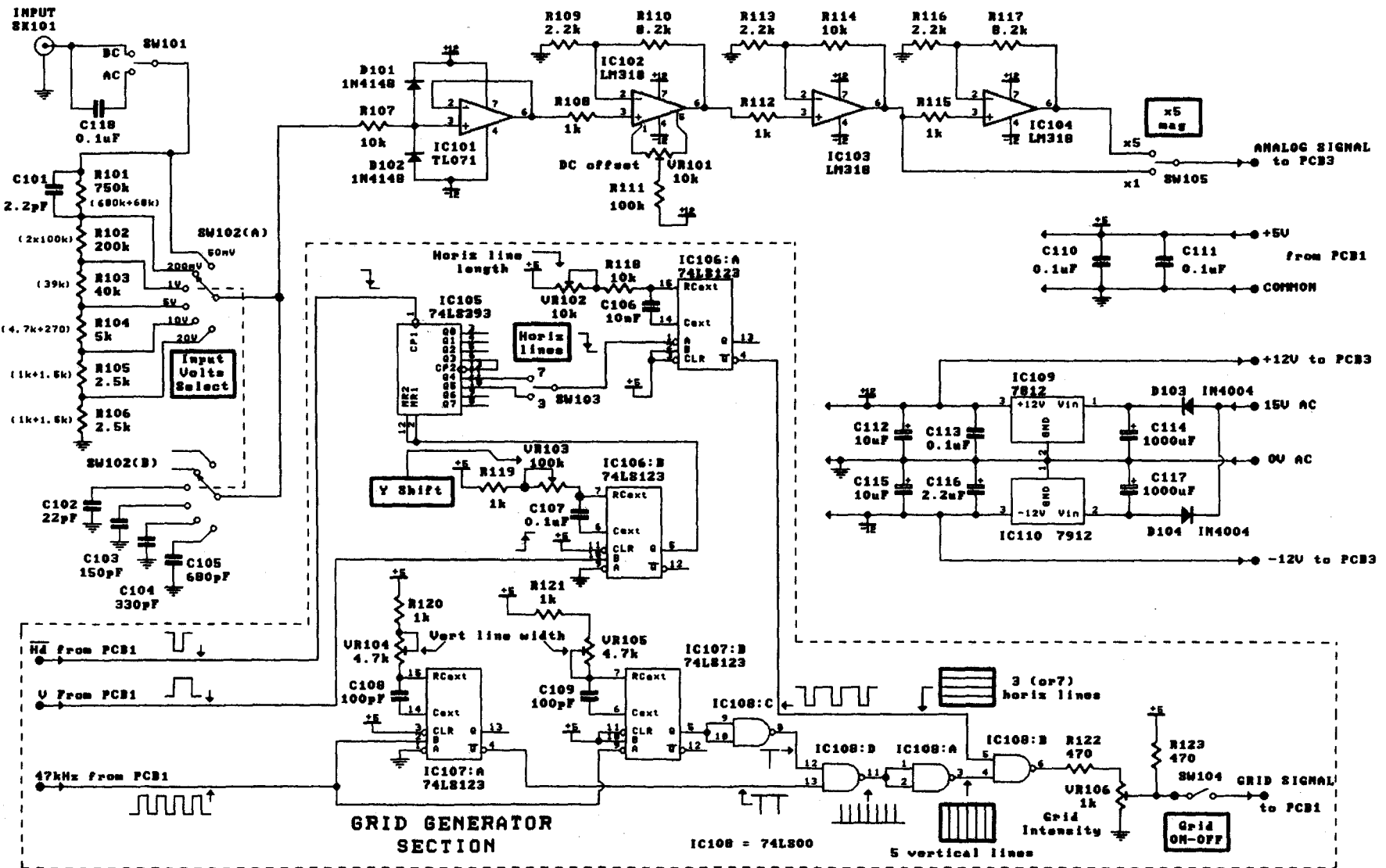


Fig.1: A taste of things to come. This shot shows how everything fits inside the case. PCB1 is on the right, PCB3 in the centre and PCB2 on the left.



The circuit schematic for PCB2 contains the signal amplifier, the grid generator and the voltage regulators for the +/-12V supply. Note that VR103 is a front panel control, while VR101, VR102, VR104, VR105 and VR106 are internal presets.

Video CRO

needed, (down to 10mV per division) the added noise will be obvious though not significant.

The choice of op-amps was based on cost and availability, and although there are op-amps with lower noise figures than the LM318 (like the NE5534) they are more difficult to use and the design would have been further complicated. But the so-called 'low noise' op-amps such as the TL071, LF351, the CA3130, CA3140 and the ubiquitous LM301 all proved useless in this application, except for the input voltage-follower stage.

Another design problem was the input attenuator. As well as selecting a suitable range of input voltages, the design was complicated by the capacitance of the switch and associated circuitry. To illustrate, a 1pF capacitance represents an impedance of around 160k ohms at 1MHz. Thus when the rest of the circuit has an impedance of 1M ohm, it becomes obvious that tiny capacitance values become a real problem. Unless you want to figure out your own compensating network, we strongly advise that you use the same wafer switch used in the prototype. This switch is available from Dick Smith Electronics, and has the catalog number P-7510.

The circuit to generate the calibrated grid consists of a counter and four timers that collectively generate the horizontal and vertical lines. An interesting feature of this circuit is the so-called 'Y-shift' control.

While it is possible to move the signal display across the screen, it is not technically feasible to move it vertically. To provide this feature, the answer was to make the grid position adjustable. Thus, the Y shift moves the grid,

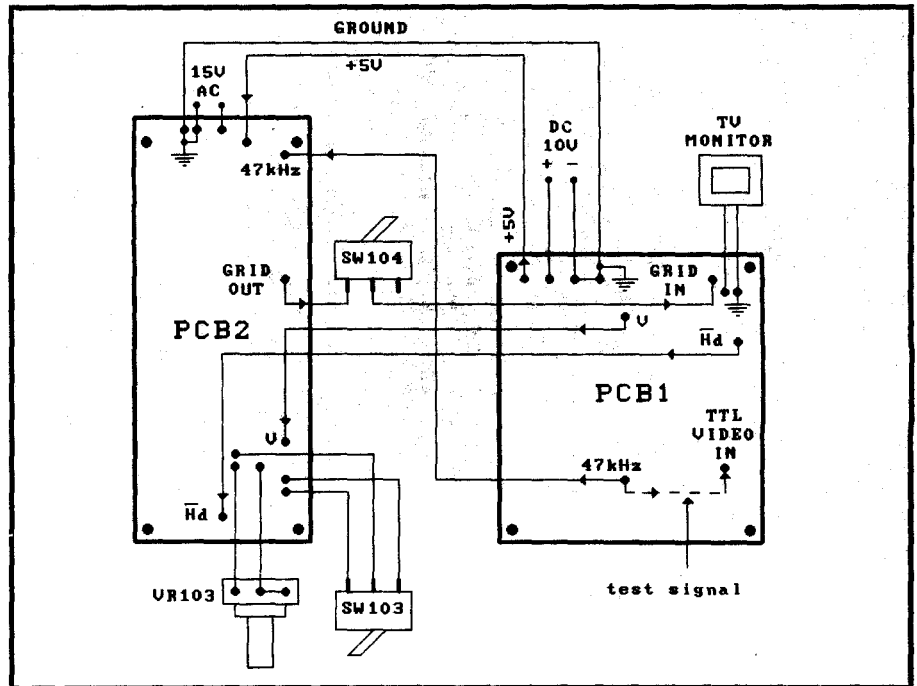


Fig.2: These are the connections required between PC1 and PCB2 to complete all the adjustments for PCB2.

while the X shift moves the waveform. The grid has five vertical lines, but the number of horizontal lines can be either three or seven, selectable with SW103. The attenuator is calibrated (V/div) for a peak to peak signal related to the seven line setting, but by switching to three lines, the display is less crowded. Having given some background, here's how everything works.

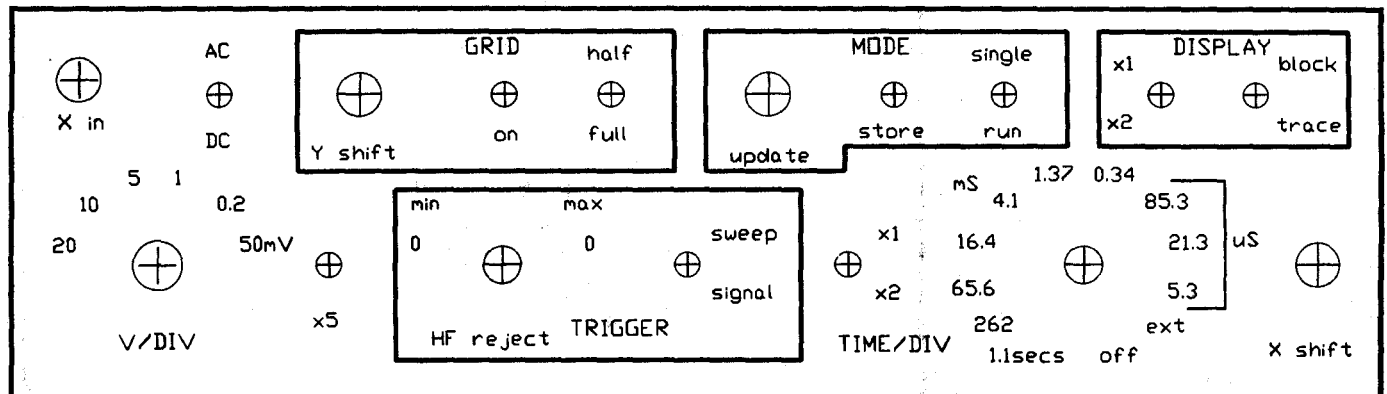
How it works

The input signal is applied to the BNC socket SK101 and SW101 selects either AC or DC coupling. Note that C118 should have a voltage rating of 500V or so, to give adequate protection against a DC component. The attenuator switch provides six levels of

input to the amplifier, and the values shown on the circuit are the theoretically correct values.

Because these resistor values are not readily available, two resistors are required to give a close approximation for all except R103. The suggested values are shown on the circuit diagram and the details of how to mount these resistors are shown in Fig.4.

Frequency compensation for the switch and circuit capacitance is provided by C101 to C105, and these capacitors also mount on the switch. The wiper of SW102A supplies signal to the protection network of R107, D101 and D102. Either D101 or D102 will conduct when the input to IC101 exceeds +/-12.6V, with R107 limiting



This front panel design will fit the case described in the text but can be adapted as required. The calibrations for the TIME/DIV switch are a function of the master oscillator frequency. It is shown here 65% of full size, to fit on the page, enlarge to 125% for full size.

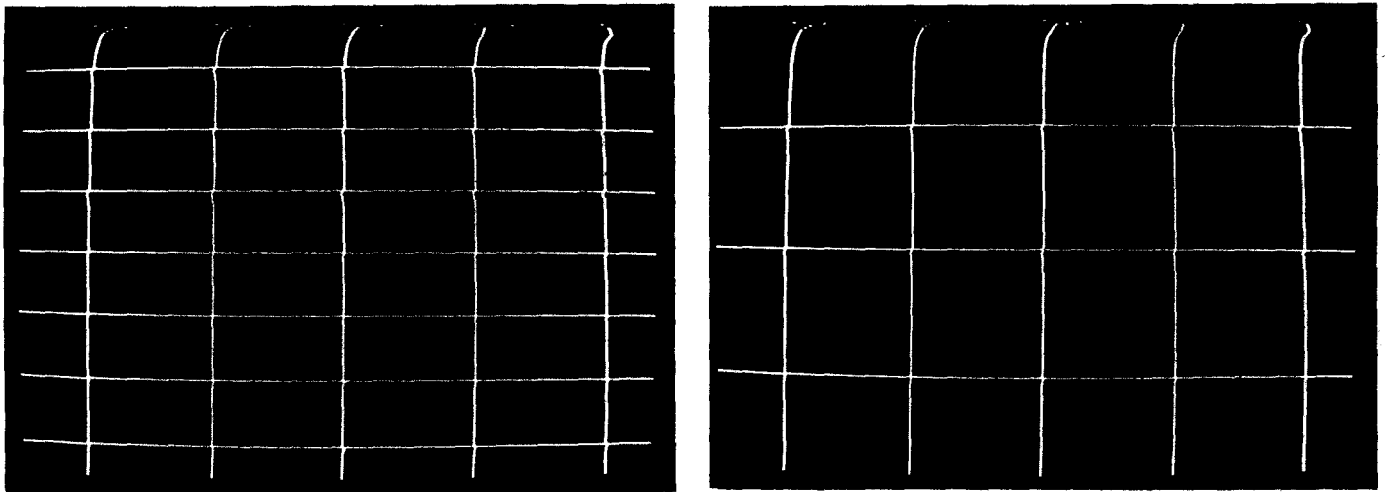


Fig.3: The grid display should look similar to that shown in Fig.3(a) when seven horizontal lines are selected, and like that in (b) for three lines.

the current flowing in the diodes. The signal is buffered by IC101, which is connected as a voltage follower. The output of IC101 connects directly to the first of three non-inverting amplifiers comprising IC102, IC103 and IC104. These three op-amps are all LM318's, chosen for their relatively high bandwidth and low noise figure. Because the whole amplifier is DC coupled, the DC offset control VR101 is required for IC102 and is set to give 0V at the output of IC103.

The theoretical gain of both IC102 and IC104 is 4.72, while IC103 has a gain of 6. This gives a total gain of 133.6 for all three stages and a gain of 28.3 at the output of IC103. The required output is selected by SW105 and the resulting signal is then fed to PCB3, where it is converted into a digital signal for storage in the memory IC.

The grid generator uses three timing signals developed by PCB1 and produces five equally spaced vertical lines and seven equally spaced horizontal lines. The vertical lines are developed by the dual timer IC107 and the trigger for both timers has a frequency exactly three times the horizontal scan rate of the TV monitor.

The timer of IC107(a) responds to the positive edge of the trigger signal (labelled as 47kHz on the circuit but actually 46.875kHz) and the other timer triggers on the negative edge of the signal. The sequence starts when a horizontal sync pulse occurs on the first of three cycles of the 46.875kHz waveform. When this pulse is generated, an output pulse will also be produced by IC107(a).

Although this pulse would normally produce a bright spot on the screen, it will not be visible as the beam will be retracing across the screen. However,

10.6us later, the negative edge of the trigger signal will cause an output from IC107(b) which will appear as a bright spot on the left of the screen.

This sequence will continue, in which every 10.6us either timer (a) or (b) produces a spot on the scan line. Thus five spots appear on each scan line, with the sixth hidden by the horizontal retrace. The outputs of the timers are gated together with the NAND gates of IC108 and the width of each spot is set by VR104 and VR105.

The settings of these trim pots determine the width of the output pulse from each timer and thus set the width of the vertical lines.

The horizontal lines are produced by the counter of IC105 and the timers of

IC106. The counter is clocked by the pulse referred to as Hd-bar, which was described in Part 1. Two outputs from the counter are connected to SW103, which selects either seven or three horizontal lines.

When the selected output goes low, it will trigger the timer of IC106(a) and this timer is adjusted with VR102 to give an output of around 60us, or the width of one horizontal scan line.

A complete field has 256 horizontal lines and the counter outputs used provide division by 32 (seven lines) and 64 (three lines). Thus if seven lines are selected with SW103, a line will appear on the screen after 32 scan lines; or if three lines are selected, after every 64 scan lines. As elementary division will

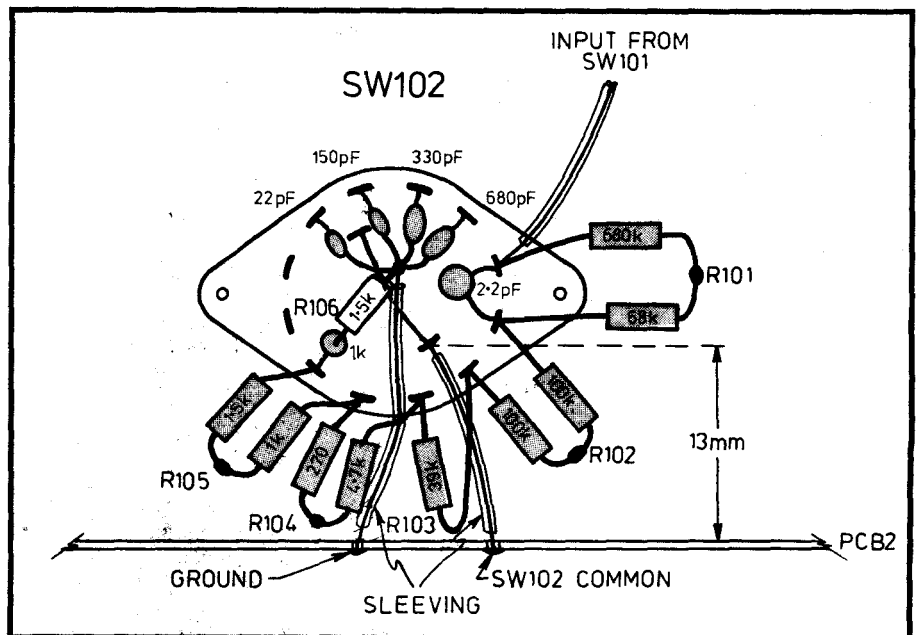


Fig.4: A rear view of the attenuator switch and all associated components. The resistors should be mounted vertically, and the ground end of the capacitors and R106 are solder together to form a self supporting junction.

Video CRO

show, this gives respectively eight or four lines per field, with one of these lost during vertical retrace.

To allow these lines to be moved, the counter is reset by the timer of IC106(b), which in turn is triggered by the positive edge of the vertical sync pulse. If the counter was reset by the vertical sync pulse, the position of the horizontal lines would remain stationary, with the first line occurring 32 scan lines after vertical retrace.

The counter is reset by a logic 1, and it will remain in the reset condition for the duration of a logic 1 at the reset terminals, pins 12 and 2. The timer extends the duration of the reset pulse and depending on the setting of VR103, the position of the horizontal lines can be moved by up to 32 scan lines. The vertical and horizontal lines are gated together with the NAND gate of IC108(b), which has its output applied to VR106. This potentiometer gives a degree of adjustment to the intensity of the grid, although this may not be obvious on a TTL monitor as opposed to a composite monitor. The grid can be turned on or off with SW104 and R123 maintains the DC conditions of the video output amplifier on PCB1 when the grid is turned on.

Construction of PCB2

Construction of the PCB is quite simple, as being largely analog, there are only four links, and all tracks are widely spaced (well — nearly all). After confirming that the PCB is free of faults, drill the four mounting holes to suit the mounting hardware you intend using.

Fit the four wire links first, then solder all the IC sockets in place. Sockets are not essential, but are highly recommended. Then stock the PCB with the passive components as per the layout diagram, leaving the large electrolytic capacitors (C114 and C117) until last. Take care with the polarity of the tantalum capacitors (C112, C115 and C116), and the four diodes. Also carefully observe the orientation of the two regulator ICs.

The trim pots are all 10-turn types, although the PCB pattern will allow conventional vertical mount types to be used for VR102 and VR106 as their setting is not critical. Once the board is fully stocked, but before any ICs are fitted or the external switches and wiring are attached, the power supply section should be tested. As described,

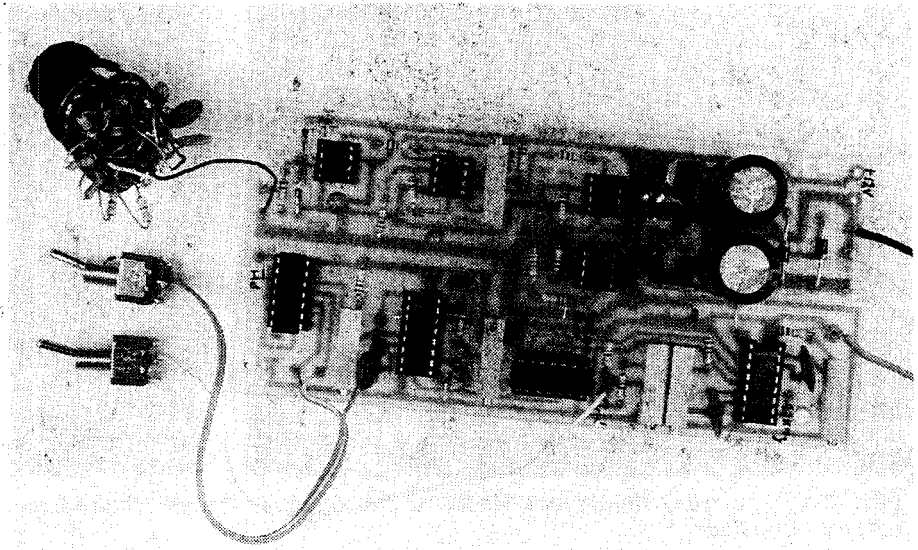
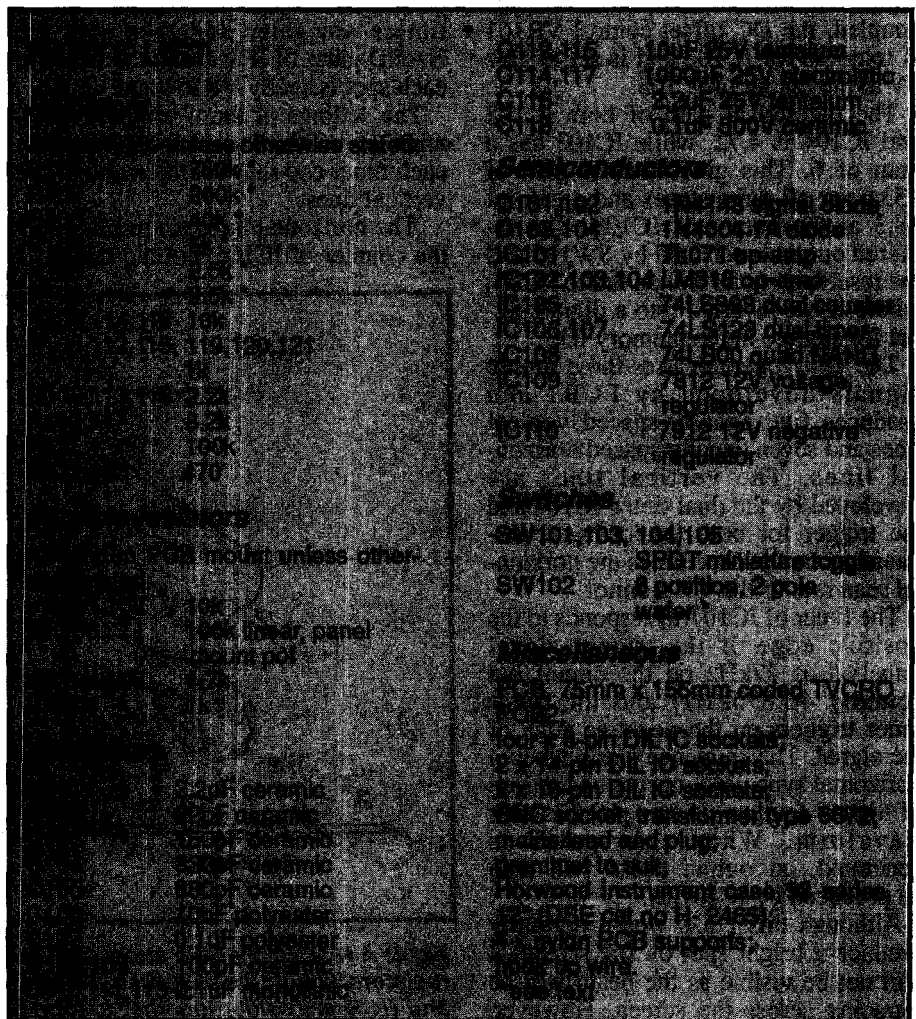


Fig.5: This shot of PCB2 was taken before SW105 and VR103 were added. Otherwise the layout is identical, although the attenuator should be fitted with shorter wires and constructed as shown in Fig.4.

the board contains two individual sections of the circuit, and the 12V dual polarity power supply powers the amplifier section only. The grid gener-

ator section is powered by the 5V rail derived from PCB1, and the rectifier section for the regulator on PCB1 is contained on PCB3, to be described



next month. The transformer used to power the complete project needs to have two separate secondary windings. As such a transformer is not readily available, we decided to adapt a multi-tapped 0 to 30V, 1A transformer sold by most parts suppliers. This transformer, commonly known as a type 6672, has a secondary with tapings at 15, 17.5, 20, 24 and 27.5V. To adapt it, the wires at the 15V tapping need to be unsoldered from the 15V lug, then separated and rewired to give a 0-15V winding independent from the rest of the winding.

Carefully unsolder the wires connected to the 15V lug, then use an ohmmeter to determine which of the two has continuity to the 0V tapping.

This wire is then resoldered to the 15V lug, and the other wire covered with plastic sleeving and located out of harm's way. The 0-15V winding is used to supply power to PCB2, and the rectifier section on PCB3 will be supplied with 7.5V AC by connecting to the lugs marked 20V and 27.5V. The 240V lead to the transformer will later need to pass through the rear of the case,

requiring it to be disconnected from the transformer. Once the transformer has been prepared, connect the 0V and 15V tapings with 1 amp hookup wire to the newly wired board to allow the regulator section to be tested. As mentioned, this should be done before any ICs are fitted. Use a DVM to check that voltages of around +12V are obtained at pin 7 of each of the 8-pin DIL sockets and -12V at pin 4 of each of these sockets. Naturally, make sure that the polarity as well as the actual value is correct.

Next fit the op-amp ICs to their sockets and confirm that the voltages are still correct and that the regulators are barely warm. The switches and the attenuator have yet to be connected, but this is best done after the various adjustments have been completed. This way any faults can be remedied without all the peripheral switches getting in the way.

Testing PCB2

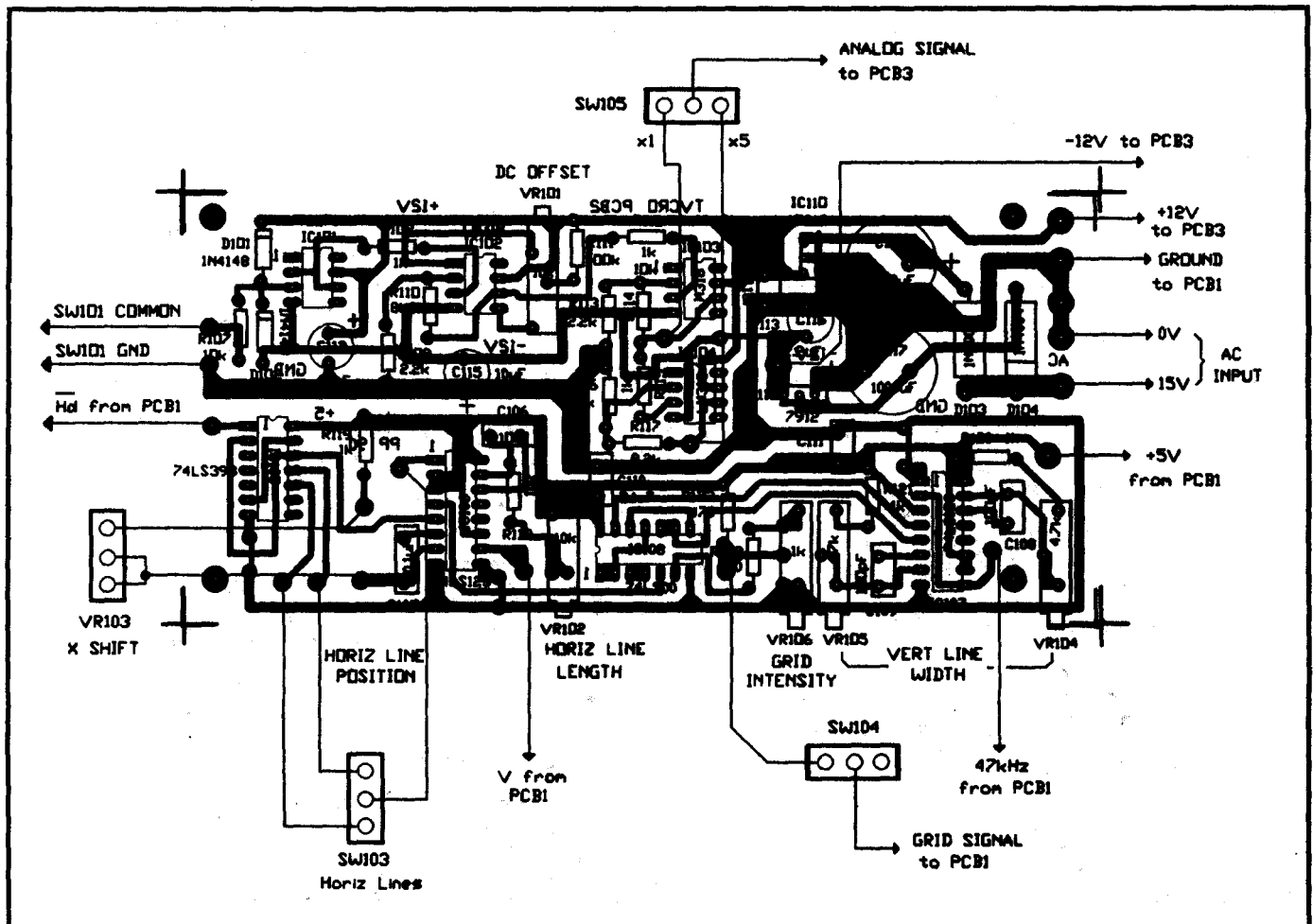
The first adjustment is the DC offset provided by VR101. As well, if you have a scope and a signal generator,

the amplifier can be tested. Apply 15V AC to the board and connect a short circuit across the input terminals of the amplifier section (between the points referred to as SW101 common and SW101 ground). Then, with power applied, measure the DC voltage at pin 6 of IC103 and adjust VR101 until the DC voltage at this point is within a few millivolts of zero. Temperature variations and other factors will cause this voltage to vary, so don't be concerned if you find that later on the DC level has changed by 20mV or so.

Next measure the DC voltage at pin 6 of IC104 and confirm that its value is also very close to zero. For best results, adjust VR101 to average the voltage readings for both outputs. The amplifier can be tested by applying an input signal of 100mV p-p. This should give approximately 13V p-p at the output of IC104 and 2.6V at the output of IC103.

