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Electronics Australia

JUNE 1988

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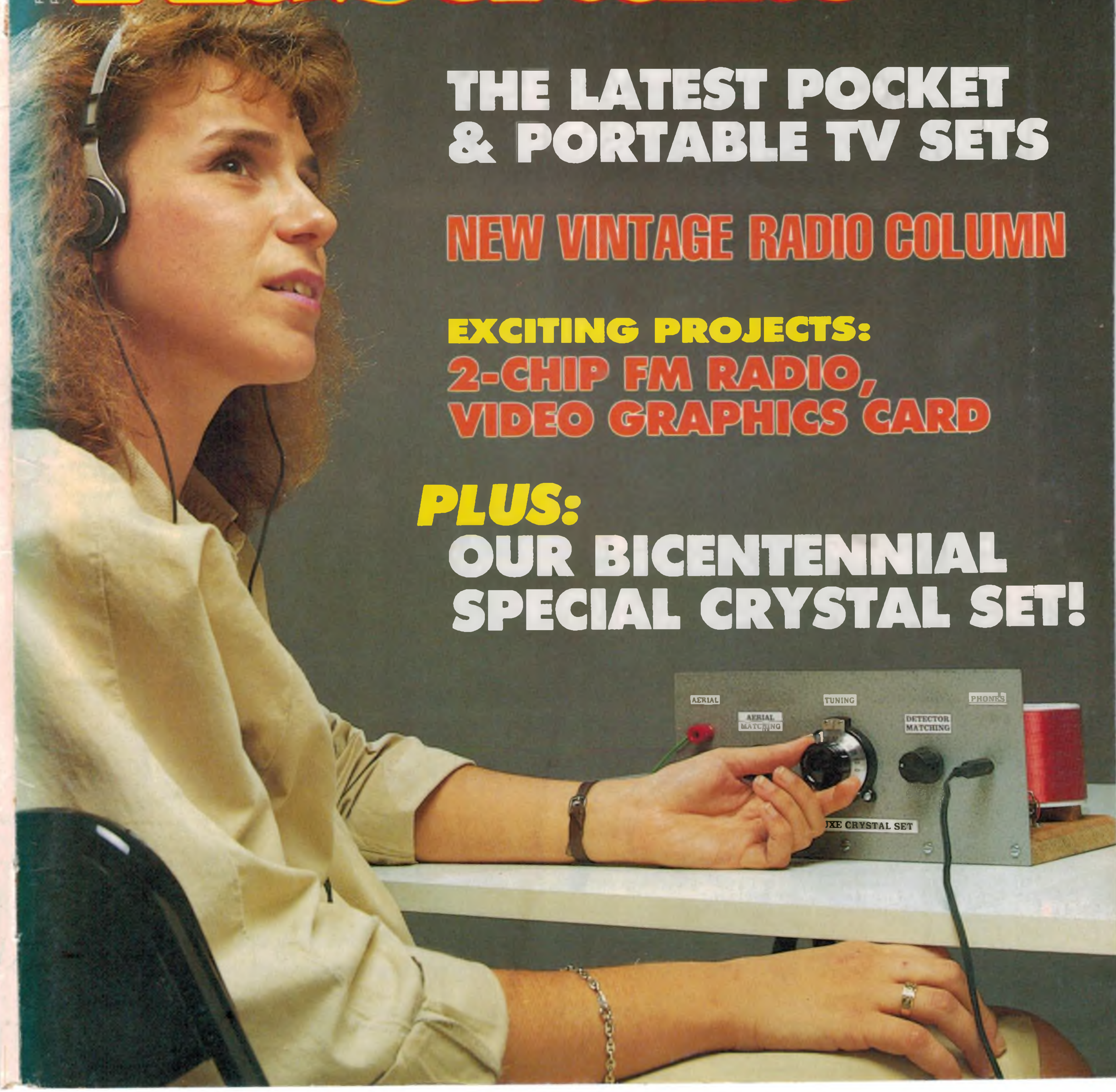

How to beat the high cost of cheap meters.

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You'll get more meter for your money, whether you choose the affordable 73, the feature-packed 75 or the deluxe 77.

All of them will give you years of performance, long after cheaper meters have pegged their fishhook needles for the last time.

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Of course, you may only care that the world-champion 70 Series combines digital and analog displays with more automatic features, greater accuracy and easier operation than any other meters in their class.

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Coming next month in Electronics Australia

Low cost line filter

Even the simplest power line filters are now surprisingly expensive. Here's the design for an easy-to-build unit that provides improved protection against noise and spikes, but will cost you less than half the price of commercial units. Great for your computer or hifi system!

Music tuner

Wouldn't it be great to be able to tune your guitar, piano or other instrument quickly and accurately, without any hassles? Our new music tuner does just this – yet it's easy to build, pocket sized and much cheaper than comparable commercial tuners. You can use it as a pitch reference, too...

TV field strength meter

Setting up a TV antenna system for the best results can be a tricky and tedious business. Here's a project designed to take away the guesswork and frustration, especially for those who want to do the job professionally.

**Note: although these articles have been prepared for publication, circumstances may change the final content of the issue.*

KIT COMPUTER REVIEW

By Jim Rowe

Reprinted in part from the December 1987 issue of Electronics Australia', by arrangement.

A couple of weeks ago I discovered that Dick Smith Electronics was about to release a new AT clone in low-cost kit form. So when the opportunity came to assemble an advance sample kit for this review. I jumped at the chance.

Particularly when I learned that the kit was essentially a 'knocked down" machine, which didn't involved any soldering or the tedious low-level assembly - just bolting pre-assembled (and tested) modules together and plugging in cables to connect them all up.

By the way, the modules making up the kits are all going to be available separately, so you don't have to buy them all at once. This also means that you could buy them separately.

The kit itself goes together to make a standard 8-slot AT level machine, with space on the motherboard for up to 1 megabyte of RAM and able to run at any of four clock speeds: 6MHz, 8MHz, 10MHz or 12MHz. It features a 200W switch-mode power supply and a choice of video, I/O, disk controllers and drives, all housed in a standard two tone bone coloured box. There's also a choice of either 84-key or 101 key keyboards.

In theory then it all sounds great. But how did it turn out in practice?

Everything seemed to be attractively packaged, and protected against damage.

There is literally no soldering to do in assembling the kit, because all cabling is supplied ready assembled. All you need to do is identify where they go, and connect them up.

Needless to say, there are various links and DIP switches to check on the various boards, before you mount them and connect things up.

You have a choice of video/ graphics adaptor card as there are three available. These are a mono adaptor (MDA) with parallel printer port; a colour adaptor (CGA), also with printer port; or an extended colour graphics adaptor (RGA), with the usual multiple modes including Hercules.

All in all, the whole job took about 3 hours to assemble.

When it was complete, I hooked it up to the monitor and turned on the power. Everything sprang to life very smoothly.

How does it perform? Not too badly at all. I sooled Peter Norton's Advanced "System Information" utility onto it, and it came up the following CI (computing index) figures for the kit's CPU performance compared with an original IBM PC/XT:

CLOCK SPEED	CI RATING
6MHz	5.1
8MHz	7.7
10MHz	9.2
12MHz	11.7

I for one certainly enjoyed putting the sample kit together. All I have to do now is work out how I can afford to buy one — preferably the one I've already put together!

Needless to say, you'll find the A computer kits at all Dick Smith Electronics stores, and at many of its larger dealers.

This man isn't a computer expert, yet he chose a UNI-X CompuPak kit – and assembled it in one night!

$942* Including Tax.

At this price **WHY NOT?**

...and the experts agree with his choice.

Australian Personal Computer LOW COST IBM COMPATIBLE SURVEY – OCTOBER 1987

Australian Personal Computer have now proved what our customers have known for years

Processor.

NEC. The Uni-x contains a NEC V20, manufactured by Sony.

Thus a V20 running at 4.77MHz will outrun an 8088 running at the same clock speed.

machines examined provided a standard PC clock rate of 4.77MHz as a minimum, although the Uni-x delivered higher than standard performance even on this clock rate by virtue of the V20. The Atlantis and

Performance.

The Uni-x is fastest overall, providing a 50 per cent boost over the Technology Interface due to the V20.

Display.

delivered with a nice INTRA tilt/swivel amber screen.

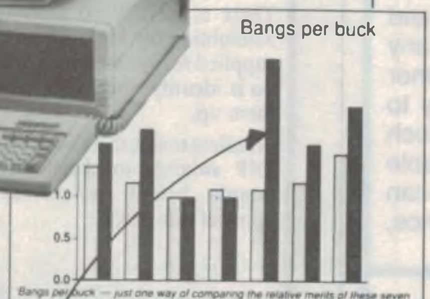
Cost Effectiveness.

As you might expect, the do-it-yourself Uni-x comes up trumps with its low cost and relatively high performance

Specifics.

The Uni-x features a delightfully small motherboard. It has employed a VLSI component to replace the Intel 8253 timer, 8255 PPI, 8237 DMA controller and several other components. This reduced the component count and a simplified motherboard serves to reduce costs

. . . see for yourself in the full Report in the October '87 issue, or ring us for a copy.



Bangs per buck — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are ... Rod Irving, MicroDOS, Commodore, Uni-x, Altronics and Techn...

No, he's not a genius, but he's brilliant at spotting great value. Like many of us, he's realized that a personal computer is invaluable, yet the price tag for a professional unit has always been a little beyond his reach. Until now.

Quite simply the UNI-X CompuPak kit contains all the major componentry of a top quality Industry standard computer, in an unassembled form. You save the dollars and increase your knowledge, by putting it together yourself.

UNI-X also provide a National Warranty through Honeywell Ltd, a professional network of expert backup and service.

The complete Super 10 kit contains:

- ☐ **Super — 10 mother board** 640K Installed, 4.77/10MHz, plus V-20 chip (very fast!)
- ☐ **Colour graphics adaptor card.**
- ☐ **Multi I/O Card**-Serial/Parallel Ports, Games Port, Clock, calendar, Floppy Controller.
- ☐ **Dual Frequency TTL Monitor** (Green or Amber) includes tilt and swivel base.
- ☐ **Top quality Japanese Disk Drive.**
- ☐ **150 watt switching power supply.**
- ☐ **High tech flip-top case.**
- ☐ **Complete set of accessories.**
- ☐ **AT style keyboard.**
- ☐ **Industry standard — runs all IBM software.**
- ☐ **Assembly manual**
- ☐ **Utility Disk.**
- ☐ **All upgrade options available.**

Ring PATRICK SIMONIS (07) 356 7866 right now.

UNI-X Pty Ltd **CompuPak** Division

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Volume 50, No.6

Electronics Australia

June 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

The new colour pocket TV sets

Will pocket and other baby TV sets finally take off, now that the new colour models have arrived? Thomas E. King explores the possibilities in our story starting on page 12.

Projects to build

Our construction projects for you this month include an easy to build 2-chip FM radio, a multi-mode video graphics card for PC-AT computers and compatibles (using only 4 chips!), and of course our special 1988 Deluxe Crystal Set!

Test & Measuring feature

This month's special feature on T&M includes an interesting story on how a microcomputer can be used for more effective temperature compensation of crystal oscillators (page 103), also a review of Leader's new LCD-readout digital scope/DMM (page 106).

ON THE COVER

EA's production editor Carmel Triulcio tries out our new 1988 Deluxe Crystal Set, and experiences for herself the fascination of "pulling in the stations" using a 1920's style radio – see page 66. (Photo by Helmut Mueller)

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Entertainment Electronics

Projects and Technical

News and Comment

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Letters to the editor

Low distortion oscillator

I thought I'd drop D.E. Graham of Wembley Downs, WA, and N.V. of Parramatta a supportive line, through your column.

They are not alone in experiencing that frustrating problem with the frequency calibration of the Low Distortion Oscillator. I'm experiencing the same characteristics as D.E.G. described, in his letter to you published in the November 1987 issue. My kit was also from the same supplier. I checked the "pot" for linearity and tracking before installing and it was OK. I've also done the same work around as D.E.G.

I didn't like your comment (inference) that you "doubt if it could have been fitted with a antilog pot (i.e., prototype), or there would have been many more complaints beside yourself (D.E.G.) and N.V.".

Surely a bit of maths (haven't had time yet to do it) would resolve this without the above hypothesis being offered; the two events — given human nature — aren't that strongly linked.

Enough of this brickbat — please put my letter in the same file as N.V.'s and D.G's — maybe the file will get bigger.

Len Bray,
Aranda, ACT.

Comment: Thanks for writing, Len. My earlier comment wasn't meant to be rude, just an observation. We've had further discussions with the kit supplier concerned, as all the problems with this project do seem to have been with their kits. The only conclusion we can reach at present is that one batch of pots may have had a subtly different resistance/rotation law, or perhaps a different angular rotation range (perhaps 300° instead of 270°).

All we can suggest is that if you have this calibration problem, try judicious changes to the values of the series and shunt resistors associated with both sections of VR5.

Electrostatic speakers

I fear that your review of the book 'Electrostatic Speakers Design and Construction' (EA Jan 88) seriously misleads readers. While the book goes into great detail about building the actual speaker panels, the lack of information on building the driver transformers and supply circuitry stops it being 'an invaluable guide to those who would like to try their hand at making electrostatics'.

The author suggests making measurements on an existing transformer to see if it is suitable, but where does one find a selection of transformers to make measurements on, remembering that the transformer must have a frequency response up to 20kHz, be of suitable power rating and turns ratio, and be insulated for a safe WORKING voltage in excess of 4kV? The latter feature, so necessary for safety, is not mentioned! The high voltage supply shown is in error, producing 325V, not the 9kV claimed.

Looking at the design of the panels themselves, these should work, but the diaphragm material chosen will produce strong and intrusive resonant peaks, and the radiation pattern will be very poor.

I write to warn readers that building electrostatic speakers on the basis of this book is likely to result in frustration and disappointment. I am a great fan of the things, having been experimenting with them for the past ten years, but only now do I feel that I know enough about them to be able to build ones that equal the best commercial speakers.

Steven Robinson,
Lane Cove, NSW.

Comment: Thanks for the reaction, Steven. There is some information on sourcing components in the book, but of course this isn't of much use in Australia as the book is of US origin. Why not send us details of your own design, to give readers the benefit of your experience?

Sulphation

Following up on the letter from Greg Clitheroe (EA March 1988) on the subject of sulphation in lead/acid accumulators, the description given by Greg is basically correct.

A fully-charged battery has a positive plate of lead dioxide and a negative plate of lead, both in finely-divided form. On discharge, the negative plate reacts with the sulphate ions of the sulphuric acid electrolyte to give lead sulphate, whilst the lead dioxide is reduced to lead on the positive plate and water is generated at the same time. When fully discharged, the negative plate is now finely-divided lead sulphate, the positive plate is fine lead and the electrolyte is weaker.

When we re-charge the battery, all this is reversed. We pass a current through the battery and electrolyse the water in the weakened acid, producing hydrogen at the negative plate and oxygen at the positive plate, both in a 'nascent' or very reactive form. The hydrogen reacts with the lead sulphate to produce lead on the plate and more sulphuric acid in the electrolyte. The oxygen re-generates the lead dioxide on the positive plate.

However, if the battery is left in a discharged state for some time, a new problem occurs. Lead sulphate is very slightly soluble in sulphuric acid. It will dissolve and slowly re-crystallise on the negative plate, but this time in large crystals which do not react easily with the hydrogen during the charging process. This re-crystallising is also helped by the normal day-to-day temperature fluctuations, as the lead sulphate is more soluble at higher temperatures. Another problem is the mechanical effect of the growing crystals, which tends to loosen portions of the plate material.

This change from finely-divided lead sulphate to big crystals in a partially or fully discharged battery is the process generally called 'sulphation'.

What can be done about it? Once it has occurred, it is almost irreversible. Certainly any mechanical damage cannot be repaired. A very long, very slow trickle charge may restore a little capacity but this will only put off the evil day for a short time.

Prevention is the only way. Keep the battery fully charged at all times. Even a partly discharged battery will undergo some sulphation. If the battery is to be left unused for a time, regular top-ups of charge or a very small trickle charge is necessary, because internal leakage will gradually discharge the battery, even if it is disconnected. A figure as high as 1% of charge per day has been quoted for this.

As a matter of interest, during WW2 batteries were almost unobtainable and all sorts of things were tried to restore them. I recall an article being published, in 'Radio and Hobbies' I think, which suggested replacing the sulphuric acid electrolyte with sodium solution (Glauber's Salts) and trickel charging. This resulted in sodium hydroxide being

Continued on page 145

Editorial Viewpoint

OK, I was wrong – but accidents do happen!

You wouldn't read about it! Except that you did, of course, and I had written it.

You may have noticed the one page story/advert I wrote recently, explaining why subscribing really benefits readers as well as the magazine (see page 146). Near the end I made the rather rash statement that past problems with deliveries of subscription copies had been fixed. This was based not only on assurances from our distribution people, but on my own experience over the last 8 months or so, getting copies sent to my home as a dummy subscriber. And they certainly *had* been arriving reliably and on time.

I suppose it *was* tempting fate. You can guess what happened (although if you're one of our subscribers, you won't have to guess – you'll *know*, and only too well).

That's right: the very first issue that carried the claim was April, and Murphy's law struck with a vengeance. First there were delays in binding the issue, because it was so fat with the big Rod Irving catalog inside. Then our subscriptions mailing people ran out of the right envelopes, and the subscription copies were held up until new ones could be obtained. The nett result was that pretty well all of our subscribers received their copies much later than usual. It was a disaster!

Needless to say, subscribers old and new were anything but amused by this irony. Some became quite irate, in fact, but I can hardly blame them. I wasn't too amused myself at having been made a liar, and so soon. And as I'd been the one rash enough to make the claim in the first place, it was only fair that people rubbed my nose in it.

So to all of our loyal but justifiably annoyed subscribers, please accept my sincere and abject apologies for the delay in getting your April copy to you.

All I can say is that we've had a thorough post-mortem into how the foulup occurred, and I'm fairly confident that it shouldn't happen again. We'll certainly be working hard to try and make sure it doesn't – that I *can* assure you.

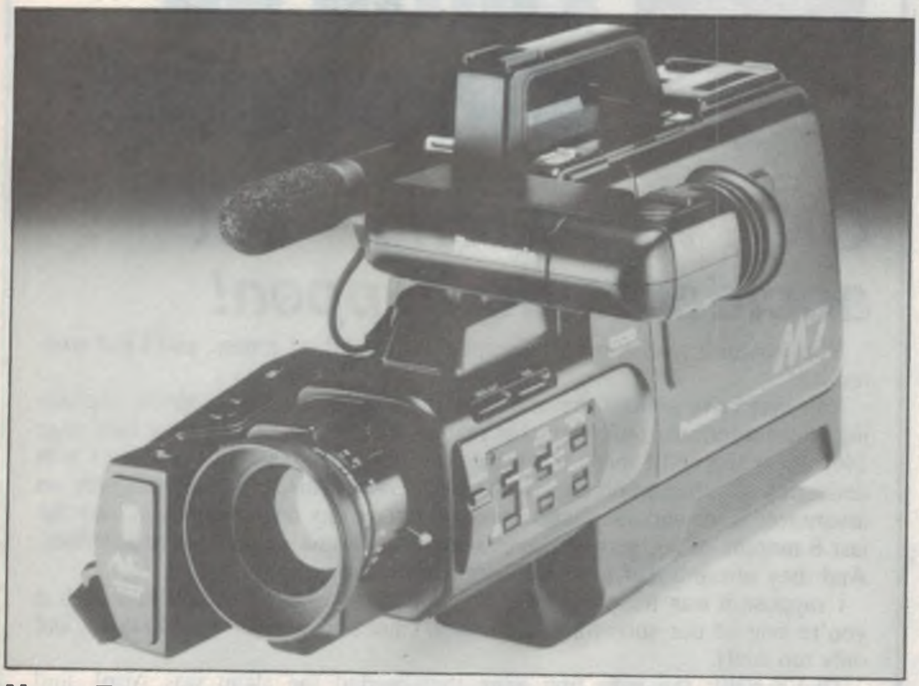
Our subscribers really are the last people we want to upset, because as I explain in my little spiel, subscriptions help us to reduce costs and provide a better magazine. That's why we're making the current offer of a 12-month subscription for only $30, including postage. Despite the April kerfuffle, I really do believe that this is still an excellent offer (and one that we won't be able to maintain for long).

So if you do like what you're seeing in EA nowadays and you appreciate the effort we're putting in to make it even better, please forgive our occasional trespass and instead give us your support, in the most practical way of all: by subscribing.

Jim Rowe

What's New In

Entertainment Electronics



New Panasonic digital VCR, full VHS camcorder

Panasonic has released a new digital VHS video cassette recorder, the NV-D48, featuring the ability to open up a second small area within the playback picture, and watch a normal TV picture simultaneously. Alternatively the machine can store and display up to three still pictures, again within the main picture.

Other features of the NV-D48 include four video heads for very clean slow motion (from 1/25 to 1/5 normal), a digital bar-code programming scanner with LCD display and infra-red coupling to the VCR, cordless remote control and synchro-edit control button for convenient editing. RRP is $1429.

Also just released by Panasonic is the NV-M7A full-size VHS camcorder. This offers a high-resolution CCD image sensor with 10-lux sensitivity, HQ recording for high resolution recording, a flying erase head for the cleanest possible editing and scene transitions, Panasonic's 'Piezo' autofocus system, 6:1 power zoom with F/1.2 aperture, auto date recording and two-step high speed shutter (1/1000, 1/500 sec) for crisp shooting of rapid action.

The NV-M7A also has an optional character generator unit which can add insert/superimpose captions, titles and other alphanumeric data on pictures being recorded. RRP of the basic NV-M7A is $3699.

Both products are available via normal Panasonic stockists.

Agreement reached on 8mm 'hi-band' format

Aiwa, Canon, Fuji Film, Hitachi Maxell, Konica, Matsushita, Sanyo, Sony and TDK have announced that, following technological development in this area, an agreement has been reached on specifications for an 8mm 'Hi-band' VCR recording format.

This format is intended to meet the growing needs for the recording and playback of high-resolution, quality pictures in the 8mm format. It will be offered as an optional format to the current 8mm video format, much in the same way that the PCM audio system is offered as an option.

The new 8mm 'Hi-band' format will be submitted for filing to the Electronic Industries Association of Japan (EIAJ), the body which had been charged with administrating format related issues.

Sony announces ED Beta high-quality picture for PAL

Sony has announced another development of the Beta Format, by introducing ED Beta 625/50 for PAL countries, a PAL/SECAM version of the previously introduced ED Beta (NTSC-525/60).

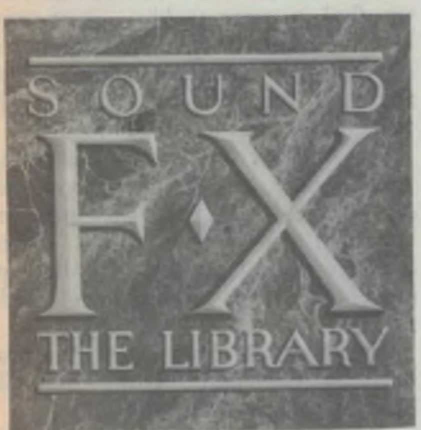
The ED Beta (NTSC-525/60), the first half-inch home use VCR to employ metal particle tape, achieves five hundred lines of horizontal resolution and features a high signal-to-noise ratio through enlarged deviation. The format produces high picture quality with reduced jitter by using a newly-developed tape stabiliser, and improves picture quality after editing by adopting a separate luminance and chrominance (Y/C) input/ouput signal method. In North America and Japan, the ED Beta (NTSC-525/60) has already earned a considerable reputation, especially among the most demanding videophiles.

For PAL countries, the newly-developed ED Beta 625/60 system includes all the features of the ED Beta (NTSC-525/60) described above. It is also compatible with SECAM.

Toshiba introduces new 4″ LCD colour TV

To date, large-screen liquid crystal CTVs have been a rarity, due to the inherent difficulty of manufacturing large-sized liquid crystal display (LCD) panels. However, Toshiba has succeeded in mass-producing 4″ full-colour LCD panels by utilising the company's aggressive R&D activities and long experience in this field. Toshiba's LCD panel incorporates the active-matrix-type LCD, which means that there is a thin film switching transistor (TFT) at each of the picture elements (pixels). The new 4″ screen is composed of 105,600 pixels.

Toshiba has released a new portable colour TV receiver in Japan, the LZ-400D. This utilises a backlight, so that a bright, high-quality and high-contrast image can be realised even in sunny conditions. In addition, the angle of the screen can be freely adjusted from horizontal to vertical position. The new liquid crystal CTV consumes only 4.9 watts and can be powered by AC adaptor, batteries (dry or rechargeable) and car batteries. It weighs only 700 grams.



'Sound FX – the library'

A new series of digitally recorded sound effects is now available as a 25 Compact Disc set. "Sound FX – The Library" comprises thousands of sound effects, many once considered impossible to find, and all produced naturally – not sampled – with the highest digital and recording technologies.

The critical demands of radio, television, film, video and studio production industries for quality and realism have been met with this collection of over 25 hours of sound effects. Utilising the most advanced techniques of digital recording and mastering, it is claimed to supersede the many packages of CD sound effects that contain analog sounds from vinyl disc or that are simply weak electronic samples mimicing real life.

Developed by Valley Recording, this comprehensive library of sound effects is totally new, with all sounds recorded under optimum conditions in 1987. In addition, it is apparently the first sound effects library to embody the technology of O.R.T.F., Stereo-Sphere and M.S. audio advances for precise control of playback parameters. Depth, presence, dimension and stereo imaging can be easily altered. Moreover, the flexibility of this digital format coupled with a number of controlled edit points allow the engineers and producer full latitude and creative freedom in making their own precise effects for the most complex requirements.

It's also claimed to be the only sound effects library in the world with its own comprehensive User's Handbook; not just a catalogue but a creative guide with aural blueprints giving users the ability to alter and adjust sounds for exactly the desired effect.

For further details contact Stuart Livingston of Castle Music in Sydney, (02) 908 0788.

CD Video delayed

The market release of CD Video now seems unlikely until later in the year, according to overseas reports. The reasons for the delay are not clear, but may be due to difficulties in taking both discs and players into full mass production.

To support this, overseas rumours suggested that Philips was shifting all of its CDV player manufacture from Belgium to Japan. However a local Philips spokesman has denied this, pointing out that Philips' intention all along has been to make PAL players at its own plant in Belgium, and NTSC players at the Marantz factory in Japan.

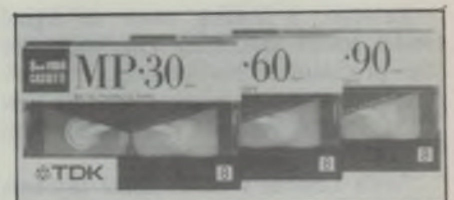
New Fuji GT-11 car audiocassette with 'ZMD'

Fuji has announced the release of a new GT-11 Super Cassette, featuring clear 'wide body' shell and Fuji's special 'Zero Melt Down' capability.

Zero Melt Down is the tag for Fuji's claimed ability for the cassette to withstand in-car temperatures as high as 230° Farenheit, enabling it to keep on reproducing perfectly at temperatures that reduce other cassettes to an expensive blob of useless plastic.

ZMD is claimed to make the Fuji GT-11 cassette range perfect for cars – and for any other high temperature application the Australian climate might throw at it, including outdoor use on Australia's sun-drenched beaches or in the oven-like conditions of the Great Outback.