Adjusting the grid generator

To perform the following adjustments you will need PCB1, a DC voltage of around 8 to 10V and the video



The layout diagram for PCB2. See text for appropriate lead lengths for the switches and VR103.

Video CRO

monitor being used with the project. As well, SW103, SW104 and VR103 should now be connected to PCB2. To do this, SW103 should be connected with a lead length of around 140mm, and VR103 and SW104 with lead lengths of 100mm and 140mm respectively. Then connect the +5V supply lead for PCB2 to the +5V output from PCB1 and also connect both the ground wires together.

Now link the points called Hd-bar, V and 47kHz. The required wiring is shown in Fig.2. A wire from SW104 is also connected to the point called GRID SIGNAL IN on PCB1. As shown in the photo of Fig.1, when the boards are mounted in the case, PCB3 will be in between these two boards, so use lead lengths that allow the boards to be spaced apart by 100mm or so.

Note that the 15V AC supply is not required to test the grid generator. When the connections are complete, connect the video monitor to PCB1 and apply 10V DC to PCB1. Confirm that PCB1 is operational by linking the 47kHz output signal (now connected to PCB2) and the point called TTL VIDEO IN on PCB1. As described in part 1, five vertical lines should be displayed when SW4 is on 'trace'.

With SW104 turned on (grid signal applied to PCB1), adjust VR106 (clockwise for a 10-turn pot) until a grid display occurs. If you don't get a display when this adjustment is at full output, something is wrong and it is time to start fault finding.

The circuit is relatively simple, and investigation with a logic probe or a

'scope should soon find the problem. Once a display such as that shown in the photos of Fig.3 has been obtained, it remains to adjust the width of the vertical lines and the length of the horizontal lines. This is achieved by adjusting VR104 and VR105 for the vertical lines and VR102 for the length of the horizontal lines. The settings don't interact and the adjustments are not critical. You should also find that the grid can be moved vertically with VR103. By selecting 'block' (SW4) to display a solid rectangle on the screen, the position of the grid should be able to be moved so that the block is exactly centered inside the grid.

There may be unequal spacing between the lines, depending on the linearity of the video monitor. There is nothing much you can do about this, apart from using another monitor.

As well, there may be a degree of waviness at the top of the screen and possibly a faint vertical trace in the centre of the screen. Again, don't be too critical, as this is a function of the monitor and other factors that can't easily be fixed.

The input attenuator

The next part of the construction is the input attenuator, in which resistors R101 to 106 and compensating capacitors C101 to 105 are mounted on the switch itself.

The photo of the PCB in Fig.5 shows how this was achieved in the prototype, while the diagram of Fig.4 shows somewhat more detail. Note however that the photo of the PCB was taken before VR103 was made a front panel adjustment, and before the x5 mag

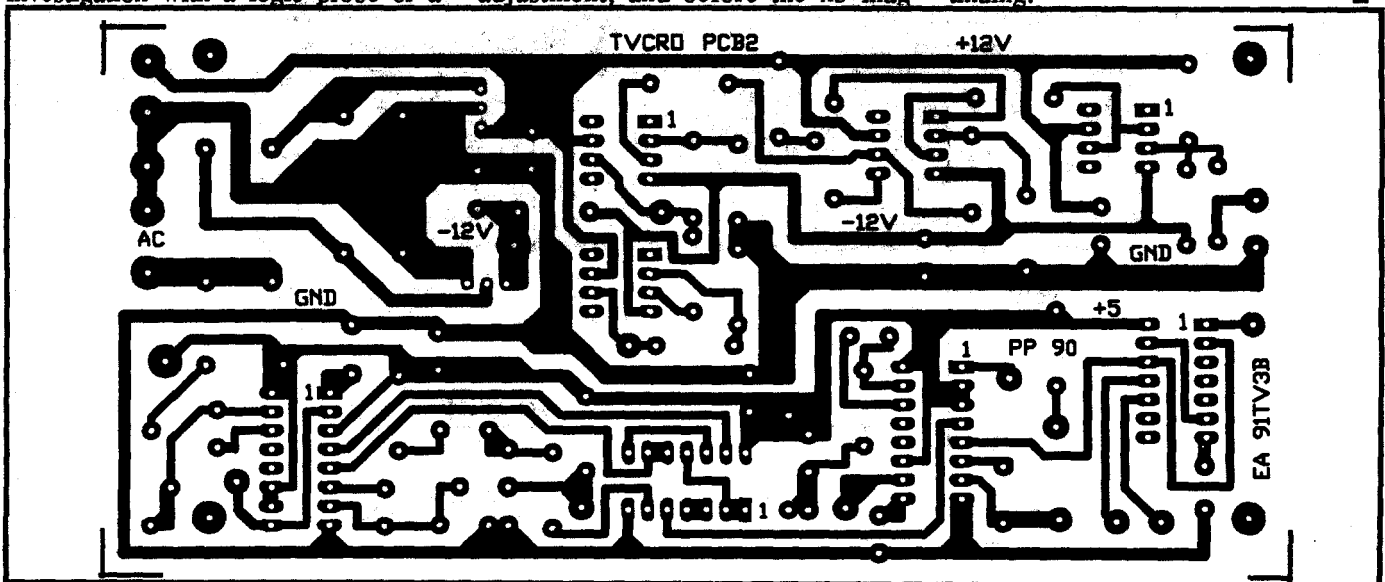
switch (SW105) was added. Also, the attenuator network has been changed, with shorter lead lengths used to connect the switch to the PCB (13mm as shown in Fig.4). Because there are no spare terminals on the switch, the capacitors and R106 are connected to ground by joining their pigtailed and connecting a wire from this junction to the PCB. Also keep all component leads very short and position the resistors vertically, although for clarity, the diagram shows them laid horizontally.

The case

The choice of case is up to individual constructors, and some may even elect to build the electronics into a monitor or obsolete TV set. Because separate boards are used rather than one large PCB, flexibility is obviously possible in how the unit is housed. We chose a Horwood instrument case (12" x 3" x 9" as Dick Smith lists them), as this case, though relatively expensive, looks the part. The front panel artwork is for this case size.

The case preparation requires the front panel to be drilled and labelled. Mounting holes for the three PCBs and the transformer are required in the bottom of the case, and the rear panel needs holes for the output sockets, (RCA panel mount and, if used, a panel mount DB9 socket). An external BNC socket is also mounted on the rear of the case to allow an external sweep signal to be applied. The photo of Fig.2 shows the completed unit.

Next month we complete the description, but make sure everything works to this point before continuing. ■



The PCB pattern is shown here full size so that you can make your own.

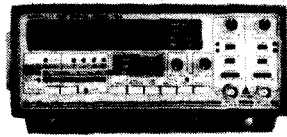
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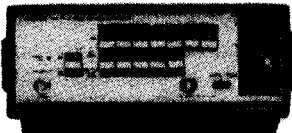
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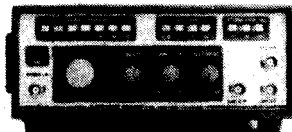


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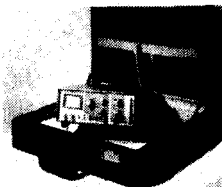
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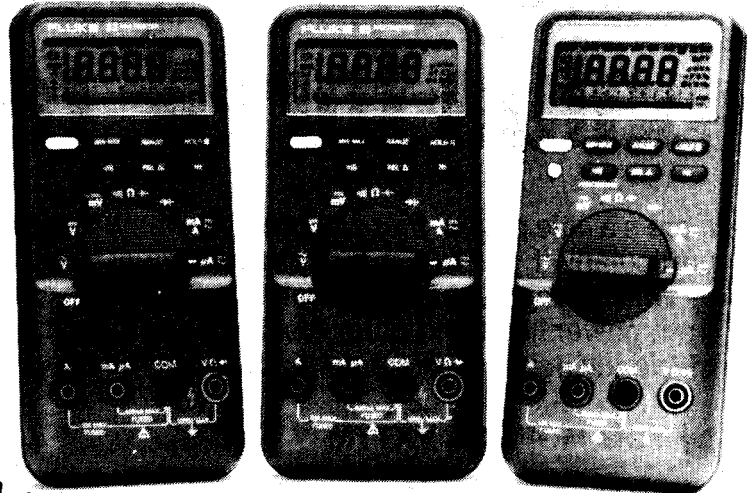
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Simple Construction Project:

Variable-tapped balun for HF receivers

Here's a little project that can make an immense improvement to the performance of an HF receiver, particularly if you live in a city environment. It's a balun — a balanced to unbalanced transformer — which, when used with a balanced antenna, goes a long way toward eliminating noise picked up from power lines and other electrical sources. It also offers a matching facility to improve coupling efficiency between the antenna and the receiver.

by TOM MOFFAT, VK7TM

Many radio enthusiasts are still using a single random-length piece of wire for a receiving antenna. This is possibly because many receivers come with the piece of wire already supplied, along with instructions about how to erect a wire antenna. This lets you get the receiver 'on air' as soon as possible, but that type of antenna is by far the WORST thing you can use over the long term, unless you live in the dead quiet of the country, or at sea.

Single-wire antennas respond to off-air signals all right, but they also respond to locally generated rubbish just as well — and the closer it is, the stronger the response. How many receiver users put up with this hash, possibly getting rid of some of it with a noise blanker, but still suffering lousy reception! Things will be much better with a balanced antenna; one in which the line to the receiver connects in the

middle, with two antenna wires heading out symmetrically from each other.

This simple antenna is called a dipole. One of its characteristics is that it responds well to radio 'waves' arriving from a distance, since they get its two ends vibrating (electrically) in opposition to each other. So a voltage is developed across the middle, where the line to the receiver connects. Nearby noise, however, isn't so well organized; it tends to affect both halves of the antenna equally, so there's little voltage difference across the middle, and consequently little voltage fed to the receiver.

Purists might regard this as a rough-and-ready explanation, but it gets the point across.

The 'point' we're trying to make is that the better balanced and more symmetrical the antenna is, the better it's going to perform in the presence of noise. And anywhere there are power

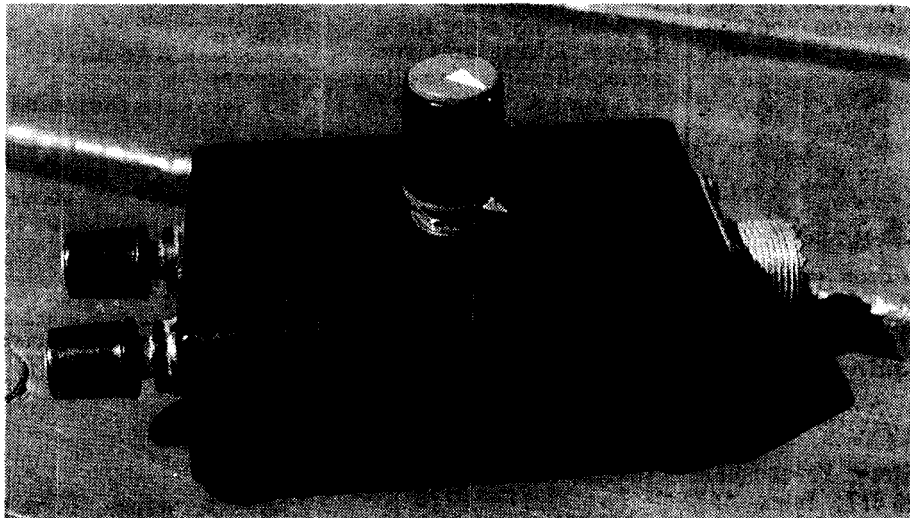
lines there is going to be electrical noise — heaps of it!

All HF receivers nowadays have a coaxial antenna input, as well as the single wire feed. (Some even force you to connect the single wire to the center of the coax connector!) You can then use coaxial cable to carry received signals from the centre of your dipole antenna to the receiver. The shield (the outer part) of the coax provides a screen around the inner wire which carries the signals, protecting it from the noisy nasties trying to force their way into the receiver along with the signals.

Coax-fed dipole

The coax-fed dipole is probably the most popular shortwave antenna today, and it works fairly well. But it has two shortcomings: The cable itself is not symmetrical; one connector is a wire and the other is a 'pipe' surrounding it. This unbalanced feedline means the whole system contains a degree of unbalance, despite the fact that it's still connected in the centre of the antenna. Another problem with coax is that it is fairly expensive, as well as being relatively heavy.

The solution to all of this is to use balanced feedline — two wires running parallel to each other — all the way from the centre of the antenna to the receiver. One would think that eliminating the shield from around the antenna feeder would leave it wide open to attack from nearby noise. But this is not the case; like the antenna itself, noise affects both sides of the balanced feeder equally. There is no voltage difference, and thus no input to the receiver.



For some reason balanced feeders have gone out of fashion; perhaps because they must be installed clear of other metalwork. You can't just clamp a balanced feedline to a metal gutter or something and expect it to work, although you can with coax. However I have now gone over to balanced feeders for all my HF amateur radio work, and most professional users such as international broadcasters use them as well.

The best form of balanced feeder is called 'open wire line'. This consists of two parallel wires, spaced some distance apart, and held that way with insulators attached periodically along the line. As well as being a great noise-canceller for receiving, this kind of line has very low loss. And it can withstand quite enormous voltages across it, voltages that would surely send a piece of coax right up to feedline heaven.

Open wire line used to be commonly available for TV antennas, but now that coax has become so popular the open line is pretty rare. The stuff I use came from Hills in Adelaide, and there might still be some of it about if you're lucky. A good substitute is the television 'twin-lead' that used to be so common before the days of colour TV. It should still be available, possibly from your friendly local TV repairman.

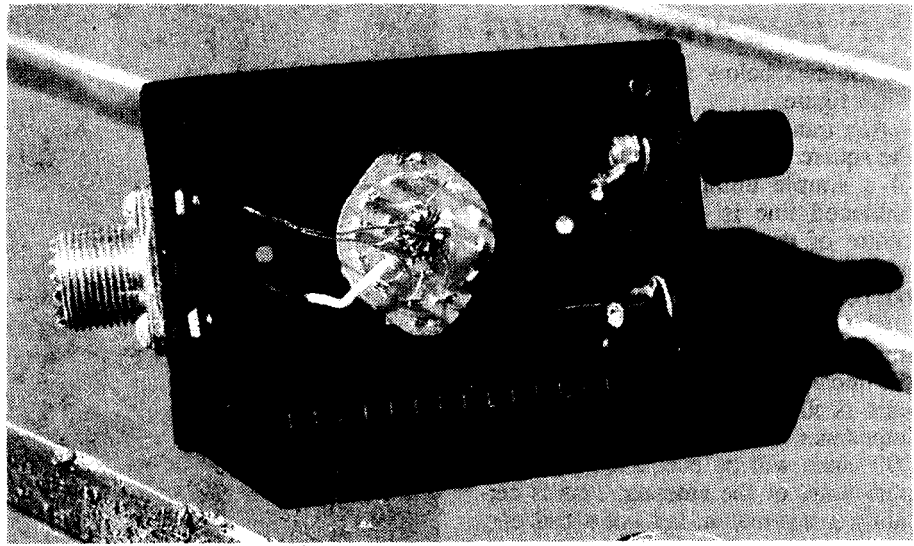
Or if all else fails you can do what many others do; use the stuff known as 'speaker wire'. It's certainly parallel feeder, perhaps not so low-loss at television frequencies, but it works fine at HF as antenna feeder. And contrary to what you read in the hifi columns and 'Forum', it makes pretty good speaker wire too.

Right! We've got your antenna organized, with nice balanced feeders, but there's still a problem. You've got balanced line ready to connect to the receiver, but an unbalanced coaxial connector to hook it up to. What to do?

Build a balun, that's what. This interesting little transformer, usually wound on a toroidal core, provides a nearly perfect balanced to unbalanced conversion. Our project this month adds another feature, a selectable impedance ratio between the balanced and unbalanced part.

About Impedances

Let's talk about impedances for a moment. The centre of a half-wave centred dipole has an impedance of around 75 ohms. The coaxial input to the receiver is usually arranged for 50 ohms impedance, and coaxial cable is normally either 50 or 75 ohms. In a perfect antenna you would have a 'match' be-



Inside the balun case. As you can see, there's not much involved. The balun itself mounts directly on the back of the switch, supported by its leads. A UHF type socket is used here for the coax output, but other types can be used if desired.

tween the antenna and the coax and the receiver, all the same impedance. Without going into too much detail, the idea is to provide the best energy transfer from the antenna to the receiver.

Notice the mention of 'half wave'. Any antenna is a half wavelength long only at one particular frequency. But we're interested in using one antenna to listen through the whole HF spectrum and even lower, say 30MHz right down to the 100kHz region where all the aircraft beacons live.

With only the one antenna the receiver is going to see a real mish-mash of impedances. (This is what 'mis-match' sounds like if you say it when you're feeling tired and emotional...)

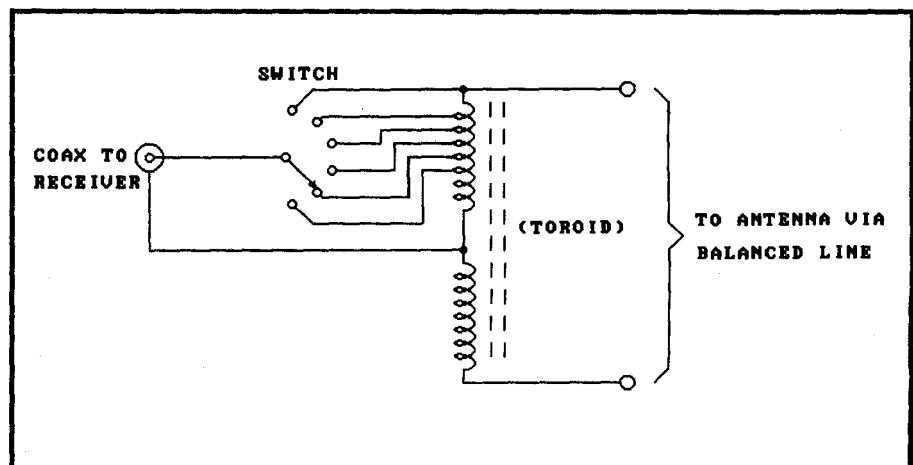
A correct match between radio and antenna is absolutely essential if you're transmitting, but you can get away with some quite horrible mis-matches with a receiver. Still, it's worth trying to put

things right if possible. It means better energy transfer, and better signals. That's the advantage of using a variable-tapped balun.

As a dipole antenna is used further from its half-wave frequency, its impedance at the centre will rise. It can become quite high, several thousand ohms instead of 75. As the frequency rises the impedance peaks and then begins to fall, again approaching 75 ohms at three times the design frequency. At this point the antenna is 1-1/2 wavelengths long; a half-wave with an extra half-wave stuck on each end.

Going below the design frequency, the impedance starts to rise and just keeps going to quite ridiculous levels, never coming down again.

The tapped balun makes an attempt to match these impedances. It won't be perfect, but it does make a definite improvement in reception, particularly at



The schematic couldn't be much simpler. The switch allows selection of the best turns ratio to match the antenna and balanced line.

HF Receiver Balun

frequencies below the antenna's half-wave figure.

Any transformer's impedance ratio is the square of its turns ratio. In the case of a simple untapped balun the unbalanced line is connected from the centre of the transformer to one end, while the balanced line connects across both ends.

This means there are twice as many turns across the balanced part as across the unbalanced part, and the impedance ratio is four to one. If the unbalanced impedance is 50 ohms, an impedance of 200 ohms will be connected to the 75 ohm point of the antenna. This is certainly a mis-match, but not a bad one. For practical purposes we can ignore it.

If, however, we begin moving the unbalanced connection further toward the centre, the impedance ratio increases. At halfway between the centre and one end there would be four times as many turns covered by the balanced part compared with the unbalanced part, and a 16 to 1 impedance ratio. Tapping a quarter the distance from the centre would give a turns ratio of 8 to 1, or an impedance ratio of 64 to one.

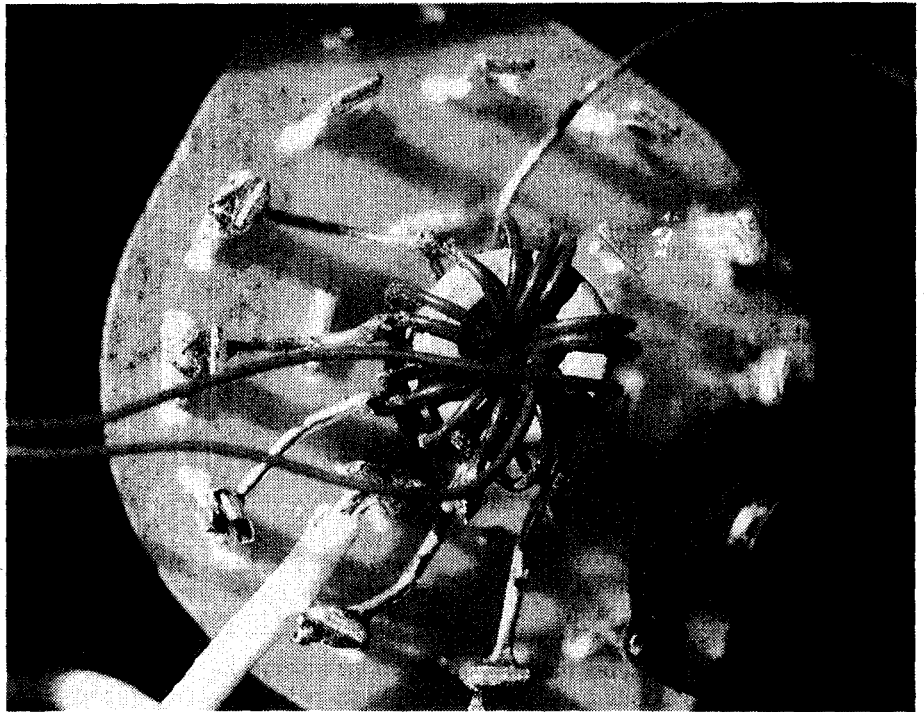
Our little balun provides unbalanced taps over five or six consecutive turns, beginning from the end of the windings and progressing inward. So the impedance choice is pretty wide.

Construction

First your antenna: If you are installing a new balanced antenna, be sure both ends are of equal length. The total length can be whatever will fit in your yard; mis-matches will be taken care of by the tapped balun. The centre should be as high as possible; the ends can be higher or lower than the centre but make sure they are both the same if possible.

The balanced feedline, be it speaker wire or whatever, should be brought into your radio room completely clear of gutters and other metalwork. You can use bits of nylon string or fishing line to tie it away from any metal.

The choice of the toroidal core is important. Some core materials are meant for use at VHF and are consequently useless at HF. Other cores are for audio frequencies, again useless for HF radio. Many electronics suppliers sell balun kits with cores that would be suitable for this project. Trouble is they are usually meant for transmitting, so the cores are quite bulky and can also cost well over \$20. I have found a source of nice little balun cores just like the one



A close up of the balun mounted on the back of the switch. Suitable ferrite toroids to wind it on are available from the author. The winding requires only half a metre of 24 gauge enameled winding wire.

in the photos, but I'm going to have to buy 100 of them. I'll be able to pass them on to readers one at a time for a cost of \$6.00 each, posted anywhere in Australia or New Zealand. Send a cheque or money order to: High-Tech Tasmania, 39 Pillinger Drive, Fern Tree, Tasmania, 7054. Be sure to state what it's for!

Winding the balun: You'll need a length of #24 gauge winding wire, about half a metre long. Bend it in the middle, lay the two halves parallel to each other, and then carefully smooth them so they don't cross. The wires must not be allowed to cross at any time during the winding procedure.

Hold the end where the wires are joined in one hand, and then feed the other ends together through the center of the core — over and over, working your way around until you've got about eight turns through the centre. The wires may bunch up a bit through the hole, but don't let them cross as they go around the outside.

When the winding is finished, clip the place where the windings are joined. Then scrape the insulation from the four ends. Next use an ohmmeter to establish which ends belong to one winding, and which ends belong to the other. Now you must carefully connect the START of one winding to the FINISH of the other, such that the wires become one long winding that goes right around the core twice. This junction of the two

windings becomes the CENTRE of your balun, the part that connects to ground (the outer part of your coax connector). The two free ends are where the balanced feeder will connect.

If you now connect another wire from the centre of the coax connector to one of the end wires, you will have a traditional four-to-one balun. You can simply do this and leave it, if you don't want to bother with the tapping feature.

For the tapped balun you'll need a five or six position single pole rotary switch. Suitable switches are available just about anywhere. I ended up using a two-section switch, since I couldn't get a single pole version. I simply ignored the second half.

You'll see from the pictures that the suggested balun core is small enough to nestle right down in the centre of the switch, with the taps running out radially to the switch contacts. To connect the taps you must carefully scrape some insulation from the outside of every second winding of the coil. If nothing has been crossed you should be repeatedly scraping the same wire, once for each time it passes through the core. You can then carefully solder a short jumper wire to each scraped spot.

One end of the switch goes to one free end of the balun winding (this is the 4 to 1 tap); then soldered on taps should continue toward the centre connection for as many turns as you have positions on your switch. With the taps in place,

temporarily disconnect the end wires where they join to make the centre of the coil. Then use an ohmmeter to establish that you've soldered all your taps to the same half of the winding (nothing is crossed).

When the coil is finished it can be soldered in place. Have someone grip each wire with a pair of long nose pliers as you solder it, otherwise the heat may unsolder the coil end as you solder the switch end. This is a very fiddly business and you'll certainly deserve a cool drink when it's over!

Last you can mount your new balun in a nice plastic box. The photo shows how I did mine; a coax connector on one end to go to the receiver, and some springy terminals at the other to take the parallel feeder wires. Connect the two free ends of the balun coil to the parallel terminals, rejoin the two centre wires and connect them to the shell of the coax connector, and finally run a piece of hookup wire from the centre of the coax connector to the moving 'selector' part of the rotary switch. All done!

Using it

When you connect this little gadget through parallel feeders to a centre-fed dipole, you will be quite amazed at the

things you can hear that were earlier buried in the noise. To test your balun, disconnect first one half of the balanced line, reconnect it, and then do the other side. As each side is disconnected the noise should rise dramatically. With both wires connected the noise should be just about zilch.

If you tune a station, particularly below the antenna's half-wave frequency, and then vary the position of the rotary switch, the signal should peak at some setting. It will be fairly broad, not really dramatic, but under the worst mis-match conditions you may see an improvement of a couple of points or so on the S-Meter. On other frequencies performance may be best with all the turns switched in, using the whole coil. Every antenna is different, and the effect also varies with the length of the feedline.

To see the full benefit of the balun, it might be interesting to look for an AM broadcast station outside your local area in the middle of the day. With a single-wire antenna you'd be lucky to hear more than a maddening buzz from the power lines, but you might be pleasantly surprised with the balanced antenna system.

Give it a try! ■

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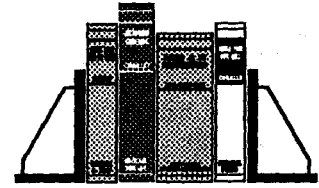
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NEW BOOKS



Classic radios

MORE GOLDEN AGE OF RADIO, by John W. Stokes. Published by Craig Printing and Publishing, 1990. Hard covers, 308 x 218mm, 204 pages. ISBN 0 908629 29 X.

A further journey down the 'memory lane' of historic radio receivers, written by well known New Zealand expert John Stokes. This is the third such title from Mr Stokes, whose previous titles *70 Years of Radio Tubes and Valves* and *The Golden Age of Radio in the Home* have become highly regarded reference works among the world's radio technology historians and vintage radio enthusiasts. Mr Stokes is also Editor of the New Zealand Vintage Radio Society's quarterly journal, and has contributed articles to the US magazine *The Old Timer's Bulletin*.

This book seems to cover much the same general scope as the previous 'Golden Age' book, although there is very little duplication of material. The approach here is to explore other facets, with somewhat less text and correspondingly more pictures.

It's divided into six main sections, whose headings indicate their content: 1 - Australia; 2 - New Zealand; 3 - United States; 4 - Canada; 5 - Great Britain; and 6 - A Small Miscellany. This last section covers early German sets, a novel early set from Japan, early components and loudspeakers. There's also a bibliography, to assist the reader interested in further reading.

A gratifying aspect of the Australian section (which takes up almost half the book) is that quite a few of the illustrations used have been taken from early issues of our own predecessor *Wireless Weekly*; Mr Stokes having asked for our permission to do this. I note also that our own Vintage Radio columnist Peter Lankshear has apparently assisted with the book's proof reading — so there's a kind of double link with our own magazine.

If you're at all interested in the early days of radio, it makes very rewarding and informative reading. Not just to look through the various examples of different early radios, and examine their prices and performance features, but also to

compare the models produced in the different countries and see how the external styling changed over the years.

It's probably a 'must' for the vintage radio enthusiast, then, but with a lot of potential interest for others as well.

The review copy came direct from the author, but copies of this and also his two earlier books are apparently available in Australia from M.J. O'Brien, 11A Park Road, San Remo, Victoria 3925. No price was supplied. (J.R.)

The impact of video

IT'S VHSTROIKA, NOT PERESTROIKA!, by Malcolm Goldfinch. Published by the author, 1990. Soft covers, 206 x 148mm, 65 pages. Recommended retail price \$12.50. ISBN 0 646 00913 3.

Malcolm Goldfinch is well known in the Sydney electronics industry, having had a long and successful career — covering just about every facet from the technical side to board-level management. He worked for Remington Rand for over 10 years, and later among other things started Convoy International, running it for many years. He has also been a journalist, photographer, artist, advertising/marketing man and RAAF pilot, and in recent years a prolific writer on video and imaging. Quite a latter-day 'renaissance man', in fact.

One of the areas in which Malcolm seems to have taken a special interest is the cultural impact of electronics technology in general, and video/imaging in particular. Over the last few years he also seems to have become something of an evangelist for the JVC-developed VHS video format, in contrast with Sony's smaller Video-8 system; but that's only incidental to this book.

One thesis he does develop in the book is that home video is 'the greatest unmentioned anthropological miracle of the century', rapidly overtaking and replacing all other forms of indirect human communication. This is certainly an interesting idea; with over 300 million VCRs now in use around the world, corresponding to around one for every 14-odd people, it could well be true. However he also seems to think there's



some sort of conspiracy among the existing mass media to ignore it, and pretend it doesn't exist. I find this a bit hard to swallow; it seems mainly based on the fact that a few newspapers and magazines didn't want to publish an article he wrote on the subject.

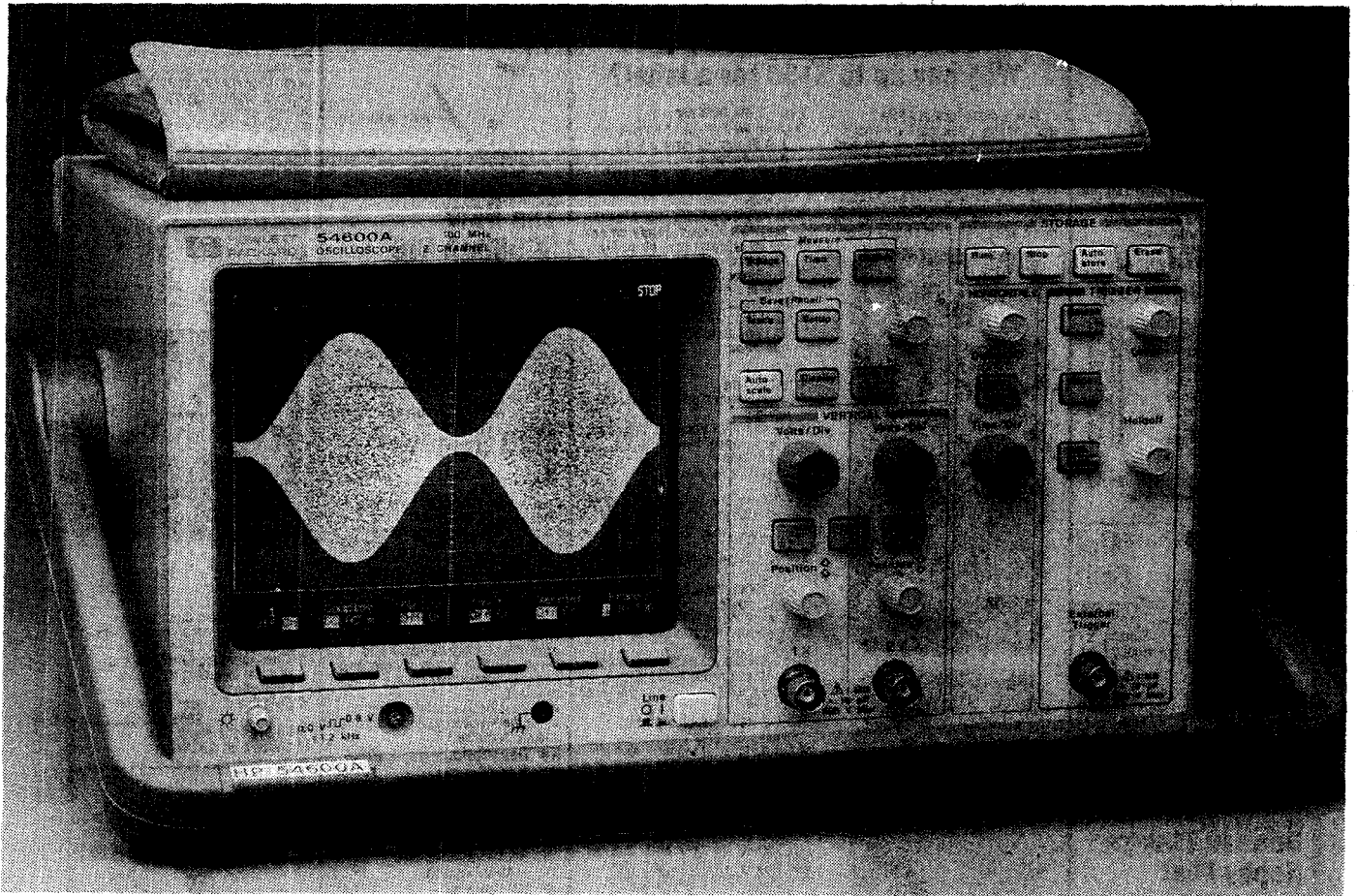
The other thesis he develops in the book is that home video has been the catalyst for the recent political upheaval in the Eastern Bloc countries, as all of those VCRs have enabled the masses in those countries to see for themselves what 'life on the outside' is like. Again it's an interesting idea, and may well have more than an element of truth.

An interesting aspect of the book itself is that Malcolm Goldfinch has published it himself, using a desktop publishing setup based on an Apple Macintosh and an H-P inkjet printer.

It does look a bit amateurish, with rather fussy layouts and to my eye at least rather too many typefaces. The text is also rather rambling and ideosyncratic. Still, it's apparently been very successful; the first edition sold over 8000 copies both in Australia and overseas, requiring a second printing — quite an achievement.

Copies are available directly from Malcolm Goldfinch himself, at 5 Kew Place, 275 Edgecliff Road, Woollahra 2025. (J.R.)

'State of the art' test instrument:



H-P'S NEW 54601A 100MHZ DIGITAL SCOPE

Hewlett-Packard has just released the 54600 series of compact, attractively priced 100MHz oscilloscopes, which combine the ease of use, display update speed and display 'confidence' of a conventional analog instrument with the additional performance features of a modern digitising unit. Here's what we found when we were able to try out one of the first 54601A four-channel models into the country...

by **JIM ROWE**

For the past few years, Hewlett-Packard's test and measuring division seems to have concentrated almost exclusively on 'high end' test instruments, with state of the art performance and prices generally beyond the reach of all but the largest and most sophisticated organisations. In fact it became an industry joke that 'HP' stood not for the

company name, but 'highly priced'. Most of us could only drool over the pictures and specs of the firm's latest products, and lament that we'd be unlikely to ever use one.

But things seem to be changing. HP has apparently decided to take advantage of some of the technology it has developed for the high end products,

and use this to provide innovative yet competitively priced instruments for wider use. The new HP 54600 series of scopes is the first of a new breed of H-P instruments, intended for 'mid market' applications such as production testing and field servicing.

At a recent press conference to announce the HP 54600 series, HP

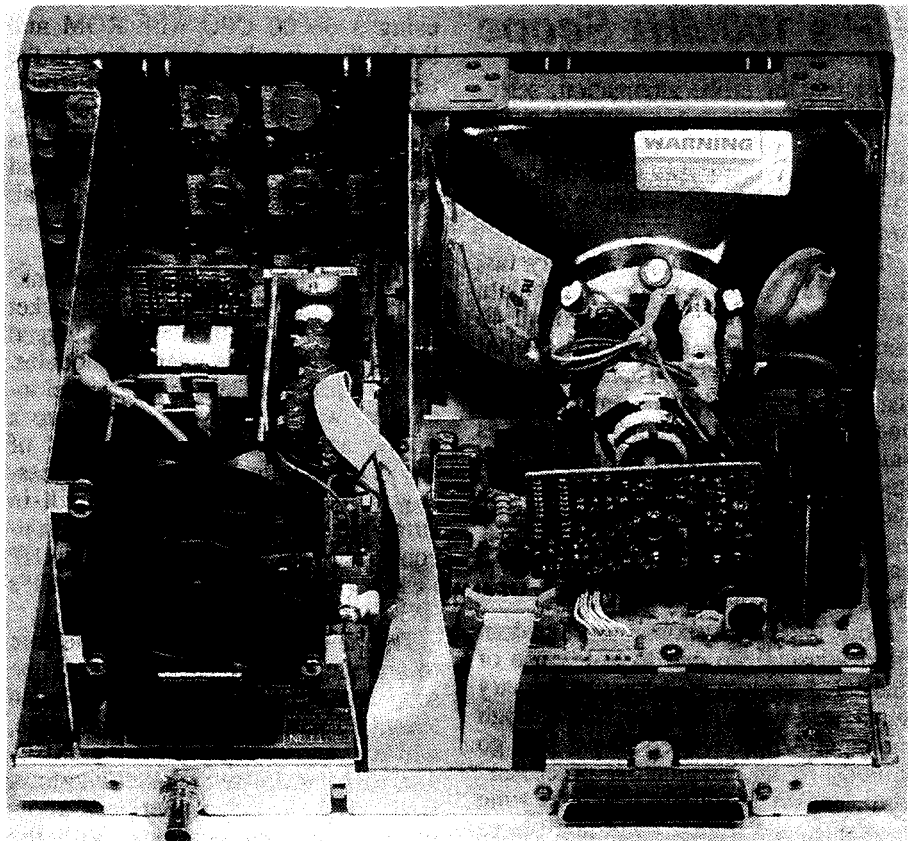
Australia's T&M division chief Frank Freschi described them as 'only the beginning', and hinted that we would be seeing more instruments of the same ilk shortly. At a time of slowing economies and tightening budgets, this seems like welcome news for T&M equipment users.

The HP 54600 series was developed at HP's Colorado Springs division, and at the release were engineers from Colorado Springs who described the effort that had gone into optimising the new scopes for the intended market. This included a great deal of down to earth research, to find out what users really wanted in a general-purpose scope.

What they found was that many users appreciated the performance of high-end digital instruments, but felt that a conventional analog unit met more of their day-to-day needs. They preferred the latter's direct, dedicated manual controls for often-used adjustments like vertical sensitivity, timebase speed, trace position and trigger level, rather than the computer-like 'keyboard and menu' system used on most digital scopes. For many real-time adjustments they also needed the virtually instantaneous display updating of an analog scope, rather than the periodic 'slide show' updating of many digital units. And finally, they were more confident of the validity of the waveform display produced by an analog scope, being aware of the errors that can be introduced by aliasing and other sampling artifacts.

At the same time, HP engineers knew from the work they had done on high-end instruments that once users became used to a digitising scope, they also wanted all the 'extra' features that only such an instrument could provide. Things like no-hassle display storage; high accuracy measurements; the ability to provide a bright, well focused display at virtually any sweep speed; the ability to display the signal *before* a trigger point; and the ability to be hooked up to a computer — not just for automated measurements, but also for storing displays on disk and printing them out effortlessly on paper.

So the challenge was to try and develop a new series of scopes, which would deliver all of the extra features and benefits of a digital sampler, combined with the ease of use and speed of response of a traditional analog model. All for a price that would compete strongly with analog models of similar basic performance!



A look inside the 54601A's case. As you can see it doesn't look much like the inside of a traditional analog scope. Visible here are the video display section on the right, and the switch mode power supply and cooling fan on the left.

The 54600 series

Out of all this came the new HP 54600 series of 100MHz scopes, which have the distinct 'look and feel' of an analog model despite the fact that they're wholly digital inside. There are currently two models in the range: the 54600A two-channel unit, and the 54601A four-channel unit.

All input channels on both models provide a guaranteed 100MHz bandwidth, using 20MSa/s random 'equivalent time' sampling for all repetitive signals. For single-shot signals, where the sampling can obviously only be done in real time, the 50ns sampling rate gives an effective bandwidth of around 2MHz. The input A/D converters provide 8-bit resolution, or around 0.4% of full deflection on any range.

Both models have two input channels with a full range of input attenuation ranges covering from 2mV to 5V per division. In addition the 54601A has two further limited-attenuation channels, providing only 100mV and 500mV/division ranges to suit logic signals. In place of these the 54600A provides an external trigger input.

A delayed timebase facility is

provided on both models, with ranges covering speeds from 2ns to 5s/division on both the main and delayed sweeps.

Dedicated rotary controls are provided for both the 'big three' controls (Ch1 and Ch2 sensitivity, and timebase speed), and five other frequently-used adjustments: Ch1 and Ch2 vertical position, timebase delay, trigger level and holdoff. A ninth rotary control is used for cursor manipulation.

There are also some 26 control buttons, many of them dedicated to such functions as trigger mode selection, main/delayed sweep selection, storage functions, measurement mode selection and selection of utility functions such as printing or saving/recalling either displays or control setups. One important button is marked 'Autoscale', and provides a one-press automatic setup function — providing a stable display of virtually any new signal.

Six non-dedicated buttons are provided on the lower lip of the screen escutcheon, as 'soft keys' which allow selection from function menus displayed along the bottom of the display. These are used only for what might be called the 'fine details' of scope setup — things like trigger source selection/polarity/coupling/filtering, com-

HP's 100MHz Scope

penetration for probe attenuation, selection of voltage measurement mode (peak/average/RMS) and selection of time measurement parameter (frequency/period/duty cycle/+width/-width/rise time/falltime).

The instruments offer extremely fast display updating speed — 1M data points per second, which is around 40 times faster than traditional digital scopes. This gives a display response that is virtually identical to that of an analog instrument, making them just as suitable for real-time peaking and adjustment applications. At the same time, there is a very low incidence of aliasing errors, which with many digital scopes can cause signals to be displayed as if they were at a different frequency.

Both the fast response and freedom from aliasing are due to H-P's use of dedicated custom ICs for the primary signal processing. After passing through the input A/D converters, the signals go directly to an 'acquisition processor' chip, which correlates them in time relative to the trigger point and places them in the appropriate locations in waveform memory. This chip uses advanced CMOS technology, to process samples from all of the input A/D converters, each operating at 20MSa/s.

A second dedicated 'waveform translator' chip then takes the data stored in the waveform memory, and processes it for presentation on the raster-scan video display. This chip works at 1MSa/s. Both chips employ what HP describes as 'proprietary sampling and display processing algorithms'.

With the custom chips looking after basic signal processing, the rest of the scope's functions are controlled by a conventional microprocessor system

using a 68000 CPU with ROM and RAM. This involves responding to the front panel controls, adjusting programmable aspects of the hardware, performing measurements on and calculations regarding the captured signal data and displaying the results, saving and recall of displays and setups, data communications and so on.

What kind of data communications? Well, the 54600 models have a socket on the back, into which can be plugged one of three different interface modules. One of these is a Centronics parallel interface, which lets you connect up a printer and produce a 'hard copy' of any captured display simply by pressing a button. The scope's built-in firmware can drive either an Epson-compatible dot matrix printer, or an HP Laserjet or similar printer using HP's 'PCL' language.

The other two interface modules are to provide communication between the scope and a computer. One provides an RS-232C asynchronous serial interface, while the other provides an IEEE-488/HP-IB addressed parallel interface. Both of these latter interfaces allow two-way communications, with the ability for both display and setup data to be passed to the computer, or setup information to be downloaded to the scope from the computer.

To facilitate communications with IBM-compatible PCs, H-P can also provide a special *Scopelink* software package. This has a graphical user interface for fast and intuitive operation, and runs on virtually all of the 'X86-family of processors and range of video adaptors.

Trying one out

So much for the basic performance and facilities, which are obviously quite impressive. But what are the new scopes actually like to use — have HP's design engineers *really* achieved their

goal of providing a fast-responding scope that is just as easy to drive as a conventional analog unit?

We've just had the opportunity to try this out for ourselves, as HP Australia kindly made available one of the first 54601A units to reach our shores, for a short trial. It came complete with an RS-232C interface module, and a copy of the *Scopelink* software so we could try out the computer communications.

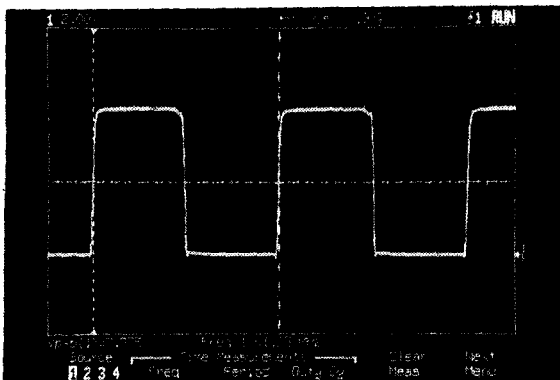
One of the first things that struck us was how much *shorter* and *lighter* it is than a conventional 100MHz scope — or for that matter, even most 20MHz scopes. The overall depth from front to back is only 300mm, about 30% shorter than the majority of analog scopes. And with a weight of only 6.4kg, it's also considerably lighter.

No doubt the reduced depth is possible because there's no longer any need for a long narrow-deflection-angle wideband CRT, while the lighter weight is presumably the result of being able to make use of a switch-mode supply for the digital circuitry, and an efficient flyback-type EHT supply for the raster-scan display. And the end result is certainly welcome, in terms of increased portability and smaller bench 'footprint'.

When it came to using the scope on the bench, there were quite a few further pleasant surprises. The first was that yes, it does 'drive' and respond very much like a familiar analog model.

Most people expect to be able to walk up to virtually any standard analog scope, turn it on and look at/measure signals without having to look up any driving manuals. The operation should be that intuitive. Does the HP 54601A pass that test?

It certainly did — in fact it *had to*, because when we tried it out, HP Australia hadn't yet received any manuals for the 54600 series. The only



Here's a close up photo of the 54601A's screen display when it was measuring the output from a crystal calibrator. Note the measurement readings just below the graticule.

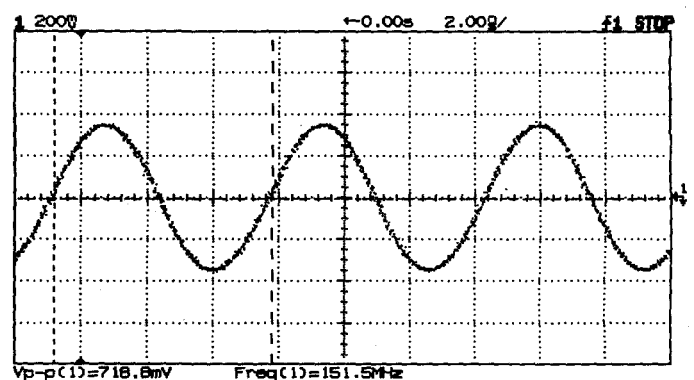


Fig.1: A look at the kind of display produced when the scope is measuring a signal at 151.5MHz. This is a reduced view of a laser printout from *Scopelink*.

documentation available was for the *Scopelink* software; as for the scope itself, all we could do was turn it on and rely on intuition.

Despite this, there were virtually no problems. Whatever the kind of signal we tried to observe and measure, it was almost always possible to achieve the desired result very quickly just by using the familiar-looking controls. And when this didn't quite work, it generally took only a little longer to figure out the further steps needed. So on a scale of intuitive operation and user friendliness, the 54601A rated very highly indeed.

Actually, it didn't take us long to discover some of the special 'tricks' built into the 54601A, which make it possible to set up the controls for a measurement *even faster* than with a conventional analog scope.

Like the wonderful 'Autoscale' button, one touch of which gets the scope itself to automatically work out all of the basic control settings required to produce a clear and stable display, with any new signal...

The speed of display response was also very impressive, and in most cases virtually indistinguishable from an analog scope. Gone is the 'digital slide show' effect, where the display is updated so slowly that it's virtually impossible to use the scope for monitoring real-time adjustments like peaking and nulling. If it wasn't for the slightly 'spotty' nature of the 54601A's displayed traces, you simply wouldn't believe you were viewing a digitised signal.

In fact the only situation where the digital nature of the scope really becomes evident is when you go into single-shot mode, and look at a fast pulse or edge. Obviously the 54601A is forced to operate in 'real time' for this kind of situation, and once the sweep rate is set for 1 μ s/div or faster, the trace

becomes a 'path of dots' — each dot representing an individual sample, spaced at 50ns intervals.

Even then, it's still surprisingly easy to visualise the waveform — unless the signal is changing too fast for its transitions to be captured by samples 50ns apart. This is presumably why HP gives the scope an effective single-shot bandwidth of 2MHz. Other nice features emerged gradually, as we used the 54601A for different kinds of measurement.

One thing we were interested to see was how it performed at high signal frequencies — approaching the nominal 100MHz bandwidth limit and beyond. Bearing in mind the behaviour of many conventional digital scopes in this region, we were on the lookout for aliasing problems, triggering problems and/or the effects of 'brick wall' aliasing filters.

Basically we found nothing in any way surprising or disconcerting; the 54601A behaved essentially in much the same way as an analog scope. The display was clean and unambiguous throughout, while the response showed a small and broad peak around the nominal limit, and then drooped away quite slowly. Both of the main input channels were still quite useable at 150MHz (-1dB), with the -3dB point at around 170MHz, while the two additional 'logic' channels were even better — being only 3dB down at around 200MHz.

The big advantage over an analog scope was that even at the fastest timebase speeds, the display was bright and crisp. No more peering under a hood at faint traces!

The display stability also seemed to be better than usual at high frequencies and sweep speeds, perhaps due to improved triggering circuitry. We even found the delayed timebase controls

much easier to drive, in order to achieve a magnified view of a selected waveform portion, and there is no flicker even at high delayed sweep/main sweep ratios.

Interestingly, the 54601A also provides brighter and more readable displays at low frequencies and sweep rates, where the trace of a conventional analog scope becomes little more than bright spot moving slowly across the screen and dancing up and down a bit in the process. Thanks to the inbuilt digital storage, the 54601A's display again presents a full waveform — which is merely *updated* at the necessarily low sweep rate. More about storage in a minute.

Another big feature of the 54601A is all of those automatic measurement facilities. Gone are the days of manipulating the shift controls, and counting graticule divisions to work out voltages, periods or rise and fall times. Now it's just a matter of pressing a couple of buttons, and you have an automatic on-screen display of almost any parameter of interest — to a resolution of four significant digits.

Want to measure the voltage? There's a selection of peak to peak, average or RMS; display all three, if you wish. Similarly with time: choose from frequency, period, pulse width, duty cycle, rise time or fall time. The measurements can even be made *after* a signal has been captured — there's no need to repeat the capture in order to make a further measurement.

The only limitation on these measurements seems to be that it must be possible to measure the parameter concerned from the captured data. For example you can't measure period or frequency if you haven't set the controls to capture a full signal cycle, or pulse width if you've only captured the front or rear half of the pulse concerned.

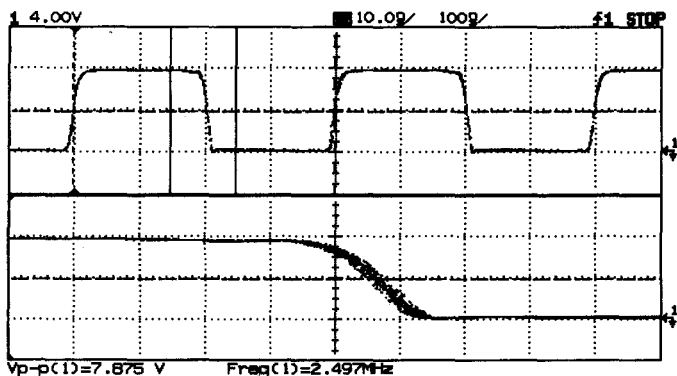


Fig.2: An example of the 54601A's display in delayed time base mode. The 2.5MHz pulses being measured have some jitter, as revealed by the lower delayed trace.

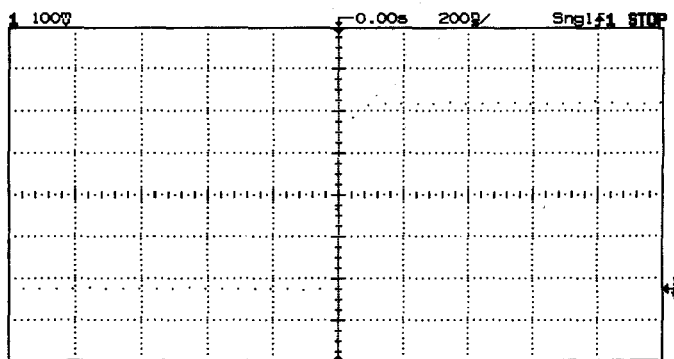


Fig.3: What happens in single-shot mode, when the sweep rate approaches the sampling rate. The trace becomes a 'path of dots', with the dots spaced at 50ns intervals.

HP's 100MHz Scope

Similarly you must have captured a signal's full voltage excursion for the voltage measurements to be valid — logical, isn't it?

Incidentally, the scope displays cursor lines which indicate clearly the signal points used to make each measurement. If your signal is 'weird' and causes the scope's micro to select the wrong measurement points, this is quickly seen. To cope with such cases there are manual cursors, which you can activate to make the correct/relevant measurements yourself.

Storage, comms

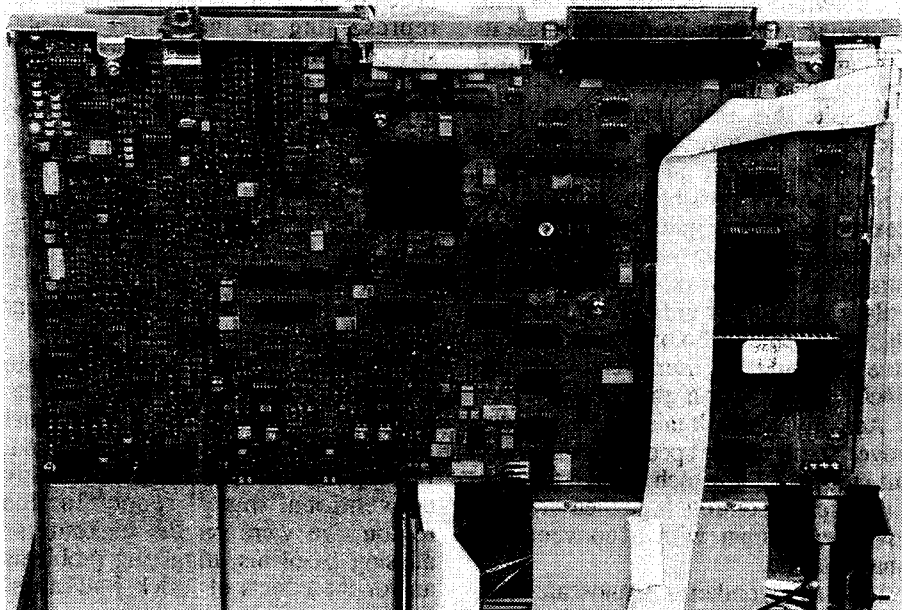
And then, there are the scope's display storage and communications capabilities — probably the most impressive aspect of all. We particularly liked the ability to be able to save and recall displays, for comparison; the ability to 'freeze' the current display with the Stop button, for closer examination; and also the 'autostore' function which combines full brightness display of the current signal with reduced brightness display of its 'history'.

But the real potential of this new breed of digital scope only became apparent when we hooked it up to a PC via the RS-232C interface, and ran HP's *Scopelink* software package. Within a few minutes, we were able to pull across copies of the scope displays onto the PC screen, and then print them out on paper.

Scopelink is a very friendly package, with an easy to use graphical user interface very much like Microsoft's *Windows*. In fact it will run under *Windows* if you wish, although it's essentially a free-standing program that normally runs under DOS. It will also work from either a mouse or the keyboard, although mouse operation is easier, and with virtually any video adaptor, although it gives best results with a VGA. In fact the presentation on a VGA is excellent.

It's very easy to set up *Scopelink* for either RS-232C or HP-IB/IEEE-488 communication with the HP 54601A, depending on the interface you're using. For RS-232C the setup menu lets you select the COM port, baud rate and so on just with a few clicks of the mouse. The 54601A interface operates at 19,200 baud.

Initiating a display screen transfer from the scope is also achieved with just a few clicks, plus typing in a



Here's the real works of the 54601A, hidden underneath on this single main PC board. Along with an impressive array of surface mount chips and components, there are three large LSI chips which form the main signal processing chain.

suitable filename for *Scopelink* to save the file on disk. The transfer menu also gives you the option of immediately viewing the transferred image on screen, plus a further option of making an automatic conversion to either PCX or TIFF image formats — for porting the images into a word processor or desktop publishing package. Needless to say, this last option appealed to us greatly. The other main option provided by *Scopelink* is the ability to print out any of the transferred images, on either an Epson-compatible dot matrix printer or a Laserjet-compatible laser printer using HP's PCL language. The printer can be addressed via any desired port, either parallel or serial.

We tried out this option with both kinds of printer. With the dot-matrix printer the results were very acceptable, while with the laser they were excellent.

Incidentally *Scopelink* has a very friendly feature when it's performing a relatively time-consuming operation like transferring a file, converting it into another format or sending it to the printer. Instead of the screen simply going 'dead' with an irritating hourglass symbol to indicate a forced hiatus, as with many programs, it gives you a dynamic bar-graph display showing you the percentage of the operation performed.

Summary

If I had to summarise my reaction to the HP 54601A in a word, it would probably be 'Wow'. Not a very high-

tech word, to be sure, and one that doesn't sound all that profound. But it's a word that seems appropriate, somehow, because this one seems rather more than just another scope.

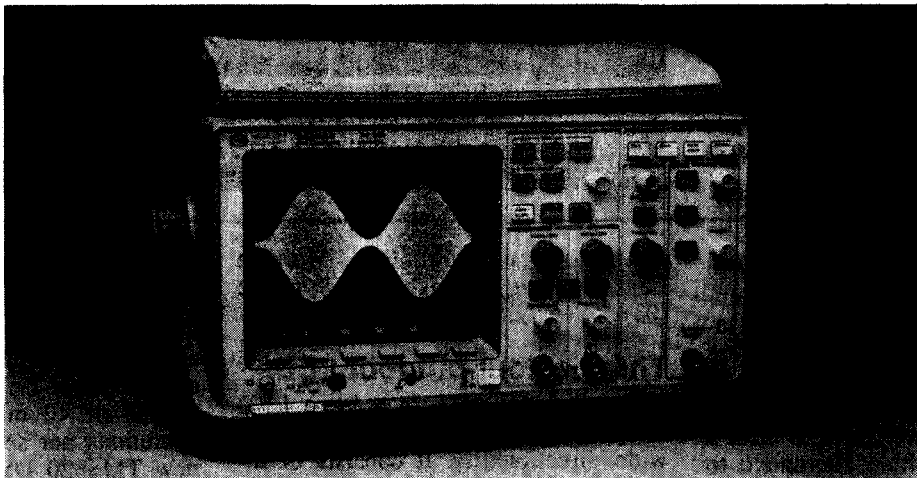
Over the years I've personally tried out and used many dozens of scopes, from low-cost audio 'cheapies' to gigahertz-bandwidth digitising instruments with price tags of over \$30,000. I've even designed a couple of simple instruments, in the distant past. I suppose that's all made me a little *blase* about scopes in general, to the point where it's unusual for me to get very excited about them.

Nowadays I suppose I regard a scope as just a tool — a tool to look at what's going on in circuits, and make measurements. This makes it a very important tool, of course; probably the most important electronic tool of all, in reality. But a tool, none the less. And in the ultimate, what really impresses me about a scope is not the technology inside, nor the number of knobs and buttons on the front — it's how well it works, and how easy it is to use, *as a tool*.