Fuji GT-11 cassettes are also claimed to be vibration proof.



TDK announces new 8mm videotape

TDK (Australia) has announced a new 8mm video tape lineup, available in 30, 60 and 90 minute playing times and priced at $18.95, $22.95 and $27.95 respectively.

TDK's new MP-8mm video tape uses a pure iron particle of very high purity and density, known as 'Super Finavinx'. These Finavinx particles are evenly dispersed to give what TDK claims to be the highest *BET value (55m2/g) of any tape in consumer use in the world.

TDK claims that a new five layer construction makes the new MP-8mm particularly suited for outdoor and heavy repeated use. The MP-8mm is compatible with all types of 8mm VTR, regardless of different loading or transport mechanisms.

New small TV from Philips

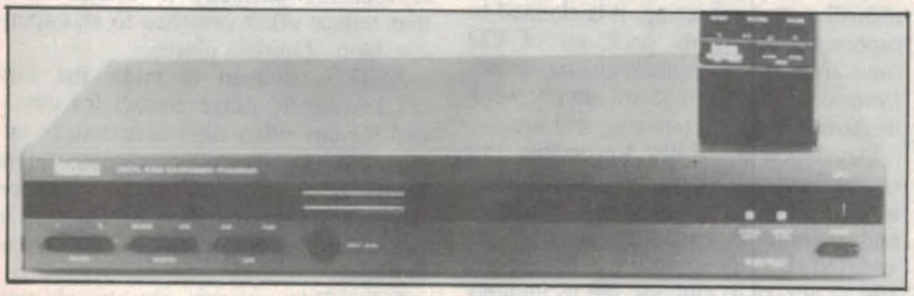
The latest 36cm FSQ (flat square tube) remote control CTV from Philips – the KH3647R – has all the big features of a large screen set packed into a portable TV.

A digital clock is just one of the on-screen displays that the remote control can call up on command while you are watching a program. Even better is its built-in timer, so that the receiver can switch itself on or off – or change to any channel – exactly at your pre-programmed times. In this range the digital clock and the timer are exclusive to this model and, Philips believes unique on the TV market.

The remote control hand set is fully dockable, sitting snugly into the KH3647R cabinet, right beside a foldable headphone set with a long (three metre) cord for private listening – such as for late night viewing.

A personal computer, hifi system or other equipment can be connected to the KH3647R through its RGB and Video/Audio In/Out connectors.

The KH3647R has a recommended retail price of $779.00.



Digital audio environment processor from Lexicon

Lexicon, a leading name in digital audio sound processing equipment for the professional environment, has entered the domestic market with its new CP-1 Digital Audio Environment Processor.

'With Lexicon's CP-1, home listeners will be able to control the home listening environment with the same high quality processing used in the world's top recording studios, using the advanced digital technology until now found only in the professional recording sphere,' says Amber's Karl Seglins.

The CP-1 includes 12 programmes for generating Reverberation, Ambience, Panorama and Surround-Processing. It enhances the home listening experience with a basic stereo system or with up to 6 additional speakers.

The unit processes sound in true stereo – i.e., all sounds are independently digitally processed. This is claimed to provide the most accurate and 'uncoloured' reverb and ambience processing available.

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

Stereo wireless transmitter

Arista Electronics has introduced a stereo audio signal transmitter, Model No.CDA-1.

Slightly larger than a match box, the unit has been designed to allow portable audio equipment such as walkmans, discmans and even TV or videos with a headphone socket to transmit a tuneable FM signal which can be picked up on your hifi or car radio, in the FM band. CDA-1 will send an audio signal over a distance of 15 to 20 metres.

Sophisticated circuitry allows the CDA-1 to transmit both in mono or stereo. Powered by a single AAA size battery with a built in audio signal sensor, the CDA-1 will automatically switch on or off the moment the audio signal is detected, ensuring that there is no unnecessary battery drain.

Further information is available from Arista retailers, or from Arista Electronics, 57 Vore Street, Silverwater 2141 or phone (02) 648 3488.

German power amps

Hertz Electronics of Sydney has released an imported high performance power amplifier series from West Germany, called 'Linear-6'.

Three amplifiers are offered in identical packages, designated Linear-6.1, 6.2 and 6.3.

Hertz has taken advantage of both power MOSFET and bipolar transistors in combination with linear ICs. A jumbo size toroidal power transformer and large electrolytic capacitors interconnected by extremely heavy solid copper bus bars form the power house, which is responsible for the difficulty you find in trying to blow-up or overload the output stage. The amplifier is happy with a 2-ohm loudspeaker load and the 6.2 delivers in excess of 1350 watts into 8 ohms in bridged mode.

The amplifier series has a number of 'user friendly' features like smooth die-cast handles, a display which provides important operational data, circuit breakers instead of fuses, a variety of input and output terminals and mode switches.

Further details from Hertz Electronics, 539 Glenmore Road, Edgecliff 2027, or phone (02) 32 3029.

Improved replacement stylii

Arista Electronics has announced what is claimed to be the first true 'replacement' for original pickup stylii (as opposed to a copy), and featuring a patented 'Carbo' cantilever system.

The new stylii have been developed in Europe and are manufactured by a fully automated production system, claimed to be the first in the world for pickup stylii.

Arista 'Carbo' diamond stylii are based on a one-piece injection moulded carbon compound cantilever, which securely mounts the diamond tip in the correct orientation and alignment. The cantilever uses a triangular cross-section, and is said to be virtually indestructible under all normal use – including backtracking, cueing and disco applications. Pivot rubber compliance is set for optimum tracking at 2 grams.

Further information is available from Arista at 57 Vore Street, Silverwater 2141, or (02) 648 3488.

A pocket full of television?

Miniature and pocket-sized TV sets have been around for a while in black-and-white form, without arousing much interest. Will the new colour models finally tip the scales and put a TV in everyone's pocket – or on everyone's wrist?

by THOMAS E. KING

Above: The Casio TV-800, a 2" colour set which measures only 97.5 x 95 x 80mm and weighs a mere 375g including batteries.

Remember the good old days when the entire family would sit around the living room watching flickering pictures from a television set the size of a refrigerator? TV was certainly a novelty then.

Times have changed or have they? These days while it's difficult to get all the family members together for any reason, let alone an evening of viewing, the novelty of TV is making a big comeback in a small way! But instead of aiming at the stay-at-home crowd, TV makers are appealing to the out-and-about individual with take-anywhere pocket and miniature television sets.

Small screen sets have been with us for a while, but only for the past 18 months have black and white sets small enough to actually fit in the pocket been on sale in Australia. Both styles of mini monitors are currently being sold by Tandy Electronics.

Tandy's 'Portavision-100', measuring in a 210×120×76mm is too large to be considered pocketable but 'it's great for sporting events', boasts the American-based company. Even more portable is its 63mm Liquid Crystal Display black and white set, which also appeals to the sports person with its snap-on backlighting hood for viewing in poor lighting conditions.

Both sets claim Tandy, can also be used by the business person who wants to keep up with world events while travelling – or insomniacs who must while away the hours between midnight and dawn from the comfort of their bed.

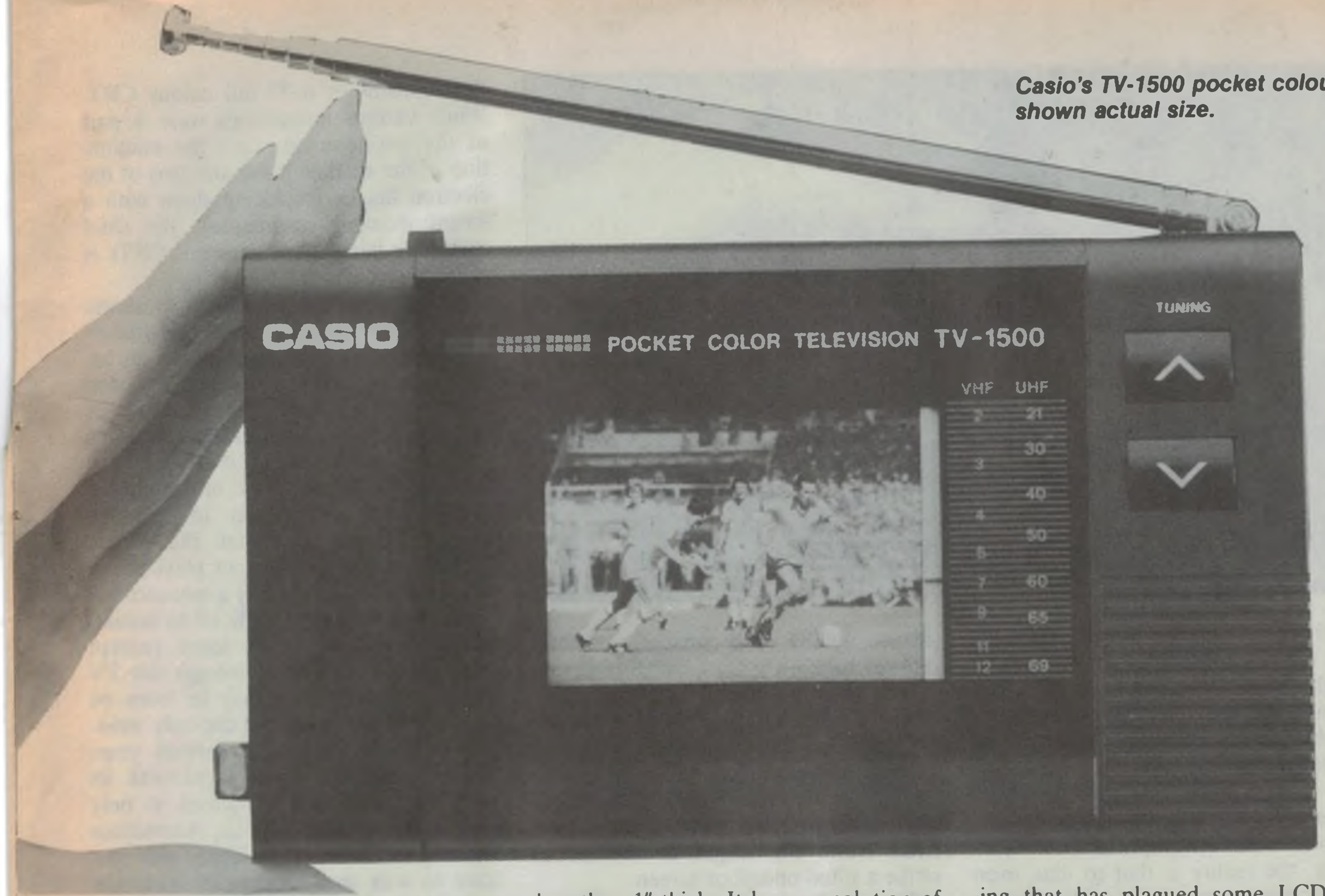
While these uses are also ideal for the five pocket and miniature *Casio* TVs distributed by Mobex, this company's marketing manager Dennis Rigon feels that there is also some novelty value in owning a palm-size colour TV set. Black and white Casio LCD units like the $159 TV-200 began appearing in Australia about 18 months ago, but it was only last October when the company launched its first colour set onto the domestic market. There are now four colour Casio sets available, a selection which reflects the acceptance of this late 20th-century small sized entertainer and informer.

Prices for Casio's small colour LCD sets are not small, though. They range from $519 for the miniature (not pocket size) TV400 to $699 for the TV800, a 375-gram unit with a 2" screen, one-touch auto tune and a fluorescent backlight to compliment its 'HQM' (high quality matrix) high resolution picture.

Casio's pocket sized TV-200 with 2" mono picture, shown almost full size.

The pocket TV market in Australia hasn't always been the domain of Tandy and Casio. For a while Citizen was also selling 2½" black and white sets for around $295. 'Unfortunately,' a spokesman for the company said, 'many people found them just too expensive'.

Citizen is actively selling its colour NTSC sets in the USA and Japan, however. The 2½" pocket colour set is priced around the $US275 mark, while the 3½" pocket colour model sells for about $US400. 'While these two models may at some stage be introduced locally such a decision would only be taken if



Casio's TV-1500 pocket colour TV, shown actual size.

the Australian market considerably broadened,' the spokesman said.

Citizen is but one of the four major suppliers of pocket sets in the USA. Casio is there, of course, but so is Seiko and Panasonic, the company which was first to solve the greatest problem of pocket TVs.

Because of the inherent capabilities and capacities of the liquid crystal display used in mini sets, the lack of picture contrast had been an ongoing problem experienced by most viewers. The picture was there but the contrast ratio wasn't.

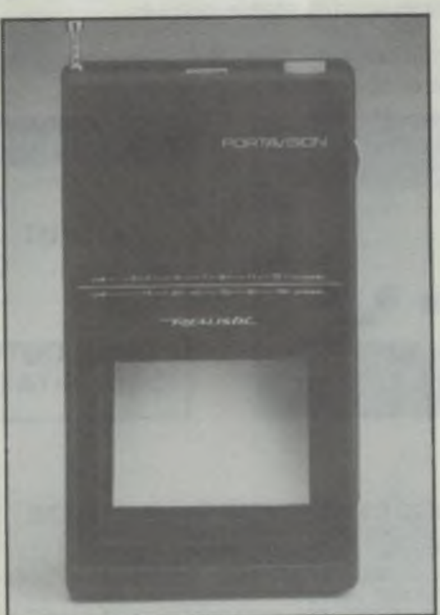
Panasonic took a giant step forward with the adoption of an 'active matrix' means of addressing the LCD: each picture element (pixel) is switched on or off by its own transistor. Active addressing produces considerably higher contrast than is possible with the older 'multiplexed' method, where a pixel is activated by the addition of voltages at the intersection of row and column electrodes.

The first Panasonic sets with the new pixel technology were launched at a major American electronics show in January 1986. Sufficient stocks of the 3" screen size sets were in retail outlets before Christmas 1986 – and it was a very happy new year for Panasonic!

This 3" Panasonic 'Pocket Watch' is less than 1" thick. It has a resolution of 372 by 240 pixels, which is comparable to that of a similiarly priced sized cathode ray tube. Apart from the use of thin-film transistors to achieve better contrast, Panasonic engineers also solved several other problems: colour striping and viewing angle.

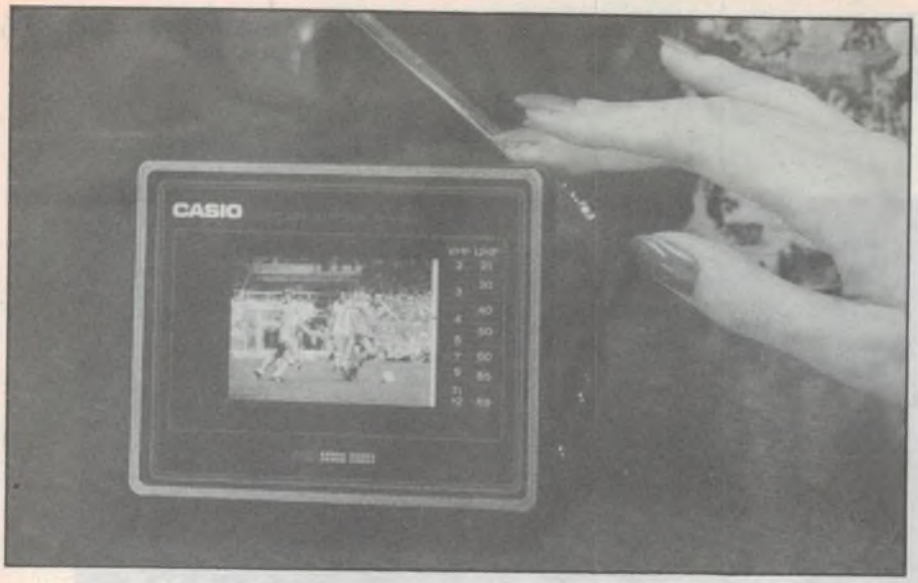
To eliminate perceptible colour striping that has plagued some LCD sets, Panasonic slightly offsets the colour filters in one row from those in the next row. Improved colour accuracy is also claimed, because the three filters form a symmetrical triangle with blue and green filters equidistant from the red.

The Panasonic set is also popular because of its contrast ratio: with the set



The Tandy Portavision 100, which measures 210 x 120 x 76mm – just a little too large for most pockets.

Casio's TV-400, a pocketable 2" colour set weighing only 320g including batteries.



directly in front of the viewer, white appears 50 times lighter than black. Although contrast diminishes as the viewing angle increases, the picture remains viewable through a range of 40° in either horizontal direction and 30° vertically.

Even with ongoing research being carried out to further improve LCD technology, the reality is that to date even the best liquid crystal TV still lacks the picture quality of a conventional cathode-ray tube.

Sony pioneered technology which continues to be the biggest rival to the LCD set: the flat CRT which is used in its 'Watchman' models. (This set is similar in size to the Tandy Portavision-100). The principle here is that electrons travel the length of the set to strike a tilted phosphor screen.

Sanyo refined this technique with the development of a 3" full colour CRT. While various innovations were a part of the development, i.e., the elimination of the shadow mask and two of the electron beams (replacing them with a 'beam indexing' technique), the chief stumbling block of ultra small CRTs is still low resolution.

As development hopefully continues to solve that problem more 'user-friendly' features are available such as an external aerial socket for the much needed signal grabbing capability of a proper antenna over the usual short telescoping one. As well, several miniature and pocket TVs already have an input that allows direct connection to a video source. In one application the pocket TV can provide on-the-spot playback of video footage just shot by a camcorder.

Although it may be difficult to miniaturise camcorders much more (except perhaps with LCD technology) the TV monitor of the future may be worn on the wrist. Seiko launched the only wristwatch TV in the world several years ago. But as the sub-tiny set with its NTSC circuitry and 1" screen is only sold in the USA and Japan, Australians wanting to imitate Dick Tracy may just have to wait until *Electronics Australia* dreams up a suitable circuit!

THIS SCREEN CAN TELL YOU AS MUCH ABOUT THE IC-781 AS WE CAN.

The huge CRT display on this new HF transceiver will show at a glance all the functions we're about to describe here.

That's because it has a built in spectra scope for the first time, for programmable, multi-functional central monitoring.

Plus there's a VFO, A/B contents, memory contents, two menu screens, band scope, and 15 operational screens.

It also has a sub display, and its DDS system offers a lock-up time of just five milliseconds. So it's ideal for data communications systems like PACKET and AMTOR.

The dual watch function is a huge advantage on DX-peditions or when chasing DX-stations. And its computer-controlled twin PBT with high efficiency IF filter eliminates interference.

Maximum frequency stability is achieved at ±15 Hz (0-50°C), which is more efficient than other transceivers on the market.

Also, the delay control noise blanker system is adjustable by up to 15 milliseconds.

There's a full and semi break-in function that can output up to 100 words per minute. And a p.a. unit that outputs 150W of power.

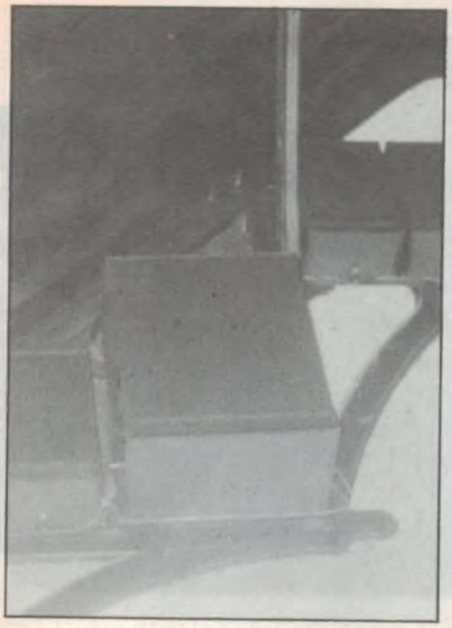
However, just because the IC-781 has so many state-of-the-art features, don't think ICOM haven't made it simple to use.

There is a built in 10-keyboard for easy operation. Or you can use the built in remote control communication interface-V system.

This lets you control your transceiver via a personal computer or other compatible equipment. Plus you have a 2 way sleep timer, and 5 separate automatic weekly timers.

For your nearest ICOM stockist, just call (008) 33 8915. And they'll tell you everything you need to know about the IC-781. Then once you've got one, the CRT display will tell you everything you need to know about what it's doing.

ICOM



Using technology to produce

A 'pipe organ' without pipes

Can an electronic organ really sound like a traditional pipe organ? Yes, it can – if the right techniques are used. A new instrument commissioned in Camden, NSW illustrates just what can be achieved.

by WINSTON T. MUSCIO

'Where are the pipes?'. This is the question asked by most people upon hearing for the first time the new Johannus organ in St. John's Anglican Church at Camden, NSW. The superb sound is such as might be expected from a very large and expensive pipe organ installation. However, in the absence of pipes, the listener is forced to the conclusion that such majestic performance is being provided entirely by electronic means. At the same time, all previously-formed impressions of electronic organs are immediately challenged.

The St. John's installation is indeed a most impressive 'pipe-less' pipe organ. In all probability, it is the fourth largest instrument in NSW, exceeded only the organ at the Opera House, the Sydney Town Hall and St. Andrew's Cathedral. Some of the major factors involved in producing such outstanding performance in a relatively inexpensive manner are outlined in this article.

The console of the organ was custom-built by the Johannus organisation in The Netherlands, in accordance with the characteristics specified by David Johnson, the organist at St. John's. The Johannus model upon which it is based is the Opus 540.

The organ has a three-manual keyboard with radiating and concave pedalboard, built to specifications observed by the American Guild of Organists and the Royal College of Organists (AGO/RCO). There are 66 drawstops, set in two jambs at 45 degrees to the manuals. The drawstops control the 57 different voices of the organ, the six inter-manual and pedal couplers and the three tremulants. There is a total of 73 ranks, making the organ equivalent to a pipe organ with some 3989 pipes, plus a carillion.

Tone generation

This type of instrument uses a multi-generator system, with eight separate groups of independent tone generators constantly employed to produce the basic tones required. In this way, a total of 96 individual harmonic-rich tones are generated simultaneously, thus allowing the production of all the harmonics and sub-harmonics required for the synthesis of authentic organ tone. This system also allows for the necessary phase-shifts, transients and formants to be produced for creating the true 'out-of-tuneness' associated with celeste stops and mixtures and the type of speech attack impurities peculiar to a pipe-organ.

The ability to produce controlled phase-shifts allows the production of another pipe organ characteristic to occur. When listening to a pipe organ, the sound appears to come in 'waves' or surges. In a true pipe organ, this is due to minute discrepancies in tuning between the pipes, coupled with the nature of the air movement created by a pipe organ. Simulation of this effect is facilitated by the multi-generator system.

Keying

The organ is operated by spring-loaded gold-plated contacts activated by each key or foot pedal. Associated with this key or foot pedal action, as appropriate stops are drawn, the control circuitry thus energised selects the required fundamental or derivatives from the appropriate tone generators via the necessary filtering and makes the output available at a low-level terminal of the organ console. When multiple-rank stops are involved, the multi-generator system is particularly helpful as it allows the production of a number of different sounds simultaneously, rather than just a single synthesised sound. In this respect, the organ is truly additive. As each stop is introduced, a new sound is actually added to the palette.

The production and combination of tones in this way allows all of the imperfections normally created in pipe organ sound to be present, resulting in a warmer and truer sound than is possible with the more conventional type of electronic organ. When 'voicing' the organ, each stop is capable of being individually balanced to suit the acoustics of the building, by means of adjustable potentiometers within the console.

Accessories

In addition to the three manuals, foot pedals and drawstops, the organ has other accessories which enhance its capabilities. There are six pre-set thumb pistons, giving combinations from PF to Tutti. There is also a 'general cancel' piston and a 'reeds off' piston. In addition, there are eight general pistons operated on a capture-action principle, plus three memory pistons.

The piston action of the organ is controlled by a digital computer with non-volatile memories. The three memory pistons allow the organist to assign three different combinations to each of the eight capture-action pistons, thus making 24 variable combinations immediately available at will. The eight variable pistons are duplicated by toe studs, as is the Tutti piston. The Tutti toe stud is double-acting and, when switched on, a red warning LED provides a reminder to the organist.

There are three swell pedals; one for the Choir, one for the Great and Pedals and one for the Swell. In addition, there is a a crescendo pedal which progressively adds stops until full organ is reached as it is depressed by the foot. The degree of opening of the pedal is indicated by a series of green LEDs which light sequentially as the pedal is depressed. The crescendo pedal can be stopped at any degree of opening. As it is returned to its closed position, stops are gradually withdrawn until the combination set by the organist, either before the use or during the use of the crescendo pedal, is reached. The list of stops available is set out in Appendix 1.

Production of sound

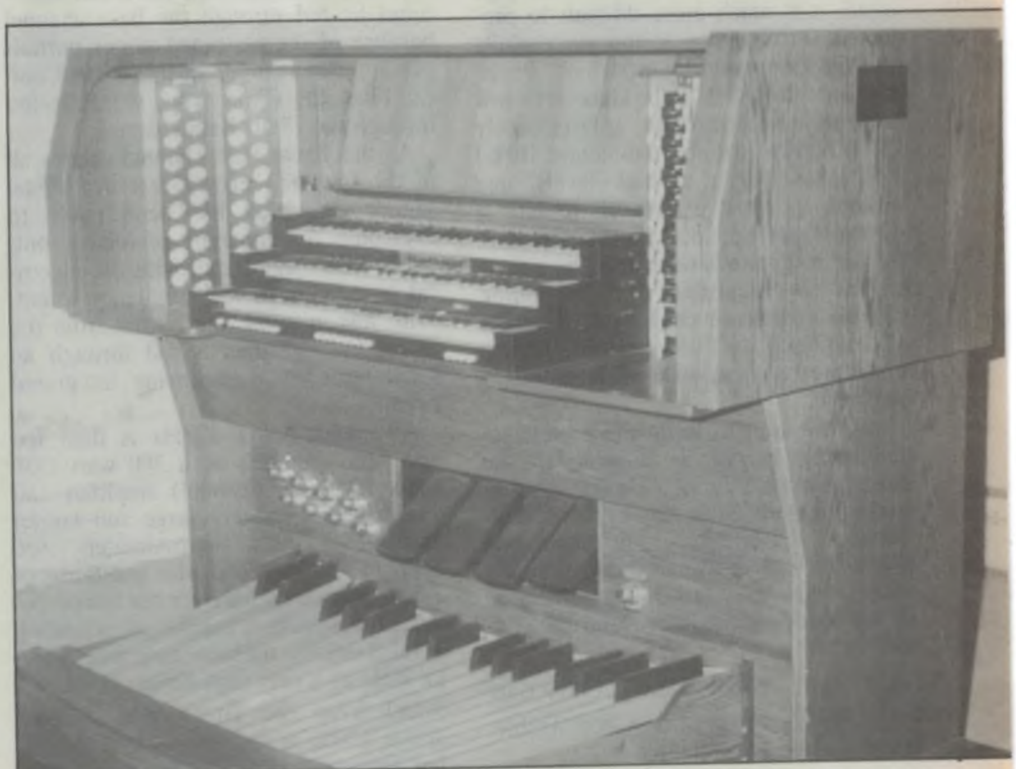
A pipe organ sounds as it does, not only because of the harmonics, transients, formants, etc, in its sounds and the additive effect of those sounds, but also because of two other factors. These comprise the extreme clarity of each sound, produced virtually without distortion, and the ability of the organ to set in motion large volumes of air.