I suppose that's why I'm so impressed with the HP 54601A. The end result of all that effort by HP's engineers is that they've produced a really excellent tool: intuitive to drive, easy to manipulate, 'transparent' in its operation, and capable of displaying, storing and measuring effortlessly almost any kind of signal below 150MHz. Not to men-

Continued on page 107

Get the best of both worlds.



The oscilloscope you always wanted is finally here. Hewlett Packard's new HP 54600A series has all the digital troubleshooting power you need combined with an analogue look and feel. All at a traditional analogue price.

Unlike analogue scopes, the new 100MHz scopes have superior waveform viewing. So no more eye strain, no more viewing hood and need for a scope camera.

See for yourself. Attend our free seminar "The Best of Both Worlds" being held in the following cities:

Brisbane	21.5.91	Melbourne	28.5.91
Sydney	22.5.91	Adelaide	29.5.91
Canberra	23.5.91	Perth	30.5.91

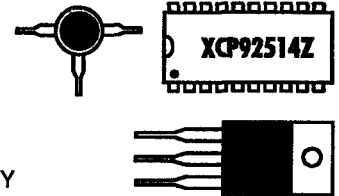


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Solid State Update

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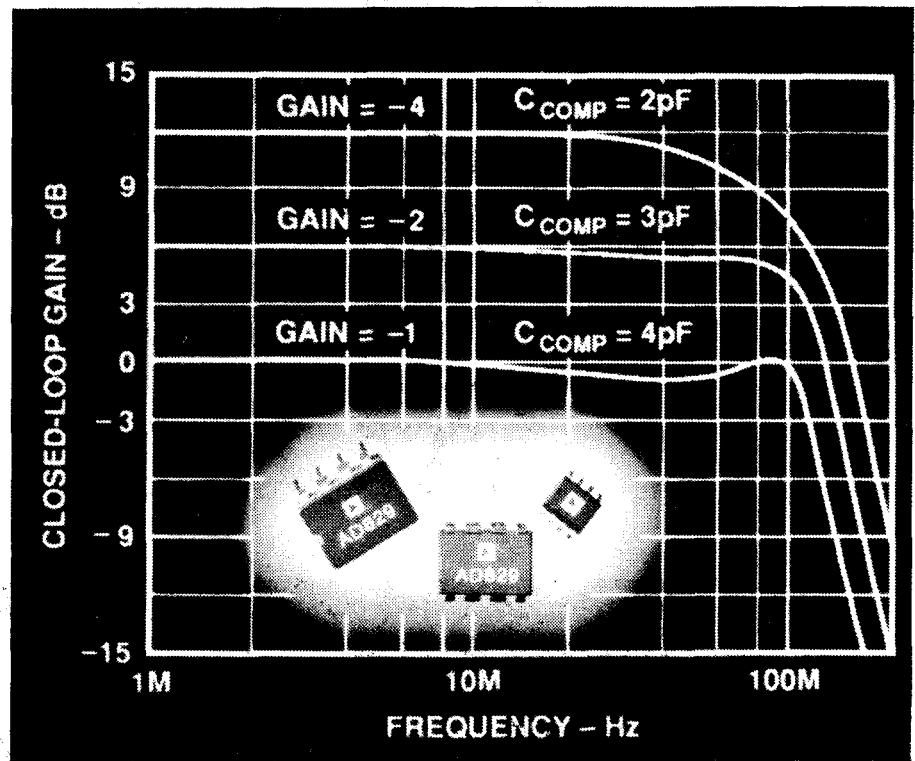


Video op-amp

Analog Devices AD829 monolithic video amplifier achieves 120MHz bandwidth at a gain of -1, has voltage noise of only 2nV/√Hz, yet costs much less than competitive devices with equivalent specifications. Exceptionally low 0.02% differential gain and 0.04° differential phase error make it well suited as a cable-driver, preamplifier or buffer in video applications. Fully specified for +/-5 to +/-15V power supplies, the AD829 features a fast 90ns settling time for multichannel, high speed data conversion systems.

The AD829 can be externally compensated, allowing bandwidths exceeding 50MHz for gains ranging from +/-1 to +/-20. For example, operating with a gain of two as a line driver of a doubly terminated 50 or 75 ohm cable, the -3dB bandwidth can be increased to 95MHz with only 1dB of peaking.

For more information circle 271 on the reader service coupon or contact NSD Australia, PO Box 264, Box Hill 3128; phone (03) 890 0970.



Super blocks

National Semiconductor has announced the release of two highly integrated single-chip solutions for analog designs, the LM612 and LM615. Part of National Semiconductor's 'Super-Block' family, the new devices offer a space-saving monolithic alternative to traditional multichip solutions.

The LM612 integrates a dual-channel comparator with a fixed output voltage reference, while the LM615 combines the features of a quad comparator with an adjustable voltage reference.

Key targets for these devices include manufacturers of power supplies, automotive diagnosis, and industrial products.

Applications for the LM612 include voltage window comparators, power supply voltage monitors and dual-channel fault monitors. Its low power comparators and adjustable voltage reference makes this device ideal for use in power supply monitors and adjustable threshold detectors.

For more information circle 272 on the reader service coupon or contact

National Semiconductors, Monash Business Park, Nottingham 3168; phone (03) 558 9999.

Three colour outdoor LEDs

The SLL-5080ML is a large LED lamp featuring high luminosity and wide directionality. It consists of individually waterproofed 5mm red and green LEDs assembled in a 50mm case.

The SLL-5080ML's extended directionality makes it ideal as a light source for outdoor advertising displays that must be bright and easy to view across a wide area.

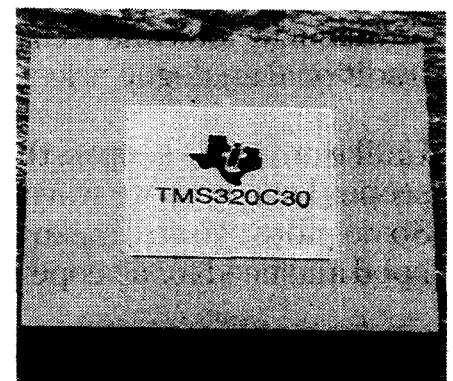
Used in place of incandescent lamps for outdoor information display applications, large LED lamps have the advantages of little or no maintenance and versatile four colour display capability. Moreover, ideal brightness and directionality can be achieved by altering the lamp assembly according to the purpose of use.

For further information circle 273 on the reader service coupon or contact Fairmont Marketing, 726 Plenty Road, Preston 3072; phone (03) 471 0166.

Very fast floating point DSP

A very fast 32-bit floating point digital signal processor (DSP) will be available from Texas Instruments before the end of June. Delivering peak performance of 40 million floating-point operations per second (MFLOPS), the new TMS320 DSP provides increased performance for new designs requiring floating-point capability. It also allows existing designs to see substantial performance increase.

Designated the TMS320C30-40, the



new DSP operates from a 40MHz clock and has a nanosecond instruction cycle. Its 40MFLOP performance is equivalent to 230 million operations per second (MOPS), or 20 million instructions per second (MIPS).

Pin for pin and object-code compatible with the previous model TMS320C30, the new chip is a plug-in replacement which is 20% faster. It can also be used with 20 to 25ns SRAMs.

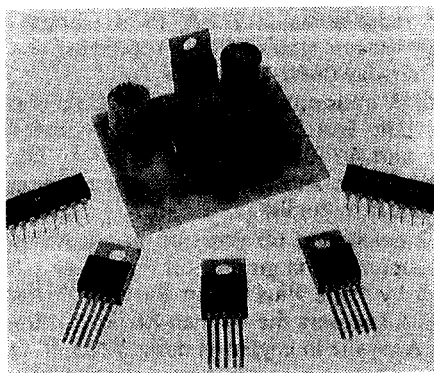
For more information circle 274 on the reader services coupon or contact Texas Instruments, 6 Talavera Road, North Ryde 2113; phone (02) 887 1122.

Simple switching voltage regulators

The 'Simple Switcher' family of switching regulators from National Semiconductor can now be used in applications that demand greater output current, with the introduction of a three amp step-down switching regulator, the LM2576, and a high-voltage version of the popular LM2575 and LM2575HV. These step-down (buck) Simple Switchers are easy to use in a system, because they require only four standard off-the-shelf external components. This combination of the LM2576 and four external components saves valuable board space, while providing a power efficiency rating of 80%.

Accepting a wide input-voltage range, 7V to 40V, and an output load of three amps, the LM2576 is designed to be used in applications requiring high-efficiency power conversion. This includes areas such as industrial control systems, factory monitoring equipment, consumer products as well as automotive entertainment and control systems. It is ideal for replacing DC-DC converters because it takes up less space.

For more information circle 276 on the reader services coupon or contact National Semiconductor, Business Park Drive, Monash Business Park, Nottigham 3168; phone (03) 558 9999.



Dual 8-bit ADC runs at 50MS/s

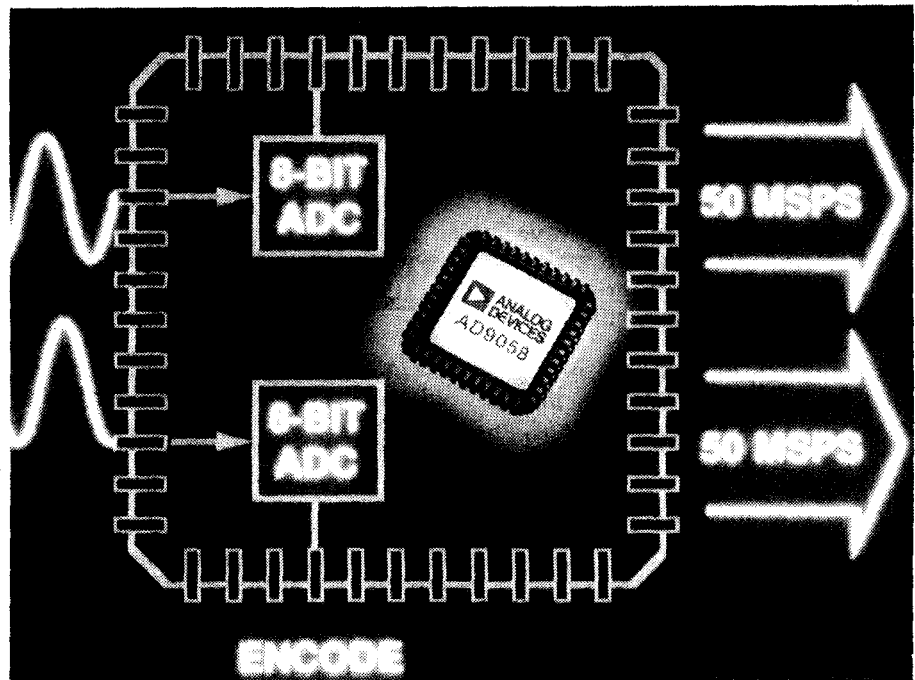
The very fast AD9058 dual 8-bit analog-to-digital converter (ADC) from Analog Devices can encode two input signals — independently or simultaneously — at rates up to 50 megasamples per second (MSPS).

Because its converters are independent — not shared — this 'true' dual converter is 30MSPS faster *per channel*, and costs nearly 40% less than any comparable dual converter. In contrast to complex multichip solutions, this single monolithic IC, housed in a 12.5mm square 44-pin surface mount package, saves valuable board space and eliminates the high cost of multiplexing circuitry. The AD9058 can be employed in simultaneous sampling ap-

plications, requiring closely matched channel-to-channel performance without costly external trim circuits. Tests at input frequencies of 2.3MHz and 10.3MHz, show a signal-to-noise ratio of 45 and 44dB with an effective number of bits of 7.2 and 7.1 respectively.

Switching specifications include a maximum 10ps aperture uncertainty (jitter) while analog input specifications include 175MHz full-power analog bandwidth and 10pF input capacitance. The AD9058's flexible analog input range is optimised for 2V peak-to-peak operation.

For further information circle 278 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970.



'Smart' sensor for cars

Operating from a car battery power supply between +9 and +30V, and over the complete -40 to +125°C temperature range, Analog Devices' AD22001 monolithic five channel comparator automatically detects the failure of headlamps, indicators and other lights. The device improves safety by continuously monitoring the condition of up to five lamp filaments, whether *on* or *off*, and also by testing the in-line fuse in two series circuits.

The AD22001's five comparators operate by detecting a very small threshold voltage, nominally 1.75mV, across a small shunt resistor in series with the lamp being monitored. A

length of standard copper track on the circuit board can serve as the shunt resistor, minimising IR dissipation and component count.

Each comparator automatically compensates for variations in both the power supply or the shunt resistance value. No external circuitry is required for operation. Packaged in a space saving 20-pin DIP and consuming only 300mW of power, the AD22001 replaces complex, less reliable discrete designs and costs only a few dollars.

For more information circle 275 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970. ■

SHORTWAVE LISTENING

by Arthur Cushen, MBE



Listener survey shows interesting results

Recently radio clubs in Australia and New Zealand surveyed their membership and the results were very interesting. One of the main findings was that 50% of the membership is over the age of 50, and though listening is being taken up by all age groups, the appeal for those retiring from work for this pastime is evident.

Both the Southern Cross DX club in Adelaide, and the New Zealand Radio DX League in Invercargill found similar results from many of the questions asked. In terms of membership, in the age group 15-30 there are 17%; 31-50, 34%; and 51+ 49%.

The various interests of members still show that listening on shortwave is the preferred band for the majority, while about a third of the membership find mediumwave their main listening challenge.

The majority of members are interested in programme listening, though there is still a dominance of the membership who write for verification of their reception — this was 56%.

Questions on aids to listening showed that 64% use a tape recorder, while 19% use computers.

The receivers in use cover a wide variety of brands, but most seem to prefer a modern portable.

Although communication receivers such as Kenwood, Icom, FRG, Grundig and Philips are in use, the portables such as Sony and Sangan are the most popular. Several members still use valve receivers such as Racal, Murphy and Philips.

When the membership was asked about the most popular features in their magazines, the survey of shortwave activity was the most popular. This lists the frequency, the time of reception, station details and programme information.

There is a considerable interest in receiver reviews, as this enables the newcomer to assess another viewpoint on the performance of new receivers on the market.

Most listeners apparently find that the *World Radio and Television Handbook*

is their main source of station and frequency information, while *Passport to World Band Radio* is second in this category.

These surveys, carried out from time to time, enable the various radio clubs to keep in tune with the needs of the membership. They can then devote

more energy into the areas of greatest interest.

Members of the two clubs surveyed showed less interest in television, FM DX, utilities and amateur radio activities but the other groups are more specialised in these fields of radio listening.

AROUND THE WORLD

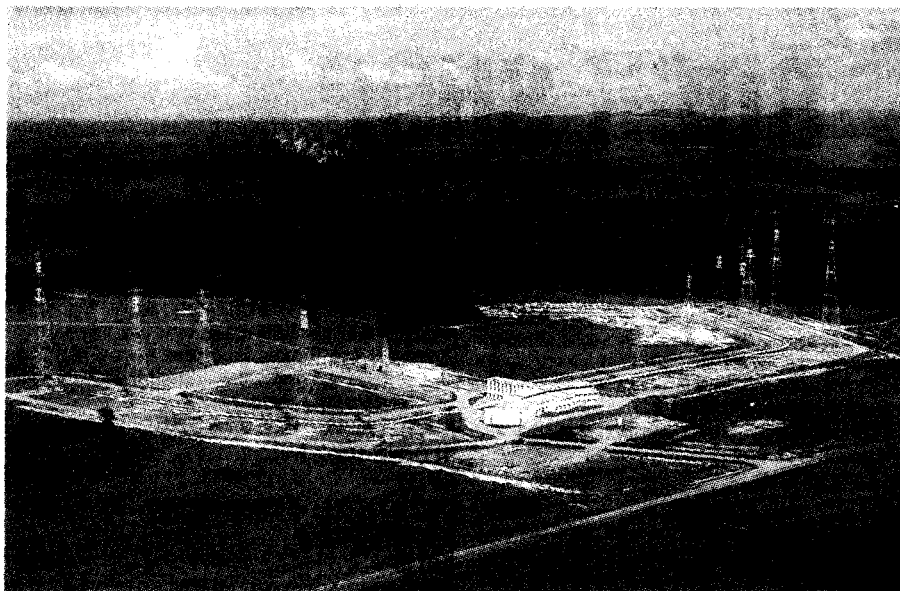
ECUADOR: HCJB has a special contest to mark their 60th Anniversary on December 25, 1991. Every listener who writes in and wishes HCJB a happy anniversary will have his or her letter placed in a draw. At the end of the year, two people's names will be drawn at random. The two people whose names are drawn will receive a one week trip to Ecuador as guests of HCJB. The draw will take place just before Christmas 1991, and there is no limit to the number of letters written wishing a happy 60th anniversary. HCJB will pay for the return trip from the country from which the letter was sent. They will also provide a week of hospitality with HCJB in Quito, Ecuador. The address is: PO Box 691, Quito, Ecuador. HCJB broadcasts to the South Pacific 0700-1130UTC on 9745 and 11925kHz.

FRANCE: Radio France International is to replace its 12 aging 100kW transmitters in France with sixteen 500kW transmitters with rotatable curtain antennas. The overseas relay station in Montsinny, French Guiana, will have a fifth 500kW transmitter while two new relay stations will be built, one in Thailand and the other in East Africa (presumed Djibouti). Each of these two new relay stations will have three 500kW transmitters.

NEW ZEALAND: ZLXA 3935kHz on Monday 0900UTC has incorporated 'Arthur Cushen's Radio World' with a programme supplied by Jim Meecham of the New Zealand Association of Radio Transmitters titled, 'CQ Pacific.' The broadcast incorporates news for the shortwave listener and radio amateur. ZLXA, Print Disabled Radio, PO Box 360, Levin relays the mediumwave station 2XA, 1602kHz, and operates Sunday 0630-0900 and Monday to Thursday 0600-1000UTC.

SRI LANKA: Radio Japan has installed two 300kW transmitters at Ekala near Colombo and is using these for transmissions to the Middle East. Two broadcasts have been heard in English, 1400-1500 on 9535kHz and 1700-1800 on 15210kHz. The programme includes news in English for 10 minutes and five minutes of news in Japanese, the balance of the programme is a feature in English.

VATICAN: The Vatican Radio on February 12 celebrated 60 years of broadcasting. The first transmitter was built by Guglielmo Marconi in the grounds of the Vatican. It was officially opened on February 12, 1931 by Pope Pius XI. In the 1960's the transmitters were increased to five 100kW units, but now the Vatican Radio is using transmitters of 250 and 500kW. The service to Australia in English is daily, 2205-2225 on 9615 and 11830kHz.



Radio France International's relay base at Montsinery, French Guiana, South America, which is to have a fifth 500kW transmitter added to the four such units already in use.

KTBN on shortwave

The Trinity Broadcasting Network which is carried on television across the US, has recently purchased KUSW Salt Lake City with its 100kW shortwave transmitter, studios and offices for US\$2.1M. KUSW had the slogan 'From the West to the World', and was established some three years ago. But it did not seem to be a financial success.

The new owners, Trinity Broadcasting Network, are using the shortwave transmitter to carry the audio feed from the television network.

Broadcasting 24 hours a day, the new transmission has been well received in the South Pacific. It uses two frequencies, 7510kHz 0200-1600UTC and 15590kHz 1600-0200UTC.

According to station manager James Mitchell, the broadcasts are intended for reception worldwide, and it is expected that there will be other frequencies in use. In the meantime, the transmissions are beamed northwards into Canada.

A station announcement is heard on the hour each hour, and the station still uses the super power KTBN an-

nouncement. Reception reports are requested to: Radio KTBN, PO Box 18147, Kearns, Utah, USA.

41 metre band expansion

The 41 metre band is used by both international broadcasters and radio amateurs, except in North and South America, where the band is exclusively used by amateurs.

Listeners will be aware of interference between amateurs and international broadcasters, particularly in the section 7100/7300kHz, which is used by both amateurs world-wide and international broadcasters outside the Americas.

A recent meeting in Washington between the American Radio Relay League and United States shortwave broadcasting groups, has put together a plan to break the band into two sections, thus avoiding the present interference. A working group has set up a proposal to be put to the Federal Communications Commission that the amateurs be allocated a new band 6950-7250kHz and international broadcasters 7250-7750kHz. Both these bands would be on an exclusive worldwide basis; thus the amateurs would have freedom of operation between 6950-7250kHz and the higher section of the band would be for international broadcasting.

Following further discussion, it is proposed that this suggestion be taken to Geneva at the next meeting of the World Administrative Radio Conference. ■

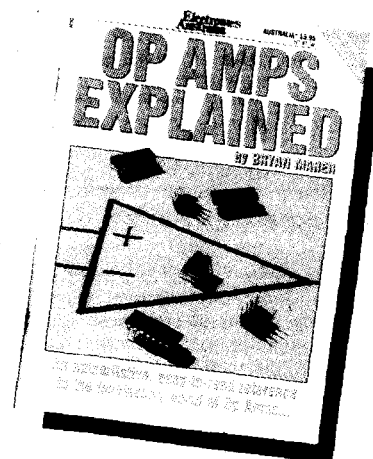
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This column is contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand, who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT), which is 10 hours behind Australian Eastern Standard Time.

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The basic Transistor Amplifier

Transistors can do many things, but their most basic role is as an amplifier. We not only examine the transistor amplifier, but show you how to design your own. It's surprisingly simple, as you will see...

by PETER PHILLIPS

In the previous chapter we introduced the transistor and showed a basic amplifier circuit. In this chapter we take the topic further and examine the transistor amplifier more fully. By using very simple arithmetic, we will show how to design a transistor amplifier and also describe what each component does. If you have some basic electronic equipment, you might even like to build the circuit we will design. All you'll need is a power supply, a multimeter and a few electronic components. A 9V battery or the power supply described in Part 9 can be used to power the circuit.

Amplifiers come in all shapes and sizes, and the most familiar is the audio amplifier. In a future chapter we will describe an audio amplifier module, again one you might like to construct. As you will see, an audio amplifier contains several stages, and for now we concentrate on the simplest stage, called the *voltage amplifier*. To explain, let's start with an overview of an audio amplifier before we get down to designing a voltage amplifier.

The audio amplifier

Most audio amplifiers have a number of sections, or stages, as shown in Fig.1. For example there's a section, usually referred to as the *pre-amplifier* that accepts signals from the various input devices, such as the record player, tape recorder, compact disc player and so on. The pre-amp section often includes the tone controls and other features, and can vary from a very simple circuit to a highly complex unit.

The following stage is the *voltage amplifier*. This section takes the output of the pre-amp and amplifies the signal to a level required by the output stage.

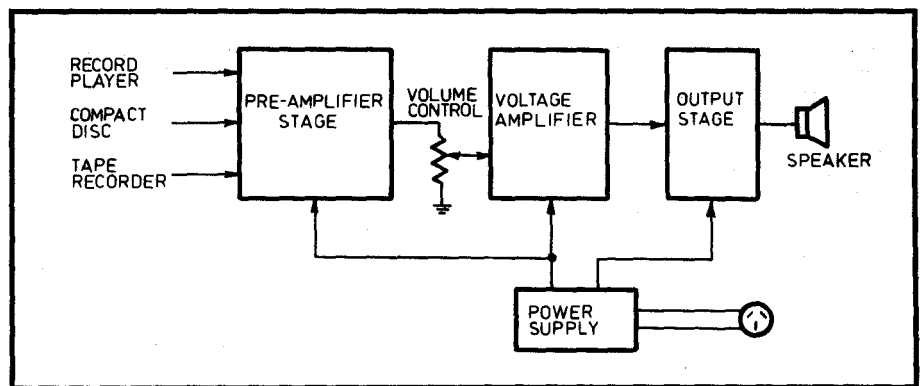


Fig.1: The block diagram of a typical audio amplifier, containing a pre-amplifier, a voltage amplifier, an output stage and a power supply.

The output stage has the task of driving the loudspeaker, and its circuit will be described later in this series.

Our subject in this chapter is the voltage amplifier, which in one form or another is a fundamental part of any amplifier. Its basic task is to amplify an electrical signal to the required level, and the circuit may contain one or more transistors. However, there are several aspects to a voltage amplifier that need explaining before we can get onto an actual circuit.

Amplifier gain

The most important thing to know about a voltage amplifier is the value of the voltage *gain*. Gain is a measure of how much the input signal is amplified, and is found by measuring the input and output signal levels. The voltage gain is then calculated by dividing the output signal level by the input signal level. For example, if the input voltage is 1V and the output is 10V, the amplifier has a gain of 10.

The gain of the circuit is determined

during its design, so it's important to know what value of gain is required before starting the design. Although a single transistor amplifier can have a very high gain, it is usual to combine two or more amplifier stages if a high gain is required. If two amplifiers each with a gain of 10 are combined, the overall gain will be 100. This is illustrated in Fig.2, in which the first amplifier with an input of 0.1V (100mV) produces an output of 1V. The second amplifier has an output signal of 10V, giving an overall gain of 10V/0.1V which equals 100. In other words, the total gain of the circuit equals the *product of the individual gains of each stage*.

By the way, notice the symbol used for

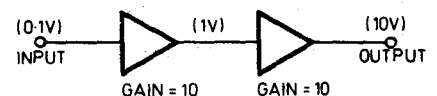


Fig.2: When two amplifiers are connected in cascade, the overall gain is the product of their individual gains.

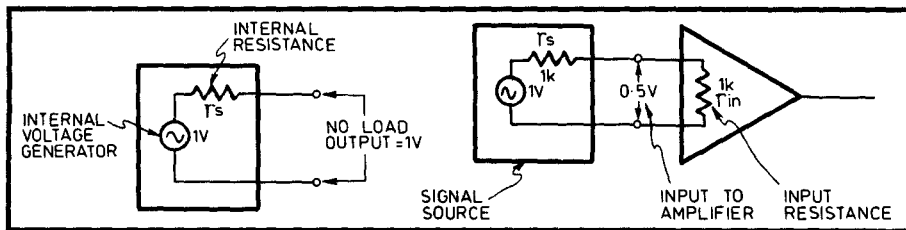


Fig.3: Any signal source is equivalent to an internal voltage generator in series with a 'source' resistance, as shown at left in (a). When the source is connected to an amplifier as in (b), the latter's input resistance reduces the signal level.

each amplifier stage in Fig.2. This is a standard way of depicting an amplifier, in which the input is to the base of the triangle and the apex is used to represent the output.

Another important aspect of the voltage amplifier is its *input resistance*. This term refers to the effective resistance between the input terminals of an amplifier, and ideally it should be as high as possible. To explain, we need to use Ohm's law and the diagrams of Fig.3.

In Fig.3(b), a signal source such as the pickup from a record player is shown connected to an amplifier with an input resistance of 1k. The signal source is shown in Fig.3(a) as having an *internal resistance* of 1k and an internal voltage generator that is producing 1V. In fact, Fig.3(a) is a general diagram that describes any type of signal source in which the internal resistance is between the part that produces the electrical signal (internal generator) and the output terminal. In some cases this resistance value can be very high, often up to several megohms, and depends on the type of device.

If the signal source is connected to a measuring instrument with a high input resistance, such as a cathode ray oscilloscope, the *no load output signal level* of the device can be measured. This will equal the value of voltage being produced by the internal generator, which in this case is 1V.

When the signal source is connected to the amplifier, the input resistance of the amplifier *loads* the output of the source, and because (in this case) the values of both resistors are the same, the output signal level of the signal source will now be 0.5V as shown in Fig.3(b). Notice how the output of the signal source dropped when it was connected to the amplifier.

If the amplifier has a very high input resistance, the output of the signal source will approach its no load value. The lower the input resistance of the amplifier, the more it loads the signal source. If the signal source has a very high internal resistance, the loading of the amplifier can be such that very little signal is produced by the source, hence the need for a high input resistance for the amplifier.

The amplifier itself can also be regarded as a signal source, except it needs an input signal to produce an output. A signal source produces the electrical signal by other means, such as by movement of a stylus in a record track.

The diagram of Fig.4 shows the equivalent circuit of an amplifier, and includes the input resistance (R_{in}), an internal voltage generator (representing the gain of the amplifier) and a resistor, called R_o , between the generator and the output terminal.

The internal generator produces a voltage equal to the product of the gain of the

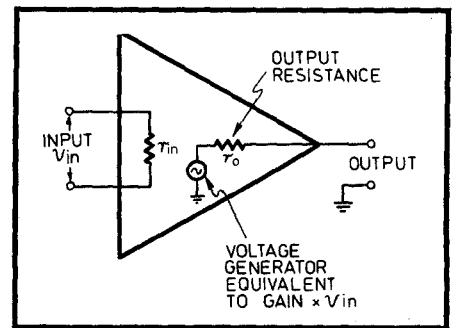


Fig.4: The equivalent circuit of an amplifier. The internal voltage generator connects to the output terminal through resistor R_o , which is ideally as small as possible.

amplifier and the input signal. The generator connects to the output of the amplifier through a resistor known as the *output resistance*. This is much the same as the internal resistance of the signal source described before.

Ideally, the output resistance of an amplifier should be as low as possible, to ensure that virtually all the signal produced by the internal generator is passed to the output terminal. Naturally, if the amplifier is not connected to a load, there will be no loss across the output resistance, but in a practical situation the amplifier will be connected to a load of some sort. The lower the value of the load, the greater the loss across the output resistance.

Summarising all this, an amplifier should have a high input resistance so it doesn't load the signal source, and a low output resistance to ensure maximum output when it is connected to a load. The design of the amplifier determines the value of the input and output resistance, as well as the overall gain.

Common emitter amp

Now that the three most important characteristics of an amplifier have been described, we can start designing a single stage voltage amplifier. To begin with we will not design for particular values of gain, input or output resistance, but rather show how these values can be calculated from the final design. This way you will get an understanding of the factors that determine these values.

The starting point is the actual circuit configuration. In the previous chapter, a circuit diagram of a transistor amplifier was presented and described as being 'typical'. This circuit is called the *common emitter* amplifier, which suggests that there are other circuit configurations.

In fact there are three possible configurations: common emitter, common

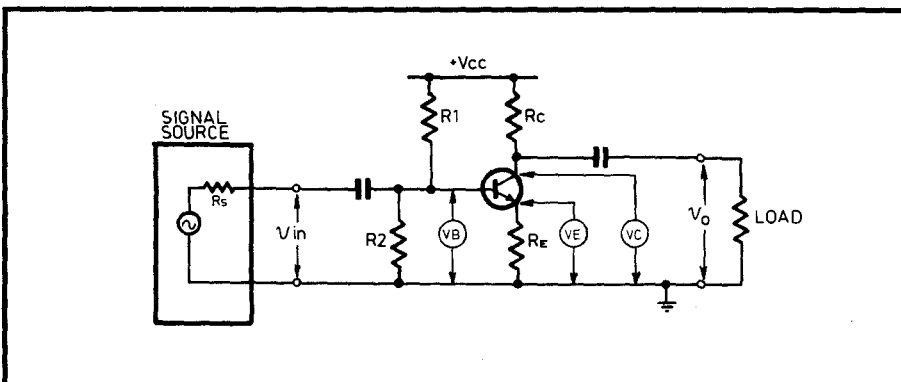


Fig.5: A basic common emitter amplifier. Note that the emitter terminal is neither an input nor an output terminal, but common to both. The coupling capacitors isolate the DC voltages from the signal source and load.

Basic Electronics

collector and common base. In the common emitter circuit, the emitter is neither an input or an output terminal and simply connects to the common rail. The common collector amplifier has the input applied to the base terminal, and the output is taken from the emitter. Notice how the collector is neither an input or an output terminal in this configuration.

Similarly, the common base circuit has the input applied to the emitter and the output is taken from the collector. The base terminal is simply used to establish the DC conditions. The common base configuration is not used a great deal, and we will describe the common collector amplifier in a future chapter.

The circuit of a common emitter amplifier that uses an NPN transistor is shown in Fig.5. The DC conditions of the amplifier are determined by the values of the resistors, and as described in Part 10, are chosen so that the collector voltage (V_c) equals half the supply voltage. Now let's calculate the values of the resistors.

DC conditions

The first thing is to decide on a value for the collector current. A reasonable value is 1mA, as this suits most small signal transistors and gives resistor values that are typical. The next decision is the value of the supply voltage, referred to as V_{cc} . Let's use 10V, as this will make the maths easy. Because the collector voltage needs to be half the supply voltage, we need 5V at the collector and to drop 5V across the collector resistor R_c . Ohm's law says that $R_c = 5V/1mA ((V_{cc}-V_c)/I_c)$, giving a value of 5k ohms. We will pick the nearest preferred value of 4.7k.

Next is the value of the emitter resistor. Good design practice says to use a resistor that gives an emitter voltage of around one-tenth the collector voltage, so the emitter voltage (V_e) needs to be approximately 0.5V. Using Ohm's law, where $R_e = V_e/I_e$ (we can assume that $I_e = I_c$), we get $0.5V/1mA$ which equals 500 ohms. The nearest preferred value is 470 ohms.

The DC voltage at the base of the transistor needs to be 0.6V higher than the emitter voltage, so $V_b = 0.5V + 0.6V$, giving 1.1V. Now we need to calculate the values of the base bias resistors, R_1 and R_2 . This may seem impossible, as there are several unknowns. In fact there are an infinite range of values, so more empirical decisions need to be made.

Because the transistor being used has a current gain (h_{fe}) of more than 100, it is

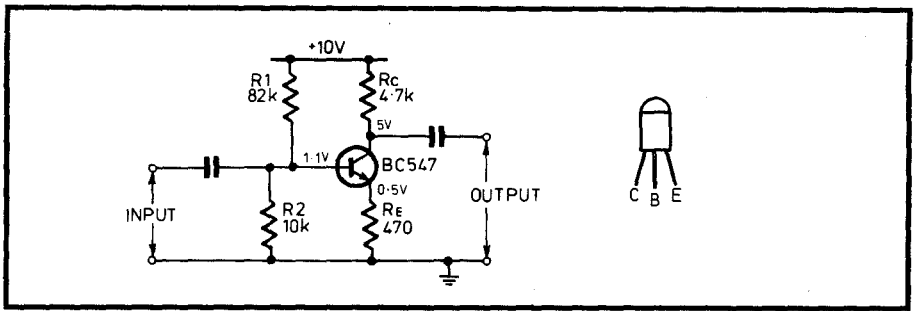


Fig.6: The common emitter amplifier described in the text, shown here with the resistor values to give the DC voltages shown. Any NPN small signal transistor with a current gain of greater than 100 can be used.

reasonable to say that the DC base current is small enough to ignore. This means that the current flowing in R_1 (of Fig.5) equals the current in R_2 . This type of approximation is valid for voltage amplifiers and makes the design process much easier.

The voltage across R_2 will equal V_b , which in this case is 1.1V. Therefore the voltage across R_1 is $V_{cc}-V_b$, giving $10-1.1 = 8.9V$. The ratio of the resistors is therefore 8.9:1.1 or 8.1:1. In other words, R_1 needs to be 8.1 times higher than R_2 . There are still many possibilities, so we need to pick a value for one of the resistors and calculate the other. If we choose 10k for R_2 , then R_1 needs to be $10k \times 8.1$, or 81k. In this case, the nearest preferred value is 82k.

The values of the bias resistors R_1 and R_2 both affect the input resistance value of the amplifier, so the higher their values the better. However, there is a practical limit to how high these values can be, and a value of 470k for R_1 is generally the maximum.

(Strictly speaking, to ensure stable operation of the transistor, R_1 and R_2 should be chosen so that the current through them is more than about 10 times the transistor's base current. However as the base current will typically be only a few micro-amps, you normally don't need to worry about this.) We now have resistance values that will give the specified DC voltages — but we have not considered voltage gain, input resistance or output resistance. To show how these values are all affected by the values of the resistors, we need to study the AC conditions of the amplifier.

AC conditions

So far, the design process has been based on *approximations*, and if you were to build the circuit, shown complete with its values in Fig.6, the DC voltages of the circuit would be close to the theoretical values. A suitable transistor is a BC547, which is specified as a general purpose amplifier. This transistor

has a value of h_{fe} greater than 100, which is essential to our approximations.

The gain of the amplifier can be roughly determined by dividing the collector resistor by the emitter resistor, which in this case gives a gain of 10. This relationship is only true if R_e has a value greater than a few hundred ohms, as we will explain later.

If a higher gain is required, then the 10:1 ratio of the emitter and collector resistor values needs to be changed. However this will upset the rules already described, in which the DC voltages need to be in a ratio of 10:1. We will describe how to get around this anomaly shortly, after the input and output resistance values have been calculated.

The output resistance of the circuit is the easiest one to calculate, as it simply equals the value of the collector resistor. In this case, the output resistance is 4.7k. The input resistance is more difficult to determine, but as a very rough approximation, it equals the parallel resistance of the base bias resistors. This gives a value of 8.9k, which is a practical input resistance for a voltage amplifier.

The complication now comes when we need a higher gain than a figure of 10.

Emitter bypass cap

To increase the gain of a common emitter amplifier, a capacitor, called a *bypass* capacitor can be connected across the emitter resistor. Remember that a capacitor blocks DC voltages, but can behave as a short circuit to an AC voltage. By placing a capacitor across the emitter resistor, the DC conditions are not affected, as the capacitor is effectively an open circuit. However, when the gain for an AC signal is being calculated, the capacitor is now a short circuit, giving a value of zero ohms for the emitter resistor — which gives the impossible gain figure of $R_c/0$, or infinity!

Obviously there is something wrong, as no amplifier has such a high gain. The answer lies inside the transistor in the form of an internal resistor that is effective

tively in series with the emitter terminal, shown in Fig.7(a). This resistor is given various names, but we'll use the term 're' ('little re'). Its value can't be measured easily, and needs to be calculated using the empirical equation of $30\text{mV}/I_c$. Some text books use $27\text{mV}/I_c$ and others are as low as $25\text{mV}/I_c$, suggesting that the calculated value will be an approximation anyway.

In the example design, the value for re will be 30 ohms ($30\text{mV}/1\text{mA}$), and if the emitter resistor Re is bypassed with a suitable capacitor, the gain is calculated using the equation R_c/r_e , or $4.7\text{k}/30$ — which gives a gain of 156.6.

In fact, the gain equation should always include the term re, even when the emitter resistor is not bypassed. However, as we have already said, if the unbypassed emitter resistor is more than a few hundred ohms, the effect of re is minimal. This figure of gain we have just calculated is the maximum that the transistor can produce, at the collector current and with the value of Rc shown.

To obtain a gain of less than this maximum of 156.6 but more than 10, the circuit of Fig.7(b) can be used, in which two resistors are included in the emitter circuit, with one bypassed by a capacitor. The value of the capacitor is another story, but the values shown in the diagram will give correct performance. Note that they are all electrolytic types, due to the relatively high values of capacitance required.

In Fig.7(b), a resistor of 15 ohms has been connected in series with the 470 resistor, which is now bypassed with a $47\mu\text{F}$ capacitor. The effect is that the total emitter resistance for AC conditions is now 30 ohms (re) plus 15 ohms, or 45 ohms. When this is divided into the value of the collector resistor, the gain is now $4.7\text{k}/45$, or approximately 100.

Another side effect of adding a bypass capacitor across the emitter resistor is

that the input resistance of the amplifier reduces. A more correct equation for determining input resistance is one that includes the effective resistance of the transistor. Previously this was ignored, as the high value of the emitter resistor (470 ohms) made the input resistance of the transistor high enough to ignore.

The equivalent input resistance of the transistor is found by multiplying the sum of re and any unbypassed resistance in the emitter circuit, by the current gain of the transistor. If we assume a current gain (hfe) of 200, then in the example, the equivalent resistance of the transistor is 200 times (30+15), or 9k. This resistance is across the input terminals of the amplifier, and needs to be included with the parallel combination of the bias resistors. Thus, the input resistance of the amplifier is now the parallel combination of all three resistor values, which gives a much lower value of 4.48k.

So the cost of a higher gain is a reduction in the input resistance. For this reason, designers often use several amplifier stages to get a high gain, as the input resistance can be maintained at a reasonably high value.

To complete the story, we now need to consider the effect of the load resistor on the gain of the amplifier. As already described, the output resistance is effectively in series with the load, and in our example, the output resistance is the relatively high values of 4.7k.

By applying the same logic used to describe the effect of input resistance of an amplifier on the signal source, it's easy to see that connecting a load to an amplifier reduces its output voltage. In the example, if an AC load resistor of 4.7k is connected to the amplifier, then the output voltage from the amplifier will drop by half. This is because half the output voltage is lost across the output resistance. Because gain equals the output divided by the input, then obviously

TABLE OF EQUATIONS USED	
DC conditions: Refer Fig.6.	
Collector resistor	$R_c = \frac{V_{CC} - V_c}{I_c}$
Emitter resistor	$R_e = \frac{V_e}{I_c}$
Base bias resistors	$R_1, R_2 = \frac{(V_{CC} - V_b)}{V_b}$ where $V_b = V_e + 0.6\text{V}$
AC conditions: Refer Fig.7.	
Voltage gain	$= \frac{R_c // R_{load}}{r_e + R_e}$ where $R_e = \frac{30\text{mV}}{I_e}$
Input resistance	$= R_1 // R_2 // [hfe(r_e + R_e)]$ where $R_e =$ any unbypassed resistance in the emitter circuit
NOTE: // means 'in parallel with'	
Output resistance	$= R_c$

the value of the load resistor needs to be considered in the gain equation.

All that needs to be done is to determine the parallel combination of the load resistor and the collector resistor, then divide this value by the resistance in the emitter circuit.

In summary

We've now examined the common emitter amplifier in reasonable detail, sufficiently to allow you to start working out a few designs of your own. The equations used are summarised in the table, but remember that they are approximations. If you need a particular value of gain, then build the circuit using the equations as a design guide, then measure the gain and trim values to suit.

For those of you who are now scratching your head and wondering what it all means, don't worry. This part of the series is the most mathematical of all, and knowing how to design a transistor amplifier is not an essential part of understanding electronics. I've described the process for those who want to try their hand at building a voltage amplifier, and also to show the purpose of each component in the circuit as a help when faultfinding.

For example, if you discover that the gain of an amplifier is no longer as high as it used to be, try replacing the bypass capacitor in the emitter circuit. Also, you should now have a better idea of the typical DC voltage values in a common emitter amplifier. If you measure more than 0.8V or so across the base-emitter junction, then replace the transistor as the base-emitter junction *must* be open circuit. If the collector voltage is around half the supply voltage, then you know the amplifier is correctly biased.

We'll continue with voltage amplifiers in the next chapter and also introduce the field effect transistor. This will eventually lead us to a complete audio amplifier you can build.

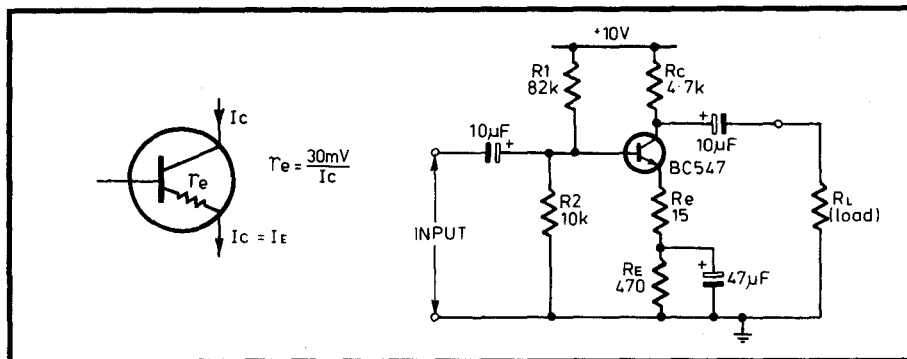
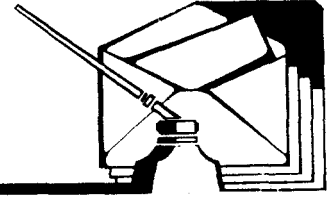


Fig.7: In (a) at left is shown the transistor's internal emitter resistor, re. Because the collector and emitter currents are virtually equal, the equation shown can be used to calculate its value. The circuit in (b) at right has an approximate gain of 100. Note the polarity of the coupling capacitors, which need to be electrolytics.



Information centre



Conducted by Peter Phillips

Spray it again, Sam!

Somehow this month we manage to mix an ancient Greek with questions and suggestions on projects. On the way we take a brief look at electronic spray packs and the trouble they can cause.

Repairing electronic equipment is a task many readers will have been involved in, as one of the advantages of being 'electronic' is the ability to save on repair bills. Over the years I have seen the results of quite a few 'fix it yourself' attempts, including those by the technically unaware. But perhaps the greatest minefield for the uninitiated is the incorrect use of electrical sprays.

I once witnessed an attempt to repair a portable radio in which the owner placed the entire radio in a drum of moisture dispelling liquid.

Commercially, this liquid is available in a pressure pack, and finds great application in fixing squeaky doors, noisy volume controls and wet distributors. But in this instance the results were predictably disastrous. The owner couldn't understand why, because he believed that if a little works, a lot should work even better.

A spray that is very handy in finding intermittent faults is the 'freezer' spray. By spraying this on sections of a PCB, temperature sensitive faults can often be located.

But again a little goes a long way, unlike an acquaintance who decided to try freezing a faulty amplifier. Not with spray mind you, but in the kitchen freezer! Unfortunately he got distracted and only remembered where his amplifier was the next day — frozen solid! (No, he didn't thaw it in the microwave, but the odd thing was that it has worked well ever since...)

Like most repair technicians, I use sprays to clean contacts, to freeze components, dispel moisture and so on; but occasionally time is the best cure.

Recently I was cleaning the family

swimming pool, wearing cossies, a radio and headphones. The radio somehow let go from its precarious hold on my swimmers and fell into the pool. I dived in after it, forgetting I still had the earphones on (*@%&#!).

Naturally the radio was totally dead after its retrieval, but given a few hours of sunshine it gradually came back to life and has never looked back. Even the earphones survived. I'm sure if I had tried a moisture repelling spray, the trimmer capacitors would have been irretrievably affected.

Which leads to our first letter this month, on how to clean contacts without a contact cleaning spray...

Repairing remotes

It seems this column is dispensing useful advice. The following letter reports great success on repairing a TV remote control unit, using a method described in the February 1991 issue.

The interesting point is that the remote control unit differs from that described and the method has been modified to make it much simpler:

In the February edition, I noticed two methods of repairing remote controls. Having a faulty TV remote unit, I decided to try the second method which involves cleaning the contacts with a nailbrush, warm water, cotton buds and switch cleaner.

The method states 'clean the copper contacts on the keyboard with the eraser'. I assumed that a pencil eraser was required for this. However, the keyboard of the remote control in question (Sanyo) has some form of carbon impregnated coating, rather than copper for the contacts. A resistance of

500 ohms is obtained across the contact when measured with an ohmmeter.

I gave each contact about five or six rubs with a very soft rubber. Without doing anything further, I put the unit together and it worked perfectly.

Apparently the trouble lies not in the carbon coated rubber push buttons, but is due to the surface becoming dirty or oxidised. I wonder how many of these controls have been replaced at \$120 a time, when all that's required is a few rubs with a pencil eraser!

Incidentally, I built the Remote Control Tester (September 1990) and it works well. I thought you might be interested in the above and thanks to the person who sent in the idea. (M.B., Toukley NSW).

I find this letter particularly interesting, as a friend of mine recently asked me to look at a VCR remote control that has an identical construction to that described by M.B. However, my friend had tried to repair the remote by spraying it liberally with one of the magical cure-it-all sprays.

As it turned out, the spray did something to the carbon and also appeared to have killed the IC, perhaps as a result of leakage currents due to the spray liquid before it evaporated.

The only way out was to buy a new control, so the message appears to be 'spray with caution'.

Low Distortion Osc

The next letter concerns the Low Distortion Oscillator described in the February and March 1989 editions of EA. This is the first letter I have received about this project, so my assumption is that other constructors have not had any problems. There is

an interesting story behind this oscillator, which I'll save for later.

I am having problems with your Low Distortion Oscillator. I purchased it as a kit and added refinements, including the suggested NE5532 op-amps and a thermistor. However, I found that when the oscillator was set to its maximum frequency range, (x10k) with thermistor compensation, the output was simply a series of spiked oscillations.

Selecting diode compensation on this range resulted in the output amplitude falling from 3.5V at 24kHz to 2.8V at 226kHz. All other ranges had no problems.

I decided to live with these problems for the moment and added a dual-ganged wirewound pot and 500 ohm dual carbon-track pot for fine adjustment of the frequency. Again all was well except for the x10k range. This time, on diode compensation, the output falls to zero below 40kHz, which I partly cured by increasing the value of R13 to 2.2k. This gives an output of 3.6V at 14kHz, which rises to 4.0V at 90kHz and then falls back to 3.5V at 223kHz.

On thermistor compensation, the same results as before were obtained. All I can assume is that the inductance of the wirewound pot is affecting the circuit. I have checked the circuit many times and have replaced the ICs with no effect on the problems. Any ideas? (D.H., Sandy Bay Tas).

The following story about this oscillator may not help you D.H., but is testimony to the reliability of the circuit. Regular readers may remember that in 1988 a fire destroyed our premises. Anything that wasn't burnt was covered in water and carbon, including the original prototype of this oscillator. This project had been submitted by its designer Phil Allison, some months before, with the proviso that we develop the PCB design and the case artwork.

I subsequently rescued it and cleaned it off as much as possible. The circuit was constructed on strip board (Veroboard), which was now very black and sorry.

There were also several wires disconnected, but otherwise the unit was intact. I reconnected the wires, then tested the oscillator to see what would happen. As it turned out, the unit worked perfectly, despite the many vicissitudes it had experienced.

Over the ensuing months I designed a PCB and built several versions to ensure a reliable design. Finally, Phil Allison and I put the completed unit

through its paces, trying various ICs and other alterations. I had previously tried a wirewound pot, but because of their cost and scarcity, reverted to a carbon track type. In other words, no other EA project has undergone so much stress or development. And as I've already stated, this is the first letter about the unit.

Regarding your problems, D.H., the drop in output voltage is consistent with the specifications, which state within 2dB for diode compensation. In fact, the change in output level quoted by D.H. is -1.9dB, so nothing wrong here.

As well, the article also points out that 'squegging' of the output can occur for frequencies above 150kHz. It seems you are experiencing this, although maybe in its extreme form. This is caused by the thermistor, so perhaps a replacement may be in order.

We used one obtained from RS Components (type RA53). This is a glass encapsulated type and is a critical component.

Otherwise, try checking the value of the timing capacitors C5 and C10. Perhaps one of these has a different value to the other. Also check the wiring to make sure the wires to these capacitors are not crossed over. Likewise try relocating the wires connecting the front panel controls to the PCB. I seem to recall this could affect the squegging.

Adding an extra dual-ganged potentiometer as a fine frequency control was something we didn't try, so I cannot comment on the effect. However I suspect it will affect the distortion figures and possibly the stability. Increasing the value of R13 will also affect the distortion figures for diode compensation.

And now for some grammar...

Us versus we

I hate to do this, but as Peter Phillips has asked for readers' corrections, here goes: You can't 'distinguish we' (Editorial, p.7, January 1991) — you have to 'distinguish us'. Nevertheless, congratulations on a great magazine. (F.K., Woomye Qld).

What I meant F.K., was correct me and my paltry writings! However, as Jim (who wrote the editorial in question) has passed your letter on to me, I'll throw in my tuppence worth. I agree that the combination of 'distinguishes we' is grammatically wrong, but in the context of 'distinguishes we electronics people' obviously 'us' is out of place.

Whether the entire sentence is wrong is another matter, although I have to admit if I had proofread the editorial I wouldn't have changed it.

Perhaps we're both wrong, so I'll leave the last word to Horace (circa 8BC) who says 'It has always been lawful, and always will be, to issue words stamped with the mint-mark of the day.' And 'we electronics people' is surely one of these! Thanks F.K., I love an excuse to quote and ramble...

House alarm

The next letter offers a modification to the house alarm presented in the April 1989 edition:

As Peter Harris said (more or less), the 'Low cost 2-sector House Alarm' provides 'all the operational features required to protect the average family home... for the best possible price.'

It makes a lot of sense to hide the unit away in some remote corner as suggested, mounting the key switch and indicator LEDs in a more accessible spot. The only disadvantage with this approach is that the connecting wires and key switch are vulnerable and if the villain can rip the wires out the alarm is completely disabled.

The provision for a panic switch makes it very easy to add a 'protect wire' facility that triggers the alarm if the wire is broken, without interfering with the operation of the panic button. The circuit consists of a BD139 across the panic switch, a BC548 to drive it and two resistors. I was able to find room alongside the 47 ohm resistor to drill three holes to mount the BD139 and the BC548 was soldered to the PCB identifying code underneath the transformer, with the resistors mounted point to point.

By cutting the track to terminal 3, I was able to use this and terminal 1 for the protect wire, the panic switch then being connected between terminals 4 and 9. As I also wanted to have the green LED mounted with the control

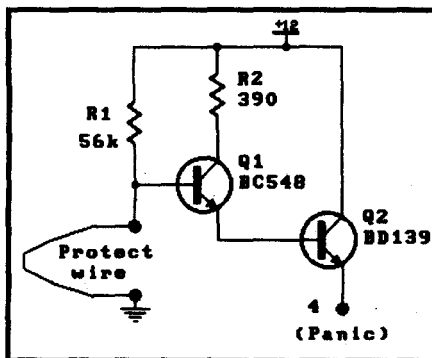


Fig.1.

INFORMATION CENTRE

switch, I cut the track to terminal 6 to give an easy connection point for this.

It is then necessary to use an 8-core cable from the alarm to the control switch, which is a small price to pay for the added security. The protect wires should be joined at the key switch so that they will separate if the cable is pulled hard enough. (A.M., North Turramurra NSW).

Thanks for your suggestions, A.M. The circuit is shown in Fig.1 for those who wish to adopt this idea.

'317K regulator

The next letter points out some errors in my description of the '317K voltage regulator, in 'Basic Electronics — Part 9'.

On page 71 (January 1991) Peter Phillips makes several erroneous statements. He states that the '317K regulator compares 'a sample of the output voltage to an internal 1.25V reference'. This is incorrect — the internal 1.25V reference is used to keep a constant voltage between the output and adjustment terminals, or across R1 (in Fig.6). This keeps a constant current flowing through R1 and therefore R2.

This also causes the voltage at the adjust pin (pin 1) to be at a potential above the negative supply rail, therefore raising the output voltage. Any current that flows out of the adjustment terminal will add to the current from the output and cause an error voltage. The '317 has been designed so that this current is very small (50-100uA), thereby minimising the error voltage.

This leads me to the next error, in which the equation quoted for calculating the output voltage does not include the effect of this current. However, I agree its effect can usually be ignored.

The statement that 'if R2 is set to zero, there is no feedback and the output will be no longer regulated' is quite incorrect. Rather, if the value of R2 is too large, then the output will no longer be regulated, because the voltage across the regulator will be too small to maintain regulation. Thus, in the circuit of Fig.6 (page 70), when R2 is set to its maximum value, the regulator will cease regulation as the input voltage (26V) will be less than the theoretical output voltage (27.5V). The correct value of R2 should be 3.6k

to give a maximum output voltage of 20V.

Peter Phillips is doing a good job with the new Basic Electronics course, but perhaps he needs to check his facts sometimes as the above information is clearly set out in the National Semiconductor Linear Handbook. However I'll let my children read the series when they want to learn about electronics, as it was the original Basic Electronics that showed me that electronics is an exciting career path.

Hope this clears things up, and please keep up the high standard you have set. (P.G., Frankston Vic).

I agree that the '317 device works in the way you describe P.G., and that my explanation doesn't make this clear. However I chose to ignore the errors caused by the current from the adjust pin, as I wanted to keep the description relatively uncluttered. Hence my simplified equation, in which I deliberately left this term out. I did check the facts here, using the National Handbook and made a decision in the interests of simplicity.

But quite obviously, I was totally wrong about the required setting of R2 to lose regulation. This is something I know very well, and I can only blame a loss of concentration when I wrote this part. I just hope I haven't caused any confusion among readers of the series.

Regarding the value of R2, I also agree but again in the interests of simplicity and available parts I chose a 5k rather than the theoretically correct value of 3.6k. As it turns out, using the specified components will give regulated voltages up to 20V, and anything above this can be regarded as unregulated. It's also 'off scale' for the suggested voltmeter.

Thanks for your letter P.G., and also for your comments on the (otherwise) merit of the series. It's difficult to keep things simple and still be 100% technically correct, and I appreciate feedback from readers.

What??

This month's question was supplied by Joshua Pitcher (VK2KJD), who has adapted it from a university textbook. Don't worry, it's easy enough and doesn't require university mathematics:

For the circuit shown in Fig.2, determine the value of capacitor Cx that gives the entire network a capacitance equal to the value of Cx.

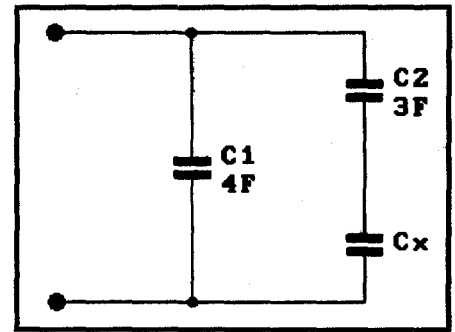


Fig.2

Answer to April's What??

The answer is zero. There are numerous methods of proof, and perhaps the easiest is to examine the currents. Call them I_p in the primary windings (the same for both transformers because of the series connection) and I_s for the secondaries (and load).

For the first transformer $I_p = I_s$ (being ideal and 1:1). For the second, $I_p = 2 \times I_s$ (being ideal and 1:2). Now subtract: $I_p - I_p = 0$, and $2I_s - I_s = I_s$. That is, $0 = I_s$.

Therefore, the secondary current and hence the load current equals zero. Some will cry 'What goes on?' After all, the nature of electronics is such that most readers will prefer to relate this strange question to their existing knowledge.

In this case, another explanation may be to think of the transformers connected with the primaries in parallel and the secondaries in parallel. Because the transformers are attempting to output different voltages, a heavy current will flow through the secondaries (mutual short circuit).

If the transformers are ideal, the resistor voltage and current will be zero, again independent of resistor value.

There are theorems in electrical engineering that allow a network to be examined in terms of the properties of its 'inverse', which has a voltage corresponding to each current in the original and vice versa.

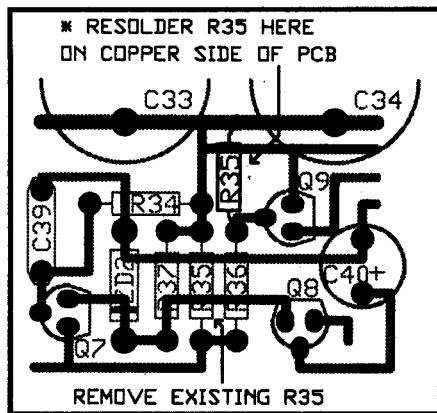
The inverse consequently has a series connection where the original has parallel and vice versa. The parallel-connected transformer case is the inverse of the original question, and its output voltage inverts to zero output current in the original.

Unfortunately, attempting to prove this by experiment will give measurements that show the departure of transformers from the ideal.

(Peter Phillips comments: I said this one would create some thought, perhaps readers might like to share their opinions.) ■

NOTES AND ERRATA

Pro Series Two Preamp (Oct 1990): There is a slight error in the power supply section of the main PCB (code 90pre8m). To correct the problem, R35 should be removed and then soldered to the underside of the PCB (copper side) as shown in the accompanying diagram — the circuit will then match the schematic on page 94. As it happens, the circuit operates correctly with R35 in either position — so if you don't feel like performing surgery, leave the board as it stands. ■



Taxis by Computer

Continued from page 23

you're listening to the radio with one ear and the other to the customer who may be talking. But the radio is the driver's lifeline — he must listen to it all the time."

"So he has all this in one ear for that length of time, plus all the other rubbish that's going on — but he's just listening for that one job, his next job. But with our system he only has to key in his location or where he is proceeding and the job is presented to me on the terminal. Less effort, less stress and it's quieter."

And what did this particular writer/driver think of the system? My first few days required me to drive with the work allotted via the radio void link. At two in the morning, after an evening dealing with mumbling drunks and foul-mouthed debutantes, having filled your insides with Big Macs and Cokes, you tend to find the base operator's bleatings less than agreeable.

The computer dispatcher, by contrast, proffered peace, accuracy and reassurance. The LCD screen was not always the easiest to read, thanks to a narrow viewing angle and the tiredness of eyes that may have seen a few too many sunsets — but if this is 'progress', I'm for it. ■

HP's 100MHz Scope

Continued from page 92

tion the newfound ability to transfer a copy of any display to your PC, store it on disk and print it out.