In a pipe organ lower frequency sounds are produced very efficiently because of the inherent resonant nature of the larger pipes and the air movement they create. However, in ascending through a rank of pipes, it is necessary to enlarge the scale of the pipes to maintain a balanced sound; otherwise, the higher frequency pipes, if left in the same scaling ratio as their bass counterparts, would sound weak by comparison.

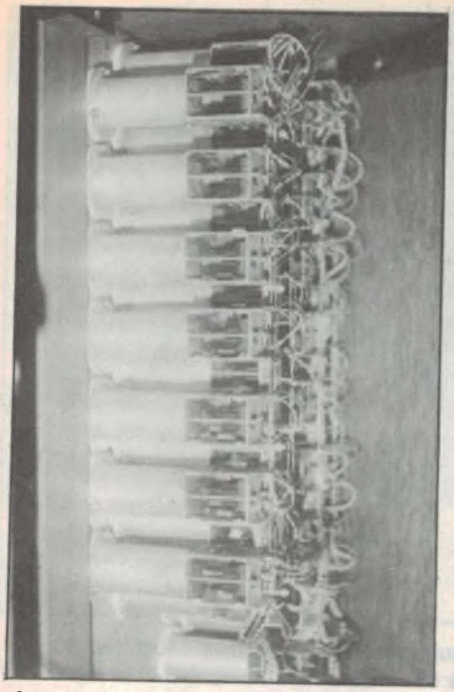
One of the predominant features of a large pipe organ is that the listener tends to 'feel' the very low frequency sounds rather than hear them. Frequently, the strong, slow pulsations produced by the larger pipes set the building and/or furnishings vibrating in sympathy. In the same way, a listener within the building will sense the vibrations physically. This is one of the characteristics which traditionally endow the pipe organ with its majesty and power.

Above and opposite are views of the loudspeaker enclosures, mounted high up in the church. The largest boxes are 650 litres.

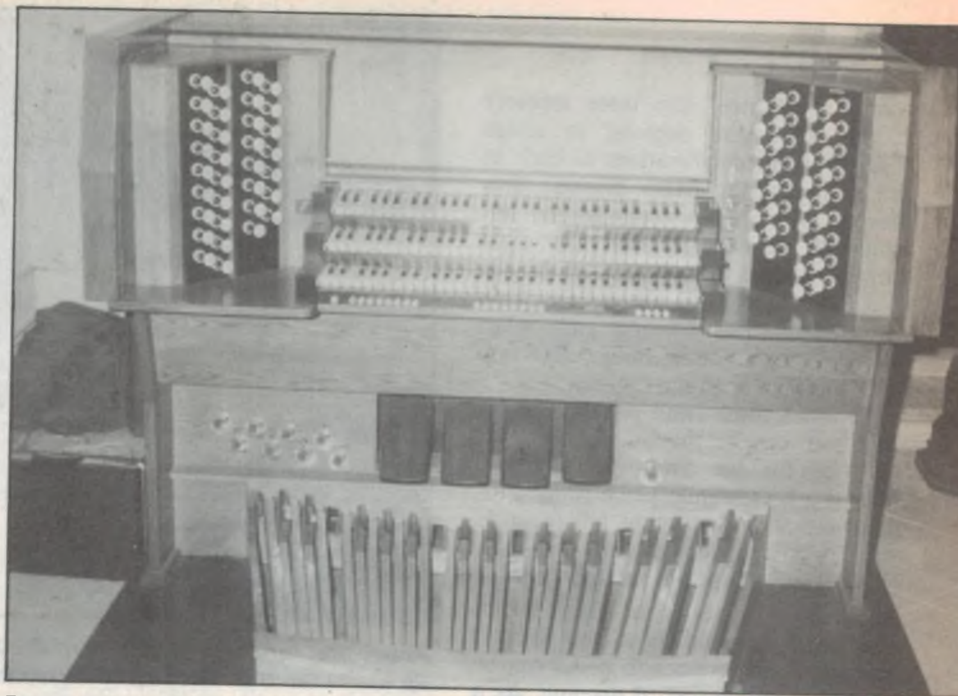
When setting out to produce the same characteristics by using audio frequency amplifiers and loudspeakers, the problems encountered are quite different. The loudspeakers must have ample power handling capability, so that distortion will not arise from that source at the maximum sound levels required. Furthermore, they must not add any appreciable colouration to the sound, so that the tones produced within the console will be propagated accurately into the building. The amplifiers must have a substantially uniform response over the entire frequency range and have adequate power in reserve so that overloading does not occur at the highest output



A view of the organ console, custom built by Johannus in The Netherlands. There are 66 drawstops and 19 thumb pistons, 8 of the latter being used for the 24-memory combination capture action.



A rear view of one of the two drawstop jambs.



Front view of the console, showing the three manuals and 32-note radiating concave AGO/RCO pedalboard, swell pedals and toe pistons.

levels envisaged for the installation. In summary, all amplifiers and loudspeakers must be as free as possible from all forms of distortion. The installation should convey the feeling that, as with the pipe organ, the sound power is produced without effort.

In contrast with the conventional pipe organ, it is much more difficult to produce low frequency sound successfully with amplifiers and loudspeakers. Provision must be made to produce very low frequency sound (from approximately 128Hz down to approximately 16Hz) with great clarity at high levels, and without appreciable 'roll-off' to give a balanced performance in the building. Sufficient air movement must be generated at low frequencies to set in motion the entire cubic air capacity of the nave of the church. In the case of St. John's, a volume of some 4000 cubic metres is involved.

In setting out to fulfill these basic requirements as far as possible in the most efficient manner, David Johnson conferred with Nick Kaye of the Australian loudspeaker manufacturer, Etone Pty Ltd. Between them, they devised a suitable system for amplification of the sounds generated within the console.

Great Bass	Swell Base	Choir Bass
Great Mid	Swell Mid	Choir Treble
Great Treble	Swell Treble	

All sounds from the Great and Pedal organs come through the Great Channels. Certain stops with low frequency fundamentals will sometimes be fed through a treble or mid-range channel, simply because that stop is rich in upper harmonics of high amplitude. an example of this is the Violon 16ft Pedal stop, which is fed through the Great Mid channel. Conversely, a stop with quite high fundamental frequencies will sometimes be fed through the base channel because of the restricted upper partials present. An example of this is the Conical Flute 2ft Choir stop, which is fed through the Choir Bass channel.

As the Great Bass channel carries all of the low frequency Great and Pedal sounds, provision has been made to overcome the inherent problems, outlined above, associated with the electrical production of low frequency sound. With this in mind, the output from the Great Bass channel is fed through an active cross-over employing integrated circuitry.

All sound below 128Hz is then fed into both channels of a 700 watt (350 watts RMS per channel) amplifier and thence into two very large sub-woofer enclosures, each approximately *650 litres* in volume. With the assistance of a little base boosting over the lowest octave, this system is capable of providing a substantially uniform response down to 16Hz at a very high output level. All sound from the Great Bass channel above 128Hz is fed into another amplifier channel and loudspeaker enclosure as described in subsequent paragraphs.

Each of the eight organ channels, including the Great Bass channel above 128Hz, is passed through a separate 12-band graphic equaliser (a total of 96 bands in all) before being fed to the appropriate amplifiers. Thus, as well as each stop being able to be balanced on site, each channel as a whole can be balanced to suit the acoustics of the building.

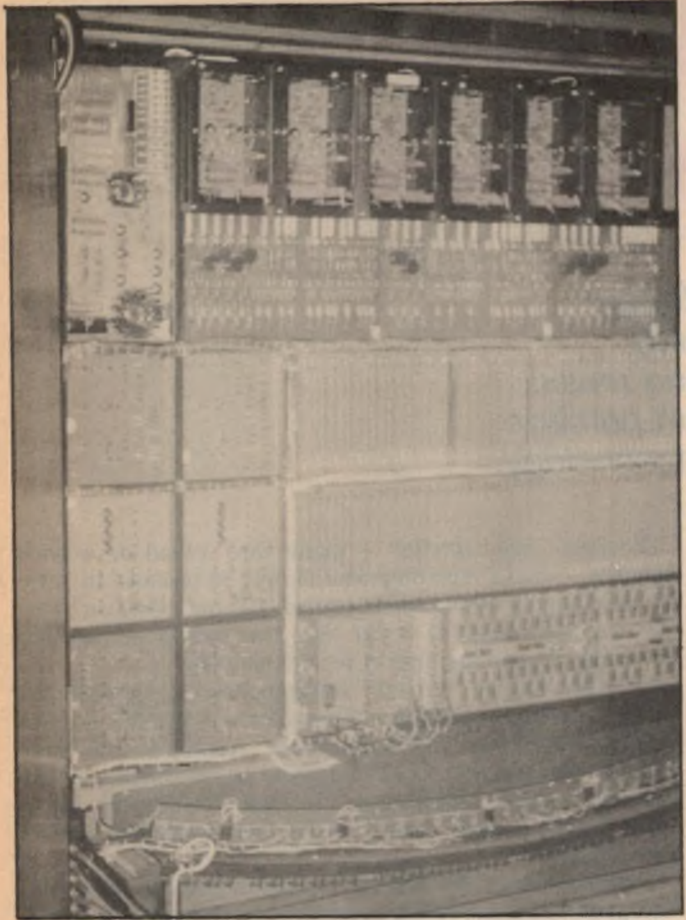
Amplifiers

All amplifiers used in the St. John's installation are WB professional types. There are four stereo amplifiers, each capable of delivering 150 watts RMS per channel, thus providing the eight channels the organ requires. Also, as discussed above, there is one large stereo amplifier delivering 350 watts RMS per channel to the two sub-woofer enclosures. Thus, the total audio frequency power available to reproduce the output from the organ console is 1900 watts RMS.

With this amount of power available to drive an efficient loudspeaker system, the organ is capable of producing more than adequate sound levels within the building with all amplifiers operating well below 'clipping' level.

Loudspeaker

There is a total of 10 loudspeaker assemblies, all designed as vented enclosures based on Thiele-Small parameters. Of these, three are bass enclosures, two are mid-range and three are treble enclosures. In addition to these there are of course the two sub-woofer enclosures discussed above.



Inside the console, showing the PCB array used for the eight separate groups of independent tone generators, stop filtering and keying.

Appendix 1: List of organ stops

PEDAL

Double Bass	16 ft
Violon	16
Subbass	16
Principal	8
Violon	8
Cedackt	8
Octave	4
Mixture	5 ranks
Bombarde	32
Contra Trumpet	16
Trumpet	8
Trumpet	4
Choir to Pedal	
Swell to Pedal	
Great to Pedal	

GREAT

Principal	16
Principal	8
Gamba	8
Stopped Flute	8
Octave	4
Open Flute	4
Twelfth	2⅔
Octave	2
Cornet	4 ranks
Terzian	2 ranks
Mixture	5 ranks
Trumpet	16
Trumpet	8
Clarion	4
Carillion	
Tremulant	
Choir to Great	
Swell to Great	

SWELL

Bourdon	16 ft
Principal	8
Salicional	8
Celeste	8
Rohrflote	8
Octave	4
Geigen Principal	4
Kopple Flote	4
Nazard	2⅔
Waldflote	2
Sesquialtera	2 ranks
Rauschpfeife	3 ranks
Fagotto	16
Cromorne	8
Vox Humana	8
Oboe	4
Schalmei	
Tremulant	

CHOIR

Quintaton	16
Diapason	8
Stopped Flute	8
Octave	4
Flute	4
Twelfth	2⅔
Octave	2
Conical Flute	2
Tierce	1⅗
Nazard	1⅓
Octave	1
Scharf	2 ranks
Clarinet	8
Tremulant	
Swell to Choir	

Bass Enclosures: Each of these contains one Etone Type 805 380mm woofer. This unit features a 100mm diameter voice coil, operating in a flux density of 15,000 gauss produced by a 9.5Kg field magnet. Its cone resonance in free air is 30Hz, and it can handle an input power of 250 watts. This low frequency unit is supplemented by an H1200 horn equipped with an Emilar 4660 driver. The response of this combination is substantially uniform from 32 to 12,000Hz.

Mid Range Enclosures: Each of these contains one Etone Type 805 woofer and one H1000 horn and Emilar BK175 driver. This combination covers the range 32 to 18,000Hz.

Treble Enclosures: Each of these contains one Etone Type 805 woofer, one H1000 horn with BK175 driver and two Motorola Type 1083 piezo-ceramic tweeters. The response of this group extends from 32 to 40,000Hz.

Each of the Bass, Mid-range and Treble enclosures contains a passive cross-over from the woofer to the horn driver at the appropriate frequency. All of these enclosures are capable of handling individually an input of 250 watts RMS.

Sub-Woofer Enclosures: Each of these contains four Etone Type 518 300mm units with 39mm voice coils and foam surrounds. This type of loudspeaker has a 2kg field magnet producing a flux density of 12,000 gauss. Its free-air resonance occurs at 30Hz and its power-handling capacity is 100 watts RMS, thus permitting a total input to the assembly of four such units in each 650 litre enclosure of 400 watts RMS. The frequency response of these units extends from 16 to nearly 4000Hz.

Summary

The St. John's Church 'pipe-less' pipe organ is a large instrument built along classical lines, but with an electric capability because of its battery of swell reeds, its strings and the English voicing of the lower stops on the Choir coupled with the brilliance of the mutations and mixtures (particularly on the Choir manual). It is capable of handling classical organ literature from all of the main schools as well as providing superb accompaniment facilities for full congregations, choirs or groups of instruments.

The Great reeds are capable of acting as a Bombards chorus and are particularly striking when used with the Great mixture. The Great and Swell flutes 'chiff'; the Choir flutes do not.

The overall installation and its adjustment have been carried out in such a way that the organ can be used at full power without giving the listener any indication that it is not a conventional pipe organ of outstanding capacity and performance. The softest and most delicate combinations convey the same impression. It is a mighty fine instrument, and needs to be heard in order to gain a full appreciation of just what musical excellence can be achieved economically by electronic means.

Acknowledgements

The author wishes to acknowledge that the description of musical aspects of the organ was derived principally from notes provided by and discussions with the organist, David Johnson. Thanks are also due to Nick Kay of Etone, regarding some aspects of the loudspeakers and enclosures used in the installation.

The colourful history of magnetic recording

Just think what the world would be like today without magnetic recording, which certainly revolutionised the recording of sounds and music. Here's the story of how it developed, from primitive early machines to today's sophisticated technology.

by DR. FUKUZO ITOH*

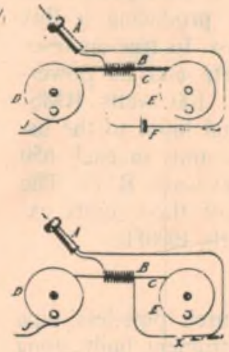
**Dr Itoh is General Manager Engineering, Magnetic Tape Division of TDK Corporation in Japan.*

In 1944, Allied intelligence was confused. Hitler's voice could be heard day and night from radio stations all over Germany, and broadcasts of the Berlin Philharmonic Orchestra were airing in London in the wee hours. The US Army Signal Corps' Jack Mullin (who would contribute to tape recorder development after the war) was puzzled. Sure, Hitler was a dictator, but even he wouldn't force the Berlin Symphony to tune up at 3.00 am. Could it be that Germany had developed an all-new recording system? No one would learn the truth until after the Allied victory, since German magnetic recording technology was shrouded in (state) secrecy.

In fact, by 1941 a console-type AC bias tape recorder (the Magnetophon) was standard at all German radio stations. Hitler kept a portable close at hand to record speeches.

Today, 53 years have passed since production began on the first practical recording tape. But the groundwork for this achievement began some five decades earlier.

Valdemar Poulsen (1869-1942)



Circuitry diagram found in Oberlin Smith's paper in The Electric World magazine

Poulsen's Telegraphone is born

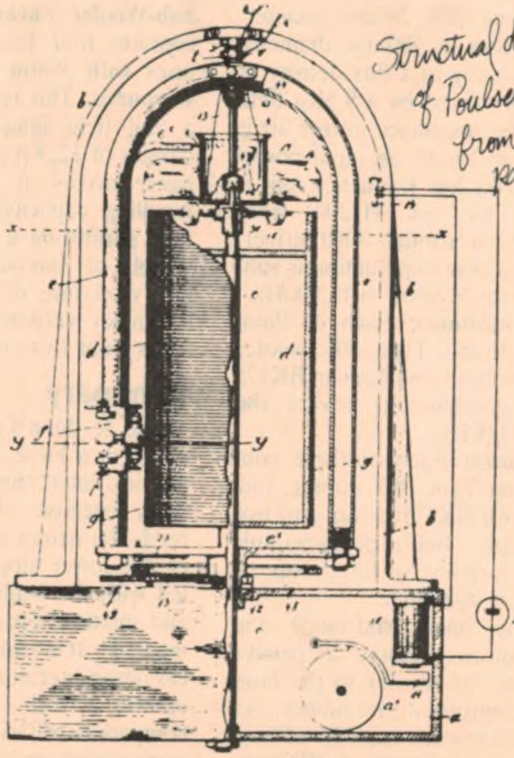
In 1898, Danish technician Valdemar Poulsen (1869-1942) developed the first magnetic recording machine based on the decade-old ideas of an American, Oberlin Smith.

Smith had proposed that a cotton or silk tape with steel dust embedded in its surface could magnetically record sound frequencies turned into audio currents, by a microphone. "Young lovers could record voice messages on the magnetic material, wind it on a small reel, and then send the messages to their sweethearts." said Smith.

Poulsen's first recorder — piano wire wound on a brass cylinder — had a recording time of only 30 seconds. In 1899, he developed a device which carried 0.01-inch steel wire past the recording head at better than two metres per second, achieving a recording time of several minutes.

In 1900, Poulsen took his "Telegraphone" to the Paris Exhibition, where it captured a Grand Prix — and the voice of Kaiser Franz Josef of Austria (the recording still exists today). *The Electric World* magazine heaped praise on the recorder's sound reproduction. In truth though, the voices were barely audible against a din that resembled buzzing mosquitoes.

Poulsen crossed the Atlantic in 1903 to form the American Telegraphone Company. Commercial production of his portable magnetic tape recorders (patented in 1907) failed, and the company folded. When Poulsen sold his patent rights and



Structural diagram of Poulsen's Telegraphone, from U.S. patent records.

turned to other forms of electrical research, it set back development of magnetic recording by almost 20 years.

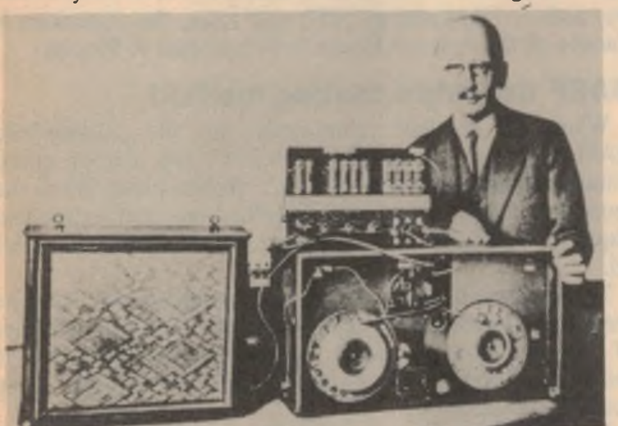
Until 1927, in fact. That's when machine technician Fritz Pfleumer, who had developed a material to replace the gold used on cigarette tips, hit on the idea of using cigarette gilding technology to develop inexpensive magnetic recording tape.

Pfleumer's golden opportunity

Pfleumer's first effort, in 1928, was a cellulose plastic film base coated with carbonyl iron powder. The rolled recording tape was 40 microns thick and 300 metres long, with 20 minutes of recording time. Production costs were low, but the coating tended to shed during testing and the sound quality was marred by noise, wow and flutter.

Pfleumer took his Sound Paper Machine to AEG, a major electrical equipment manufacturer. Quality considerations made the company balk, but AEG finally purchased Pfleumer's patent in 1932. AEG engineers knew that it would take major advances in chemical technology to make this method work. So, AEG Chairman Herman Bucher contacted his friend Carl Bosch, Chairman of E.G. Farben Chemical of Frankfurt, and the two companies pledged to undertake the project together. Finally, the wheel of tape recording history was beginning to pick up speed.

Hermann Bucher was also good friends with Wilhelm Guas, a physical chemist at BASF, which like Agfa was a subsidiary of I.G. Farben. In fact the two had a good working relationship. After a series of joint experiments on carbonyl iron powder recording tape in Ludwigshafen during 1932-34, the first practical commercial recording tape was tested for production.



Fritz Pfleumer with his Sound Paper Machine of 1928.

Originally, I.G. Farben/BASF had planned to produce recording tape solely for voice use. So when AEG produced a tape recorder in 1934, it ran at a speed of 1 metre/second and had a frequency range of up to 3kHz for recording and reproduction. That may have been good enough for recording speech, but even so, the sound quality needed work.

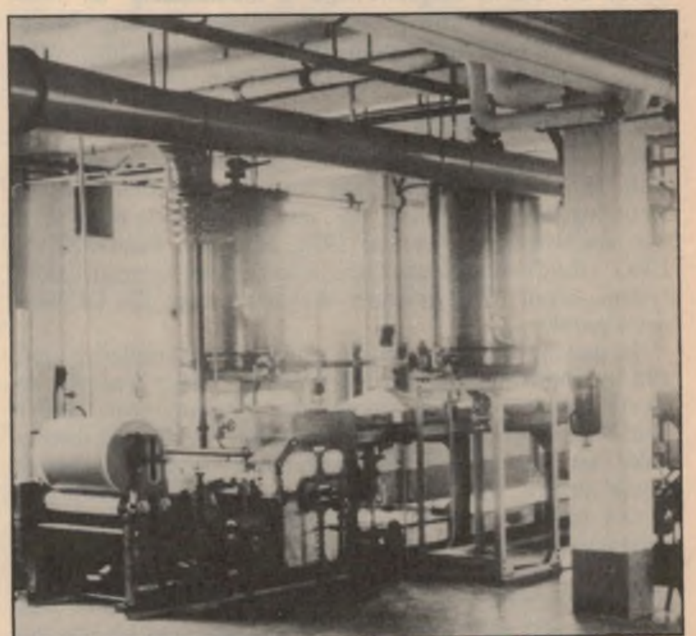
After consulting with AEG. BASF came up with a stronger tape with better electrical properties, which it called I.G. Farben Carbonyl Tape. Jusifiably proud, AEG eagerly prepared for the 1934 Berlin Radio Exhibition, comparing the quality of the new "Magnetophon" to that of disc recordings. Unfortunately a hitch with the tape's rewind mechanism meant production had to be stopped just one week before the exhibition. At the last minute, it was forced to pull out of the exhibition.

But the undefeated AEG engineers revised the tape recorder in October that year, and by the following summer, they were ready in plenty of time for the next Radio Exhibition, in August 1935. This time, the Magnetophon was a roaring success. One of the project members, Friedrich Matthias, said, "Dealers and the public literally stormed the demonstration room, so that we were forced to close the door temporarily." Within a few hours, the first eight recorders were sold. The tape recorder was on its way.

After a series of experiments in 1932, BASF was able to develop the first coated recording tape.

In August 1935, W. Gaus of BASF wrote a letter to his friend H. Bucher, suggesting that they might be able to extend recording time by reducing the tape speed from 1m/sec to 30-50cm/sec. He also proposed extending the upper frequency range to 8-9kHz, by reducing the diameter of the magnetic particles from 3-5um to 1um. This would permit the recording of music as well as voice.

The only problem was that carbonyl iron powder couldn't be produced that finely. Instead, he suggested, why not use a magnetic ferric oxide? This was magnetite, a black ferric oxide. Erwin Lehler of I.G. Farben had already proposed magnetite in 1934, but no one had listened to him at the time. I.G. Farben was already producing magnetite as a non-soluble electrode for electrolysis, and when they tried it for recording tape in 1936, the improvement was obvious. W. Gaus authorised its use, producing a vastly superior recording tape.



The first magnetic tape production plant, at BASF in Germany (1936).

Magnetic Recording

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

Recording the London Symphonic Orchestra

The new tape underwent a dramatic test when the London Symphonic Orchestra, conducted by Sir Thomas Beecham, was invited to play at BASF's own concert hall, where a recording was made. After the performance, Sir Thomas listened to the recording and was impressed, but not impressed enough to try it again soon. (He didn't attempt another tape recording until 1950.)

Another landmark event occurred in 1938, when the German Broadcast System (Deutsche Rundfunk) gave the go-ahead for use of magnetic tape in broadcasting. By 1939, BASF was ready with a tape of broadcast quality. Meanwhile, BASF and AFG jointly created a magnetophon company, with first sales of the tape recorder in 1936.

Weber discovers AC bias

Excess noise was still a problem, but help was on the way, with the discovery of AC bias recording. At this time, all recording was done on DC bias, and the resulting noise level was unsatisfactory. Then in 1938, H.J. von Brammuhl of RRG (Reichs-Rundfunk Gesellschaft), the German radio system, asked RRG engineer Weber so solve the DC bias noise problem.

By moving the noise phase 180°, which cancelled it out, and by improving the SN ratio by 3dB, Weber was able to create a noise reduction circuit. The following year, Weber tried recording voices as if they were sine waves, and discovered that high frequency characteristics produced a better sound quality, with reduced noise and harmonic distortion Weber had discovered the AC bias recording method, and perfected the method by the summer of 1940.

Weber was not alone. In the US and Japan, several independent researchers were conducting research into AC bias recording and each took out a patent, believing he was the first to discover it. They included Americans W.L. Carlson and T.W. Carpenter in 1928; Japan's T. Igarashi, M. Ishikawa, and T. Okuyama in 1937; and later, the American M. Camras of the Armour Research Foundation in Chicago.

BASF develops casting method

When an accident temporarily put the Ludwigshafen BASF plant out of commission in 1943, I.G. Farben quickly transferred all production to Agfa's Wolfen plant. When they reopened, it was with a new, simplified tape production technique developed by Karl Pfleumer, called the casting method.

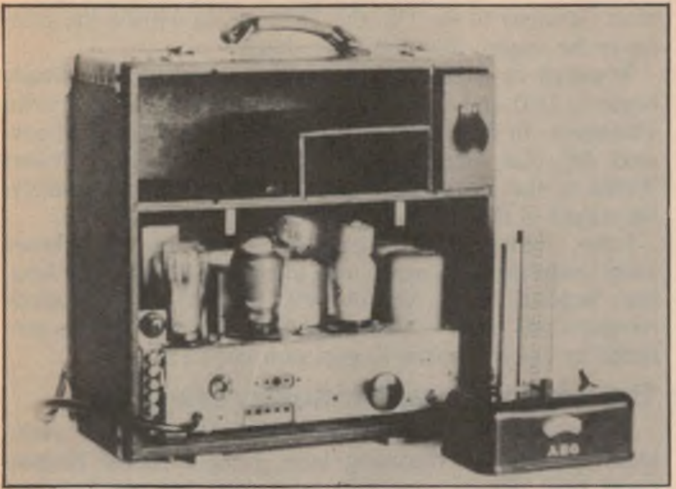
This method blended all the tape materials into one layer, creating a homogeneous or refined tape. Because both sides of the tape were the same, either side could be used for recording. Besides being stronger, it was not as hard on tape heads as coated tape.

Unfortunately, the new tape suffered loss of electrical performance, and was too thin to be practical for mechanical operation. BASF went back to coated tape in 1950.

Recording tape had now gone through three stages. Type C, the earliest tape, had two layers — a magnetic ferric oxide layer laid on an acetyl cellulose film base, using the casting method. Then came Type L, a one-layer tape of polyvinyl chloride film called Luvitherm. and finally, Type G: consisting of two layers, produced in the spring of 1945 in Germany.

Both mass production of tape and recording technology had made great strides under BASF and AEG, a fact which did not escape the notice of the Allied Occupation armies, who issued their first report on the Magnetophon in 1945. The PB Report, as it was called, referred to the BASF tape (played on an AEG Magnetophon) as having "excellent sound and very low noise." The next step in tape development would come in the United States.

As early as 1936, AEG had secretly demonstrated the Magnetophon K2 model for General Electric in the United States. But the K2 still used DC bias recording, and its sound quality was inferior to that of 78rpm disks, so GE wasn't interested.



AEG's amplifier and microphone for its K2 recorder of 1936 — portable, but not exactly lightweight!

Then when German engineer Walter Weber of the Reichs-Rundfunk Gesellschaft discovered the superior AC bias recording method, Germany made it a state secret. Cut off from German recording know-how during World War II, Americans continued their own work in recording development, concentrating on the magnetic wire recorder.

One of them was S.J. Begun, founder of the Brush Company. In 1944, he asked 3M (Minnesota Mining and Manufacturing) to develop a thin recording tape coated with ferric oxide. Two years later, Brush came out with America's first experimental tape recorders, the "Soundmirror".

Meanwhile in Europe in 1944-45, US army personnel discovered quantities of the new Type L tape, a one-layer polyvinyl chloride film called "Luvitherm". At the same time, Allied Intelligence discovered Magnetophons in use in radio stations all over Germany. A young member of the US Signal Corps, J. Herbert Orr, visited the BASF plant at Wald Michelbach, and obtained tape samples there. After returning to his Alabama home, he assembled a Magnetophon using components he had brought home with him from Germany, and went on to conduct demonstrations at radio stations along the East Coast. Later, he founded Orradio Industries, and produced both the Orr tape and the Irish tape.

Another Allied soldier impressed by the sound quality of BASF tape was J. Mullin, who listened to it on an AEG Magnetophon at the Frankfurt radio station. He sent components for two Magnetophon machines and 50 rolls of BASF tape to his San Francisco home. On his return to the US he conducted several demonstrations, both with William Palmer and at the IRE (IEEE) fair held in San Francisco on May 16, 1946 to an audience of 250 people.

By this time, research based on German tape technology was going on at 3M, Audio Devices, Reeves Soundcraft, and Orradio. 3M was the first to succeed and in 1947 under the direction of W.W. Wetzel, developed its own tape for use with the Soundmirror. This was the Scotch 100, a magnetite-coated paper-base tape. Soon after, 3M developed a plastic-based version of the tape, which they called the Scotch 110.

Meanwhile, Ampex developed America's first tape recorder for commercial use in 1946. The quality of 3M's tape was still not comparable to the BASF tape, and was not suitable for either the new Ampex machine or Mullin's Magnetophon. Moreover, 3M decided that its Soundmirror had no future as a commercial machine, and began concentrating its research efforts on producing a recording tape for the Ampex machine.

Milestones in the history of recording tape

1880s	Oberlin Smith proposes magnetic recording theory.
1898	Valdemar Poulsen's first magnetic recording machine.
1900	Poulsen's Telegraphone wins at Paris Exhibition.
1903	Poulsen starts unsuccessful bid to commercialize technology.
1907	The Telegraphone gains a patent.
1928	Fritz Pfleumer unveils Sound Paper Machine.
1932	AEG and I.G. Farben buy Pfleumer's patent, start R&D.
1934	AEG produces first Magnetophon and tests recording tape produced by BASF.
1935	Magnetophon sells out at Berlin Radio Exhibition.
1936	BASF manufactures recording tape on a large scale, and records London Symphony Orchestra. Soon after, Fe_2O_4 powder and Fe_2O_3 are used in producing magnetic tape.
1938	German Broadcast system allows use of recording tape in broadcasting.
1938	Researchers at Tohoka University independently discover AC bias recording.
1939	BASF produces practical recording tape.
1943	IG factory/Wolfen (Agfa) begins producing recording tape.
1943-1944	BASF develops casting method of tape production.
1946	Ampex develops America's first commercial tape recorder.
1947	3M develops Scotch III, a low-cost, long-playing tape.
1950	Sony introduces first Japanese tape recorder and recording tape.
1951	The first experimental cartridge tapes appear.
1953	The Magnetic Recording Industry Association is formed.
1954	Reeves Soundcraft reduces tape thickness, while increasing length by 50%.
1962	Philips announces the compact cassette recorder.
1968	TDK introduces Super Dynamic cassette.
1973	TDK develops Avilyn particle.

Recording was a time-consuming process in the 1950's.

Magnetic Recording

In 1962, Philips introduced the compact audio cassette.

In 1948, they succeeded, with the gamma ferric oxide-coated Scotch III. It soon became world renowned, and was to have a considerable effect on the Japanese recorder and tape industry. Meanwhile, Orradio merged with Ampex, giving Ampex an inhouse source of tape.

Both recorder and tape production began to pick up speed. In 1950, Concertone, Revere, Webcor, and Wilcox-Gay produced recorder models that would influence consumer product development in Japan, while small and simple tape recorders appeared for general use in Germany, Austria and other European countries.

Tapes were becoming thinner and longer, and playing longer too. In 1954, Reeves Soundcraft reduced base thickness from 36um to 25um and increased tape length by 50%. 3M also announced an acetate-based 25um-thin playing tape, while Audio Devices introduced a tape with a coloured reel. In 1955, Orradio announced a 12.5um mylar film tape which doubled recording time, calling it "Double Play". Later, they announced an even longer playing "Triple Play" tape.

Then in 1956, tape recorders and magnetic recording tape entered a new era. That March, Crosby Enterprises/RCA demonstrated a videotape recorder with a tape speed of 240"/sec, a tape width of 1/2", and a stationary head. This model was not commercialised, but in April, Ampex announced a videotape recorder at the Chicago NARTB (NAB) convention which caused a sensation. Its tape speed was 15"/sec, and it had a revolutionary rotary head. This was the VR1000, a model which would have a profound effect on the television industry and tape recording in general.

In 1957, Audio Devices announced a new type of reel as well as a low print through tape. 3M built the largest tape production plant to date, and started developing the technology that would eventually lead to a low-noise tape. By the end of 1957, 39 companies were producing over 650 different kinds of magnetic tape products, while the US Magnetic Recording Industry Association counted over 30 members.

The 1950s had seen the technical development of the new tape materials as well as a trend toward thinner, longer running tapes. In the 1960s, tapes incorporated newer, high-density recording materials and base film and became even thinner, eventually breaking through the 10um barrier to achieve the shortest recording wavelength at that time.

When Philips announced the compact cassette recorder in 1962, it changed sound recorders forever. In Japan in particular, tape recorders become synonymous with cassette recorders, and tape with compact cassettes. Just as the 1950s had seen the leadership in tape recording technology shift from Germany to the US, the 1960s would witness the passing of the sceptre from the US to Japan.

Research in Japan into magnetic recording had already begun in 1931 under the direction of Kenzo Nagai at Tohoku University. In fact, Nagai and his associates actually discovered AC bias independently of German engineer Walter Weber of the Reichs-Rundunk Gesellschaft. Unfortunately, the output of the tape they produced was barely audible.

Later, during WWII, samples of German paper-based 5mm recording tape came into the possession of the Japanese Imperial Navy. And by 1950, the first Japanese-made recorders and tapes — known as the KA series — were produced by Tokyo Tsushin Kogyo, now known as Sony.

The Japanese tape industry takes off

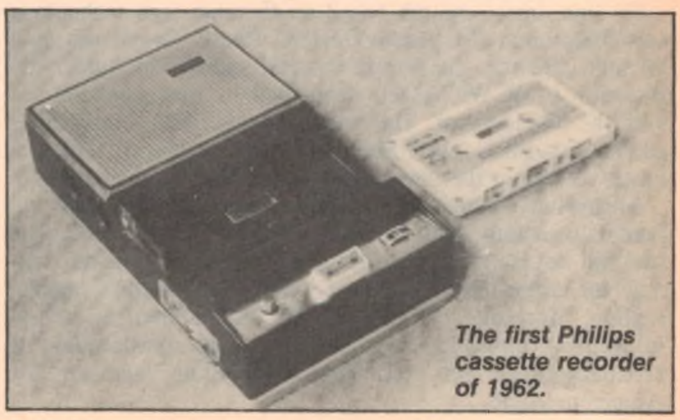
In October 1952, Tokyo Denki Kagaku Kogyo (now TDK) began research in recording tape, using a 3.5cm Honshu paper base. Exactly one year later, the tape, marketed as "Synchrotape" (TDK's original brand) was ready. Other

tapes also introduced around this time included Tohoku Konzoku Kogyo's "Talky Ribbon" and "Refined" (homogeneous) tape by Nitto Denki Kogyo (now Hitachi Maxell).

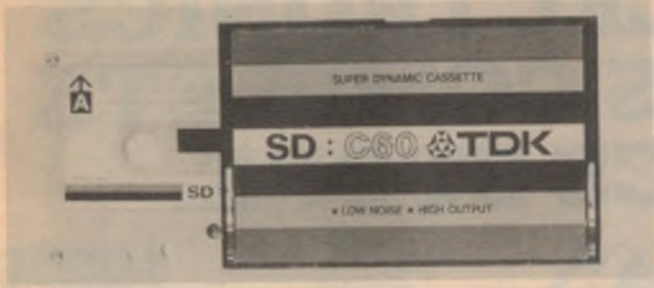
In August 1955, NHK (the Japanese national broadcasting network) selected the Scotch 111A tape, a gamma ferric oxide-coated tape, for use with its tape recorders, setting the magnetic recording standard for Japanese tape products. NHK officially shifted over to domestic tape in December 1956, and began using TDK and Sony tapes in its broadcasts.

In 1957, Japan first began producing domestic base film. Until this time, tape manufacturers had been importing base film, which often caused low-quality dispersion of magnetic particles. At first, diacetate film was used, but this was soon replaced by the more durable triacetate film, and then, by polyester film. Also that year, the home-use tape recorder market opened up and tape production began to pick up speed.

In 1962, Philips modified the RCA cartridge by reducing tape size for ease of use. The first compact cassette tape recorder, the EL 3300, was born. For the first two years, Philips limited test sales to Europe. But in 1965, the EL 3300 appeared at Mitsukoshi Department Store in Tokyo. One year later, the first Japanese cassette recorder, made by Aiwa, came on the market.



The first Philips cassette recorder of 1962.



TDK introduces the first Japanese cassette tape

With the advent of the cassette recorder and tape, Japan plunged into the world tape market. The first Japanese cassette tape was marketed in 1966 by TDK, followed closely by Matsushita Electric (OEM), Sony, Hitachi Maxell, and Fuji Film. With the advent of FM broadcasting in 1963, a new low-nose, low-transfer 6.3mm recording tape was needed.

Research into noise reduction continued, and in 1968, TDK introduced the SD cassette, which made high-fidelity music recording possible for the first time on cassette. The name "SD" was originally derived from "Single Domain", the code name for the project but eventually came to stand for "Super Dynamic". (Since that time, TDK recording tapes have always had a nickname as well as a brand name, a trend which has also influenced other tape manufacturers' products).

Realising that compact cassettes would have to become standardised before becoming popular, Japanese tape manufacturers negotiated with Philips to set a standard for cassette tape, with as low a patent compensation as possible. This created a much larger market for cassette tape than had ever been possible for open reel tape.

Low-speed cassette tapes demanded a higher tape coercivity in order to improve magnetic recording performance. In 1961, DuPont developed a new type of high-coercivity chromium dioxide tape called "chrolin tape". Japanese tape manufacturers could not ignore this important new development, but the high patent royalties were discouraging. So a search began for other materials that would also result in high coercivity.

The birth of "Avilyn" — the super particle

In 1968, W.P. Haller of 3M developed a magnetic particle with high coercivity, by adhesing a cobalt compound onto the surface of gamma ferric oxide. This was marketed as "High Energy" tape by 3M.

In 1973, Yasuo Imaoka of TDK succeeded in adhesing a cobalt compound onto the surface of ferric oxide. TDK called this magnetic material "Avilyn", and initially used it to produce videotape. This magnetic particle is superior to other cobalt ferric oxide particles, because it retains heat stability despite high coercivity. In 1975, TDK used Avilyn to create its "A" (audio) cassette tape, which it called "SA".

In recent years, we've seen astounding progress in tape technology, with the introduction of metal tapes, microcassettes, and most significantly, digital audio tape. These latest advances in recording will open the door to even more dramatic developments in days to come.

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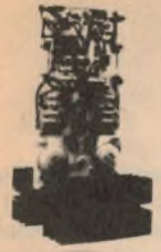

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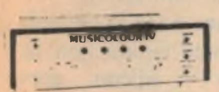

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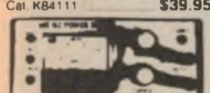

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SPECIFICATIONS
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Indication Method: LCD display
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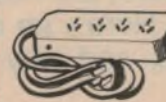

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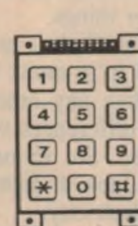

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Keeping up with technology:

Grasping GaAs

Gallium arsenide semiconductor technology is slowly but surely gaining ground against silicon, especially in certain areas such as LEDs, low-noise microwave amplifiers and very high speed logic. Here's an easy to understand explanation of how GaAs works, and why it is better than silicon in these areas.

by GEOFF BAINS

Everyone and their dog knows about silicon. It is almost a synonym for advanced technology to say a product contains a 'silicon chip'. However the days of 'popular' silicon may now be numbered, as new semiconductor materials come into our lives.

The first of these to make a real impact is gallium arsenide. This may not sound as elegant as silicon, but it has the potential for greater things.

Gallium arsenide (or GaAs, as the chemists would call it) is in many ways a semiconductor just like any other. It has just a few subtle differences which make all the difference. So, to understand GaAs, we must look at how any semiconductor treats electricity.

The conduction of electricity is all about electrons. All matter is made of atoms, around which orbit a number of electrons – the exact number of which determines the chemistry of the element concerned.

These electrons can only orbit in a number of specific energy levels (exactly why this is so, Einstein and Heisenberg would be pleased to tell you in no more than 40 or 50 pages of quantum mechanical mathematics). When an atom is hit by some energy, one of its electrons can absorb the energy to jump up to a higher energy level. The electron can also radiate the same amount of energy when it returns to its normal state.

If the outer electrons in the atoms are excited right out of the control of the atom from the normal 'valence' band of energy levels into the 'conduction' band, they can flit from atom to atom quite easily – moving around the crystal.

An electric field applied to these free electrons will move them uniformly through the crystal – that's what we call an electric current.

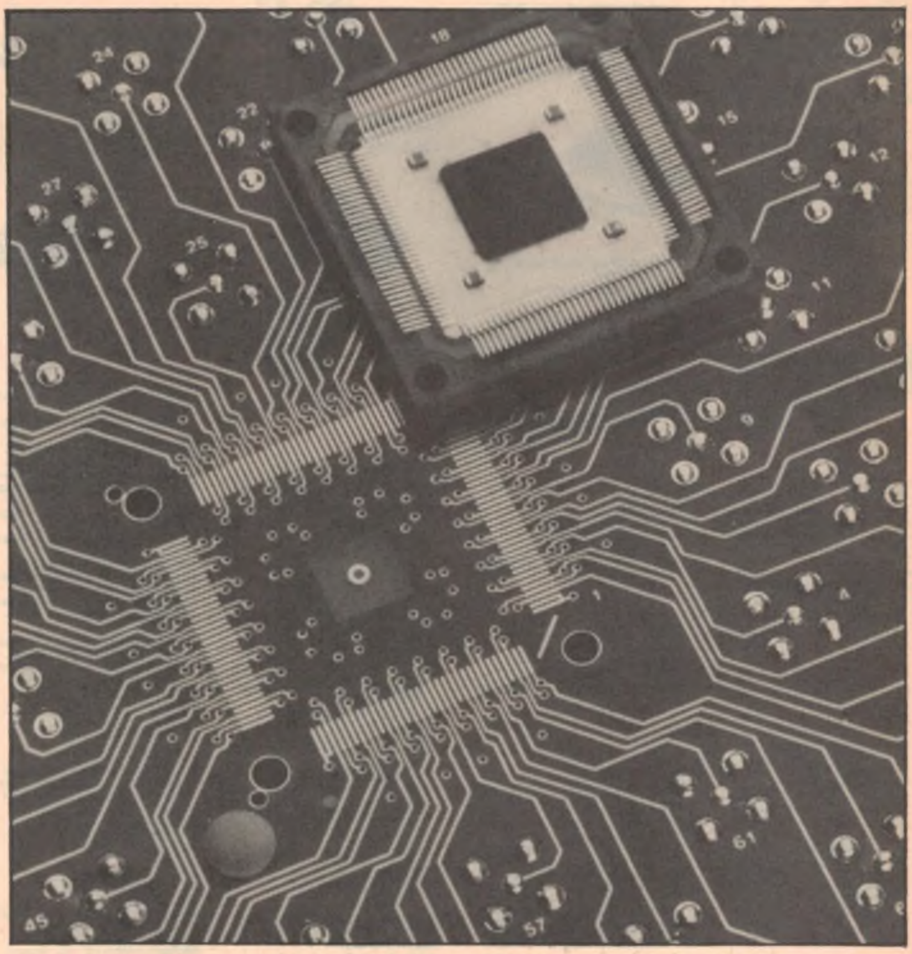
In *metal* atoms it takes next to no energy to shift electrons into the conduction band, because the bands overlap in energy terms. At room temperature the conduction band is bristling with electrons ready to conduct (Fig.1).

The atoms in an *insulator* have widely separated valence and conduction band energy levels, and so it takes enormous energies to break down the insulator and let the current flow.

Semiconductors also have a gap, like insulators, but in this case it is relatively small. So at normal temperatures a few electrons have sufficient energy to cross the barrier and provide conduction.

Several elements have a small enough band gap to allow some conduction at normal temperatures – silicon, germanium and of course gallium arsenide.

What makes semiconductors so useful is that when an electron leaves the valence band it leaves behind a hole. This acts just like a positive charge and when an applied electric field sends the free electron one way, passed from atom to atom in the crystal, it is as though a



The TQ3000 gallium arsenide gate array, which achieves a 2 picosecond gate delay and operates at a clock speed of 1GHz.

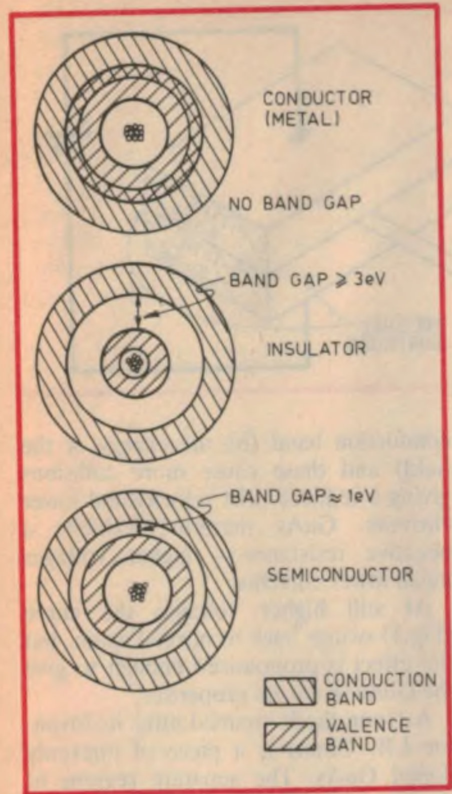


Fig.1: Atomic energy diagrams for a conductor, an insulator and a semiconductor, used to explain electrical behaviour.

hole is moving the other way.

A pure or 'intrinsic' semiconductor has just as many holes as electrons. To control the way currents flow through the material, small and precisely controlled amounts of other elements are added to the intrinsic semiconductor. These additives are either electron *donors* or electron *acceptors* and so the 'doped' semiconductor has either a surfeit of electrons or a lack of them (a surfeit of holes).

A semiconductor doped with a donor substance has more electrons than holes and is called an 'N-type' semiconductor. One doped with an electron acceptor will have some electrons 'mopped up' by the dopant, giving a surfeit of holes, and is called a 'P-type' semiconductor.

Combining these types together gives interesting and useful effects at the junctions, and that is how semiconductor diodes and transistors operate.

A diode is simply a junction of an N-type and a P-type semiconductor. When a potential is applied with the positive terminal to the N-type half (reverse biasing) all the free electrons from the N-type semiconductor rush into the positive terminal leaving no free charge carriers (electrons or holes) behind (Fig.2).

Similarly in the P-type half, the free holes are cancelled by electrons from the negative terminal. There are no free charge carriers and so no current can flow.

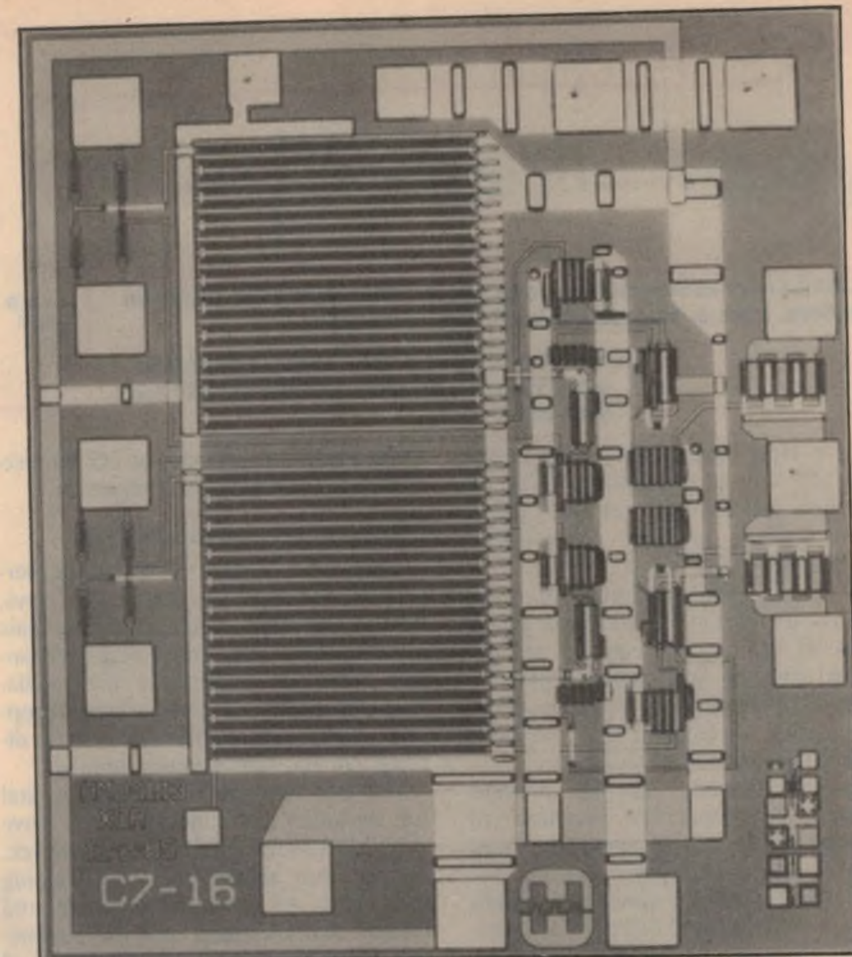
Connect the diode the other way around (positive to P-type) and electrons issue from the negative terminal into the N-type half, holes rush from the positive terminal into the P-type half and they constantly recombine at the junction – lots of current!

Now, that's how any semiconductor diode works. What makes GaAs diodes special is the energy levels involved.

GaAs diodes

When the electron-hole pair recombine, energy is given off as heat or light (the same energy as was needed to separate them in the first place). The energy given off by the recombination of the electron-hole pairs in silicon is mostly heat. But the energy from GaAs electron-hole pairs happens to be in the visible part of the spectrum.

So, when diodes made from GaAs are forward biassed, the constant recombining of electrons and holes at the junction produces light – and that's a LED



Closeup of a GaAs dual 2-input ExOR gate chip capable of running at 1 gigahertz. (Courtesy Harris Semiconductor)

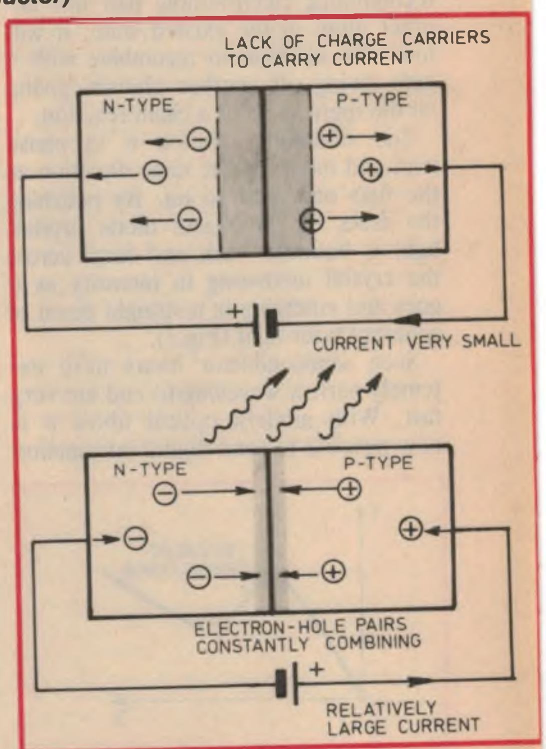


Fig.2: A junction diode formed between oppositely doped semiconductor regions is very polarity sensitive.

Grasping GaAs

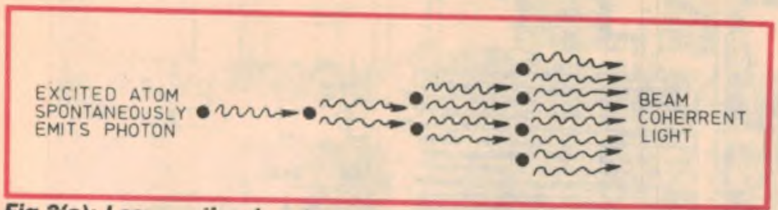


Fig.3(a): Laser action involves one photon stimulating the emission of others, from a "population inversion" of carriers.

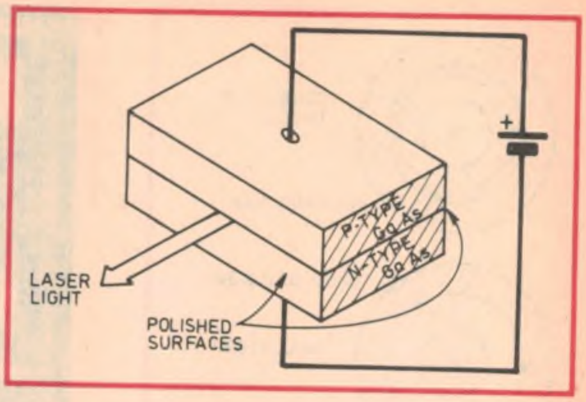


Fig.3(b): In a solid state laser, light finally emerges after bouncing between polished surfaces.

for you! Next time someone tries to impress you with all the flashing LEDs on their hifi, just remark 'just looks like a lot of gallium arsenide electron-hole pair recombination to me'.