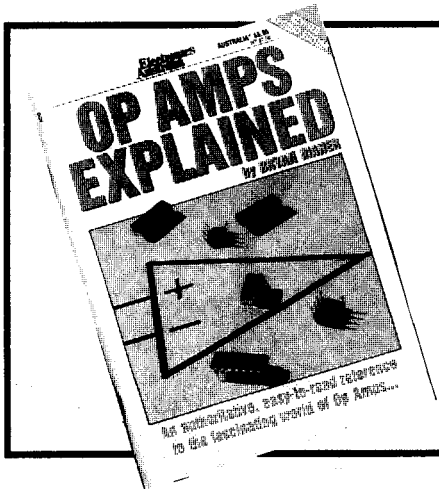
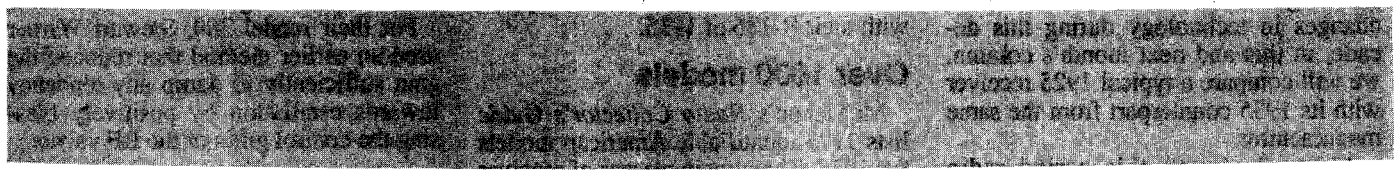
The way scopes should have been all along, in fact, but until now the technology wasn't available. The HP 54601A is so good that after using it for only a few hours, it really spoils you for using any normal scope.

I was most reluctant to send the review unit back to HP, I can tell you. And ever since then I've been trying to figure out how to persuade our company to buy one for the EA lab!

The prices for these new paradigms of scope technology are just as impressive, comparing very well with existing 100MHz analog scopes.

The two-channel 54600A is listed at \$3895, while the four-channel 54601A lists at \$4695. Each of the three optional interface modules lists for a further \$775. These prices include a three year limited warranty. The quoted delivery time after receipt of order is currently four weeks.

For further information, you can contact HP Australia at its offices in each state, or by phoning its Customer Information Centre on 008 033 821. ■



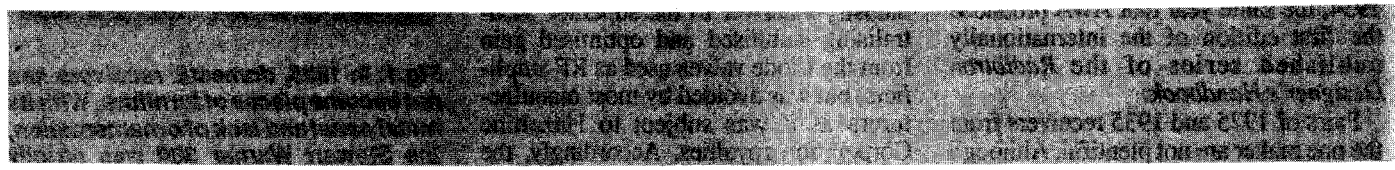
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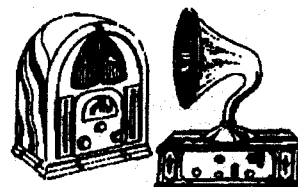
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Vintage Radio

by PETER LANKSHEAR



A decade of radio development — 1

Electronics technology has never remained static for long. Personal computers, home video recorders, compact disc players and satellite TV are some examples of considerable development in this last decade. In the 1920's and early 30's, there was a similar period of rapid evolution in domestic radio receivers.

In 1925, American radio manufacturing was expanding rapidly, to satisfy a huge demand for receivers for the booming new broadcasting industry. And despite the stock market crash and the following depression, a rapid rate of technical progress was maintained during the following decade.

By 1935, domestic receivers had evolved from dependence on battery powered triodes and with major problems in stable RF amplification, into high performance and reliable equipment that underwent little further basic development right to the end of the valve era. To get some idea of the extent of the changes in technology during this decade, in this and next month's column, we will compare a typical 1925 receiver with its 1935 counterpart from the same manufacturer.

Although during this period radio equipment was produced in many parts of the world, American developments were foremost — a result of the sheer size of their market, competition, purchasing power, the number of makers and economic influences. Because they were therefore 'state of the art', I have selected a pair of typical US-made receivers for comparison.

Despite our geographical remoteness and small populations, Australia and New Zealand receiver design was often in advance of Britain's and not far behind America's. For example, by 1933 the superheterodyne accounted for only 50% of British models, whereas here it had already become the standard. Philips did not produce a superheterodyne until 1934, the same year that AWA produced the first edition of the internationally published series of the *Radiotron Designer's Handbook*.

Pairs of 1925 and 1935 receivers from the one maker are not plentiful. Although literally hundreds of American firms

joined the rush into radio manufacturing in the mid 1920's, the majority did not survive the crash and the depression. Similarly, few of the pioneer Australian companies were still making receivers in 1935. Furthermore, after 1930, tariffs restricted US imports into Australia and to a lesser extent into New Zealand.

One make that was available in both 1925 and 1935 was Stewart Warner. Like the better-known Atwater Kent organisation, before entering the radio business Stewart Warner was a well established maker of automobile accessories. In 1925, they produced their first radio, the model 300 TRF. This will be compared with their R-136 of 1935.

Over 1000 models

McMahon's *Radio Collector's Guide* lists 1173 identifiable American models for 1925. Three main classes of receiver were being produced, comprising 15 superheterodyne, 70 neutrodyne and an incredible 695 tuned-radio-frequency (TRF) models.

The remaining receivers were a miscellany ranging from crystal sets, through simple regenerative to reflexed receivers. Many were low performance or obsolete types that would not have sold in large numbers.

Of the three major types, most advanced was the expensive, and, for the time, very complex superheterodyne to which RCA had the monopoly for complete receivers. (They did, however, licence AWA to make an Australian version). The neutrodyne, usually with two neutralised tuned RF stages, was the industry's answer to the superhet. Neutralising stabilised and optimised gain from the triode valves used as RF amplifiers, but was avoided by most manufacturers as it was subject to Hazeltine Corporation royalties. Accordingly, the majority settled for the TRF receiver.

This usually consisted of two RF amplifier stages, a grid-leak detector and two transformer-coupled audio amplifiers. As there was no ganging of the tuned circuits, the TRF, like the neutrodyne, generally had three tuning controls — which had to be adjusted more or less simultaneously.

The TRF was so simple that many makers did not bother to supply circuit diagrams. The chief variations were in the means of stabilisation of the triode RF stages to prevent oscillation, none being as efficient as neutralisation. One popular method was to connect resistors in series with the grids of the RF valves.

For their model 300, Stewart Warner used an earlier method that reduced the gain sufficiently to damp any tendency towards oscillation by positively biasing the control grids of the RF valves.



Fig.1: In 1925, domestic receivers had not become pieces of furniture. With its metal panel and lack of ornamentation, the Stewart Warner 300 was strictly functional in appearance.

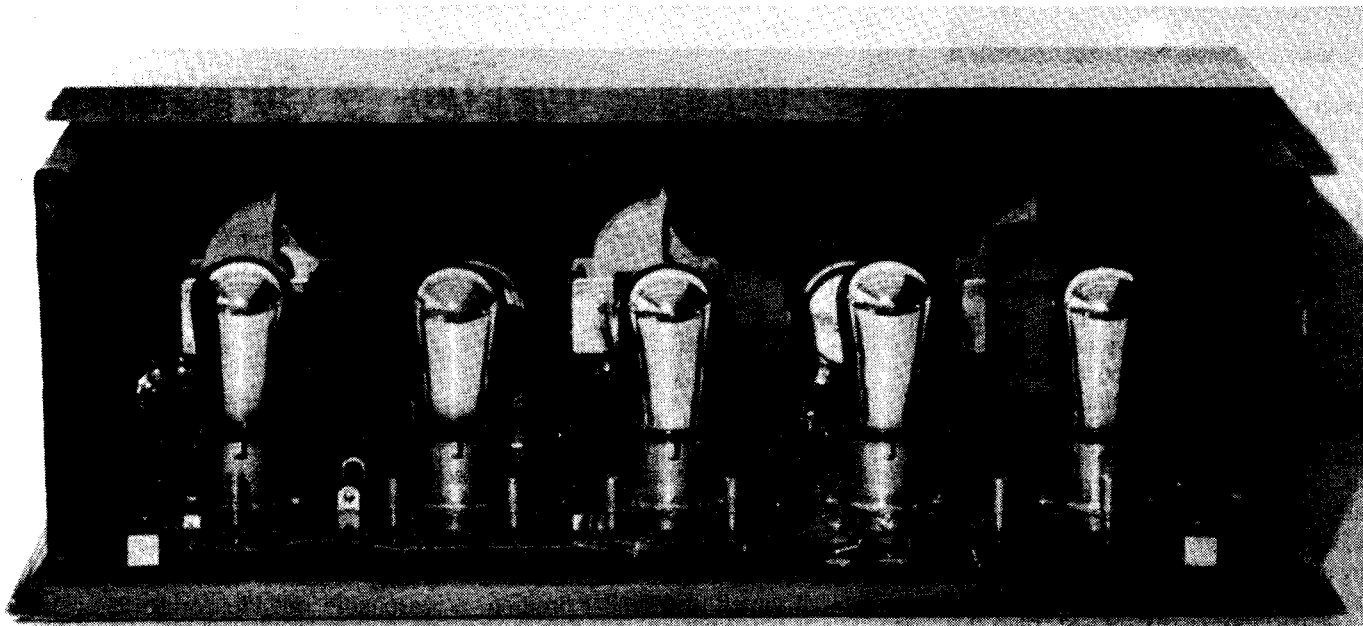


Fig.2: The rear of the Stewart Warner 300 with the wooden back and its attached lid removed. Directly under the lid, the all-important UV201A valves were readily accessible. From the right, they are 1st RF, output, 2nd RF, 1st audio and detector.

Many 1925 receivers had wooden cabinets and polished black front panels. For the 300, Stewart Warner chose a wrap-around brown crackle painted steel panel instead, but retained the mandatory hinged wooden lid and base.

Few components

Inside, the few components are laid out symmetrically on a baseboard. To minimise coupling, the large tuning coils, wound with green silk-covered wire, are mounted so as to be mutually at right angles. Between them are two audio transformers. An engraved strip of bakelite at the rear carries the five UV201A valve sockets, minor components and terminals.

There are only two fixed capacitors, both mica, and one fixed resistor — a 1 megohm grid leak. Two wirewound potentiometers and an on/off switch, complete the parts list.

The circuit in detail

Stewart Warner's model 300 is about as simple as a five valve radio can be. There are three variable capacitors, each carrying its associated tuning coil. The aerial terminal is connected to a tapping on the first coil — an efficient coupling method, but aerial capacitance affects the tuning capacitor setting, preventing ganging. Two RF amplifier stages follow, their anodes being fed through flat wound primary windings positioned inside the coil formers.

The 250pF grid capacitor for the detector is made of sheets of mica and tinfoil clamped between two pieces of fibre.

There are two clips for the 'plug in' grid leak resistor, which may be anywhere between 0.5 and 5.0 megohms. Early grid leak resistors were made much like automotive fuses, with brass caps at each end of a glass tube protecting a carbonised element. The detector anode RF bypass capacitor is similar to the grid capacitor.

Following the detector is the audio amplifier, consisting of two identical transformer-coupled stages. With a transformer turns ratio of 1:3, each stage has a gain of about 25. In 1925, fidelity was not an issue, and like the associated horn loudspeakers, the small simple audio transformers have a very restricted response. More serious is the lack of power output. Even with optimum bias, a 201A with an anode supply of 90V is rated at providing only 15 milliwatts.

The two variable resistors provide interactive control of the receiver gain and stability. R1, called 'Battery Control' with a total resistance of 3 ohms, is connected in series with the negative filament lead, and is used to reduce the 6.0 volt battery supply to the rated 5.0 volts for the 201A valves.

The correct use of negative grid bias was not always fully understood in 1925, and a casual glance at the circuit gives an impression that the audio valves have none. In fact the voltage drop across the battery control does provide some bias, but only about 1V, which is less than RCA's recommended 4.5 volts for correct operation of a 201A at 90 volts HT.

Bias can be increased by reducing the filament voltage with the battery control,

but the performance of the output valve is restricted even more. The Stewart Warner 300 is strictly low powered and low fidelity!

RF amp 'volume control'

'Volume Control' R2 is a 300-ohm potentiometer connected across the filament supply line, enabling the grid returns of the two RF valves to be varied continuously between the positive and negative leads. This effectively allows the grid bias to be varied from negative to positive. Valve operation is more or less normal with the wiper at the negative end of the control, but at the positive end, grid bias is cancelled and grid current flows, loading down the tuned circuits sufficiently to prevent oscillation.

The term 'volume control' is a misnomer, as it is more of a stability control. Significantly, positive grid operation was abandoned and grid bias batteries were used in the following year's models.

The third tuned circuit is connected to the grid-leak detector. Simple, sensitive and suited to transformer coupling, grid-leak detectors were used universally in early receivers. They effectively used the grid and cathode of the valve as a diode detector, with the resulting audio developed across the grid-leak resistor and then amplified by the valve in the normal way, as an audio amplifier.

Two transformer-coupled audio stages follow. They provide adequate gain, but as mentioned previously, the valves for these stages are under biased with inadequate power output even for a horn speaker. By later standards, audio trans-

VINTAGE RADIO

former fidelity is poor, with little low frequency performance, and a restricted and peaked treble response.

The S-W 300 in use

Direct comparison of the operation of the 300 with that of a modern radio is difficult. In the early days, large outside aerials were standard, typically with 30 metres of wire suspended between 12-metre poles; but the situation today is very different. Signal strengths are now much higher, receivers are more sensitive, and internal ferrite aerials are generally adequate.

Connected to an aerial about 20 metres long and rising to 10 metres, a good earth system, a horn speaker and battery eliminator, the 300 was 'fired up'. First the 'Battery' control was set to give 5.0 volts at the filaments and then the 'Volume' control set at mid scale. A gentle tap on the detector valve produced a healthy 'pong' from the loudspeaker, showing that so far, all was well.

Tuning in a station ideally requires three hands! Unless all three tuned circuits are in fairly close alignment, these ungangd receivers are quite 'dead'. An essential aid is a station log, giving individual settings for the dials. Unlike most of its contemporaries, the middle dial of the 300 has a wavelength scale in addition to the normal 0-100 scale, making station finding easier.

Initially, this dial was set to the wave-

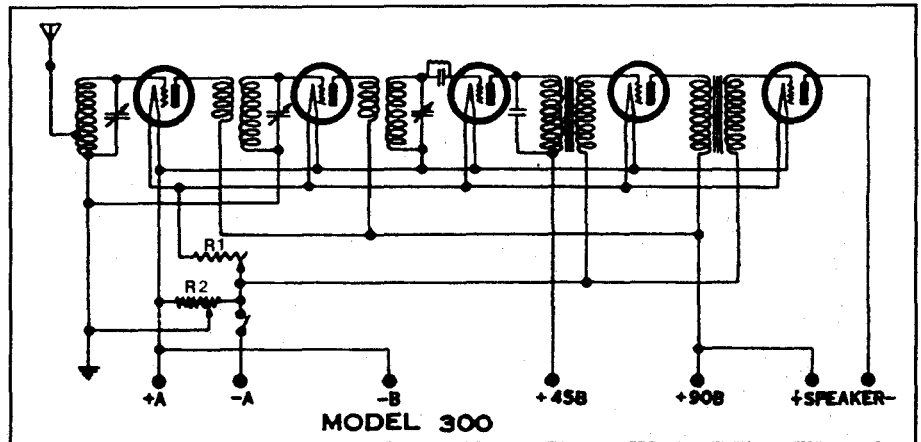


Fig.3: At this early stage, those manufacturers who did provide circuits rarely bothered to give component values. It's hard to imagine a simpler five valver.

length of a local station and the aerial tuning dial turned to a similar position. Next the detector dial was slowly rotated until a faint signal was heard. All three dials were then adjusted for resonance.

With the first station logged, the settings for other stations became easier to find. At the lower frequencies, where RF gain is low, the 'Volume' control has little effect, but at the upper half of the tuning range, it is needed to prevent oscillation. Receiver gain is best controlled by detuning of one of the variable capacitors.

Selectivity is more than adequate to separate local stations, and below about 700kHz is comparable to that of a simple superhet. But it falls off at the upper end of the band. On the other hand, sensitivity becomes noticeably greater as the fre-

quency is raised. When connected to a reasonable outside aerial, RF performance overall is much the same as that from a modern receiver using a small ferrite aerial.

With the restricted audio fidelity and power output, listening quickly becomes tiring. However, in 1925, radio in the home was a miracle, and receivers such as the Stewart Warner 300 brought much pleasure and opened new horizons for literally millions of listeners, who were unconcerned about any technical limitations. These could be dealt with later.

During the following decade they were in fact overcome, and in addition there was a tremendous number of new developments — many of which were incorporated in Stewart Warner's R-136, to be described next month. ■

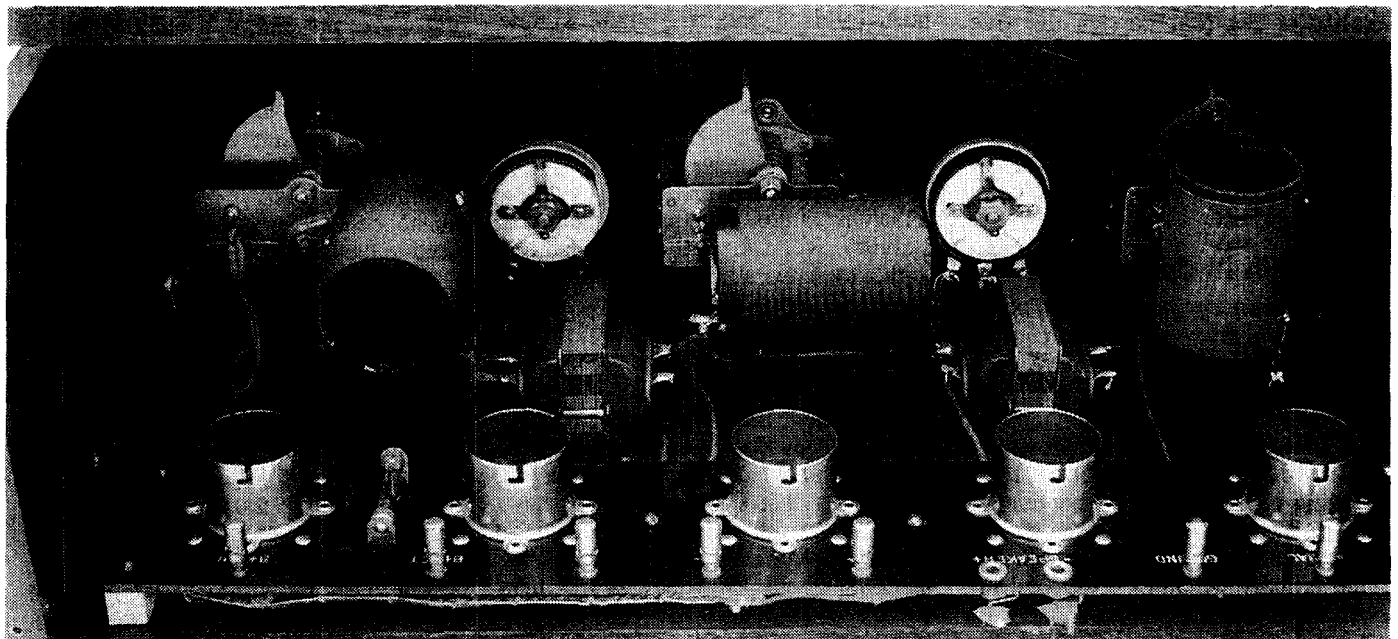


Fig.4: As this closeup shows, the construction was simple and not far removed from the 'breadboard' method popular with amateur builders of the time. TRF receivers used little if any shielding.

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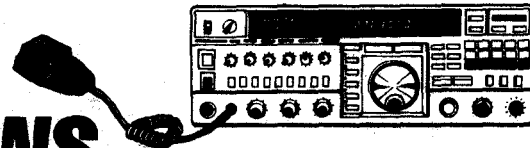
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Amateur Radio News



6m Repeater for Manly Warringah

The latest edition to hand of Manly Warringah Radio Society's Newsletter reports that the Society has decided to build an FM repeater for the 6m band.

The allocated frequencies are 52.675MHz for the input and 53.675MHz for the output, both 125kHz higher than originally published so that they are not too close to the popular 52.525MHz simplex channel. At the same time, they should be well within the transmitter bandwidth of older 'carphone' type rigs currently on the simplex channel.

The Society has also been trialling various new antennas with its 70cm repeater, with a view to improving its service area. A pair of commercial vertical phased arrays have been obtained by John VK2ZJJ, and it was hoped to instal these on the Society's 110-foot tower in a working bee.

Further information on MWRS can be obtained by writing to PO Box 186, Brookvale 2100.

North Queensland Radio Convention

This year's NQ Radio Convention is to be held in Townsville at the campus of James Cook University, on September 27-29.

As in previous years the Convention will combine lectures, practical demonstrations, tours of the local area, junk auctions and 'junk maiming' contests. It also provides a chance for everyone who communicates via radio to meet the people normally at the 'other end' of tenuous radio links.

Further details are available from Townsville Amateur Radio Club Inc., PO Box 964, Townsville 4810, or phone (077) 79 7869 or 79 1161.

Special station for SA's Cornish festival

The Moonta Scout Group Amateur Radio Club, of Moonta in South Australia, has advised that it will be operating a special event station (VI5KL) during the Kernewek Lowender Cornish Festival, later this month.

One of the major festivals held in

SA, Kernewek Lowender is held in the 'copper triangle' towns of Kadina, Wallaroo and Moonta from May 17 to 20. This year VI5KL will be operating at Kadina on the 18th, Wallaroo on the 19th and Moonta on the 20th.

A special certificate will be available for a small fee, to commemorate the event, while special QSL cards will be available for contacts made during the festival.

Operating times are 0030 to 0830 UTC, and the frequencies to be used are 3.590, 7.130, 14.300, 21.190, 21.300 and 28.400MHz SSB, and 146.000 to 148.000MHz FM (simplex or via local repeaters).

Youth amateur group formed in WA

A new Youth Amateur Radio Group has been formed in Western Australia, to encourage the entry of young people into the hobby.

Membership is free, and an amateur licence is not required. Activities include building equipment, shortwave listening, searching for hidden transmitters (fox hunting), and participating in contests.

Young people who already have a licence can contact the Group via the Perth VK6RAP 2m repeater, on 146.700MHz, or on 3.580MHz (LSB, +/-QRM) at 8.30pm local time on the first Sunday of every month. Details of meeting are also given on the WIA WA Division's weekly news broadcasts at 9.30am local time on Sundays, on 3.560 and 7.075MHz SSB, and 146.700MHz FM.

Further details are also available from James McBride VK6FJA on (09) 448 9823.

Magazines available

A reader in Cremorne, Sydney has advised that he has an extensive collection of back issues of *Wireless World*, *EA*, *ETI*, *Electronics World* and *Radio Electronics*, plus a few textbooks, which he would be happy to make available to a radio club.

Office bearers of any club interested in boosting its library should send their club contact details to the Editor, who will pass them on to the reader concerned. ■

EA CROSSWORD

ACROSS

1. Conceives a plan or pattern. (7)
5. Active communications station. (7)
9. Measured. (7)
10. Terminal in domestic supply. (7)
11. Non-corroding metal. (4)
12. Surge of voltage. (5)
13. Said of certain HF. (4)
16. Measuring device. (5)
17. Electron accelerator using transformer principles. (8)
21. Without reverberations. (8)
22. Sections of spectrum. (5)
25. Self-operating (abbr.). (4)
27. Brand of electronic instruments. (5)
28. Low setting on heat appliance. (4)
31. Collapse. (7)
32. Lines that produce a spectrum. (7)
33. Reciprocal of damping factor, the — of decay. (7)
34. Inventors' rights. (7)

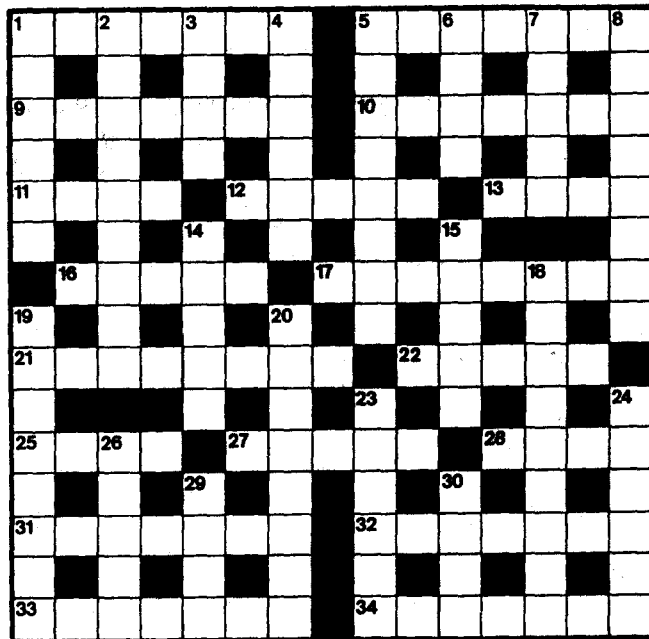
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DOWN

1. Render inoperative. (6)
2. Orbiting object. (9)
3. Stabiliser (abbr.). (4)
4. Active metal. (6)
5. Element used as element. (8)
6. Having high sound level. (4)
7. Typical number of AC phases. (5)
8. Retransmitting. (8)
14. Common term for common solvent. (5)
15. Unit of capacitance. (5)
18. Physical emanation and propagation. (9)
19. Twenty-third element. (8)
20. Communicating device. (8)
23. Terminate telephone call. (4,2)
24. Video pictures. (6)
26. Recorded. (5)
29. Part used in 20 down. (4)
30. Substance used by electrolytic chlorinators for pools. (4)



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May 1941

Better sound recording: A dancing mirror taken from the laboratory to render more faithfully reproductions of phonographically recorded sound is part of a new sound system for home and commercial phonographs which has recently been demonstrated.

Instead of the conventional needle, a feather-weight sapphire floats along the groove of the record. The recorded sound is translated into minute bobbings of a paper-thin aluminised mirror, such as heretofore has been used only in galvanometers and oscillographs of research laboratories.

A thin beam of light from a specially made lamp plays on the mirror, which reflects it to a small photo-electric cell, creating in the cell an electric current that corresponds to the sound variation on the record. Amplified and reproduced in a

loud speaker, this current gives a high degree of faithfulness with a minimum of scratch.

Phone secrets: To guard defence secrets, the new telephone line between Darwin and Port Augusta will be equipped with a new device — a secrephone — which will present to anyone tapping the line an unintelligible jumble of words.

This was one of the details of the new line revealed in Sydney by the Director of Post and Telegraphs. He estimated that it will take about eight months to complete the line, and at last bring Darwin — a vital strategic point — in direct telephone contact with southern States. The Overland Telegraph Line will be brought up-to-date by the Post Office. It is proposed to add a single copper wire to the one now running between Port Augusta and Darwin.

May 1966

Integrated circuits for IBM: Information on new, high-speed integrated circuits which will speed operation of computers comes from IBM in the USA. Experimental monolithic circuits have been developed which function at sub-nanosecond speeds. They complete a logic operation in 700 picoseconds. The fastest logic circuit in today's computers function at times in excess of one nanosecond. The fastest IBM computers currently operates at about 1.5nanoseconds.

Trans-Pacific satellite TV: New satellite launches to be carried out this year will establish an intercontinental communications network covering America, Australia, Europe and Asia and will enable Australia to take part in international television for the first time. The Overseas Telecommunications Commission (Aust) is investigating sites in the Eastern States for the Australian link.

The satellites known as 'Intelsat Two', will be launched into synchronous orbit by the US Space Agency in August. They were originally ordered by the Agency to cover Project Apollo (the man-on-the-moon project), but the satellites have been provided with 180 channels surplus to the requirements of Project Apollo to give them a useful life as an international relay. ■

Electronics Australia

with **ETI**

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EA'S COMPUTING SUPPLEMENT

**RAM-DAC UPGRADE
DRAMATICALLY
ENHANCES
VGA GRAPHICS**

(See page 122)

NSD AUSTRALIA



ANALOG DEVICES

Computer software review:

'Serialtest' - analyse serial data on your PC

This versatile software from Advanced Computer Consulting Inc. (ACCI) allows any IBM or compatible PC to monitor, capture and send serial data via its standard RS-232 communications ports. In effect, it turns your PC into a serial data analyser.

by **ROB EVANS**

Most readers who deal with personal computers will have noticed that virtually all machines are fitted with one or more serial data ports (COM1, COM2 and so on), and generally one parallel data port (LPT1). While the parallel port is configured for sending data to a printer at high speed, the serial port can both send and receive data in a wide range of formats, to almost any device equipped with a serial interface.

It's this capability that allows a PC to easily communicate with the outside world — literally, if it's connected to a modem for example. However, many of us may not be aware of the essential — and ever increasing — role of serial communications in industry. In this environment the data transfer can take on many forms, ranging from a simple networking scheme between office computers, to say remotely controlling and monitoring complex manufacturing machinery. All of this is possible since only a few wires are needed to carry large amounts of serial data in both directions, and over large distances. As you can imagine, it's vital that these lines maintain reliable communications, and suffer minimum down-time if they do in fact fail.

Unfortunately, troubleshooting serial communications can be extremely difficult due to the differing signal standards adopted by each installation, and the transient nature of the data stream.