By adding small quantities of phosphorous to the GaAs, the band gap is increased and so the frequency of light emitted goes up. So it becomes possible to make LEDs of green and blue-green, with shorter wavelengths than the natural infra-red and red of GaAs alone.

More importantly, at high forward currents the 'population invertion' in the region of the GaAs diode (the great many electron-hole pairs pouring together to recombine) allows light amplification by stimulated emission of radiation to occur – that's LASER for you!

If the photon of light emitted by a recombining electron-hole pair hits another atom in the excited state, it will force the electron to recombine with a hole giving off another photon, giving all the ingredients of a chain reaction.

The stimulated photon is in phase with and moves in the same direction as the first one, and so on. By polishing the faces of the GaAs diode crystal, light is bounced back and forth across the crystal increasing in intensity as it goes and emerging in a straight beam of coherent laser light (Fig.3).

Such semiconductor lasers have extemely narrow wavelengths and are very fast. With modern optical fibres it is now possible to send digital information using GaAs laser diodes at 2G bits/second over 100km, without repeaters.

Microwave oscillations

Light isn't all that GaAs can be persuaded to emit. In the early days, microwaves were produced with archaic klystron tubes which used near-mechanical resonance to produce the oscillations. GaAs crystals have a useful property which enables microwaves to be directly created with a steady voltage.

The free electrons in a GaAs crystal (or any other semiconductor) can move very fast through the crystal. However, because they actually move by hopping from atom to atom, recombining and forcing new electrons into the conduction band, the average 'drift velocity' of electrons through the crystal is relatively slow.

The drift velocity is increased by an increased electric field (because the electrons are charged). However, with GaAs, above about 3kV/cm of applied field more electrons are excited into the conduction band (by the energy of the field) and these cause more collisions giving a reduced drift velocity and lower currents. GaAs therefore exhibits a negative resistance – higher voltages mean lower currents.

At still higher voltages the curve (Fig.4) swings back to normal again, but the effect is pronounced enough to give the *Gunn diode* its properties.

A Gunn diode (named after its inventor J.B. Gunn) is a piece of unevenly doped GaAs. The separate regions of doping cause regions of high and low electric field. In the high field strength regions the negative resistance of the GaAs cause few electrons to flow out of the region, despite the large number flowing in.

Eventually an enormous negative charge builds up which rockets towards the positive terminal like a spark. The process then repeats itself again and again, and with a resonant inductor gives an oscillating current at 2-20GHz.

Although Gunn diodes are much sim-

	Silicon (Si)	Germanium (Gi)	Gallium Arsenide (GaAs)
Electron Mobility	1350	3900	6800
Hole Mobility	480	1900	680

Fig.5: Carrier mobility of three common semiconductors

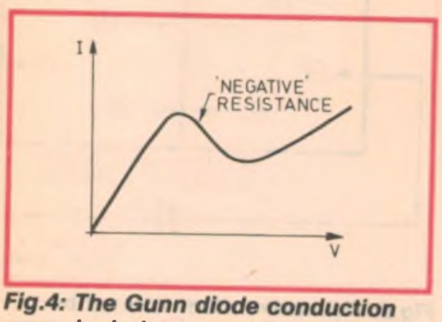


Fig.4: The Gunn diode conduction curve includes a negative resistance section.

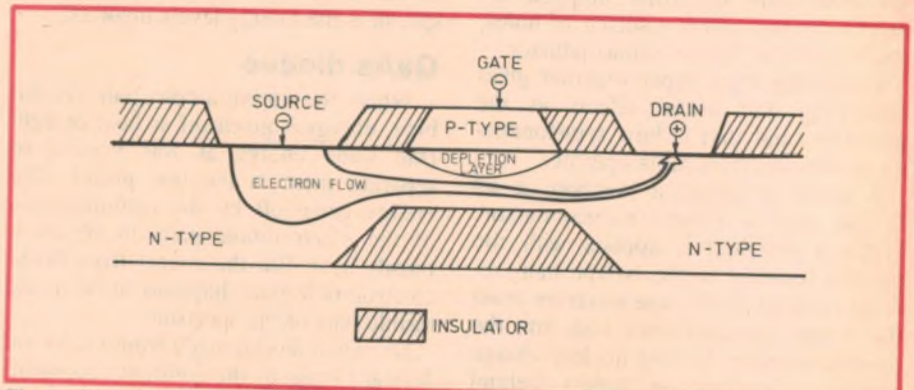


Fig.6: Construction of the typical GaAsFET, as used in low-noise UHF and microwave amplifiers. It's a depletion mode device.

pler and tougher than klystron tubes, the snag is they are inefficient and can produce only about 0.2W against the 10's or even 100's of watts from a klystron. However, the output is largely determined by the heating of the GaAs crystal and with good heatsinks and pulsed operation outputs of 250W have been achieved.

High speed operation

The drift velocity of the free charge carriers in GaAs is responsible for perhaps the greatest application of gallium arsenide.

As we have seen, the movements of the charge carriers in all semiconductors is limited by their collisions with atoms in the crystal. Since the drift velocity increases with increasing applied field strength (at least, until the negative resistance region is reached) the quantity 'mobility' – the ratio of carrier speed to field strength – is used to describe the freedom of the carriers in a particular semiconductor.

As luck would have it, the mobility of electrons in GaAs is much higher than in other semiconductors such as silicon or germanium (Fig.5).

The high speed of the electrons means that transistors and ICs manufactured from GaAs are themselves capable of much faster operation.

GaAs transistors have been around for some time. These are mostly FETs, as straightforward NPN GaAs transistors do not work well. This is because of the slow speed of *holes* in GaAs.

GaAsFETs are depletion mode FETs (Fig.6). The negative charge at the gate forms a depletion layer (with a few charge carriers), which blocks the main flow of electrons from the source to the drain terminals.

The high speed (up to 18GHz) and low noise of GaAsFETs has made them popular for receiver front-end design and for the ouptut stages of power amplifiers. GaAsFETs are the basis of most satellite TV low-noise block down-converters (LNBs).

GaAsFETs are also relatively simple to fabricate, and the basis of many GaAs ICs. However, GaAs ICs as a whole have proven tricky to manufacture. Defect-free GaAs wafers have been difficult to make, and to obtain full advantage of the high speed of GaAs, ICs must be small and densely packed, stretching IC technology to the limit.

Nevertheless, some developments have been made in the field of digital ICs where gate delays of only 50ps and operating frequencies of 5-10GHz have been achieved – around 5-8 times faster than equivalent ECL circuits.

GaAs IC manufacturing problems *will* be overcome. The market is hungry for these high speed devices.

Indeed the next generation of Cray supercomputers (the $30 million Cray-3) will be using GaAs chips and immersing them in liquid nitrogen, for superconductivity speed to give speeds of 3 gigaFLOPS. That's 3000 million floating-point operation per second!

The future

The time will come, in the not too distant future, when silicon is as old hat to the marketing men as transistors are today. Gallium arsenide has so great a future, over such a wide spread of applications, that the difficulties it presents to manufacturers will not be allowed to stand in the way.

Already GaAs has proved itself in LEDs and high frequency receivers. It may not be too long before we see it in everyday 'household' electronic circuitry, proving its worth in speed and versatility and finally becoming the 'people's semiconductor'. EA

FORUM

Conducted by Jim Rowe

More on the nanofarad, the billion – and the jar

You didn't need to be Nostrodamus to predict that there'd be a lively response to my March column, with its somewhat provocative comments about some people being unwilling to accept metric/SI units like the nanofarad. The letters started rolling in as soon as the issue hit the streets.

I know it was fairly predictable that the column *would* generate such a response, but all the same I still find it a bit surprising that things like the humble nanofarad and other units can generate so much activity – sometimes even passion. Especially when things like nickel-cadmium batteries and the problems of Australia's manufacturing industry seem to generate so little!

Perhaps it's because things like measurement units are so basic, and directly affect so many people. Or because they're relatively simple black-and-white issues, and easier to understand than complex things like economics and cost effectiveness.

Anyway, whatever the reason, the aforementioned nanofarad column certainly did trigger quite a few people into writing in with comments, both for and against the points I put forward. And that's great. Nice to know that so many people are interested in the musings of yer 'umble scribe, and ready to spend the time and effort to contribute. This is exactly the kind of interaction that *Forum* should generate!

Getting down to specifics, I think the first letter to arrive was from Ian McInnes of Alphington, Victoria. Mr McInnes also sent a contribution to last month's discussion of amplifier earthing, you may remember.

This time, he finds himself in broad agreement with me over the nanofarad itself, which he says has now become second nature – although he admits that like many of us, he tended to reject it at first. His point is that electronics is a fast changing activity, and as a result we all need to keep open minds and adapt to the changes as they occur. Fair enough.

He then goes on to suggest that we at *EA* shouldn't have stopped with the nanofarad, but gone further and also embraced the use of the unit multiplier as decimal point:

I feel it is a pity you couldn't have led the way to educating EA's readers with the multiplier decimal point principle (4R7, etc) in your drawing practice.

In the early fifties, while on TV development, a colleague recently returned from the UK introduced this concept. He explained that it was introduced because of the uncertainty associated with a conventional point, which may be lost or gained in the succession of paperwork between development, production and service. The logic of this eventually seeped through, and along with the nanofarad, it became second nature to talk about 4R7 resistors and 6n8 capacitors.

I shudder now when I see things like .00002uF in print. How could we ever have used such figures – although we did!

"I shudder now when I see things like .00002uF, in print!"

So for Mr McInnes, it's not a matter of *EA* having gone too far by using the nanofarad; we haven't gone far enough. Moreover, he points out that I made a rather silly error in the March piece, in the explanation of *femtofarads* at the bottom of the second column on the very first page:

I think you have become a victim of the multipliers yourself, in describing a femtofarad as a thousand-billionth of a farad. If the billion were an English billion, i.e., a million million, the statement would be correct. But as you use the American billion (thousand million), there is a discrepancy.

I used to get hung up on these American billions and trillions, thinking that the English system was more logical, but usage seems to have gone the American way.

He's absolutely right, of course. How embarrassing! After making such a point of effectively defining the (US-derived) billion and trillion, I went on to make this mistake only a few paragraphs later. Talk about hoisting myself on my own petard...

A few other people were to point out the same 'blue', as well. Thanks folks, my face is a suitable shade of crimson. I've given myself a penalty of typing out 'A femtofarad is a thousand-trillionth of a farad' a thousand times – although nowadays this sort of thing is pretty easy, thanks to modern word processors!

But I digress. Mr McInnes's justification for the use of multiplier symbols to replace the decimal point is quite reasonable. That is to say I can see the logic behind it, although I'm still not sure about the desirability of magazines like *EA* 'leading the way'.

Perhaps this is just revealing my own conservative streak, and personal resistance to change. But to me it's something of grey area, this matter of whether or not (or to what extent) we magazines should force change on our readers. There's certainly a need for us to help our readers keep abreast of changes and developments, but if we move too far ahead of the bulk of our readers and their needs, we risk losing them – and their patronage.

In short, as Mr McInnes suggests himself, there has to be something of a compromise between what we might call *logic*, and *usage*. And where you make this compromise is probably always going to be a subjective decision. As I explained last month, it was I who made the decision that we'd go with nanofarads, but not with multiplier symbols replacing decimal points. And right or wrong, I tried to make this decision on the basis of a compromise between logic and usage.

Ten years ago, I'd probably have given 'logic' greater weighting, and gone the whole way as advocated by Mr McInnes. But nowadays I tend to take 'usage' more into account, as shown by my use of the dominant 'American' convention for *billion* and *trillion*. I suppose I'm mellowing a little!

Passing on to other correspondents, Mr H. Heinemann of Fairfield NSW also seems to support both the nanofarad and the use of multipliers as decimal indicators. He writes that although he grew up with the old CGS system, he adapted to SI units and conventions with time, and will vote for clarity of understanding every time. With regard to the use of multipliers as indicators, he's even more firmly in favour than Mr McInnes:

I believe that decimal points should be discontinued. They could be caused by 'fly poo' or whatever, and included as the real thing in photocopies, etc. In contrast, 6R8 and 4n7 are not to be mistaken. If this means EA publishing a guide sheet on accepted drawing conventions, to bring its readers up to date, then so be it.

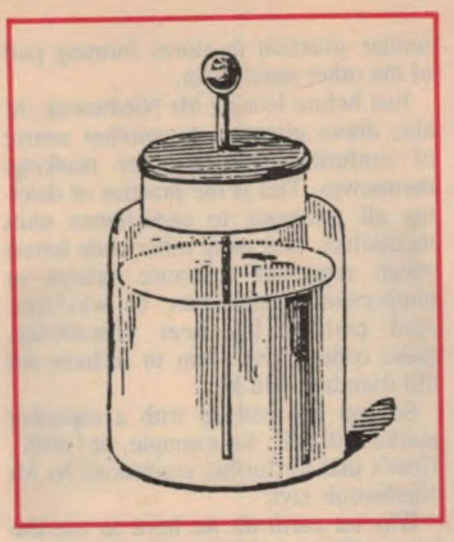
"Builders loathed metrication, at first..."

Another writer in favour of the nanofarad is Stephen Green, of Leongatha in Victoria. Mr Green says he for one finds no difficulty in working with the *nano* prefix. As soon as he sees it, he immediately realises that discussion centres on the region around 10^{-9} – without having to think in terms of fractions of a microfarad. In other words, he sees the nanofarad simply as a working unit in its own right, just as legitimate as the microfarad and picofarad. And that's surely the way it should be – just like the ohm, the kilohm and the megohm.

Actually Mr Green suggests that those who don't like the nanofarad are being just a bit reactionary:

I would suggest that most opponents simply do not WANT to familiarise themselves with this unit. Similarly I'm sure that many builders loathed metrication when it was introduced. But how many would like to return to the cumbersome Imperial system?

I know that's not a direct comparison, but it illustrates that people are often resistant to change, whether it's good or bad. In the case of micro, nano and picofarads, I believe that the full use of the available units clarifies rather than confuses the issue.



A sketch of a Leyden jar, from a textbook of the 1920's. By sheer coincidence, its capacitance was very close to a nanofarad!

Along similar lines came a letter from Gordon Wormald, of Oatley, NSW. Mr Wormald is definitely not in agreement with the original writer quoted in the March column:

Your correspondent's suggestion that SI practice be abandoned would not be agreed to by those working more towards the front wave of electronics — for instance, in communications. It is hard to see how such an inflexible mind manages to cope with the fast pace of development in today's electronics.

He even suggests that those who aren't happy with nanofarads may wish to go even further back in time:

I remember coming across some old condensers with values marked in 'Jars'. It's a wonder that some of those reluctant to use 'nanofarads' are not stuck back in those days. For that matter, how is it that they have progressed as far as using the 'micro' prefix?

I presume that (if it were not for that advance) they would maintain that .000000001F is preferable to 1nF!

That reference by Mr Wormald to the 'jar' as a unit of capacitance is an interesting one. This was used long before my time, in the 1920s and 1930s, and presumably took its name from the Leyden Jar, which was (I think) the first kind of fixed capacitor. It was essentially a glass jar with metal foil cemented around the outside as one 'plate', and the inside filled with metal shot to form the other. A metal rod passing through the stopper formed the electrode connecting to the inner plate.

Out of interest I looked up a few old books on the subject, to refresh my memory. And I found something quite ironic, and relevant to the present discussion.

According to that venerable and classic text the 1938 *Admiralty Handbook of Wireless Telegraphy*, the 'jar' was officially obsolete even in 1938, having been replaced by the farad and its submultiples. But as a unit of capacitance, there were 900 jars to the microfarad. Or in other words, a jar was *very close* to the dreaded nanofarad – in fact it was equivalent to 1.11nF, to be exact!

Incidentally there was another very old unit used to measure absolute capacitance, in the old CGS system. This was the *centimetre*, believe it or not. According to the Admiralty Handbook, a charged body has an absolute capacitance of one centimetre if giving it a charge of one electrostatic unit (ESU) raises its potential by one ESU of potential.

Apparently one centimetre of capacitance was around 1.11 picofarads, because there were 9×10^{11} centimetres in a farad.

I can only guess that the centimetre was used to measure the diameter of a charged metal ball, at some fixed distance from another ball at reference potential. It can't have been a measure of the separation, or it would have been some kind of inverse unit (getting smaller for increasing capacitance).

The only time I've ever come across this unit myself is seeing it used for the calibration of tuning capacitors in very old military and marine radio gear. I don't remember having seen the *jar* used anywhere, but presumably it was.

But enough about ancient trivia, and back to our current controversy.

Mr S. Niedworok of Blackwood in SA writes that he doesn't quite understand what all the fuss is about. He regards the nanofarad as simply one of the unit multipliers which form an essential part of the knowledge required by anyone working in electronics, whether professional or amateur. Mentally translating between picofarads, nanofarads and microfarads is simply part of the day-to-day activity, so elementary that it's not worth worrying about.

What concerns Mr Niedworok much more is the confusion he finds in vari-

FORUM

ous well known self-serve electronics stores, in marking their component drawers and bins. Apparently he finds all sorts of weird and wonderful markings, many conflicting with each other quite wildly. Things like:

CAP POLYCARBONATE 240VAC .047UF
CAP MN SERIES 250VAC .01MFD
CAP 341 MPC 1600V .001MFD
CAP STYRO 63V 1000PF

Mr Niedworok says this multiplicity of markings undoubtedly confuses people, and much more than things like the nanofarad. Apparently almost every time he goes into the store in nearby Darlington, some customer asks him if he can identify the value of a capacitor. But when he had the temerity to take this up with his local store manager, he was almost thrown out of the store:

I was told by the manager to go and shop somewhere else, and not to waste his staff's time

All this confusion and not a single nanofarad in sight!

One problem with the use of the old 'MFD' to represent microfarads, as Mr Niedworok points out, is that nowadays it is easily confused with mF, the correct symbol for *millifarads*. There are certainly quite a few capacitors now produced with values in the millifarad range, as well as a few going right up to the farad area.

Mr Niedworok even suggests, I suspect a little tongue in cheek, that there could be a possible confusion between 'MFD' and *megafarads*, for which the correct symbol would be MF! Somehow I don't think we need worry about that for some time, but there's certainly a potential confusion right now between MFD and mF – particularly where everything in printed is capital letters for some reason.

Since the bin labels of the stores concerned are apparently all produced by a computer printer, Mr Niedworok asks why, in this hi-tech era, they couldn't all be printed with consistent, standard and non-confusing units. The greek 'mu' (μ) may not be available, but at least they could be printed in pF, nF and uF as we do in *EA*. As you can see we do have the mu available, but getting the typesetter to produce it is a little messy, so we tend to stick with uF for simplicity.

By the way, Mr Niedworok says that this confusion of capacitance units isn't confined to only one of the main chains of electronics stores. He found a very similar situation in stores forming part of the other main chain.

Just before leaving Mr Niedworok, he also draws attention to another source of confusion with capacitor markings themselves. This is the practice of deleting all reference to capacitance units themselves, and using other code letters which represent tolerance ratings or temperature coefficients, or whatever. And perhaps by sheer coincidence, these code letters seem to include our old friends K and M.

So you can end up with a capacitor marked '.012K', for example, or '184K'. How's that for further confusion! As Mr Niedworok says:

Why on earth do we have to use the letters 'K' and 'M' for tolerance, since they obviously conflict with the symbols for kilo and mega. Have we run out of letters of the alphabet?

To which I can only agree. Incidentally if that '184K' is still puzzling you, the capacitor concerned actually has a value of 0.18uF (or 180nF, if you prefer). Some of the Japanese component makers often use a system of giving capacitor values in picofarads, and using a third digit to represent the number of zeroes. So '184' means 180,000pF, and '224' means 220,000pF or 0.22uF. Similarly '222' means 2200pF, or 2.2nF.

"Have we run out of letters of the alphabet?"

Still on the subject of component markings and their relevance to the nanofarad question, regular *EA* contributor Jim Lawler of Hobart Tasmania has some very relevant comments. His approach is quite matter of fact and down to earth:

I have no objection to the nanofarad as such. But the question of whether we should adopt it or not is really out of our hands. Until the manufacturers and distributors make, package and sell capacitors marked in nanofarads, it is patently useless specifying these values in schematic diagrams.

Where ever a circuit diagram specifies a capacitor in nanofarads, I have to convert its value into micro- or picofarads before I can select a real-world capacitor. If I don't do the conversion, then someone else has to. Either way, it's an unnecessary waste of time and a negation of all that metrication stands for.

I will accept and use nanofarads as soon as I can go to my supplier and buy nanofarad caps, without either he or me having to convert the value to match the goods on his shelves.

After reading your March column, I scanned through the magazine, looking for a source of nanofarad capacitors. There were none.

The Jaycar catalog offered only capacitors in microfarads and picofarads. Ritronics and Tandy were the only other advertisers offering capacitors in that issue, and then only in micro- and picofarads.

I went back through other catalogs, from Dick Smith Electronics and Altronics, and they didn't list any nanofarad capacitors either. Not even that bible of the parts industry, the RS Components catalog had any nanofarad capacitors for sale.

That last one is even more surprising, because it is printed by the giant Radiospares Components Ltd in the UK, and distributed here by its Australian subsidiary. And if the largest UK supplier of capacitors declines to sell nanofarads, in the very home of nanofarads, then what hope is there for us lesser mortals?

Fair enough. I can only agree that very few actual capacitors are marked in nanofarads as yet, and until they *are* the use of the unit on circuits, etc. must inevitably involve us all in some degree of mental gymnastics.

Whether you regard this as a good or bad thing is presumably a matter of your personal situation. Jim Lawler obviously finds it an annoying waste of time, and I'm sure a lot of people will agree with him. Presumably Mr Niedworok would be among them, for example, whereas others like Messrs McInnes, Heinemann, Green and Wormald would perhaps see it as a challenge — an opportunity to keep their mental gym equipment in good shape.

Moving on to other letters, Mr Ron Hunt of McCrae in Victoria obviously isn't in favour of the nanofarad at all. In fact his letter was basically a plea for it to be immediately consigned to oblivion:

I have been buying EA for years, and I could understand your circuit diagrams until you changed the capacitor markings.

Why did you do this? I simply cannot understand '1nF', '22nF' and so on. What was wrong with the old way?

I can't find any reference to this new system of units. Please revert to the old way as soon as possible.

Mr W.A. Jolly of Nambucca Heads, NSW writes not so much to comment on our use of the nanofarad, but again to take me to task for electing not to use multiplier symbols instead of the decimal point:

I feel I must take you to task over your comments in the March Forum. I do not believe that, as editor of a leading electronics journal, you are in a position to pick and choose which parts of an international standard you are going to adopt. So your Karen Rowlands has my sympathy.

A better approach may have been to publish an article setting out what changes in circuit layout, values etc., were going to be introduced and why. With maybe some examples, together with tables of equivalent old and new values, in an attempt to educate your readers.

Mr Jolly is certainly entitled to his opinion regarding my right to pick and choose whether we adopt the full SI conventions 'boots and all', and I can see the logic of this approach. It's just that I beg to differ.

As I see it my prime responsibility is to make the material in *EA* as clear and understandable as possible to the widest possible group of people, commensurate with it also being as up to date as possible. This inevitably involves finding a compromise, between sticking with the old familiar ways and adapting to change.

To achieve this compromise I'm happy to give lots of careful consideration to both national and so-called international standards, but in the end I believe it has to be a matter of personal judgement.

Incidentally this is no more than the kind of decisions made by other magazines, technical and scientific organisations, industries and even countries. Look at the USA, for example: they're still largely ignoring metric units and the SI conventions.

I guess what I'm trying to do with *EA* is steer a course roughly midway between the thoroughly SI-committed Europeans, and the 'SI – what's that?' Americans. So that hopefully, our readers will be pretty aware of what's going on at the leading edge, but at the same time will be able to follow circuits and other information from almost anywhere.

As for Mr Jolly's suggestion that we should have published an article explaining the changes we were making, I can only agree. My only excuse is that at the time, we were very short staffed, and hard pressed to get the magazine out at all!

Still, it is an excellent idea, and one that I'll try to follow up as soon as I can.

The only other noteworthy comments arising from my piece about the humble nanofarad were not about the topic as such, but taking me to task for my 'American' use of the word *billion* (meaning a thousand million or 10^9), rather than giving it the true-blue 'British and best' meaning of a million million or 10^{12}. Some correspondents suggested that if I simply *had* to have a word to represent 10^9, I should use the French word 'milliard' rather than 'corrupt' the meaning of *billion*.

Sorry folks, but usage of these words does seem to have followed the Americans. I'm simply following the majority!

So to summarise on the nanofarad question, judging from the correspondence I've received it looks as if most people are fairly happy with the unit itself. The main gripe seems to be that because very few capacitors are actually marked in nanofarads as yet, using the unit does seem to be a little premature.

As so many of the world's components are made for the US and Asian markets, where adoption of metric/SI standards is relatively slow, I guess it may be a while before we see too many caps with nanofarad markings. But having now introduced the unit into our circuits, it would probably be foolish and confusing to change back again. Better to keep it, I think, and follow Mr Jolly's suggestion of publishing an article explaining the mysteries of capacitor units and marking codes.

"I suspect they'd organise a lynching party – for me!"

But as for following the advice of Messrs McInnes, Heinemann and Jolly, and going the full SI route with multipliers instead of decimal points, I don't know. After all this fuss about the humble nanofarad, I hesitate to think what would happen if we tried weaning *EA* readers onto 4k7's, 6n8's and 2u2's. I suspect they'd get together and organise a lynching party – for me!

Just to end up this month, you may recall that the other subject I tackled here in March was a weird item on electric vehicles. Well, that attracted a few responses too – although not from the AEVA as I half expected.

One response was from my fellow scribe Ben Furby, editor of the retail industry journal *Counterpoint*, who is very keen on electric vehicles. I suspect he wrote mainly to correct any impression I may have given (or received) that EV enthusiasts were all muddle-headed weirdos. You needn't have worried, Ben, it was only the item concerned that I found so unbelievable.

Gordon Wormald also made reference to this item in his letter. I don't think there's any doubt that Gordon had his tongue planted firmly in his cheek though, because here's his comment:

With reference to use of the Earth's magnetic field to power vehicles, you seem to have ignored an even simpler possibility. Modern permanent magnets are so powerful that an array of them should be capable of attracting the vehicle to the nearest magnetic pole. To go in the opposite direction, rotate the array to convert the attraction to repulsion. Other directions may be achieved by 'tacking', as well known to any sailor.

The mind boggles! Apart from the size of the array you'd need, and the concept of extracting energy from a system consisting of two permanent magnets, I suspect you also might have some difficulty turning the array around, to reverse direction. A reliable braking system could be a problem, too. But thanks for the idea, Gordon – it's a corker. Send us a picture when you get one going!

The final comment came from the redoubtable Mr Jolly, however. He ignored the actual item on the car driven by power from the Earth's field, and instead jumped on me for being charitable about electric cars in general:

I also cannot go along with your belief in the potential of the electric car. These vehicles are limited not by the battery, but by the sheer size of the electrical units involved. Even with a perfect battery, or an extension cord if you like, 100 amps at 100 volts is still only about 10 horsepower – i.e., the performance of a ride-on lawnmower. More voltage become lethal, more amps impractical. So where is the potential?

He's right to be pretty skeptical about electric cars, of course – I am myself. The enthusiasts do tend to overlook the practical difficulties, which are still quite huge, and to ignore the extremely high energy storage efficiency of old-fashioned petrol and the IC engine.

But I'm sorry, Mr J, I can't agree that higher voltages are necessarily lethal. Microwave ovens have *potentially* lethal 4000V supplies inside, but millions use them every day quite safely. I see no reason why quite high voltages couldn't be used in electric cars, with the appropriate technology.

Compact Disc Reviews

by RON COOPER

TCHAIKOVSKY

Symphony No.5, Op.64
Capriccio Italien, Op.45
London Symphony Orchestra
Conducted by Gennadi Rozhdestvensky
IMP PCD 875
Playing Time: 63 min 39 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

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

Here are two of Tchaikovsky's most popular works, which curiously were written around the time when he was under physical and mental stress. In the latter part of 1877 his marriage broke up and with this crisis he was thrown into a deep creative depression that lasted seven years. What a mind!

In the years following up to 1884 apart from these magnificent works, there emerged the piano trio, piano concerto No.2, the 1812 Overture, the Serenade for strings, and the Orchestral Suite No.3. Here I make a plea for more recordings of all these orchestral suites which deserve much more exposure. (When did you last hear a Tchaikovsky orchestral suite playing on air?)

This recording, another all new release from the budget IMP label, is quite stunning and certainly not a budget sound. But with very familiar works such as these, we tend to have a "favourite" sound and interpretation, chosen after listening to the many versions available. This one is perhaps slower and a little more dramatic than most, yet on even a second playing you seem to "feel" extra detail from Rozhdestvensky's handling.

The sound is clear and open with superb brass and woodwind detail. Surface noise as usual is a thing of the past.

The Capriccio Italien for me though was a little too dramatic and the sound no match for the Telarc version. Overall though, a very good disc.

MOZART

Symphonies No.36 in C K.425 "Linz"
Symphony No.39 in E flat, K543
Scottish Chamber Orchestra
Conducted by James Loughran
IMP PCD 877
Playing Time: 62 min 48 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

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

Mozart wrote the Linz Symphony in just three days for an urgent concert – quite incredible as this is one of his many popular works and it indicates the pressure under which he often worked best. Just three days to conceive, compose and write out a major work which then had to be copied out for the Linz Orchestra (and then at least one rehearsal) – an amazing feat as the work itself is so polished.

The Symphony No.39 in E flat was written during a sense of inner emergency in a six week period in 1788, along with the G minor (No.40) and the Jupiter (No.41). Both symphonies here have prominent dotted rhythms (dum-te-dum if you're purely a listener!) The No.39 features the famous Minuet and Trio often played separately – reminiscent of my own high school days, where I was one of "the bashers" of this piece in the school orchestra.

Here on disc the performances are excellent – equal to the best I have heard to date on any recording. Tempos are "right" and the sound quality is very well balanced – everything is heard yet nothing seems to predominate. There are excellent cover notes on the works, too.

Overall an excellent disc, more so with it being at a budget price.

GUITAR CLASSICS FROM SPAIN

Marcelo Kayath
IMP PCD 876
Playing Time: 61 min 46 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

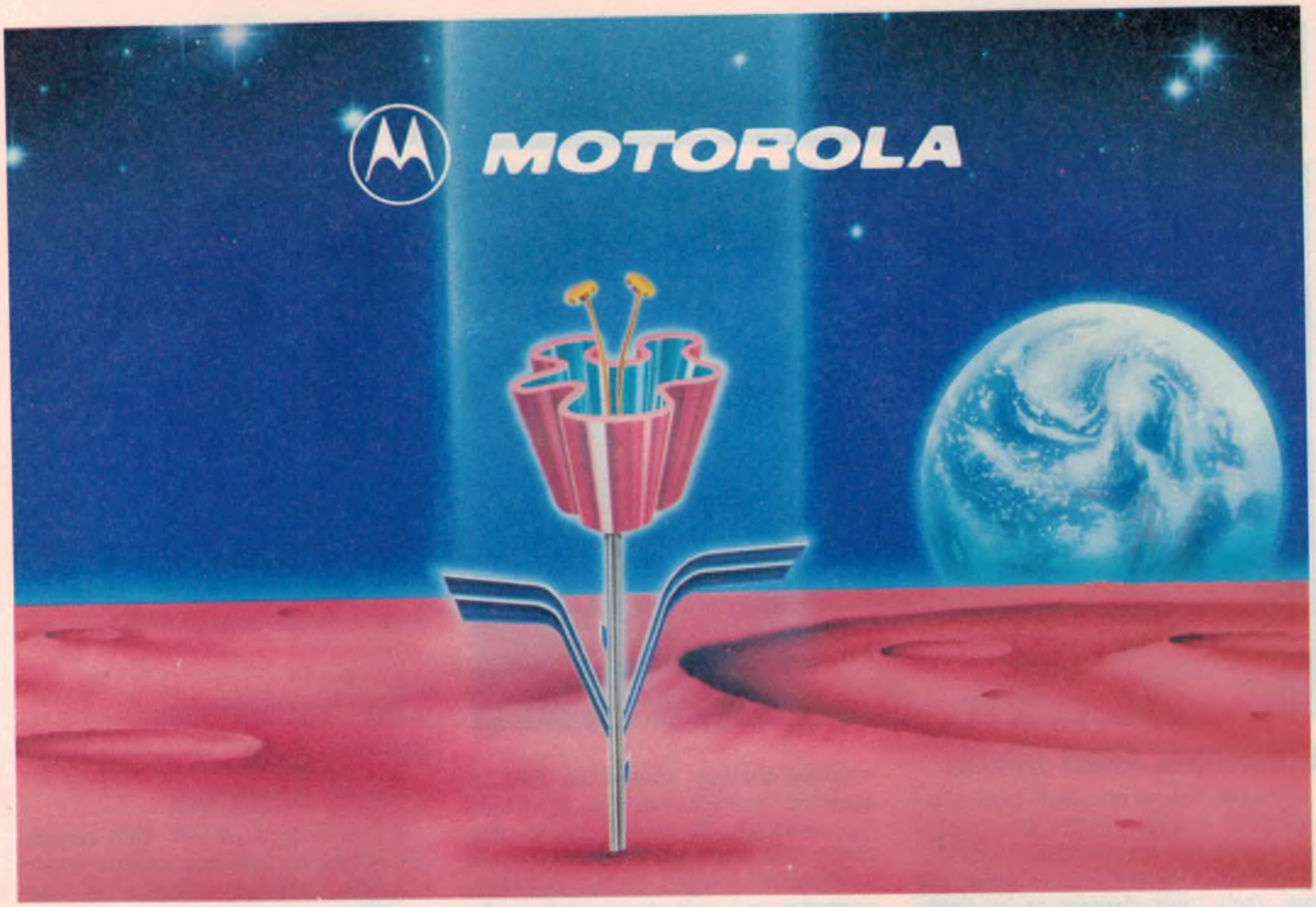
SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

I am sure this new digital release from IMP will be welcomed by fans of this fascinating instrument. There are 13 relatively short works and they are:

1. Predule in A minor (Francisco Tarrega)
2. Capricho Arabe (Francisco Tarrega)
3. Recuerdos De La Alhambra (Francisco Tarrega)
4. La Maja De Goya (Enrique Granados arr. Marcelo Kayath)
5. Granada (Isaac Albeniz arr. Marcelo Kayath)
6. Zambra Granadina (Isaac Albeniz arr. andres Segovia)
7. Sevilla (Isaac Albeniz arr. Marcelo Kayath)
8. Mallorca (Isaac Albeniz arr. Andres Segovia)
9. Prelude in E (Federico Moreno Torroba)
10. Sonatina (Federico Moreno Torroba)
11. Nocturno (Federico Moreno Torroba)
12. Zapateado (Joaquim Rodrigo)
13. El Noy De La Mare (Trad. arr. Marcelo Kayath)

Though probably unknown to most, Marcelo Kayath certainly gives a brilliant performance on this disc and is worthy of comparison to Segovia. Whilst I was unfamiliar with most pieces recorded here, the Albeniz "Sevilla" was a delight and most will recognise this popular composition.

The recording is excellent, with a good amount of ambience which does not seem to distract from the presence of the performer. If you are a devotee of the guitar, this disc would be a very worthwhile addition.



Motorola sows the seeds of invention

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MC1468705F2	CMOS	1080	64	20	28	Self Prog. Bootstrap
THE M6801 FAMILY OF MICROCOMPUTERS						
MC68701	HMOS	2048	128	29	40	SCI.MUX BUS Ext. Clock
MC68701U4	HMOS	4096	192	29	40	SCI.MUX BUS
THE M6805 FAMILY OF MICROCOMPUTERS						
MC68705P3	HMOS	1804	112	20	28	Self Prog. Bootstrap
MC68705U3	HMOS	3776	112	32	40	Self Prog. Bootstrap
MC68705R3	HMOS	3776	112	32	40	Self Prog. Bootstrap
MC68705S3	HMOS	3600	112	20	28	A-D Converter SPI
MC68HC05C4	HCMOS	Mask 4160	176	24	40	SCI, SPI
MC68HC805C4	HCMOS	EEPROM 4K	176	24	40	SCI, SPI
THE M68HC11 FAMILY OF MICROCOMPUTERS						
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MC68HC11A8P1	HCMOS	–	256	38	48DIL 52QUAD	8KMonitor 512 Bytes EEPROM
MC68HC811A2P	HCMOS	EEPROM 2K	256	38	48DIL 52QUAD	SCI, SPI A-D Converter

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NEXUS 11/134

News Highlights

Electronic shelf labels

The new Accu-chek shelf label is designed to interface with a retail store's point-of-sale system through the familiar hand-held, data entry unit, which permits shelf price changes to be implemented and verified electronically.

As a result labour to update shelf prices is reduced by 40% and accuracy between the shelf and the check-out scanning system assured.

The system uses standard Telxon portable tele-transaction computers, which are widely used throughout Australia by grocery stores, connected to a special probe to access the shelf units for electronic price changing.

The special probe can also be used for ordering products without the need for inputting product numbers or details. By connecting the probe to the electronic shelf label, product information is immediately relayed to the hand-held computer and only the quantity to be ordered needs to be manually inputted.

The shelf label contains all the information on a particular line, including shelf space, turnover and stock levels.

The Accu-chek labels are completely self-contained and powered by a lithium battery with an expected life of five to six years and is guaranteed for three years.

The units attach easily to existing shelving with tamper-proof locks to prevent removal.

Semi laser emits visible light

A semiconductor laser emitting light visible to the human eye has been developed at Philips Research Laboratories. The laser, made of mixed crystals of aluminium, gallium, indium and phorphorus, emits light at a wavelength of 650nm and is particularly suitable for digital optical recording, because of the high peak output power (more than 0.1W).

Contributions to this new development were made by researchers at the Philips Research Laboratories in Eindhoven and at the Laboratories d'Electronique et det Physiquie appliquee (LEP), which are part of the Philips international research organisation.

The new semiconductor laser consists of a number of single-crystal layers of compounds of aluminium, gallium, indium, and phosphorus of different composition and with different doping. These layers are deposited on a gallium-arsenide substrate by means of chemical reactions in a gas mixture.

The researchers at the two laboratories have now succeeded in optimising the epitaxial deposition technology. As a result, the materials obtained are of such purity and have such a structure that the internal losses in the laser are minimal, so that light is produced with a high luminous efficiency.

Toshiba ships microwave ovens to Japan from USA

In a move that seems reminiscent of the old joke about 'shipping coals to Newcastle', Toshiba Corporation has begun selling in Japan microwave ovens made at its US subsidiary in Tennessee.

Announcing arrival of the first shipment of 5000 ovens, Toshiba's senior VP in charge of consumer products Hidehiko Yoshida explained that currency movements were responsible for the somewhat unexpected change:

"The dramatic depreciation of the dollar against the Japanese yen over the past two years is beginning to cause a radical change in our global marketing and manufacturing strategy." Perhaps this may also augur well for consumer product manufacturing in Australia.

Tiny transistors respond to single electron

Researchers at AT&T Bell Laboratories have created experimental single-electron transistors – devices so sensitive that just one electron produces changes in the current flowing through them.

The devices are prototypes that operate only at very low temperatures. However, scientists feel their performance may foreshadow a generation of all-metal transistors that are extremely fast and small and consume very little power.

The devices work best when composed of superconducting materials. In their present form, they could be used as electrometers in experiments to measure induced charges as small as 1% of an electron.

The transistors consist of three microscopic parts. The first is a small island of metal just a few hundred atoms across. Connected to the edge of this central island electrode are two tunnel-junction electrodes separated by an insulating barrier only a few atoms thick. The substrate forms a remote "gate" junction that applies an electrical field, creating a steady-state bias – and thus a charge – across the junctions.

This charge controls the current passing through the central electrode via the tunnel junctions. As in a field effect transistor (FET), current through these devices can be turned up or down by changing the gate voltage.

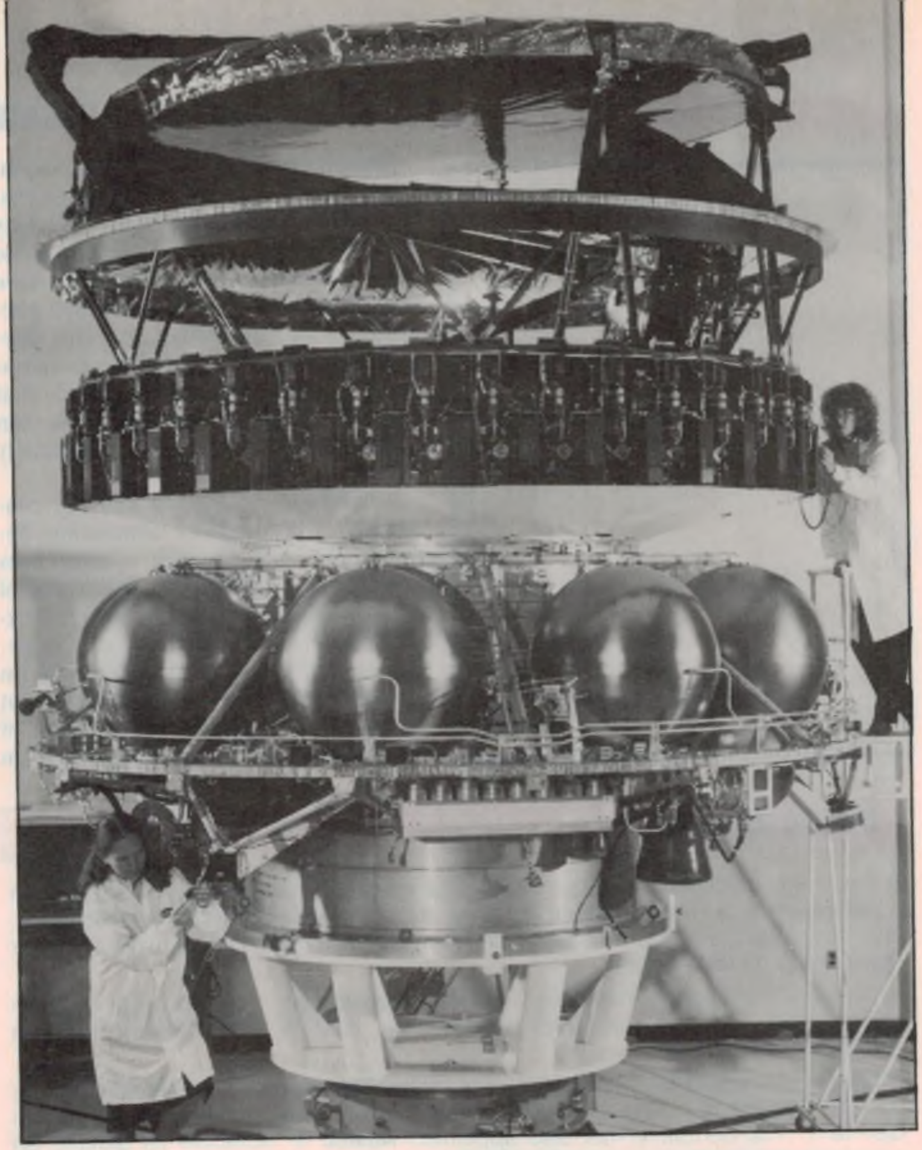
Repeaterless fibre optic links between continents?

Scientists at AT&T's Bell Laboratories in Holmdel, New Jersey may have discovered the way to produce fibre-optic cable links as long as 9000km, without repeaters.

Physicists Linn Mollenauer and Kevin Smith have succeeded in sending pulses 4000km along a fibre-optic cable without losses, by taking advantage of the *soliton* effect. This is a phenomenon where waves are guided without energy loss over very long distances, given the right circumstances.

Mollenauer and Smith have combined the soliton effect with *stimulated Raman gain*, whereby a second laser 'pump' beam is sent along the fibre with the data pulses, and transfers energy to them to cancel out losses.

Although the results are very encouraging, it may still be necessary to have semiconductor pump lasers every so often along a practical cable, to provide optical amplification. However these would be far simpler than repeaters with optical/electronic conversion, multi-channel amplifiers and electronic-/optical reconversion.



Technicians at Hughes Aircraft Company's El Segundo, California plant, check JCSAT, Japan's first commercial communications satellite, after its two major subsections were mated for the first time. Hughes is building two satellites – both HS393 wide body models operating on the Ku band frequency – for Japan Communications Satellite Company, a joint venture between Hughes and its Japanese partners, C. Itoh & Company and Mitsui & Company. The first spacecraft is expected to be launched into orbit around March 1989.

Final element of Raven handed over to Army

The final element of Raven, the Australian Army's new combat net radio system, has been dropped into place with the handover of a prototype Frequency Management Facility by the prime contractor, Plessey Pacific Defence Systems.

Raven is the name given to the $350 million Australian Department of Defence project to replace its inventory of combat net radios (CNR) with a new generation of frequency hopping radios highly resistant to jamming and eavesdropping.

At a handover ceremony at the Plessey facility in Sydney, Army Brigadier Jim Farry accepted the Frequency Management Facility from Mr Duncan Spencer, general manager of Plessey Pacific Defence Systems.

Brigadier Farry said, 'Electronic warfare is universally recognised as a serious hindrance to military operations, and the Australian Defence Force took a far sighted approach to counter it. With development of Raven almost complete, the Australian soldier will soon have the tactical advantage of secure communications well into the 1990s and beyond.'

The means of jamming and eavesdropping of combat radios, known as electronic countermeasures (ECM), has become very sophisticated in recent years and is a significant threat to military operations.

Raven uses a number of techniques to counter ECM, including frequency hopping – the automatic, synchronised frequency changes of both the sending and receiving radios, according to a predetermined code, making transmissions difficult to intercept. However, the technical problems in generating the frequency assignments and delivering them to each radio in the field are substantial.

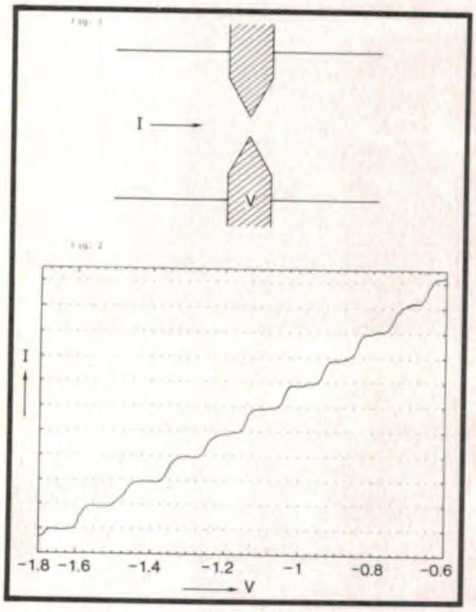
These problems have been overcome by the Freqency Management Facility (FMF), a novel system of assigning and distributing radio frequencies and call signs known as signal operating instructions (SOI) throughout a command.

The FMF is an all-Australian innovation, the product of a co-operative development programme between the Department of Defence and Plessey Pacific Defence Systems, based in Sydney.

Because the FMF is the only system of its kind in the world, the export potential is enormous. Plessey is actively marketing it as part of System 4000, the export version of Raven. System 4000 is already undergoing evaluation in Turkey, and strong interest has been shown from Malaysia, Brazil and the United States.

News Highlights

New conduction mechanism discovered



Experiments carried out in the Netherlands in close co-operation by International Philips Research, Delft University of Technology and the Foundation for Fundamental Research into Matter have revealed a new electron-conduction phenomenon in semiconductors. This phenomenon occurs at very low temperatures in a thin semiconductor layer that has the property that electrons can move more freely in it than is normally the case.

It has been established that the conductivity of a narrow connection between two areas in such a layer does not change uniformly as the width of the contact decreases, as might be expected, but in extremely regular *steps*. The size of the steps depends only on fundamental physical constants and not on material properties or the shape of the connection. These results have in the meantime been confirmed independently by researchers at the Cavendish Laboratory of the University of Cambridge.

The measurements were made on gallium arsenide, to which very pure aluminium gallium arsenide had been applied very thinly. A thin layer of highly mobile electrons exists at the boundary between the two compounds. At temperatures just above absolute zero (about −272°C) the "mean free path" in the layer, i.e., the distance between collisions in the material, is many microns (1 micron = 0.001mm). Such a thin layer of highly mobile electrons is termed a two-dimensional electron gas.

Two insulated metal electrodes were applied on the aluminium gallium arsenide, see Fig.1, with a narrow space (0.25um) between them. A voltage applied to these electrodes influences the electron gas below. At a negative voltage of −0.6V there should no longer be any electrons below the electrodes. When the voltage is reduced even further the "depopulated" area will also spread beyond the electrodes. In this way a controllable, almost point-like connection between the electron-gas on the two sides is obtained. The work showed that electrodes with such small spacings could be made successfully and that the width of the connection could be varied.

In measurements of the conductivity of such a contact it was found that with a gradual reduction of the width of the connection the conductivity decreased in steps, with the size of the steps dependent only on physical constants (the electronic charge and Planck's constant). Fig.2 shows the measured results. The wave nature of the electrons was shown to be essential for the explanation of the effect.

News Briefs

- The communications divisions of **Plessey** and **GEC** have merged worldwide, in a move aimed at helping Britain regain a leading position in telecommunications. The new head of GEC Plessey Telecommunications (GPT) Australia is former Plessey MD, Godfrey Hole.
- Component importer/distributor **Soanar Electronics** is celebrating its 25th anniversary. The company was founded by current Arlec-Soanar chairman George Soanes in 1963.
- Klaus Lahr has taken office as the new MD of **Siemens** in Australia, succeeding Juergen Mache who has moved to a new position with the parent company in Germany. The company has also appointed **Auslec** to distribute its Simatic S5 programmable controllers in Victoria, NSW and Queensland.
- Distributor **Amtron Australia** has moved to the Eutech complex at 687 Gardeners Road, Mascot NSW. The new phone number is (02) 317 5511.
- A new retail outlet for components has opened in Melbourne: the **Electronic Components Shop** is trading at 289 La Trobe Street, formerly the premises of Ellistronics/Active Wholesale. Manager Michael Petkovic, who has 10 years' experience in the industry, intends to specialise in semiconductors.
- Adelaide PCB maker **Teknis** has won a $13 million contract from IBM Australia to supply boards for its PS/2 range of personal computers.
- Distributor **Amtex Electronics** has moved to 13 Avon Road, North Ryde 2113. The new phone number is (02) 805 0844, and the fax number (02) 805 0750.
- Software publisher **Microsoft** has also moved, to Unit 2/1 Skyline Place, Frenchs Forest 2086. The phone number is (02) 452 0288, with fax number unchanged at (02) 452 4387.
- Correcting an impression which may have been given earlier, Sydney cable maker **CSSC Australia** advises that it has acquired the PCB assembly business of **Sanders Electronics**, not the company itself. Mr Theo Sanders has joined CSSC on a five year contract.
- Australia's only manufacturer of oscilloscopes **BWD Precision Instruments** has extended the warranty period on all of its equipment from 1 to 2 years. Three new 'scopes are planned for release later this year.
- Lucky winners of the **Pioneer Hifi** prizes in our recent subscriptions promotion were Mr D.Lamb of 19 Duart Road, Trigg WA (1st prize), Mr S. O'Donnell of 23/58 Queens Road, Melbourne Vic (2nd prize) and Southern Ocean Yachts, Suite 4 Pymble Grove, 33 Ryde Road, Pymble NSW (3rd prize). Congratulations to all three winners.

VALE: Norman Edge

It is with sadness that we record the passing of Norm Edge, who would be well known to many of our readers from his long involvement with the former Radio Despatch Service, and more recently with his son Bill Edge's businesses.

Norm passed away on April 15 following a heart attack, aged 73. He had worked in the local electronics industry for over 50 years, apart from a break for military service during the War – an impressive achievement.

Our condolences to the Edge family.

Hi tech storage system

A new vertical carousel storage system launched by Brownbuilt is claimed to achieve major advances in retrieval speed and accuracy.

Maxstor is being marketed in Australia by Brownbuilt under licence from the UK maker Linvar, a recognised world leader in advanced storage technology. Maxstor is a fully computerised system of revolving storage bays. It brings stock together into one place where one operator can access any item.

The range is designed to carry products from delicate electronic components to spare parts and machine tooling weighing over ten tonnes.

Computer technology allows orders, stock selection and stock monitoring to be programmed for faster operation and more accurate stock control.

A colour display of the required part and quantity ordered keeps the operator fully in touch with job requirements.

An interrupt feature can suspend a picking sequence to commence an emergency pick. The original pick can then be resumed at the point of suspension.

Stock is accessed via a waist-high aperture at the front of the unit in conventional mode.

Government signs partnership agreements with IBM, Wang and DEC

The Federal Government has recently signed partnership for Development agreements with three major international firms, each of which has committed to very significant export and R&D programs in the area of high technology.

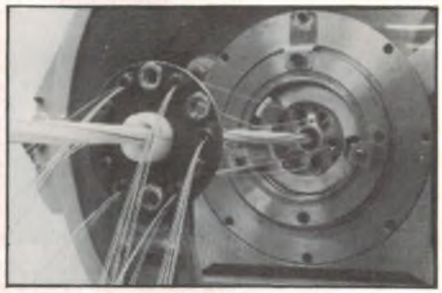
IBM has agreed to increase R&D investment to $75 million, and to achieve exports of $340 million annually by 1993.

Wang has similarly agreed to spend $70 million on research, and achieve exports worth $300 million over the next seven years.

DEC (Digital Equipment Corp.) has also agreed to spend $82 million on R&D, with $240 million of exports by 1992.

Figures released by the Minister for Industry, Technology and Commerce Senator John Button show that overall committment by transnational corporations under the Partnership program now amount to investment of $145 million per year in R&D, and exports of $720 million in a year by 1994.

News Highlights



Record 20km length of optical fibre cable

Austral Standard Cables Pty Limited (ASC), part of the Metal Manufactures Group, has set an Australian industry record by producing a continuous 20km length of optical fibre cable. This is claimed as a technological breakthrough for the optical fibre industry in Australia, which until now has been unable to supply lengths in excess of 12km.

The long cable, containing 14 single-mode optical fibres in continuous unjointed 20km lengths, should prove a boon to Telecom Australia, who intend using it in the second stage of the East-West communication trunk route between Perth and Port Augusta.

Single-mode optical fibres in the cable will be an effective medium for digital transmission at rates up to 565M bits. This is equivalent to about 60,000 simultaneous telephone conversations.