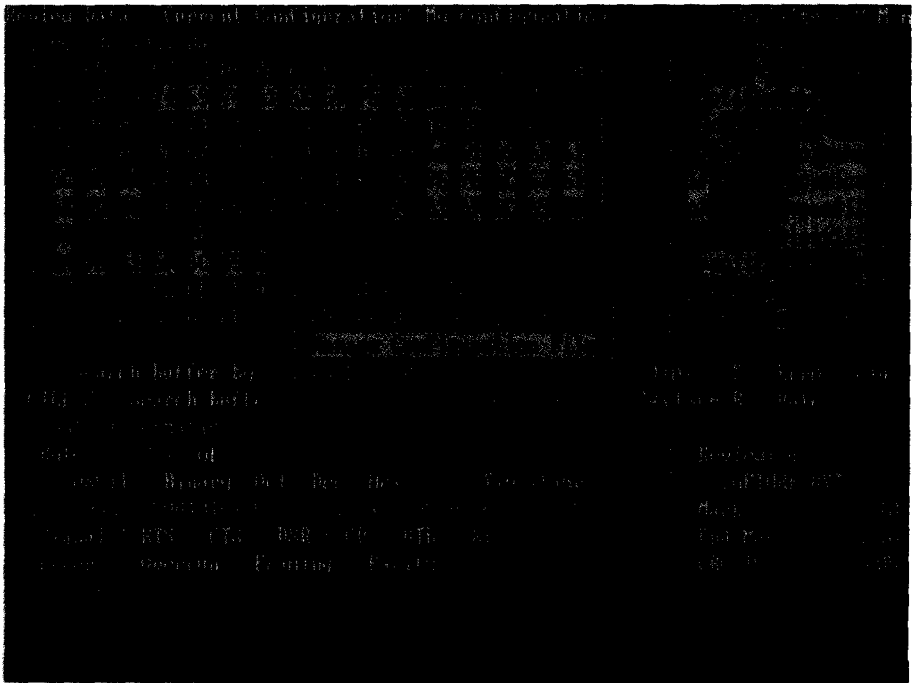
If you've ever tried to set up a serial printer or plotter on your PC, the problems will be quite familiar — the number of data, stop and parity bits must be correct, the baud (transfer) rate must match, and the various control (handshaking) lines have to be in-

terpreted in the correct manner by both the printer *and* computer. In short, installing and maintaining serial communications can be a nightmare without specialised equipment.

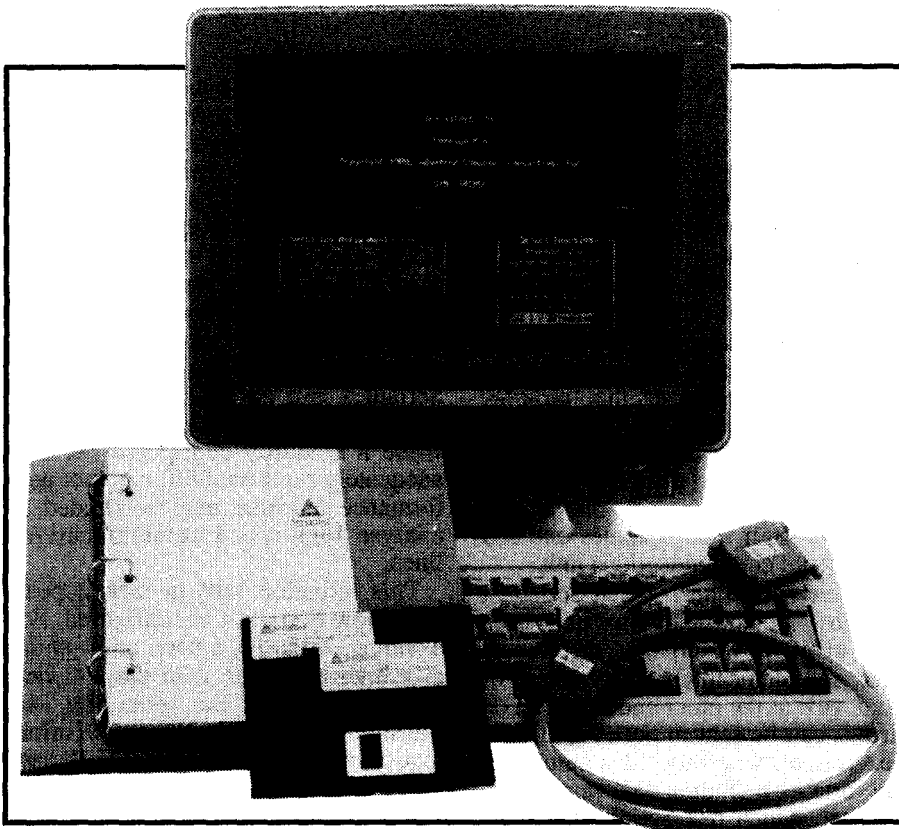
Enter the data analyser or 'datascope', which is traditionally a dedicated test instrument designed to monitor and diagnose communication lines, by offering a digital 'window' for viewing (and capturing) the data stream and control line signals. As with many other specialised test instruments that perform significant amounts of number crunching, manufacturers of datascopes are tending towards a more software-based solution based on hardware that is es-

entially a computer with similar capabilities to a common PC. Which leads to a logical question: why not use such a PC itself as the basis for a datascope?

With this scheme the PC's standard features may be used to full advantage — disk drives for data storage and software updates, the keyboard and screen for entering and viewing data, and various input/output ports for hardware connections. In the case of a serial datascope however, a special hardware interface is not required since the PC has RS-232 serial ports as standard equipment. This, then, is the idea behind Serialtest, a package of software and specialised connecting



A shot of the Review Data screen and its captured data. Note the help information at the bottom of the screen, and the utilities pop-up menu in the centre.



The Serialtest package includes a user manual, software on both types of common floppy disks (5.25 and 3.5 inch), and a number of special connecting cables — the PC is not included!

cables which turns your PC into a full-blown datascopes.

Serialtest

ACCI have developed Serialtest into a very practical package. You don't necessarily need a high performance machine (XT or better) or sophisticated display type (Hercules monochrome is fine), and the system can execute most of its functions with only one RS-232 port.

The software offers a full graphical display with popup menus, and help information in the bottom few lines of the screen which automatically updates with each new function. To monitor an existing serial communications line, Serialtest's 'monitor head' cable connector is simply plugged in series with the line under test (LUT), with the main Serialtest cable used to connect the head to the PC's serial ports.

The header unit itself appears as a straight-through connector to the LUT, allowing normal communications to operate while your PC is monitoring the action. All Serialtest connectors are DB25-type, as you would expect.

When you fire up the Serialtest software, a startup menu offers the following functions: Breakout Box, Customize Serialtest, Define Triggers,

Exit Serialtest, Initiate Datascope, Review Data, and Set I/O Parameters. This main menu can be recalled at any time by pressing the F1 key. The Breakout Box emulates its hardware equivalent, and is pretty well what you'd expect — the screen shows the on/off action of the various RS-232 control lines (CTS, RTS, etc.) in real time. As a bonus however, each line has a 'count change' indicator which shows the number of times each control signal has changed its state since the Breakout Box was activated.

Customize Serialtest allows the user to configure the overall system to their personal tastes, in terms of screen colours and which keys activate Serialtest's various popup menus (these could conflict with the activating keys of memory-resident TSR programs).

The menu also offers various display options for the Datascope and Review Data screens, and control over the capture buffer size (up to 54K). All of these customised functions may be saved to disk as you own personal configuration — the next time Serialtest is run, the program will take on this arrangement.

The Define Triggers feature of Serialtest is one of its most powerful features. This allows the user to define

a number of special conditions which might appear in the LUT, such as specific ASCII strings or control signal states, and assign these to trigger the monitoring action of the datascopes. For example, the system could be configured so the datascopes will commence capturing data only when a framing or parity error occurred — the resulting data stream could then be stored for later analysis. The triggers can also be edited, deleted and disabled at will.

When a complete triggering arrangement has been programmed, Serialtest allows the user to save the settings to disk with a 20-character name. This length of file name is very handy, as a quite descriptive expression can accompany the trigger setup — say 'framing/parity error' or 'store after Hex 68'. A saved setup can also be deleted, loaded while the program is running or nominated as the power-up configuration with Serialtest's Utility Functions menu.

Not surprisingly, the Exit Serialtest selection in the main menu does just that. It does however warn the user if the configuration has changed, and offers the opportunity to save the new arrangement to disk. Before finally returning to DOS the software prompts the operator with 'Really Exit Serialtest?' — not a question appreciated by this reviewer!

Next on the main menu is the Initiate Datascope option, which is really the core of Serialtest's functions. As serial data is detected, the screen displays each consecutive byte across the screen in a row — the bytes may be represented as ASCII graphics characters or raw Hex data. In Serialtest's normal monitoring mode, both the transmitted and received data is shown, which allows the user to observe the entire action of the LUT. If a framing, parity or overrun error is detected, the characters representing the invalid byte will blink on and off to alert the user. By the way, while the data stream will soon fill the display and the earlier information appears lost, all data is stored in Serialtest's buffer in the PC's main memory.

The remaining sections of the datascopes screen offer further real-time information on the LUT (control signals, bytes received and bytes with errors) and data regarding the datascopes itself (a high-resolution timestamp, baud rate and word format, and the trigger status). Pressing the F2 key calls a 'Datascope Utilities' menu which allows the user to (amongst others) reset

Serialtest

and pause the datascopes, and open and close a capture file on disk.

When a capture file is opened and the datascopes trigger conditions have been satisfied, all of the incoming data (including control signals) is both displayed and transferred to the nominated file in a progressive manner. This will continue until the datascopes is paused with the F2 key, and the capture file closed — the file can then be retrieved and analysed at a later date.

If the main menu is then called, it immediately offers the next logical step in troubleshooting the LUT: Review Data. This calls the contents of Serialtest's memory buffer, and displays the first 80 bytes in both Hex and ASCII formats. The screen cursor can then be placed on a byte of interest, and detailed information about that particular event read from a panel at the bottom of the screen — this shows the condition of all signal lines, and the actual byte in its ASCII, Binary, Octal, Decimal and Hex formats!

After that, the user can scroll through the buffer information using the PC's Home, End, Page-up and Page-down keys, perform automatic searches for a particular data byte or any error conditions, perform CRC/checksum calculations, and so on. A further menu can also be called at this stage, which allows the contents of the buffer to be sent to a file, or a previously saved file to be loaded into the buffer and re-analysed by the Review Data features.

The remaining 'Set I/O Parameters' option in the main menu lets the operator effectively 'tune' Serialtest into the type of the data flowing in the LUT. It sets the word format (baud

rate, stop bits, etc.), which physical port (COM1, COM2, or both) the software talks to, and whether Serialtest is in its monitoring or source mode of operation. Again, all of these settings are saved to disk with the other setup parameters.

When Serialtest is switched into the source mode, the software and hardware both take on a slightly different arrangement. The alternative 'source head' replaces the 'monitor head' in the Serialtest cable, and 'source' (rather than 'monitor') selected in the above 'Set I/O Parameters' menu — in this mode, Serialtest itself then becomes one end of the serial communications link.

The advantage here is that Serialtest can now transmit strings or whole files, manually manipulate the control lines, and then capture the response of the device at the other end of the LUT. Strings can be sent in both ASCII and Hex format, while the files can be of any form — including data captured in the past, which has Serialtest's '.byt' filename extension. By the way, Serialtest also stores the timestamp information when captured data is saved to disk — this file shares the same name, but has a '.tim' extension and is automatically saved and loaded with the main '.byt' file.

Serious use

When it comes to using Serialtest to diagnose a practical serial communications setup, most users will find the package easy-to-drive, yet a powerful diagnostic tool.

Serialtest's screen layouts are remarkably uncluttered — considering the volume of data being presented — and the popup menus appear in a logical order, with each function described in a concise manner. The context sensi-

tive help system allowed us to operate all of the software's functions without having to refer to the manual — always a good test of 'user-friendliness'. As it happens, the supplied manual is both very comprehensive, and as well organised and presented as the software itself.

However, when it comes to the practical hardware side of things, the user must be aware that the performance of Serialtest can easily be restricted by the capabilities of the PC itself — while a modestly configured PC will adequately run Serialtest, a higher performance machine may be needed to analyse high-speed communications lines.

This situation will in turn depend upon how Serialtest is configured. For example, if the PC's ports are running at a high baud rate with the software monitoring both the receiving and transmitting channels, the screen information will tend to lag behind the actual data stream — this situation is compounded when a number of trigger conditions are being scanned. On the other hand, our test PC (a 10MHz AT with two serial ports) had no difficulty with any communications links we tried — real or simulated.

To help with the analysis of captured data files, Serialtest offers a formatted or unformatted saving routine. The prior arrangement can be loaded back into Serialtest (as mentioned above) and viewed with the Review Data facility, while the latter scheme creates a text file (with a '.txt' extension) which may be printed or viewed on any text editor. This file looked a little too jumbled for our liking, and the control signal information wasn't included — however, any errors were marked with a '?' character.

The ACCI people may have come to similar conclusions, since an additional 'stdump.exe' program — which also generates a text file — has been included on the Serialtest software disk. This utility loads a file which has been saved from the main program (in the normal unformatted style), and dumps the contents to the screen in a nicely ordered text file — including the control signal information. Since the program is simply called from the DOS command line, the standard redirection command () may be used to generate a file in this format. For example 'stdump capture.byt textfile.txt', where 'capture.byt' is the standard Serialtest file and 'textfile.txt' is the resulting file in the new text format.

So all in all, Serialtest is a very ef-

Byte #	Data			Signals							Errors		
	Source	Hex	ASCII	R	C	D	C	D	R	O	F	P	
				T	T	S	D	T	I	E	E	E	
295	DTE	67	g	X					X	X			
296	DTE	6F	o	X					X	X			
297	DTE	73	s	X					X	X			
298	DTE	68	h	X					X	X			
299	DTE	65	e	X					X	X			
300	DTE	6E	n	X					X	X			
301	DTE	0D		X					X	X	X	X	
302	DTE	0A		X					X	X			
303	DTE	75	u						X	X			
304	DTE	72	r						X	X		X	
305	DTE	61	a						X	X			
306	DTE	6E	n						X	X			

Part of the printout produced by the Stdump utility program. Notice that all control signals and errors are shown — In fact, uranus has a parity error (!).

fective tool for troubleshooting and developing serial communications lines, and should be capable of matching the performance of most dedicated (hardware based) datascopes — and at a fraction of the cost. While the software only requires a PC-compatible with one serial port, 300K of RAM, one floppy disk drive and a monochrome display, a faster machine equipped with two serial ports would be a distinct advantage. In fact a '286-based portable would be the ideal machine for field testing, since the Serialtest software talks directly to the RS-232 ports without the need for extra hardware.

Most PC-based test instruments have interface circuitry on a card designed to fit into the PC's expansion bus slots, and since portable PC's have limited internal space, the slots are rarely available.

Serialtest (version 2.0) is priced at \$475, and includes both 5.25" and 3.5" diskettes, user manual and the special RS-232 cabling.

By the way, ACCI also produces a *Serialbert* software package. This is not an ongoing *Sesame Street* saga — rather, Serialbert allows a PC to conduct Bit/Block Error Rate Testing (BERT) to check the *quality* of communication links. A typical test would involve switching a modem at the far end of the link into its 'loopback' (echo) mode, while Serialbert sends packets of data down the line via a local modem — the software then reports on any change between the sent and received information.

For more information, contact Geoff Wood Electronics, 229 Burns Bay Road, Lane Cove, 2066; phone (02) 428 4111. (R.E.) ■

SERIALTEST SOFTWARE Special Offer to EA Readers!

By special arrangement with Rep-technic, the Australian representatives for Advanced Computer Consulting Inc., Geoff Wood Electronics is offering the Serialtest Software package to EA readers at the special discount price of \$425 — \$50 less than the regular price. But note that this offer only applies until June 30, 1991. So apply now if you wish to take advantage of this exclusive offer.

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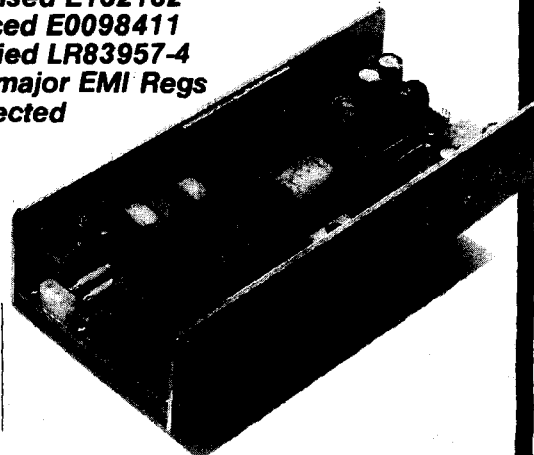
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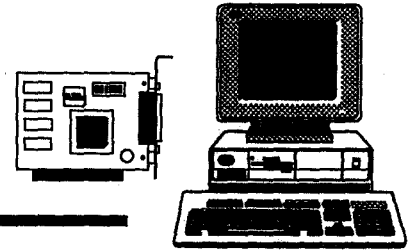


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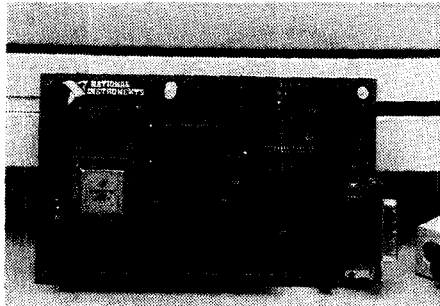
Computer News and New Products



Instrument interface for Mac LC

National Instruments has announced its ninth IEEE-488.2 compatible controller product.

The new LC-GPIB is the first IEEE-488.2 board for the new Apple Macintosh LC computer. It can be ordered with an optional 6882 floating point coprocessor that can be used by any software package to improve the computer's performance.



With its low-cost, high performance and colour capabilities, the Macintosh LC will be used extensively in educational institutions as well as by scientists and engineers.

The LC-GPIB parallels the strategy of the Macintosh LC and turns the computer into a cost-effective, maximum performance controller. This can be used by medical, scientific and engineering personnel involved in laboratory testing, production test and process monitoring and control applications.

The LC-GPIC features both the National Instruments GPIB controller chip and the Turbo488 performance enhancing chip. With these ASICs, the board can sustain data transfer rates of 1Mbytes/sec and has significantly reduced software overhead.

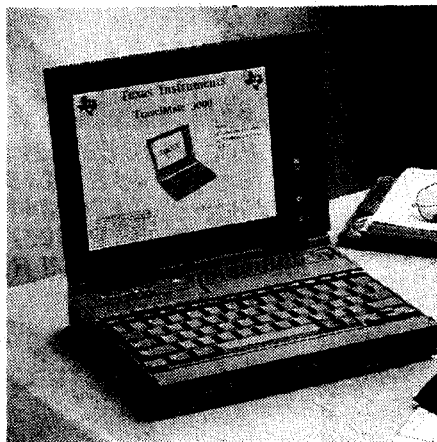
The chips also provide an FIFO buffer for decoupling the GPIB transfers from the LC bus transfers, a 16-bit LC-GPIB bus interface with byte-to-word packing and unpacking and complete monitoring of all IEEE-488 bus lines.

The LC-GPIB can be programmed with the NI-488 Macintosh OS driver software or with traditional languages.

For more information circle 164 on the reader service coupon or contact Elmeasco Instruments, 18 Hilly Street, Mortlake 2137; phone (02) 736 2888.

Lightweight Notebook PC

Texas Instruments has released the second in a powerful range of Notebook PCs. The new TravelMate 3000 Notebook PC, incorporating a 386SX microprocessor, delivers a new level of power and portability. It weighs in at less than 2.6kg including batteries. This is around 20% lighter than most equivalent Notebook computers on the market. Measuring only 216 x 280 x 46mm, it also incorporates a big bright supertwist LC VGA screen with white-on-black and black-on-white capability.



The 80386SX processor runs at a user-selectable 20/10/8MHz; an 80387SX numeric coprocessor is optional. The standard two megabytes of RAM can be expanded to six megabytes in two megabyte or 40 megabyte hard disc drive with an average access time of 23 or 19 milliseconds respectively. In addition, the TravelMate 3000 includes an internal 1.44megabyte 3.5" floppy diskette drive.

Software supplied includes MS DOS 4.01, Laplink, battery watch and Battery Pro, which conserves battery power while applications are running. A disc cache utility also enhances performance and saves battery power.

For further information circle 161 on the reader services coupon or contact Texas Instruments, 6-10 Talavera Road, North Ryde 2113; phone (02) 878 9000.

Display controller for the PC/AT

Univision Technologies of the USA has introduced the UDC-700 TI, a single board graphics controller, for AT-based systems. This newest member of the firm's 'Piranha' family features TI's TSM34010 graphics controller.

The UDC-700 TI board is capable of a vector drawing speed of 50,000 vectors/second. It can display images as large as 1280 x 1024 x 8 bits, at a flicker-free 60Hz non-interlaced refresh rate, from a display memory of 2048 x 1024. This feature is important in many applications such as cartography where off-screen memory is required. Standard high speed hardware allows the controller to perform bit-blits at up to 20 million bits per second. In additional powerful local pan and zoom hardware allows the single add-in board to handle demanding imaging and graphic ap-

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Colour laptop

Sharp has announced the release of the PC-8501 TFT Colour LCD laptop computer. The PC-8501 is the first of a new generation of advanced colour laptops based on Intel's 80386DX processor with 32-bit architecture.

The PC-8501 has many firsts packed into its innovative design. In addition to being super fast, the PC-8501 features a brand new display technology — colour thin-film transistor (TFT) — which packs nearly a million transistors into the 24cm (10") screen. This screen can simultaneously display 16 vivid VGA colours.

The resolution which results eliminates screen flicker, mis-convergence and magnetic interference. Coupled with hot cathode fluorescent tube backlighting, this provides rock steady, easy to read character formation.

Because its 32 bit architecture can be easily integrated into strategic organisation wide computing environments, the PC-8501 can provide seamless connectivity to mainframes, LANs, WANs and the Unix operating system.

The laptop weighs 8.5kg and has 2MB RAM expandable to 10MB. Its internal 100MB hard disk has a fast 19ms access time.

For more information circle 163 on the reader service coupon or contact Sharp Corporation, 1 Huntingwood Drive, Blacktown 2148; phone (02) 831 9111.



plications at eight bits/pixel. A full 16.7 million colour palette is standard.

Extensive software support for the UDC-700 TI includes Texas Instruments Graphic Architecture (TIGA), which will allow applications such as Microsoft, Windows, CADKEY, AutoCAD and HALO to be run without modification.

For further information, circle 162 on the reader service coupon or contact The Dindima Group, PO Box 106, Vermont 3133; phone (03) 873 4455.

Australian laser technology

Memorex Telex has launched an Australian designed and developed replacement controller board, the Memorex Telex 1408, which will give the previous generation of laser printers a new lease of life.

The board is based on a unique Application Specific Integrated Chip (ASIC) created by Sydney-based Pacific Semiconductor, which provides advanced hardware performance and functionality.

Features of the 1408 include 2mbytes of memory, full plotter emulation, a built-in printer server providing up to six completely independent ports ideal for local area networking, 22 resident scalable and bit mapped typefaces, the ability to use HP compatible font cartridges and high resolution print quality.

Memorex Telex has also introduced an Australian laser printer that incor-

porates the 1408 controller board, which is up to five times faster than any other eight pages per minute printer in the world.

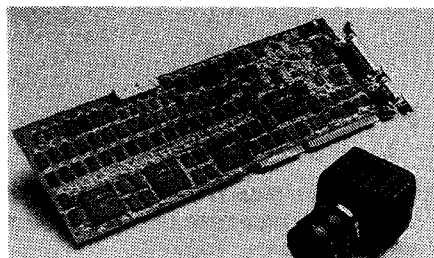
For further information circle 165 on the reader service coupon or contact Memorex Telex, 3 Thomas Holt Drive, North Ryde 2113; phone (02) 805 0420.

Line scan imaging kit

Email Electronics has announced the release of a line scan camera and a dedicated PC processor, which together perform a complete image acquisition image conditioning process.

The KC1956 kit, including the LC1902 line scan camera and the SB1956 line scan processor board is designed to transform an IBM PC-AT into a complete noncontact industrial inspection/control system. Until now, line scan camera systems designers lacked a standard computer interface. Now a PC AT configured with a KC1956 line scan acquisition and processing kit can be up and running at reasonable costs.

Popular applications for line scan



cameras include inspection of timber, steel, glass, plastic, paper and other materials, but are increasingly used for inspection of printed circuit boards, individual parts and assemblies moving past the camera on a conveyor.

The familiar area scan cameras coupled with frame grabber boards are inadequate for these tasks because neither can read or process pixel values at the speeds and resolution levels required. Line scan cameras can acquire one dimensional image data, or lines, at high speeds (up to 20 million pixels per second) and at very high resolution (up to 4096 pixels per line). Additionally, a line scan board can process images much faster than does a frame grabber/processor board which may include hundreds of times more data points. For example, a 2048 x 1 linear image provides over four times the resolution with over 128 times fewer pixels than a standard area scan image.

Image processing rates must match the pixel rates produced by the camera for efficient system operation. The SB1956 incorporates on-board hardware processing to achieve high speed system performance. The SB1956 hardware integrates three modes of processing, template matching, run-length encoding and binary compression.

For further information circle 170 on the reader service coupon or contact Email Electronics, 15-17 Hume Street, Huntingdale, 3166; phone 008 331 386. ■

PC Video display technology:

UPGRADED RAM-DACs GIVE ENHANCED VGA GRAPHICS

A new family of Video RAM-DAC devices has been released by Analog Devices, giving an apparent resolution of 1280 x 1024 pixels with a palette of 792,000 colours. The new devices also use a patented technique which apparently removes the longstanding problem of 'jaggies' caused by video aliasing.

by **BILL SCHWEBER** Senior Technical Marketing Engineer, Analog Devices Inc.

The ADV7141, ADV7146 and ADV7148 RAM-DACs for video graphics use an innovative algorithm to dramatically enhance the resolution, colour rendition, and line quality of industry-standard VGA display systems.

Using the patented Edsun 'Continuous Edge Graphics' scheme, these CEG/DAC monolithic ICs — pin and register compatible with standard RAM-DACs (such as the Analog Devices ADV471, ADV476 and ADV478 — contain embedded, dedicated DSP circuitry to implement the

user-transparent Continuous Edge algorithm automatically.

The resolution of a standard VGA system is sufficient for some applications (e.g., bar charts), with 320 x 200 pixels and 256 colours or 640 x 480 pixels and 16 colours. Yet it falls short for many others, such as computer aided design (CAD), photorealistic visualisation, and what-you-see-is-what-you-get (WYSIWYG) text and layout.

For enough hues of a given colour to create the fine shading that the eye ex-

pects to see (Fig.1, 2 and 3), these applications need a large universe of available colours, together with high resolution's fine detail and definition.

Limited resolution results in visual aliasing: lines have jagged edges ('jaggies'), when they ideally should be straight or smoothly curved (Fig.1); and a limited number of displayable colours means that the smooth colour shading and slight differences in hue of a photorealistic image cannot be achieved, because quantisation produces observable steps in colour rather than an apparently seamless transition between colours.

Most solutions to the aliasing problem require costly higher-resolution (hence higher speed) displays and support circuitry (workstations with typically 1000 x 1000 pixel or better resolution), as well as special computation-time-intensive software algorithms that are often image-dependent. CEG/DACs produce comparable images using a standard PC platform.

A CEG/DAC (Fig.4) combines embedded, dedicated DSP circuitry — to execute algorithms — with the traditional RAM, which embodies the video colour palette (or colour lookup table, (CLUT), and the associated triple DACs (for red, green and blue outputs).

Until initialised to CEG mode, it behaves like a standard RAM-DAC. But, when the video driver software initialises it to CEG mode, the algorithm hardware — interposed between the RAM and the DACs — is activated. Pixel data fed to the DACs from memory is intercepted and processed to provide antialiasing and a wider apparent colour selection.



Analog Devices' new CEG/DAC chips use the patented Edsun Continuous Edge Graphics scheme to provide workstation quality graphics resolution — 1280 x 1024 pixel resolution, without the familiar 'jaggies' aliasing problem.

CEG/DACs come with a 256-word-deep lookup table in two resolutions: 18-bits for '6-bit colour' (3 x 6 bits per displayed pixel), and a 24-bit-wide

memory with 8 bits per primary colour. Each CEG/DAC, following industry convention, has an 8-bit microprocessor port for access to the colour-palette address register, colour-palette RAM, and pixel-mask register; these registers are 100% compatible with non-CEG RAM-DACs. Information latched into the pixel port determines the DAC outputs state for each pixel.

The CEG/DAC algorithm

With the CEG/DAC algorithm, the colour of a displayed pixel depends on the colours of the adjacent pixels. If a line of pixels forms a visual boundary (a distinct line or a colour change) and the display substitutes the correctly weighted averages of the two adjacent colour values for the original pixel colours, the edge will appear smooth and unaliased.

In the CEG/DAC, only 223 of the 256 palette pixel values represent pointers to distinct colours; and in CEG mode the other 32 (one of the 256 locations is reserved for internal use), represent an op code for computation of relative proportions of two colours. The CEG/DAC allows a set of colours to be mixed according to the desired proportions. In concept, the CEG/DAC computes a real-time weighted average — an interpolated value — for each of the primary colours of each pixel as they are read out of the palette RAM. This mixed-colour (PMC) calculation can be expressed by:

$$PMC = PN (Mix) + PN-1 (1-Mix)$$

Where PN = new-pixel colour, PN-1 = previous-pixel colour, and Mix = mix ratio stored in the RAM.

In words, the colour to be displayed is the mix-ratio-weighted sum of the input colours for the new pixel and the adjacent previous pixel. This equation is executed by DSP circuitry embedded in the device in three parallel structures — for red, green and blue. The CEG algorithm is in effect an interpolation process; it blends colours of adjacent pixels to smoothly feather the perceived colour as the boundary is crossed from one colour region to the next.

The interpolation process assumes linearity between the numeric colour value representation and the apparent screen intensity. Since a CRT's phosphors do not linearly relate displayed



Fig.1: Examples of lines that are nearly horizontal and vertical, comparing the smooth lines achieved using the CEG technique (left and upper lines) with the jagged lines delivered by a conventional VGA approach.

intensity to colour number (i.e., DAC output voltage), the three mixed colours first go through a gamma correction circuit — an internal ROM containing the inverse colour value-screen intensity transfer functions in compressed, optimised form (to reduce necessary memory space) — before they go to the RGB DACs.