Expected service life of ASC's 20km optical fibre cable is 40 years.

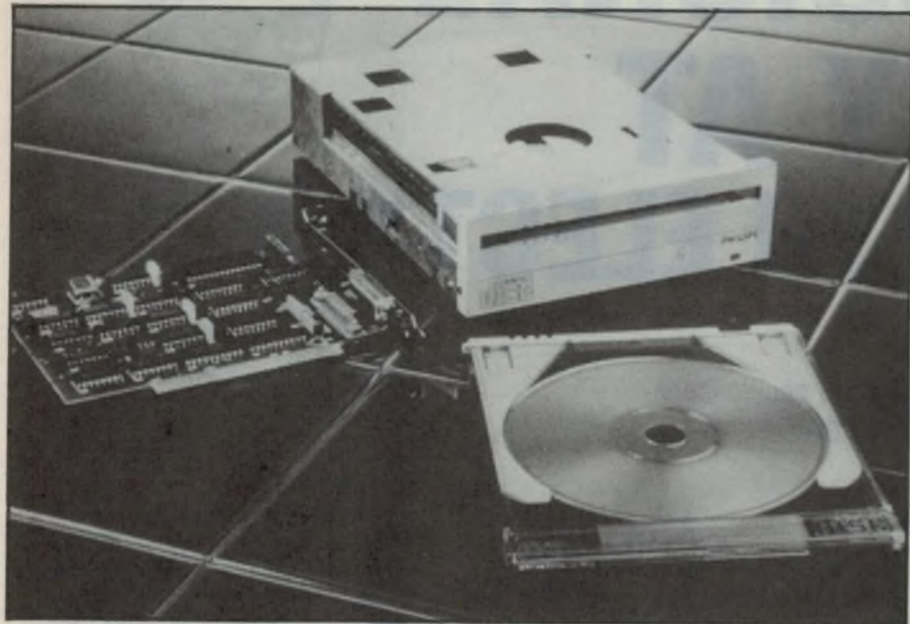
Earlier this year, ASC was awarded a $24 million contract from Telecom to supply a further 75,000km of optical fibre cable over the next two years, for use in trunk routes and the linking of country and metropolitan telephone exchanges.

"Video sculpture" at World Expo 88

A 7-metre Crystal Video wall sculpture beaming 100 different "faces" of the United Kingdom – past, present and future – will greet visitors to the British Pavilion at World Expo 88.

The 4.5 tonne Crystal Video pyramid, rising from the floor to the ceiling in the 2000 square metres of exhibition space, reflects Expo's theme – "Leisure in the age of Technology". One hundred television screens fed by 12 video disc players will relay a barrage of images and sound to the audience who will watch the computerised show from a revolving floor.

Philips claims broadest CD-ROM solutions



The inventor of the compact disc, Philips, has now made a dramatic claim for the leadership of the Compact Disc-Read Only Memory market in Australia, by establishing what it describes as the "Total CD-ROM Solution".

National marketing manager for CD-ROM and Laser Interactive Products with Philips Telecommunication Systems, Guy Norman, says that the company is catering for the many organisations who are interested in developing and "publishing" their own CD-ROMS.

"We have structured the most comprehensive range of hardware, software, and bureau services available for CD-ROM in this part of the world. And we have already taken our first orders for the preparation of Australian CD-ROMs with wide market appeal."

The Philips "Total CD-ROM Solution" includes:

- a totally new and comprehensive range of CD-ROM drives;
- the Meridian Data range of CD-Publishers for data preparation and pre-mastering.
- CD Net and CD-Server for networking CD-ROMs,
- a complete range of CD-ROM disc assessing software;
- a bureau service for CD-ROM preparation; and
- a consultancy service for CD-ROM developers.

The Philips range of disc accessing software offers a wide choice to customers allowing them to select a software that suits their application requirements.

The extensive range of Philips CD-ROM drives includes internal half height drives, and external as well as external/internal SCSI range of drives for non-PC users of CD-ROM.

Philips also market its CD-Publisher and software as complete development packages for those customers preferring to set up bureau services, or to develop their own CD-ROM in-house.

New HP inkjet printer gives laser quality for under $2000

Hewlett-Packard Australia has released the HP Deskjet printer, a personal printer with laser-quality output for less than $2000.

The new HP printer prints high-resolution text in multiple fonts and full-page graphics, all at 300 dots per inch. It uses all common office paper and also handles merged text-and-graphics output from popular application packages.

Designed for individual use, the HP DeskJet printer's compact size makes it ideal for the desktop environment. It prints text at speeds of 120cps or approximately two pages per minute for laser-quality text, and 240cps for draft-ing quality.

The printer features an automatic cut-sheet feeder (up to 100 sheets) and a front-loading design for quick reloading of paper. It accommodates US letter, legal and European A4 paper sizes, as well as manually fed #10 business envelopes.

The HP DeskJet printer has Courier, Courier Bold and Courier Compressed fonts built in. Two accessory-cartridge ports extend font capability, allow for memory expansion (up to 256K RAM) for soft fonts, and provide for an Epson FX-80 printer emulation cartridge. The printer has a 16K byte buffer.

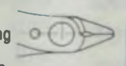
YOU WON'T BEAT THE QUALITY OF

Famous Hand Tools

PIERGIACOMI SUD — MADE IN ITALY

Around the world, Piergiacomi tools are known for their outstanding quality and reliability. They're the choice of professionals — and now DSE has available this superb range. Expensive? Yes, they do cost more than our hobbyist range: but once you feel the quality, feel the precision, you'll realise they're worth every cent! There's a Piergiacomi for every purpose... all tools feature heavily insulated handles with sprung action blades and locking bush.

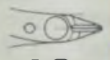
Cutting Nipper with back-angled cut



Designed especially for pcb soldering work. The cutting edge is on the opposite side to normal allowing a 1mm pigtail to remain ready for soldering — or allowing clearance of the soldered joint if you trim the pigtails after soldering. Clever — and it works! Blade opening 7mm, handles up to 1.3mm copper wire. Cat T-3261

$16.95

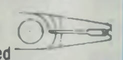
Cutting Nipper with standard cut



Ultra-precision cutter with standard angled blades allowing completely flush cutting. Special safety feature: sping in blade prevents flying pigtails. Blade opening 4mm, cutting capacity 1mm copper wire. Cat T-3262

$16.95

Inclined Frontal Cut Nippers



Very easy to handle, allowing leads to be cut 1.5mm from plane — perfect for soldering or to clear soldered joint. The blade tip is angled at 30° to allow access to tight spots. Blade opening 9mm, cutting capacity 1mm copper wire. Cat T-3263

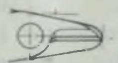
$19.95

Inclined Cutter and Bender

Two birds with one stone! Not only cuts the pigtail, but bends it away from pcb so the component won't fall out. Fantastic! Makes pcb assembly a breeze — and solves one of the biggest bugbears of hobbyists! Blade opening 6mm, cutting capacity 1mm copper wire. Cat T-3264

$18.95

Shears



For larger cutting jobs — like mini scissors but with extra strength needed to get through metal, plastics, etc. 18mm length blades means they'll handle coax cable, etc. Blade opening 10mm, cutting capacity 1.6mm copper wire. Cat T-3265

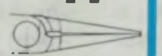
$22.95

Needle Nose Pliers

Tweezer-like ends for reaching into almost inaccessible places — and flat blades so delicate components won't be damaged. 40mm long blades with 15mm opening at end. Cat T-3266

$17.95

Flat Nose Serrated Pliers



Fine (2.5mm) ends with serrations along blade mean extra grip when you really need it. 12.5mm opening with 40mm long blades. Cat T-3267

$16.95

Mini Drivers

Mini is right! Just the size for precision models, turntable cartridges, etc. At our low prices you can afford to buy a couple in case you lose one!

Flat Blade: Cat T-6010
Philips: Cat T-6015
Size: L 30mm
D 1.6mm H 25 × 7mm

95c EACH

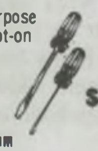
Stubby Drivers

Great for confined space — or that tough screw which needs extra muscle. You can really get a grip on these!

Flat Blade: Cat T-6020
Philips: Cat T-6025
Size: L 38mm
D 6mm H 45 × 30mm

$1.95 EACH

Standard

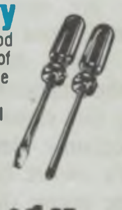


Ideal for general purpose electronic work. Spot-on for ⅛ whitworth!

Flat Blade: Cat T-6030
Philips: Cat T-6035
Size: L 75mm
D 3.2mm H 57 × 15mm

$1.95 EACH

Medium Duty



Big enough to get a good strong grip and plenty of leverage. Add this to the rest of the range and you've got the right tool for just about any job.

Flat Blade: Cat T-6050
Philips: Cat T-6055
Size: L 150mm
D 5mm H 6.5mm
Handle: 95 × 25mm

$1.95 EACH

Heavy Duty

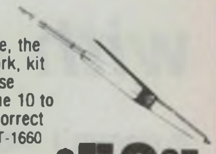
Everyone needs a big gun sometimes! Strong enough for the toughest work — ideal for the tradesman.

Flat Blade: Cat T-6060
Philips: Cat T-6065
Size: L 200mm
D 7mm H 100 × 25mm

$3.95 EACH

SCOPE Irons

Miniscope

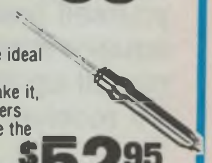


Lightweight and a delight to handle and use, the Miniscope is perfect for general service work, kit building, etc. Finger tip control gives precise temperature — the equivalent of irons in the 10 to 70 watt range. Use Scope transformer for correct operation. With spare tip and element. Cat T-1660

Needs 3.3V @ 30A. Scope Transformer Cat T-1692 $59.95

$59.95

Superscope

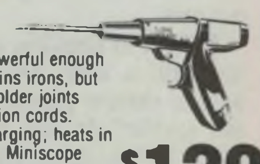


The world-famous Australian! Scope irons are ideal for the hobbyist, the work bench, the lab — everywhere. Because they're made tough to take it, they can! Huge 150 watt capacity and it delivers heat from cold in just six seconds. You dictate the temperature you want. Stainless steel non-corrosive barrel. With spare tip and element. Cat T-1605

Needs 3.3V @ 30A. Scope Transformer Cat T-1692 $59.95

$52.95

Scope Cordless Solder Gun



For soldering where you want it. Powerful enough to handle the same jobs as 60W mains irons, but inbuilt NiCads give you up to 100 solder joints away from power points and extension cords. Includes plugpack for overnight charging; heats in just six seconds and takes standard Miniscope spares. Supplied with charger, two spare elements and two spare bits. Cat T-1600

$129

The Professional 'Pocket' Soldering System

The totally portable professional soldering system from Portasol. The equivalent of 10-60 watts of power with temperature adjustment up to 400° Celsius.

Just the thing for hobbyists, technicians, repairers... anyone who needs to make repairs, alterations, etc. on the spot! Cat T-1374

Look at what you get!

- Pocket sized, temperature adjustable iron
- 4 Tips including hot knife and blow torch!
- Tip cleaning sponge
- Heavy duty plastic case with clip-on iron stand
- Butane powered — refills in seconds
- Average 90 minutes continuous use

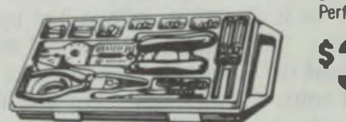
$79.95

Spare tip to suit Cat T-1375 **$12.95**

68 Piece Multipurpose Repair Kit

Already own a multimeter? This set has everything else — and then some! Auto electric checker (6-12-24V), heavy duty pliers, crimp terminal set... with 60 assorted crimp lugs, insulation tape, even connecting wire! A must for the hobbyist, technician — or even the motorist. Cat T-4834

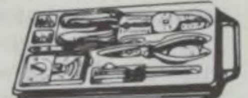
$24.95



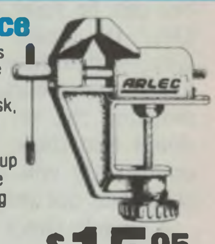
38 Piece Deluxe Repair Kit with Multimeter

Everything for quick and easy wiring repairs — with no soldering! Ideal for automotive and hobby use. Here's what you get: • Multimeter • Crimp Tool • Pliers • 2 Screwdrivers • Neo Tester (rated tp 500V) • Selection of crimp lugs. All in a handy, heavy duty carrying case. Perfect for throwing in the car — just in time! Cat T-4832

$39.95



Arlec Mini Vice



Need a third hand? Here's one that won't let go! The mini vice from Arlec attaches to any table, desk, bench, etc. (up to about 40mm thick). 50mm wide jaws hold tight — opens up to around 60mm for those big jobs. More than strong enough for cutting, filing and other testing applications. Cat T-4748

$15.95

DICK SMITH ELECTRONICS

MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS: • **NSW** • **Armidale:** Sound Components, 244 Beardy St. 72 4981 • **Ballina:** Ballina Electronics, 102a River St, 86 7022 • **Bowral:** F.R.H. Electrical, 28 Station St, 61 1861 • **Broken Hill:** Hobbies & Electronics, 31 Oxide St, 88 4098 • **Charlestown:** Newtronics, 131 Pacific Hwy, 43 9600 • **Coffs Harbour:** Coffs Harbour Electronics, Shop 3, Coffs Harbour Mall, Park Ave, 52 5684 • **Deniliquin:** Deni Electronics, 220 Cressy St, 81 3672 • **Dubbo:** Chris's Hi-Fi, 1/100 Talbragar Street 82 8711 • **Forster:** Forster Village Electronics, Shop 36, Forster Shopping Village, Breese Pde, 54 5006 • **Glen Innes:** John Sommerlad Electronics, Shops 5 & 6 Mackenzie Mall, 32 3661 • **Griffith:** Miatronics, 166-170 Banna Ave, 62 4534 • **Inverell:** Lyn Willing Electronics, 32 Lawrence St, 22 1821 • **Kempsey:** Drummond Home Entertainment, 38 Forth Street, 62 6265 • **Leeton:** Leeton Record Centre, 121 Pine Ave. 53 2081 • **Lightning Ridge:** Lightning Ridge Newsagency, 40a Morilla St, 29 0579 • **Lismore:** Decro, 12 Carrington St, 21 4137 • **Lithgow:** Douroy Photographics, 183 Main Street, 51 3173 • **Moree:** Moree Electronics, 26 Balo St 52 3458 • **Mudgee:** Headware, 136 Church St, 72 3895 • **Nowra:** Nowra Electronics, 77 North St, 21 4979 • **Parkes:** Strad Music Centre, 279-281 Clarinda Street, 62 3366 • **Port Macquarie:** Hall of Electronics, The Horton Centre, 124 Horton St, 83 7440 • **Orange:** Fyfe Electronics, 296 Summer St, 62 6491 • **Springwood:** Wellington's Electrical Discounts, 132 Macquarie Rd, 51 4888 • **Taree:** Brad's Electronics, Shop 6, Civic Cinema Centre, Pulteney St, 52 6603 • **Tumut:** Tumut Electronics, 62 Russell St, 47 1631 • **Ulladulla:** Pauls Electronic & Hobby Toys, Shop 1, 10 Wason St, 55 2454 • **Wagga:** Phillips Electronics, 60 Forsyth St, 21 6558 • **Wellington:** Wellington Electrical Service, 110 Lee St, 45 2325 • **Young:** Keith Donges Electronics, 186 Boorowa St, 82 1279 • **VIC** • **Colac:** Colac Electronics, 215 Murray St, 31 2847 • **[illegible]:** Finders Pty. Ltd., 90 Broadway St, 68 1333 • **Morwell:** Morwell Electronics, 35 Holmes Rd, 34 6133 • **Shepparton:** Phillips Electronics Pty. Ltd., 137 High St, 21 9497 • **Warragul:** Roylaine Pty. Ltd, 16 Smith St, 23 4255 • **Warrnambool:** Marrtronics, Shop 12, Norfolk Plaza, 743 Raglan Pde, 62 9870 • **QLD** • **Bundaberg:** Bob Elkin Electronics, 81 Bourbong St, 72 1785 • **Caloundra:** Electro-Mart, 9 Tay Ave, 91 8533 • **Dysart:** Dysart Videotronixs, Shop 1, Jacaranda Crt Shopping Centre, Queen Elizabeth Drive, 58 2107 • **Kawana:** Splitec, Shop 5, Cartwright Centre, Nicklin Way, 94 7349 • **Mackay:** Stevens Electronics, 42 Victoria St, 51 1723 • **Maryborough:** Keller Electronics, 218 Adelaide St, 21 4559 • **Mt Isa:** Outback Electronics, Shop 71, Barkly Hwy, 43 3475 • **Nambour:** Nambour Electronics, Shop 4, Lowan House, Ann St, 41 1604 • **Noosa Heads:** Sunshine Phone Systems, Shop 6, Sunshine Bazaar, Sunshine Beach Rd, 47 4444 • **SA** • **Mt Gambier:** Hutchessons Communications Centre, 5 Elizabeth St, 25 0400 • **Murray Bridge:** Bridge Communications, 246 Adelaide Rd, 32 6476 • **WA** • **Albany:** Micro Electronics, 133 Lockyer Ave, 41 2077 • **Geraldton:** Batavia Lighting & Electrical, 98a Chapman Rd, 23 1842 • **Harvey:** Harvey Sales & Hire Services, 94 Uduc Road, 29 1819 • **Kalgoorlie:** Todays Electronics, 295 Hannah Street, 21 5212 • **Karratha:** Dave's Oscitronics, 1st Floor, Savings House, Hedland Place, 85 4836 • **Port Hedland:** Ivan Tomek Electronics, 30 Anderson Street, 73 2531 • **TAS** • **Burnie:** V.K. Electronics, 214 Mount Street, 31 7733 • **Devonport:** A.I. Electronics & Hobbies, 165 William St, Fourways 24 8322 • **NT** • **Alice Springs:** Farmer Electronics, 31 Elder St, 52 2388

The Serviceman

More merry dancing with old CTV sets

It doesn't matter how much you know, or how much you think you know. There will always come a time when you find yourself leading a blind horse up a dark alley, or some other equally mangled metaphor. In my case, it's often me leading myself up the garden path, with a familiar old model of colour TV receiver.

This philosophising came about after I had spent several fruitless hours in a Rank Arena, looking for a fault that did not exist.

The set in question arrived one morning with a note 'Doesn't go, but did have a narrow picture and a line down the middle!' It was a model 2204, an early design featuring some fourteen separate circuit boards. I have mentioned before just how handy this multiplicity of boards can be. But it can also be misleading, as this story will show.

To begin with, NOGO in these early Ranks is often nothing more than a broken fuse. F601 on the power supply board PWC-311 is only a 0.5amp unit and these low current fuses have a habit of dying of old age.

However, in this set the fuse was blown. Not violently, but definitely blown. So rather than risk a new fuse, I installed a half amp thermal cutout which I have fitted with short leads and alligator clips. This useful device quickly shows if there is an overload on the rail, but can be reset as often as necessary. Over the years it has proved a lot cheaper than fuses.

The cutout clicked almost as soon as I switched the set on, so there was no doubt that there was a heavy overload on the 120 volt rail. In the event, the cause was not very hard to find.

A quick check with my multimeter showed zero ohms resistance between the 120 volt rail at Test Point 91 and ground. The most likely cause of such a complete short is the line output transistor, shorted between collector and emitter. And so it was.

I pulled the transistor from its socket, checked that it was indeed faulty, then left its replacement aside until I had determined what had caused the original transistor to fail. (It is all too easy to replace a faulty transistor, only to see the replacement blow instantly because other troubles have not been found and corrected.)

There are several things that can cause line output transistors to fail. One such is faulty drive. The drive must switch the transistor very quickly, and anything that slows the switching will almost certainly destroy the transistor. The set's owner had mentioned a line down the centre of the screen, and this could imply a drive fault capable of killing the output transistor.

Unfortunately, to get at the line drive waveform, I had to get the line output stage working. The output supplies the low voltage rails that run the driver, a real chicken and egg situation if ever there was one. There are ways around this impasse, but I decided to leave that check until later.

In the meantime I wanted to know if the power supply was working properly. It is not unknown for the series regulator transistor TR691 to go short circuit, putting some 160 volts on the 120 volt rail. This would certainly make life difficult for the line output transistor, so it had to be investigated.

In fact, it was here that I appeared to strike oil. The rail was up to 160 volts, although at this point there was no load on the circuit. What I wanted was a variable dummy load, one that could indicate just how well, or badly, the supply board was regulating.

The November 1986 edition of *EA* (p63) described a low cost dummy load using six light bulbs ranging from 15W to 150W. It was the ideal load for the power supply now under test, and I lost no time getting it connected between the rail and ground.

I selected a 100W load, and switched on. The lamp seemed to light more brightly than it should have done, with only 120V across it. In fact, the rail was still up to the 160V measured earlier and the 'B+ adjust' trimpot VR602 had no effect whatsoever.

I then tried the 150W lamp, only to have the thermal cutout trip off. So I tried reducing the load. Even down to 15W there was no change in the output voltage, while the adjustment pot did nothing at all at any load level. So, it was rather likely that the regulator transistor was short circuited.

A voltage check at the plug leading to the transistor showed the same voltage on the collector (FU4), base (FU3) and emitter (FU2). If there is the same voltage on all three terminals, then the transistor has to be shorted. Or so you might think!

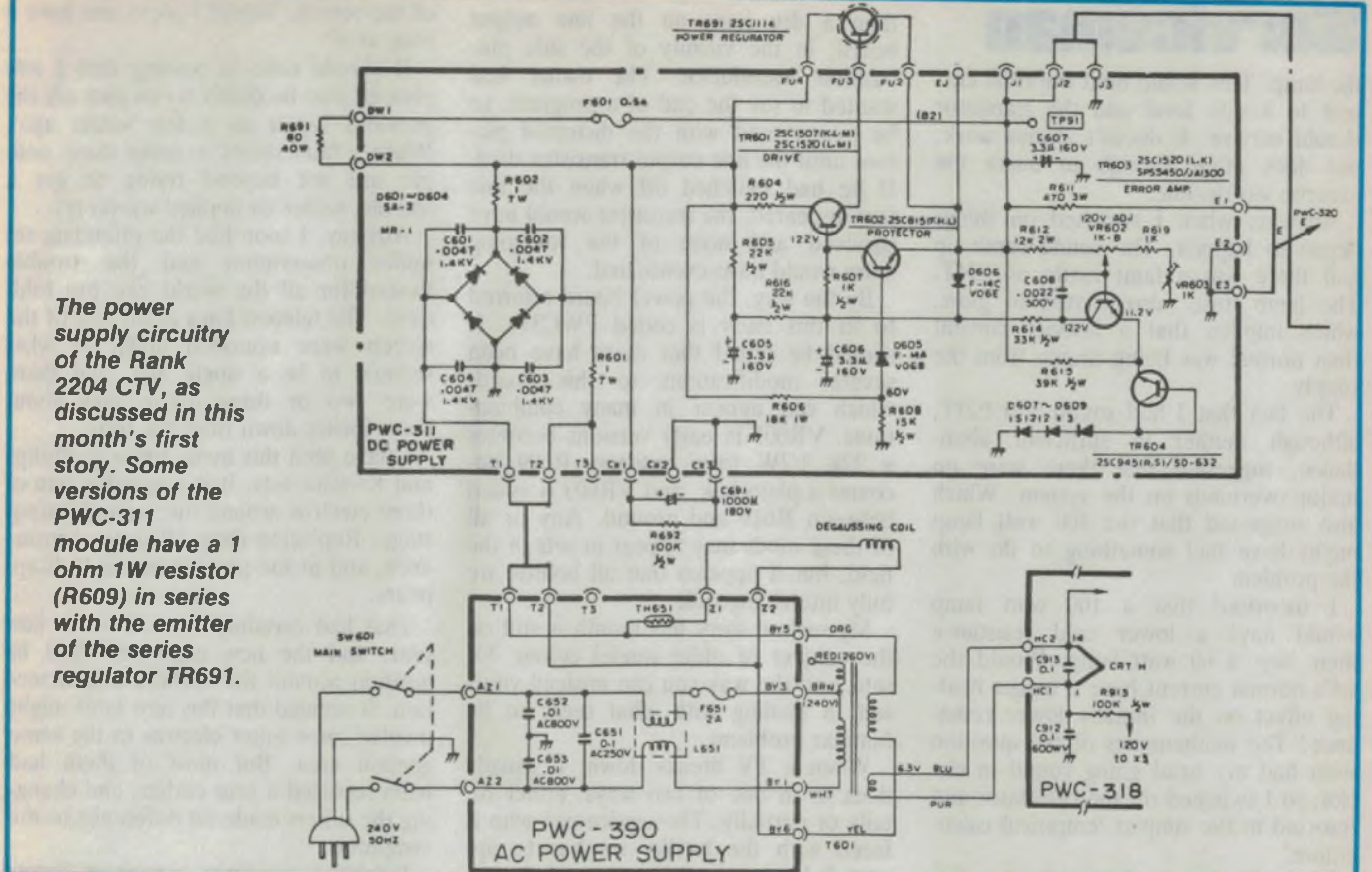
I pulled out FU and tested the transistor from the plug. (The transistor is mounted deep inside a large collection of circuit boards and is not easy to get at). This was a real let-down, because every test I could do showed the transistor to be perfect. No sign of shorts or leakage. So, if the transistor was OK, why didn't it regulate?

And this is where the story really gets interesting.

At this point, I decided to try some board substitution. Luckily I have a complete set of known good boards for this receiver so I selected the power board and plugged it in. I set up the dummy load as with the faulty board and switched on.

The result was most surprising. The output voltage was up to 160V and the adjustment pot had no effect, just as in the other board. Yet it was perfect in other sets – why not in this one?

I spent the next couple of hours comparing the faulty board with the good one. I swapped components between boards: I replaced anything that was the slightest bit doubtful: I even pulled the set apart to replace the series regulator



The power supply circuitry of the Rank 2204 CTV, as discussed in this month's first story. Some versions of the PWC-311 module have a 1 ohm 1W resistor (R609) in series with the emitter of the series regulator TR691.

transistor. All to no avail, because both boards refused to regulate the output voltage.

Then I had a stroke of luck. My battery went flat! The battery was a 9V 216 type in my digital multimeter. It chose this time to die, although it had been giving ambiguous readings on the low ohms ranges for a couple of days. Fortunately, I didn't get a new battery immediately but decided to wait until the time came to order new stock. if I had replaced the battery then I might never have found the trouble with this Rank.

Being forced by circumstances to use my old analog multimeter, I went over both boards again, to re-establish the readings at various points around the circuit. In fact, most analog readings were very close to the same digital readings, which says a lot for the older multimeter.

Still, two of the readings were *very* different on the faulty board. They were the emitter and base voltage readings at plug FU2 and FU3. They were both zero volts, where they had been 160 volts when measured with the digital meter.

And suddenly, the whole miserable picture came clear. The Rank power supply board is unusual in that the series regulator transistor passes only part of the output current. The rest goes through the parallel path R691 (80Ω 40W) and fuse F601. In fact, I had been driving the dummy load through R691 and the fuse, with no contribution at all from the transistor.

The high voltage which I had been measuring in the base and emitter circuits with the digital meter disappeared when loaded with the much lower impedance of the analog meter. It was not even leakage that I was looking at – just a static voltage on the two elements that was not discharged by the multi-megohm impedance of the digital meter.