The ADV7141 (triple 6-bit) and ADV7148 (triple 8-bit) are compatible with industry standard '471 and '478 devices; housed in a 44-pin PLCC, they are optionally available for 35, 50 and 66MHz clock rates. A similar device, the ADV7146, in a 28-pin plastic DIP, is compatible with '171 and '476 type triple 6-bit RAM-DACs.

Video graphics recap

The complete display of a video graphics monitor is composed of individual picture-element dots — pixels — which the viewer's eye integrates to form a complete image. In a monochrome black and white monitor, each pixel can have any intensity from full-off to full-on, seen by the eye as a shade of gray. In a cathode-ray-tube (CRT) colour monitor, each pixel actually comprises adjacent primary-colour phosphors on the face of the tube (red, green and blue, or RGB); these can be combined in varying intensities and proportions to produce the full range of visible colours and shadings. Three electron beams sweep across and down the CRT face in a repetitive pattern (raster scan); and pixel-determined signals control the intensity of each beam. The pixel in-

formation is synchronised with the position of the raster scan, so that pixels repeatedly appear on the screen in their correct locations.

Each pixel's intensity is established by the computer program. The hardware interface between the running program and the screen consists of a special video memory and digital-to-analog converters (DACs) — which transform the digital value associated with each pixel into an equivalent analog value ranging from pixel colour off to full on. (One DAC serves a monochrome system; there are three — R, G, B — in a colour system). How many shades of gray — or primary colour — each pixel can display depends on the number of memory bits per pixel and the DAC's resolution.

The colour potential of the memory in the graphics system is often described by the number of bits per pixel. When 6 bits are assigned per primary colour, there are 6 + 6 + 6 = 18 bits per pixel; this is known as '18-bit' colour. The actual number of distinct colours that can be displayed is

$$2^6 \times 2^6 \times 2^6 = 64 \times 64 \times 64 = 262,144$$

but they may not be simultaneously displayable if the number of available display locations — pixels — on the screen is limited. Similarly, a system with 8 bits per primary colour is a '24-bit' system (8 + 8 + 8); it can select more than 16 million colours:

$$2^8 \times 2^8 \times 2^8 = 256 \times 256 \times 256 = 16,777,216$$

The availability of so many distinct

VGA Graphics

colours may not appear to be necessary, since the screen doesn't have enough pixels to display them all simultaneously, and the eye cannot distinguish them when they are randomly placed.

However, the eye can perceive small differences in adjacent colours, so a large available-colour universe makes smooth transitions possible, permitting subtle shading and the display of photorealistic images, because the image colour varies smoothly — steps between adjacent colours are small. (A picture of a red teapot illuminated by white light can show many shades of red, depending on how the light hits it).

A perceived gap between displayed colours breaks up the image; while more colours, with smaller steps between shades of the same basic colour, leads to a cleaner image. In a system with just eight colours, the gaps are very evident; and a universe with 256, or even 262,144 colours, has noticeable gaps between colours, with a lack of smoothness in shaded areas with low or high contrast.

Lookup Tables: Memory can be used more flexibly, and with simplified requirements, by the addition of a programmable lookup table ('colour lookup table,' or CLUT, Fig.4) — a special memory area residing between the pixel information memory and the display DACs. A typical depth is 256 words.

In this 'indexed' approach, instead of using pixel memory to directly create 256 display colours, the bits of each pixel can address any one of the 256 lookup table locations, producing a palette of 256 different colours.

The word currently stored at the specified location generates the actual display colour bit pattern for all three DACs. The palette's colours can be changed 'globally' at any time by loading a different set of patterns into the CLUT.

The number of *bits* within each of the 256 words in the CLUT determines how finely the colour spectrum can be divided; the number of *words* that the CLUT contains determines how many colours from the universe are displayable on a single screen.

Lookup tables permit displayed images to be altered interactively without any rewriting of the pixel values. For example, a selected band of contrast levels in a map can be expanded to

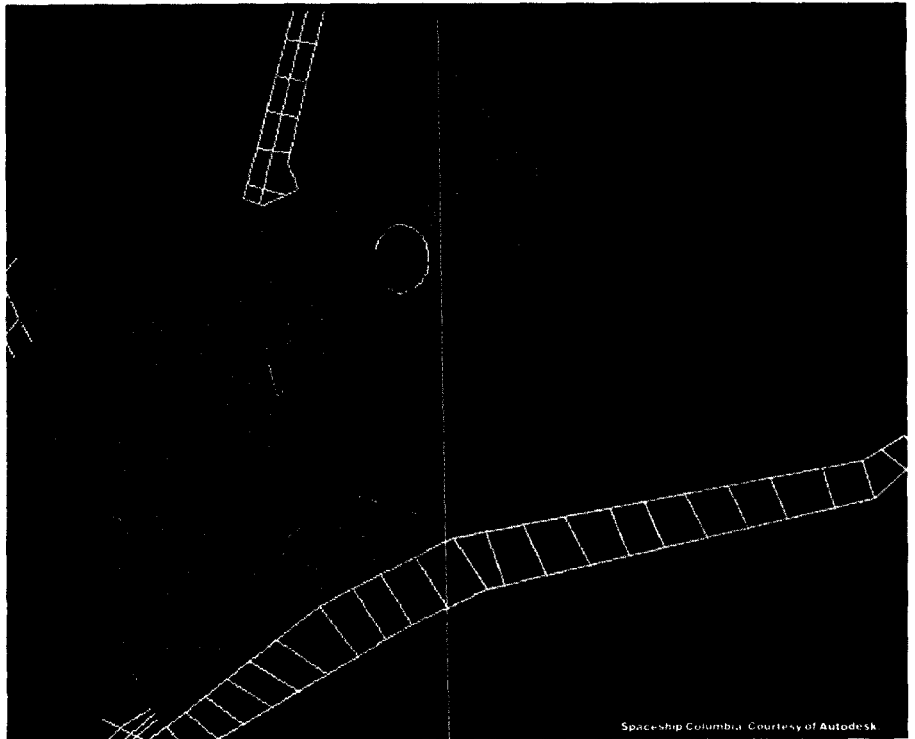


Fig.2: A split screen image of a CAD wire frame model, showing the limitations of a conventional image (L) compared with that using the CEG technique (R).

show subtle variations in vegetation density. Colours can be changed during the course of a fabric design, without any recalculation within the main part of the software; only the new set of colours need be loaded into the CLUT.

Lookup tables can also be used to apply unique corrections to the image,

e.g., gamma correction, to compensate for nonlinear intensity functions (mentioned earlier).

The lookup tables make it easier to work with the actual colour range in use, but by themselves they don't change the number of potentially available colours in the overall colour universe.

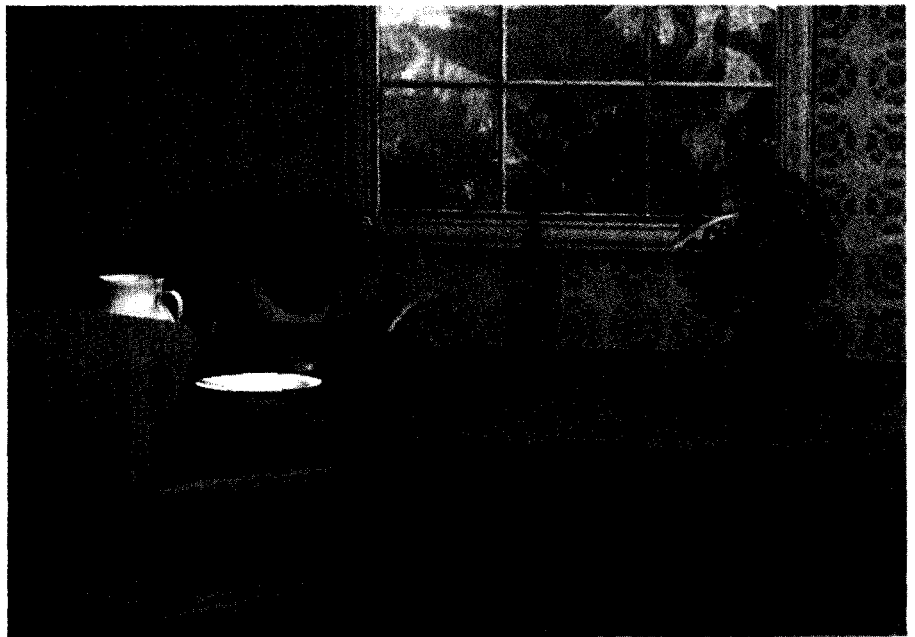


Fig.3: An example of a CEG-enhanced image, showing the smooth colour rendition and finer definition.

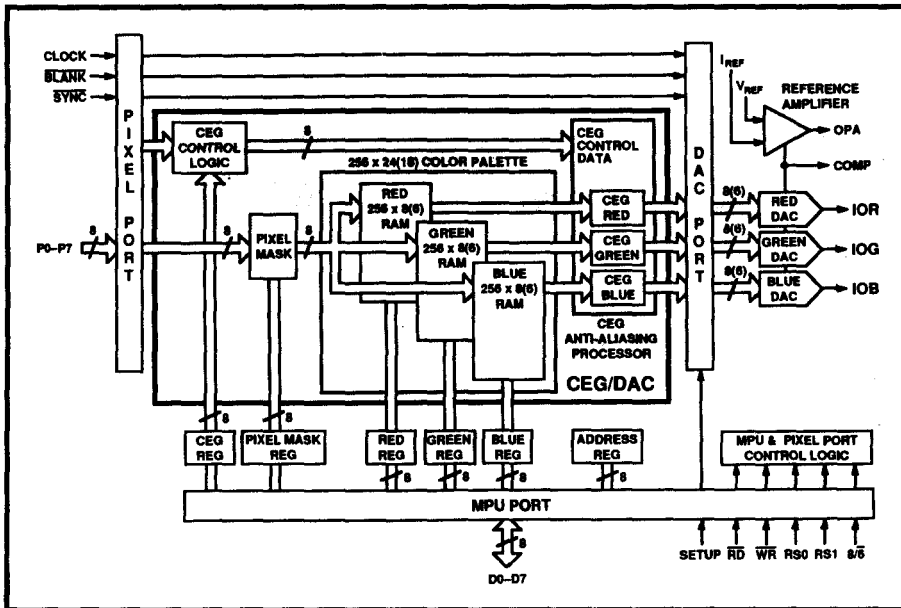


Fig.4: Block diagram of a CEG/DAC. Note the three colour lookup tables, the triple CEG anti-aliasing processors and the three video DACs.

RAM-DACs are ICs that incorporate both the CLUT memory and the three DACs, along with essential support and interface circuits — including the microprocessor bus port and pixel port (Fig.5).

Pixels, Resolution and Aliasing: Any image boundary — an abrupt change of either intensity (light blue to deeper blue) or colour (red to blue), or a pair of successive changes that form a line element — as the screen is traversed, will involve one or more pixels in each row of the raster.

Since the pixels are not finitely small, some pixels in the vicinity of the boundary lie entirely within one or the other colour [used synonymously with *intensity*], while others straddle the boundary.

Ideally, each pixel at the display boundary would display colour-1 and colour-2 in proportion to the area of each colour within the pixel intersected by the boundary. But this is not possible, because the pixel must be set to either colour-1 or colour-2. A conventional video display circuit (and RAM-DAC) can only judge the predominant colour in the pixel area and implement the choice.

The visual impact of this aliasing is that lines (both straight and curved) acquire discontinuities as they cross rows or columns of pixels. Even simple one bit monochrome line drawings and text on the screen will represent oblique lines by multiple steps, notably if the slope is just off the horizontal or vertical. In some cases,

because of misalignment due to these 'jaggies', two lines that should meet at a corner won't, raising problems in CAD systems.

Typically, to produce images in which aliasing and image corruption are reduced to insignificant levels, workstations are needed, with resolutions of at least 1000 x 1000 pixels and a universe of 262,000 — or even 16 million — colours.

But one might pay \$10,000 to \$20,000 and more for this level of performance, compared to \$2000 to \$5000 for a representative VGA system that includes PC, VGA driver circuitry and monitor.

Continuous edge graphics

CEG, a patented technique, brings workstation-like resolution and colour to VGA systems. The CEG algorithm, applied to the DAC inputs, adjusts the colour of pixels along the boundary between two colours by blending them. The precise amount of blending at each pixel — the relative propor-

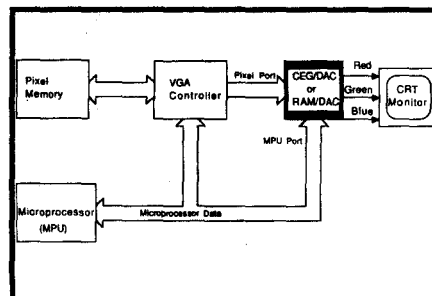


Fig.5: The RAM-DAC accepts both processor bus data and pixel data.

tions of colours 1 and 2 — is calculated by the algorithm, using the values of nearby pixels and a set of rules that specify mixing based on adjacent pixel colour differences.

The resulting 'feathering' of one colour into the other, using the existing VGA display monitor and PC, produces an apparent resolution of 1600 x 1280 pixels and 792,000 colours; visual resolution is 1/32 of a pixel.

To implement CEG, two changes to the system are needed. First, the RAM-DAC on the VGA display driver board must be replaced by the pin-compatible CEG RAM-DAC, which contains dedicated digital/signal/processing (DSP) circuitry to perform the calculations needed to adjust the colour of the blended pixels.

The algorithm is implemented in hardware, so the image is displayed without a time penalty — and the calculations, performed concurrently with the presentation of pixel information to the RAM-DAC, are transparent to the user.

Second, the software within the user application that presents display data to the VGA display card in the PC must be modified to prepare the display data in a slightly different format, so it can be accepted by the CEG algorithm.

Modified display drivers for LOTUS 1-2-3 and Autodesk AutoCAD are available now — with more coming. The modified drivers increase execution time by barely perceptible 10% compared to the non-CEG drivers.

With the modified driver loaded into the system to replace the conventional driver, the CEG algorithm is transparent to the user: CEG images automatically replace the conventional VGA images.

No changes are necessary for developed programs or software. Even after being initialised to CEG mode, the CEG RAM-DAC can be software-set to revert to conventional VGA mode and bypass the CEG DSP circuitry.

This can even be done 'on the fly' during the screen raster scans, making possible a split-screen display, with conventional and CEG VGA images side by side.

(Adapted from 'Analog Dialog' Volume 24, No.3, by permission of Analog Devices Inc. For further information on the ADV7148/46/41 RAM-DAC devices, contact NSD Australia, 205 Middleborough Road, Box Hill 3128 or phone (03) 890 0970).

Understanding Test Instruments:

THE LOGIC ANALYSER

Many people in electronics are not familiar with the logic analyser, and are unsure of its uses and applications. Here's an easy to read introduction to the instrument, for those in this position.

by J.L. ELKHORNE

"It's only a development tool", says the pragmatist, while the designer will probably assert, "It's a diagnostic machine, primarily".

My first exposure to the logic analyser came some years ago, as a result of trying to work with a Motorola D3 microprocessor evaluation board. Although Motorola's large manual seemed quite comprehensive, a few critical points needed improvement.

After failing to achieve user input on the keypad, I threw my hands in the air. One telephone call to a bloke at a local TAFE yielded an opportunity to find out what was happening. I got the chance to

see an expensive logic analyser in use; the TAFE representative got to inspect a simple, educational microprocessor board he wasn't familiar with.

It took only a few minutes to see my error. The rudimentary operating system of the D3 expected the keypad non-maskable interrupts to be disabled, before accessing the keypad GET subroutine.

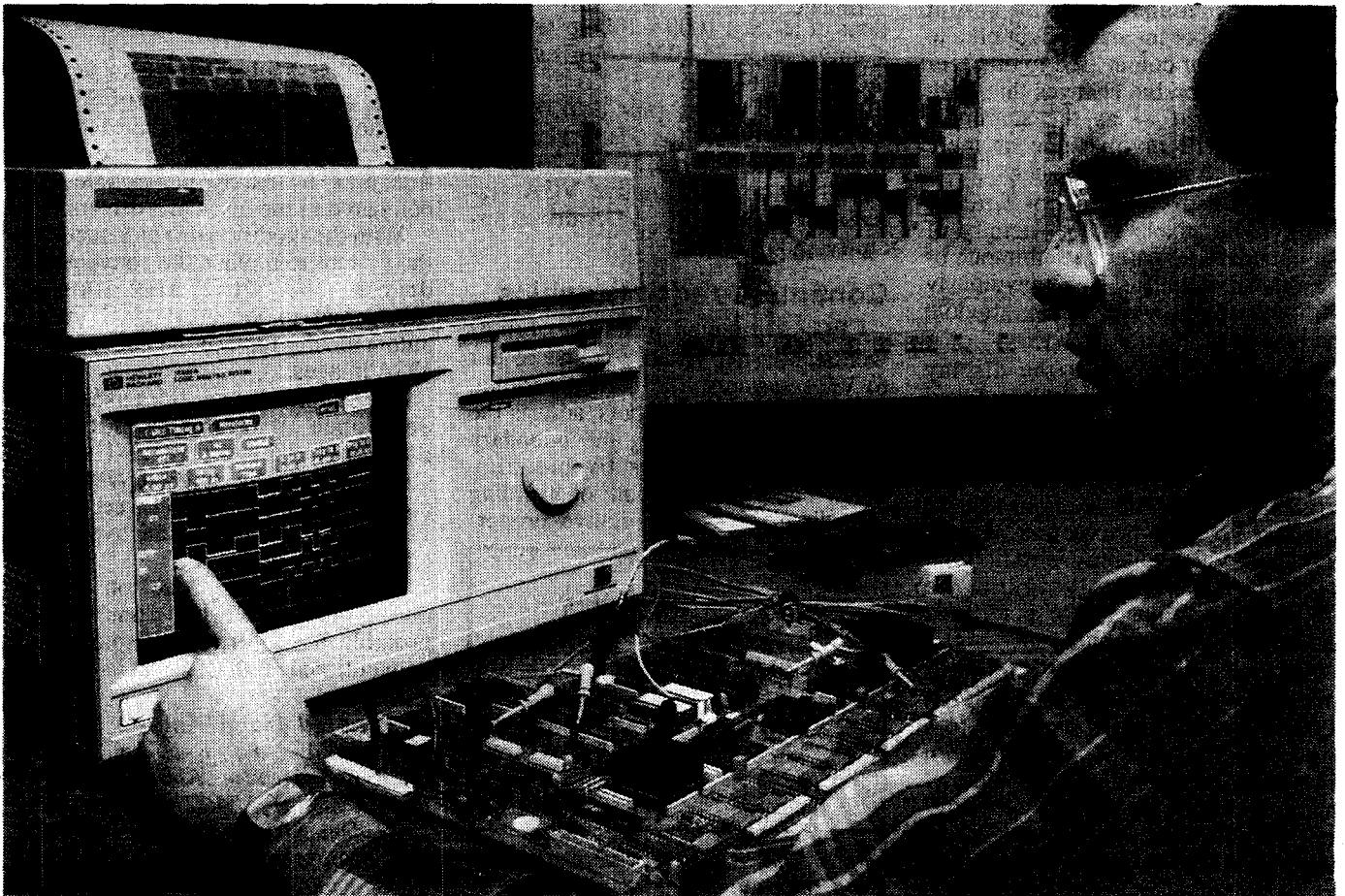
So much for the 'when all else fails, read the book' approach. I could have pounded the manual for more fruitless hours without success, yet the right tool for the job gave me the answer straight away.

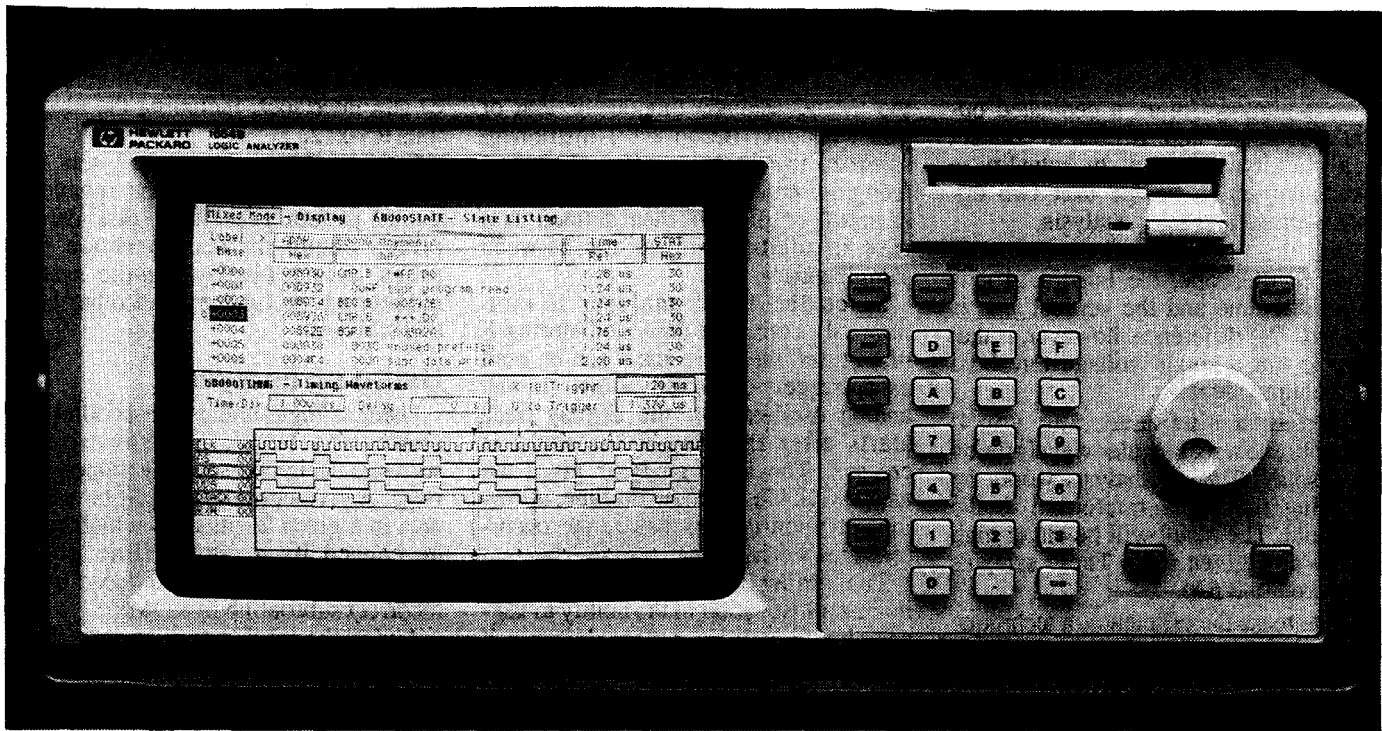
Who needs one?

I sometimes reckon the real world must come as a shock to the young person who completes his or her high-tech training.

They're likely to find themselves in a workshop that combines the worst aspects of a brothel and a Heath Robinson nightmare. No more clean and neat environment, well lighted and organised. No more comprehensive selection of test equipment and tools, or a technical reference library.

Example: one person I know accepted a job with an amusement machine com-





The Hewlett Packard HP1654B logic analyser, which has 64 channels and a 100MHz capability for timing analysis plus the ability to make state analysis to 35MHz.

pany, foolishly believing the glib promises given by the owner at the interview.

The tech's query, on his first working day there, of: "How much can I spend on an oscilloscope?" was answered with the categorical statement: "A real technician doesn't need a crutch like that."

Most service departments dealing with computer terminals, PCs, and similar equipment, do provide an oscilloscope or two. In the hands of a skilled technician, probably 90% of the repairs can be effected by using the CRO. It's the 10% that cause the headache.

In Zaks and Lesea's book *Microprocessor Interfacing Techniques*, there's a chart of test equipment versus problems (page 406). The authors assess that a fault can be fixed in an average time with a logic analyser, but 'eventually' with only the CRO.

Thus, the ubiquitous dual-channel, analog oscilloscope is outclassed by bus-oriented digital gremlins.

Suppose you have an upmarket ASCII computer terminal with the typical customer's report, 'Doesn't work!' You throw it on the bench, plug it in, switch on. It emits one beep, then sits there, no status line, no cursor on screen. A peek in the back shows the CRT filament is glowing.

So, you whip off the case, poke your CRO probe in, onto the circuit board.

Yes, the +5V rail looks OK. You go further, and find indeed the clock pulses are present. Well. Next, you probe some of the address and data bus lines. Nothing's happening.

You switch off the terminal, wait a few seconds so the switchmode power supply doesn't spit the dummy, then power up. Possibly you see activity on the buses for all of a half-second. At this point, you'll probably change — one by one — most or all of the socketed chips. But there's still no joy in Mudville.

More likely than not, a spare board goes into the customer's unit, which is tested and returned. The crook board sits on the end of the workbench as a 'rainy day' project.

A few years down the track, there's a whole carton of 'rainy day' boards. Sometimes, they even get worked on, with the shotgun approach, especially when all the spares have been used up. "Try replacing all the bus transceivers", pontificates the workshop supervisor.

If sophisticated test equipment was available, a bloke would use it. Even simple digital tools would be applied, if they were at hand. Ask any enthusiastic amateur, and he'll point you to his 'logic probe' and 'logic pulser'. But at one service department, a senior technician had to buy that pair himself, when he grew tired of the frustrations of 'professional service'.

A \$50 probe can show up an intermittent pulse so narrow, one would be hard-pressed to capture it as easily with a CRO costing thousands of dollars.

A logic board that's been worked on by half-a-dozen technicians and still doesn't go represents lost time and revenue. When this situation happens repeatedly, an astute manager ought to be able to justify test equipment that does do the job. Yet this seldom happens.

Even worse is when he tells you there's a signature analyser on hand — but no signature chart ...

The right stuff

Hewlett Packard states the case for the oscilloscope as 'providing high voltage resolution and high time-interval accuracy'. The logic analyser, on the other hand, lets you look at lots of signals at once, and in the same way the system hardware does.

The logic analyser is dedicated to 'design and troubleshooting of microprocessor based systems'. It is 'particularly useful when looking at time relationships or data on a bus — e.g., a microprocessor address, data, or control bus'.

A logic analyser looks something like a cross between a CRO and a computer terminal. There's a CRT display, a keyboard for selection of operating conditions, and some sort of multiple input

Logic Analyser

probe lead. Sometimes, instead of a general purpose input, a dedicated option module or 'pod' is used to connect to a circuit under test. In actuality, a logic analyser gives the user two options: *timing* and *state analysis*.

With the timing function, analogous to an oscilloscope, the horizontal axis represents time and the vertical axis is voltage. The difference, however, is that there is but a single voltage threshold for the input signals.

Poke in a sinewave, and you'll probably see a rectangular waveform on the display. Timing analysis works by sampling the input, referenced to the threshold. The result will be either high or low at a given time. These samples are stored in RAM.

To increase the efficiency, a technique called 'transitional timing' is used. Now, instead of using up memory for fixed sample pulses when nothing is happening with the signal, transitions are detected and the relative elapsed time is stored instead, along with the sample value (high/low).

For example, a 10ns sampling rate of a pulse train lasting 260 microseconds could effectively represent 26K of memory. Obviously, the busier the sig-

nal, the less total time duration can be captured before the memory fills.

One of the more useful capabilities of the timing analysis function is that of glitch capture. Because the instrument samples the incoming signal, it can recognise transitions that occur between samples. A glitch is then defined as a case of multiple transitions between sample pulses.

Since the logic analyser is continuously capturing data, and storing it in a buffer, the glitch itself can be used as a trigger, or 'trace point'. In the analog oscilloscope, the display trace starts after the trigger threshold is crossed. The logic analyser gives the user a variable 'window' in time, allowing retention of data before the occurrence, as well as after.

The timing function reaches maximum sophistication in the ability to trigger also on a logic pattern, because it looks at many lines simultaneously. You might, for example, tell it to start displaying only after it sees the data byte 42hex (0100 0010), or the address 1600H.

Finally, edge triggering is possible, to capture data as the system under investigation is clocked. Which brings us to the second function of the logic analyser: that of state analysis.

One difference is that, in timing analysis, the instrument provides the sampling rate, making it asynchronous to the device under test. In state analysis, however, the device under test itself provides the sampling clock.

Typically, the timing function displays multiple signal waveforms, whereas state analysis is in listing format. As HP puts it, timing is 'when' it happened, and state is 'what' did happen on the bus.

Various methods of state display are available: binary, hex, or instruction disassembly. The latter is generally a software provision of one of the preprocessor options. These were called 'personality modules' in earlier logic analysers.

The 'trace point' is specified by the user to tell the instrument when to begin capturing data for display and analysis. Because multiple 'sequence levels' of triggering can be programmed, it's possible to focus in on a subroutine, for example, and store only the steps involved with it.

In actual operation, a logic analyser will likely be connected to a microprocessor system by means of a preprocessor — the specialised mechanical and electrical link to a specific microprocessor type.

Preprocessors come in different flavours, for various manufacturer's microprocessors, and standard buses and interfaces, including the ubiquitous RS-232.

State-of-the-art logic analysers can offer digitizing oscilloscope functions, digital pattern generation, disk drives, printer output for documentation purposes, colour display, remote system monitoring via modem, and other bells and whistles!

Using an analyser

Using a logic analyser can eliminate contention between hardware and software design persons, by pinpointing bugs. A given problem might be wrong data in a given location — which could be caused by a control line glitch. Equally, it might also be induced by an incorrect subroutine in ROM.

And in the service department? Well, the above example of the terminal would be inspected with state analysis to see what the power-up initialisation sequence is doing.

One optional mode allows single-step trace, allowing the user to verify the circuit operation one instruction cycle at a time.

In this case, it's simple to remove the CPU from the circuit board, plug it into the logic analyser module, and the ribbon lead then into the socket. This tests the board in question with its own microprocessor.

Communications problems of a hardware nature can be debugged with the interface preprocessor, quickly answering various thorny questions about protocols, ports, and configuration.

Summary

An item of equipment as sophisticated as a logic analyser cannot be covered in depth in a short magazine article. Perhaps, though, these few words will help dispel the 'fear of the unknown'.

My thanks go to Mr Arthur Booth, Marketing Communications Manager at HP Australia, for providing a large amount of literature used in preparing this overview.

Suggested reading:

HP Test & Measurement Catalog, 1991

Feeling Comfortable With Logic Analyzers (HP Book Part Number 5954-2686)

Microprocessor Interfacing Techniques, Rodney Zaks and Austin Lesea. Sybex, Third edition 1979. ■

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