This digital multimeter problem is a real trap around low impedance circuits. I've been caught a number of times before and have yet to work out an effective way to avoid the problem. The trouble is that the digital meter's accuracy and sensitivity engenders a trust that can sometimes be misplaced.

The reason why the transistor was asleep on the job was not hard to find. R609, 1Ω 1 watt resistor in the emitter circuit was open circuit. For all that I could see, replacing this resistor should restore the supply to normal operation. But I couldn't make out why the good board wasn't working in this set either.

After replacing R609, both boards gave exactly the same readings, and neither would regulate the output down to 120 volts. Yet the good board had worked perfectly in another set only a week ago. The only difference that I could see was that I was now using a dummy load.

The rated consumption of this set is in the order of 150 watts, and in fact I found the fuse to blow at something over 100 watts. Allowing that the heater current, degaussing standby current and the panel lamp current do not go through the DC supply, I reckoned that the 100 watt lamp was a good, representative load on the supply.

Then I started to wonder if there was some subtle difference between a 100 watt resistive load and the 100 watt inductive load imposed by the line output stage. It could only cost me a 2SD350 to find out. So I installed the transistor in its socket and fitted a 100 watt lamp across the fuse holder, in place of F601.

The idea of using a lamp in place of the fuse is a useful trick. At low current levels the lamp has very low resistance and looks like a normal fuse. At higher currents the lamp's resistance rises and limits the total circuit dissipation.

If some fault should drive the output transistor to saturation, the whole of the supply voltage would be dropped across

Serviceman

the lamp. This would limit the total cui rent to a safe level and the transistor should survive. It doesn't always work, but does often enough to make the exercise worthwhile.

Anyway, when I switched on things began to happen. The sound came up and there was a faint rustle of EHT. The lamp 'fuse' also started to glow, which implied that a heavier current than normal was being drawn from the supply.

The fact that I had sound and EHT, although neither in sufficient abundance, suggested that there were no major overloads on the system. Which also suggested that the 100 watt lamp might have had something to do with the problem.

I theorised that a 100 watt lamp would have a lower cold resistance then, say, a 60 watt lamp. Would the set's normal current have a bigger heating effect on the initially lower resistance? The mathematics of the question soon had my head going round in circles, so I switched off the calculator and resorted to the simpler 'empirical calculations'.

My multi-element dummy load makes it very easy to try these experiments. I switched off the 100W lamp and turned on a 60W lamp in its place. I was immediately rewarded with loud sound, full EHT and very soon a first class picture.

What is more, the 60W lamp stayed dark. The 120 volt rail now measured about 130 volts, but it responded immediately to the B+ adjustment. When I replaced the lamp with a proper 0.5 amp fuse, the rail was slightly high again, but there was no difficulty in setting it to the correct level.

I tried my spare board again and it also worked perfectly. Yet if I returned to the dummy load, neither board would work. I can't see sufficient difference between the dummy load and the true load to explain the extraordinary difference in the two modes of operation.

Most other DC supplies I have worked on will regulate into a dummy load just as well as into the true load. This Rank board has to be the exception to the rule. So I spent about four hours trying to find a fault that didn't exist. I've made a note in my service manual so that I won't be caught by that one again.

And the vertical line that had precipitated this exercise? It was nothing more than a dry joint on the line output board, in the vicinity of the side pincushion transductor. The owner had wanted to see the end of a program, so he perservered with the distorted picture until the line output transistor died. If he had switched off when the line first appeared, the transistor would have survived and none of the foregoing story would have eventuated.

By the way, the power board referred to in this story is coded PWC311. It should be noted that there have been several modifications to this board, which can appear in many combinations. VR601 in early versions becomes a 22k 1/2W fixed resistor. R609 becomes a plain link, and VR603 is added between R619 and ground. Any or all of these mods may appear in sets in the field, but it appears that all boards are fully interchangeable.

My second story this month is still on the subject of older model colour TV sets, and the way you can mislead yourself in dealing with what seem to be familiar problems.

When a TV breaks down, it usually does so in one of two ways: either totally or partially. The serviceman who is faced with the baulky set has to approach his job in the manner appropriate to the nature of the breakdown.

If the set is totally dead, one has to start from the premise that the power supply is not working, and to make all the tests inside the cabinet that will reveal why this is so.

If the set is working, but not properly, we have to evaluate the total operation and decide which sections are OK, and which are faulty. This kind of examination has to be done from outside the cabinet – with any luck we will know the answer even before the back comes off.

Of course, the decision can only be made on the basis of one's reading of the symptoms and if these are misinterpreted, one goes off on a wild goose chase that wastes time and gets nowhere.

The story I'll now relate well illustrates just such a mis-reading of clear and obvious symptoms.

A year ago, I was called in to service a Philips K9 which was suffering from bottom foldup of the picture. This offered no problems; replacing one faulty and two or three suspect electrolytics cured the trouble completely.

So I was rather surprised when the customer stopped me in the street one day to say that the trouble had returned. Only this time, it was at the top of the screen. Would I come and have a look at it?

(I should note in passing that I was pleased that he didn't try to pass off the previous repair as 'a few weeks ago'. When a fault seems to recur many people are not beyond trying to get a freebie, under an implied warranty).

Anyway, I soon had the offending set under observation and the trouble looked for all the world like top foldover. The teletext lines at the top of the screen were squashed down to what seemed to be a single line, and there were two or three other lines about three inches down from the top.

I have seen this many times in Philips and Kriesler sets. It is invariably one of three electros around the vertical output stage. Replacing them all is good insurance, and in the process the fault disappears.

That had certainly been the case last year, and the new caps were still in position around the vertical output section. It seemed that this new fault might involve some other electros in the same general area. But most of them had been replaced a year earlier, and changing the others made no difference to the symptoms.

I dabbed substitute capacitors across all of the other electros in this part of the set, but nothing seemed to alter the position of the lines. So then I tried the height and linearity controls.

The height control is on the mains deflection board, alongside the vertical output transistors. It is clearly marked with a symbol representing its function and is in all ways an admirable presentation. (It's a pity some other sets couldn't be so well laid out in this area. It is often that the controls are not marked at all and one must adjust everything until one finds the required result!)

Reducing the height had very little effect on the symptoms. The teletext lines opened out to what appears to be the normal three or four lines, but the others remained immovable at something like forty lines down from the top of the picture.

At this point I decided that the fault wasn't on the vertical output board at all, but probably originated in the vertical oscillator and linearity circuits.

Unlike the height control, the linearity control in a K9 is nowhere near so easy to find or adjust. It is inside U335, the Frame Control module at the bottom centre of the small signals panel. The vertical hold control is also in this module, and both require the use of a small bladed, insulated trimming tool for adjustment.

The linearity control did seem to operate in the normal way. It squashed or stretched the circle in the SBS test pattern, but seemed to have no effect whatever on the position of the troublesome lines. Not even replacing the U335 module made any difference to their position or intensity.

At this point I was forced to re-evaluate my approach, and it was then that I did what I should have done at first – use my pattern generator as a signal source instead of the off-air signals.

When I tuned the set to my generator, there was no trace of the lines!

Retuning the set to a commercial channel produced two fixed lines. And the ABC channel produced two lines with some kind of moving, digital signal imposed upon them. Quite obviously, these were test signals of some kind produced by the professional transmitters, and were not being produced by my pattern generator.

From this I deduced that the lines were probably meant to be there during vertical flyback, but should have been blanked by the set so that they did not appear on the screen. And so began an entirely different approach to the troubleshooting: looking for a problem in blanking rather than linearity.

Unfortunately, the Philips K9 manual was printed in Europe and uses European conventions in the circuit diagrams. For the most part, circuit operations are denoted by symbols meant to illustrate the function, but only some of the symbols are explained. The rest have to be guessed at.

So it is with blanking pulses. The circuit diagram carries nothing at all to indicate where blanking originates, or to where it is applied. Some waveforms appear on the circuit diagram, while others are shown on the PCB pattern sheets, and yet others on a page that illustrates the various control module connections.

It was on this last page that I found a waveform marked 'Fly-back Suppr'. This waveform was applied to pin 7 of U260, the 'CHROMA-LUM' module and looked like as good a place as any to start my search for an answer to the blanking problem – if indeed I had a blanking problem.

As a matter of interest, and before I started to check the actual waveforms in the set, I studied the circuit diagram to ensure that I knew what I was looking at and where it came from.

In the Philips circuit diagrams interconnections between sections of the set are not shown as individual lines, but as a thick black line intended to represent a bundle of connections going to various parts of the circuit. Tracing a line from point to point entails noting a number at the place where the lead enters the black line, then looking for the place where the same number emerges again from the line.

This system may well make for tidier schematics, but doesn't make things easier for the busy serviceman. One's eyes run backwards and forwards along the line, up and down the various branches, and if one is lucky, eventually locating the number one is seeking.

And so it was in this case. The blanking pulses are fed to pin 7 from two sources. One is marked 9, and the other 32. Both lead off in a clockwise direction toward the other side of the diagram. The source of 32 is not easy to find, because it doesn't appear on the line itself. It seems that the one pulse goes to two places, 32 and 33, and of course 33 is the number against the line. 32 is printed above it and although clear enough once found, is nonetheless hard to see first time around.

But all of this was time more or less wasted, because 32 turned out to carry a line frequency pulse, and I was looking for frame frequency pulses.

That left number 9 as the source of frame blanking, and so it was that line 9 dived into a two transistor network attached to the vertical output section.

The function of these transistors is not clear, nor is there any indication on the schematic as to just what they do. In fact, one transistor appears, at first glance, to be driven through its collector, with output being taken from its base!

Still, I felt I was getting close to solving the problem, because at some time in the past I must have encountered this or a similar blanking problem before. I had ringed C572 in this network and noted against it 'retrace lines? blanking!'.

C572 was one of those old grey Japanese capacitors, and it had changed colour to a dirty brown. What's more, its plastic coat had shrunk. That's as good a sign as any that the cap is faulty, so out it came and in went a new 'un. But it wasn't faulty, and the lines on the screen were still as conspicuous as ever.

From here on there was nothing that could be done without the 'scope, so the covers came off and the old BWD was stoked up ready for action. What follows is really a bit of an anticlimax, because if I had read the symptoms properly, I would have reached this point two hours before.

The scope showed me that on pin 7 of U260 there was plenty of line frequency pulses, but not a trace of frame frequency pulses. These enter the small signals board at plug 8, pin 4 and here there was frame pulses aplenty. From the plug they go through R267 (5.6k) and C265 (22uF 63V) to pin 7 on U260. The resistor had good pulses at each end, so it wasn't open. But the cap had pulses only on the resistor side, so one didn't need to be very bright to realise that it was open circuit.

When I removed the cap, one of its two wire legs stayed stuck to the circuit board. So that removed all doubt. A new cap was soon fitted and the set was soon going like a bought one.

So back to the philosophy expressed in the first paragraphs of this story. When a set is working, though not very well, the symptoms must be accurately evaluated. Many faults look alike, but subtle differences can make big differences (sorry!).

In this case, only the fact that my pattern generator was not producing the fault that appeared on off-air signals led me away from the linearity theory. And the off-air problems led to the idea of blanking troubles. Even though both faults produce (almost) identical symptoms.

Just before I end off, have you spotted an apparent anomaly in the foregoing story? Early on I said that I used the SBS test pattern to check linearity. But an old K9 set won't tune UHF, will it? So how was I using the SBS signal?

In fact, I have a video recorder permanently connected to my workshop antenna system. I was using this as a tuner for the SBS test pattern, with the result that has been described above. Sometimes, I'm too smart for my own good!

See you next month.

TETIA Fault of the Month

Philips K9 chassis

Symptom: Two or three flyback lines at top of screen. Height and linearity controls work normally, but no combination of settings will remove lines.

Cure: C265 (22uF 63V electro) open circuit. This cap feeds vertical blanking pulses to the luminance circuits in U260. With this cap open there is nothing to blank the test signals in the vertical retrace interval.

Silicon Valley NEWSLETTER . ■ ■

Cypress plants money in Aspen

Cypress Semiconductor, one of the most successful of the most recent wave of semiconductor start-ups, is funding a new chip company to help it grow and maintain the entrepreneurial spirit it credits for its success.

Recently the San Jose chip maker announced that it has provided $US7.4 million to fund Aspen Semiconductor, of San Jose. Aspen is developing a technology that, if successful, would complement Cypress' line of high-speed memory chips. Cypress has an option to buy Aspen, which currently operates in one of the buildings occupied by Cypress in North San Jose.

'What Aspen really represents is a diversion of our research and development funds from our internal R&D to a separately funded R&D effort in the form of another company,' said T.J. Rodgers, Cypress' president and chief executive. 'It follows our company's philosophy of trying to maintain a high degree of entrepreneurship. Start-ups have higher energy levels than larger companies.'

Rodgers said he hopes to continue funding new ventures that, like Aspen, someday could be fused into the company. He said he has reviewed about 20 business plans this years and is close to providing the seed money for another venture.

Cypress Semiconductor's facility in North San Jose, from where startup Aspen Semiconductor is currently operating.

Defence projects enveloping valley in secrecy?

In the past few years, the empty shells of some of Silicon Valley's old start-up companies have been taken over by the most reclusive sector of the defence industry – so-called 'black' programs of electronic espionage, that are neither in the federal budget nor ever made public.

Today, defence analysts say, more of the Valley is stamped secret than ever before.

Exact numbers are hard to come by because of the secrecy surrounding the projects which generally involve spy and communications satellites, electronic espionage and 'star wars' research. But their growth has been unmistakable, partly because of elaborate security measures intended to foil Soviet snooping.

According to one top defence industry executive, who asked not to be identified, there has been roughly a 25% growth in black defence business here in the past year.

The botton line is the defence business has become an increasingly important part of the Silicon Valley economy, and the classified part of that has grown at least commensurate with that, and maybe even more so,' the executive said.

'It's partly that the black programs benefited from the Reagan defence buildup. It's also partly that for a lot of the kinds of things the classified community does, California has the technology. Not uniquely so, but more uniquely so than not, the kind of technology they are interested in tends to be here.'

The effects can be seen throughout the Valley, where a growing number of people work inside steel walls. They operate in a world of compartmentalised, 'need-to-know' information, silent alarm systems, special tap-proof telephones, security guards and secret codes.

To protect the projects from eavesdropping by Soviet satellites, defence contractors are lining the insides of all commercial buildings with steel or double walls before moving into them.

These concrete and steel interiors, welded shut and encased in soundproofing, are known as SCIFs or 'skiffs' taking their name from the acronym for Secure Compartmented Information Facility. The term is used by the National Security Agency to denote buildings impervious to electronic eavesdropping by the Soviets.

The valley's premier SCIF is the windowless 'blue cube', an Air Force satellite control facility in Sunnyvale.

According to Desmond Ball, an Australian expert on US space surveillance systems, there is increasing concern about mobile Soviet monitoring systems.

'In the last few years, there's been a whole burst of Soviet monitoring. There has been evidence the Soviet Consulate in San Francisco has operated a van that goes around and parks in front of these places,' Ball said.

US Senator accuses Japan over DRAMs

Tempers continue to flare in both the computer industry and in Washington over the shortage of DRAM memory chips, as US Senator Pete Wilson openly accused the Japanese government and chip suppliers of implementing 'predatory' actions aimed at creating a chip shortage. Meanwhile, the president of one major US DRAM user has proposed that US computer makers build their own joint DRAM production facility.

According to Wilson, the Japanese government has tried to get the Reagan Administration to drop $US165 million worth of trade sanctions in return for increased DRAM allocations to the US market. Wilson said his office has also learned of attempts by individual Japanese chip suppliers to try to pressure US customers to give up some of their technical secrets in return for shipments of the critical DRAM chips.

Wilson said these tactics are deplorable and vowed to seek additional trade sanctions against Japan to be added to the $US165 million in sanctions that are still in effect from Japan's inability to increase access to the Japanese market for US-based chip makers, as it is supposed to under the US-Japanese chip trade agreement.

Meanwhile, Scott McNealy, president of Sun Microsystems, told a gathering of venture capitalists that he would like to see a number of computer makers jointly build a DRAM facility that would guarantee them a reliable source for the critical DRAM chips at low prices.

McNealy invited the venture capitalists to join in such a project. But several of the attending venture capitalists were rather cool to the idea, saying the Japanese have such a lead in DRAM technology, it would be too costly for computer makers to match Japan's capabilities. 'I don't think there is any way to catch them,' conceded Pierre Lamond, a former National Semiconductor executive who is a partner in Sequola Capital.

Apple-Microsoft lawsuit raises questions

Was Apple's lawsuit against Microsoft an 'Ace-in-the-hole' kind of move held back until such time it would do the most damage against arch-rival IBM?

Why did IBM allow itself to be in such a vulnerable position in which it now faces a possible trashing of its personal computer software strategy?

Does Apple really have a chance to win its case?

Such are just some of the questions being pondered by most personal computer industry executives and analysts.

Particularly puzzling to many is why IBM would allow Microsoft to develop a presentation manager for its OS/2 operating system without having resolved the copyright and licensing issues that might be involved.

In 1985 Microsoft was granted a licence by Apple to incorporate Macintosh-like features in its Windows 1.0 operating systems. If IBM was aware of that, it should have known better than to go ahead with the development of the Presentation Manager without a similar legal assurance from Apple.

Perhaps IBM simply assumed that Apple would again provide a licence for Windows 2.0, on which much of the Presentation Manager is based.

Perhaps IBM fell in a carefully set trap if Apple, all along, had no intention of granting such licence but waited long enough with pressing the issue until it was too late for IBM to turn back and develop an alternative Presentation Manager.

If that is the case, and Apple prevails in court, the company may have pulled one of the most brilliant defences against a giant competitor in industrial history.

Still, many in the industry, particularly those on the IBM side of the issue are outraged that Apple had the tenacity to press copyrights on technologies it has publicly admitted of having 'borrowed' from Xerox.

Back in the early 1980s, Xerox invited Apple co-founder Steve Jobs to its Palo Alto Research Centre to show off some of the fancy computer technology it had been developing. Jobs was fascinated with the icons, mouse and other features of the Xerox technology. He immediately put these and other ideas to work in the Lisa system, and later in the highly successful Macintosh.

'Apple will have to prove it owns what they are defending. That won't be easy. Certainly things were borrowed from Xerox,' admitted Andy Hertzfield, one of the key members of the Macintosh development team.

If the case ever gets to trial, expect Microsoft to parade a long line of witnesses through the courtroom, all of whom will reitterate that point.

Sematech mixed blessing for small firms

Sematech, the chip industry's manufacturing research consortium, is not about to change its rules to allow smaller and non-US chip makers to participate in the venture.

While all of the larger US chip makers have joined Sematech, it counts only two firms with sales less than a billion dollars (Micron Technology and LSI Logic).

Sematech has been criticised by smaller chip makers for being locked out of the consortium because of its high membership fees. While many small firms would be willing to accept the rule of contributing 1% of their gross sales to Sematech, the $US1-million minimum entrance level is far too high for companies with sales less than $100 million. In case of Seeq Technologies, for example, the firm would have to hand over 57% of its 1987 profits to Sematech.

A Sematech official confirmed there are no plans in the works to change Sematech's membership rules. But he added that small chip makers will be able to benefit from the consortium's research without having to pay anything.

This is because equipment manufacturers who will be developing the necessary production systems will be allowed to sell the equipment on the open market, after the six-month lead time the equipment manufacturers must give to Sematech members.

Also, Sematech will license its process and other technology to non-members after a certain lead-time designed to give its members an edge over non Sematech companies.

Meanwhile, Sematech's doors will remain closed to Signetics, a company that has expressed a strong interest in joining Sematech, but is barred from doing so. According to Sematech rules, its members must be controlled by American interests.

Signetics, which thinks of itself as an American company according to spokeswoman Susan Scott, is owned by Philips of the Netherlands.

The irony in Signetics' case is that the company is a major supplier to the Pentagon which is funding Sematech with $100 million in annual subsidies for the next five years. While it would seem in the Pentagon's interest that Signetics be a member to Sematech, the company will not be allowed to join under current Sematech rules.

Recording Australia's Oral History – 2:

Choosing a Recorder

In this second article in his short series on recording oral history, the author discusses which kinds of recorder are best suited for this kind of work. He also explains the things to look for when choosing one.

by JIM LAWLER

Throughout these articles I will concentrate on 'monophonic' productions. For the most part this is what can be done best on domestic equipment. Simple interviews, or a talk by a single person does not demand a stereo production.

Only if you plan to sell your output for radio broadcast is the requirement for stereo likely to arise, and then you will have problems in producing material of suitable quality without professional equipment. We will not consider stereo production in these pages.

Also, bear in mind that our recordings will be mostly speech, with some low level sound effects in the background. For this reason we are not looking for high fidelity, wide frequency response and enormous dynamic range. All we need is intelligible speech – clean, clear sound at levels that don't make heavy demands on either the listener or the equipment.

Recorders

I have been involved with recording since the days when we used lacquer-coated aluminium discs, in big machines that would break an elephant. These machines allowed no editing and the recording had to be made in one take, mistakes and all.

Then came open reel tape recorders, which gave us the opportunity to edit the recording or to re-record if the take was just too bad.

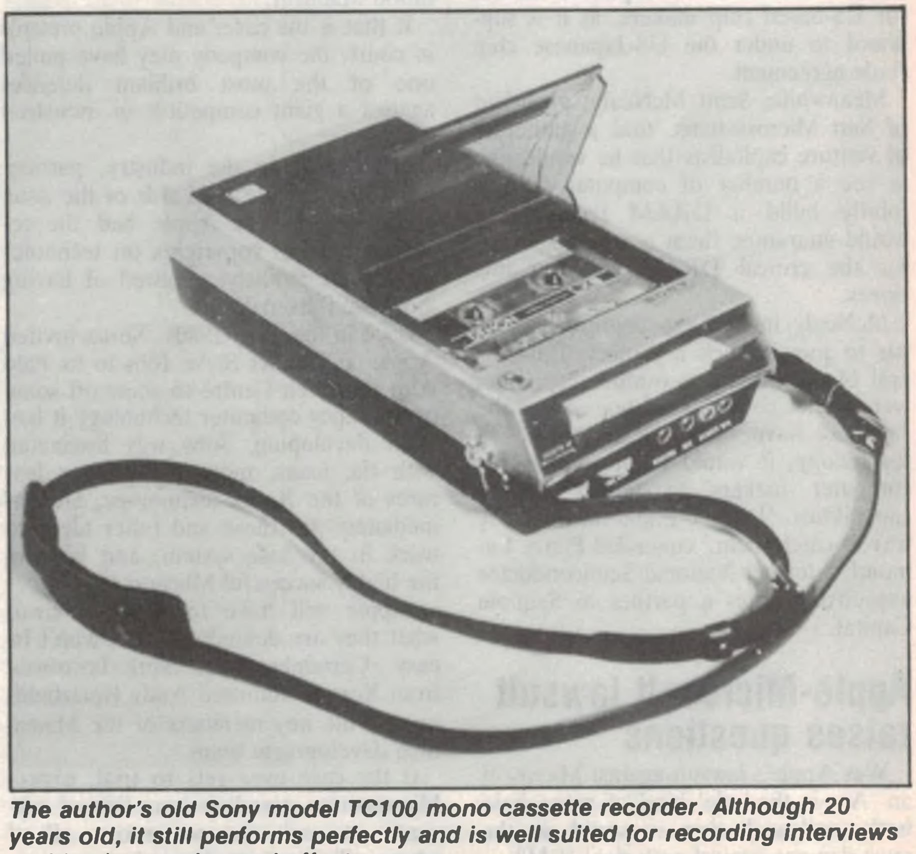
Finally, we have come to cassette recorders which are nearly back to the disc era, in that editing is difficult, if not out of the question. Only media economy remains the same as in the open reel tape era – we can at least re-use the cassette if we make too many mistakes.

Open reel recorders are ideal for editing and for the preparation of master tapes. Even the simplest open reel machine usually offers good quality, simple operation, and some degree of editing facility.

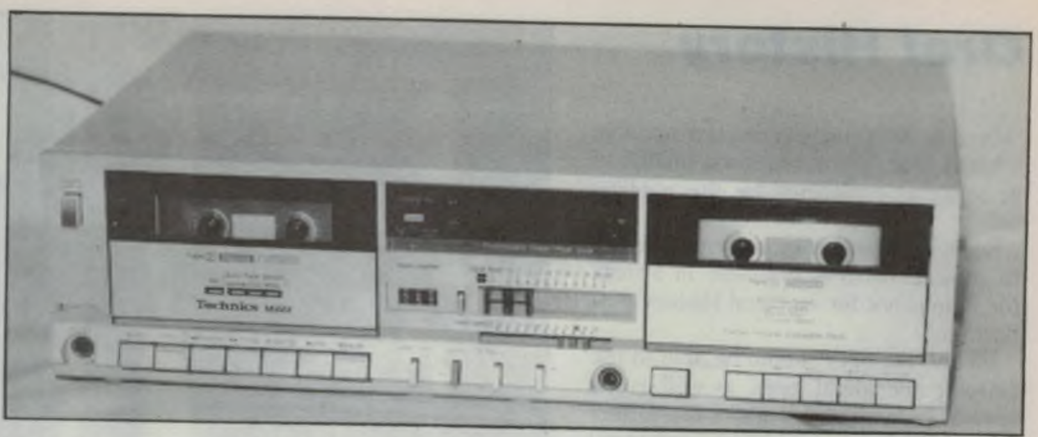
Unfortunately, open reel recorders have gone the way of the Dodo and most folk now use cassettes for both portable and static recording. Cassettes might be convenient, but most machines leave the user with very little control over what they are doing. If you have an open reel machine, by all means use it for your editing and making a master tape, but we won't consider open reelers again in these articles.

Cassette recorders are not designed to facilitate editing, although some can be used in spite of their unsuitable design. In a later article I will show how this can be done with a cassette recorder, though success will depend on a good knowledge of the particular machine and a good deal of practice.

I will divide the rest of the present article into two parts – portable recorders and stereo decks. We will look at what is desirable, rather than what is available. Then if your equipment doesn't suit, you will know what to look for when you go shopping.



The author's old Sony model TC100 mono cassette recorder. Although 20 years old, it still performs perfectly and is well suited for recording interviews and background sound effects.



A Technics M222 dual cassette deck, very suitable for editing because of its precise soft-touch controls. It can also make very accurate copies or 'dubs' at twice normal speed.

Portable recorders

At one time portable cassette recorders were just that, simple, plain monophonic machines that offered reasonable quality and no frills. Now they are fully stereo and combined with AM/FM radios, stereo amplifiers, graphic equalisers, sing-along microphones and some of the latest even have compact disc players built in. These 'ghetto blasters' are not for us.

In fact, stereo is a distinct disadvantage in our exercise because of its poorer 'signal to noise ratio'. A good S/N ratio relies on picking up as much signal as possible from the tape, and this is directly related to *track width*.

Because cassettes are 'turnover' devices, a one-way track cannot occupy more than half of the tape width. Then for stereo, two signals have to be recorded side by side, so that each can only occupy no more than one quarter of the tape width. Then there has to be a guard band between the two tracks, so you can see that there is very little tape left to record a signal on.

A mono signal, on the other hand, can occupy not only the same width as the two stereo signals, but also the guard band between them. So a mono recorder can record its single signal over more than double the track width, for significantly better signal to noise ratio.

A 'Walkman' type personal portable cassette recorder would seem to offer advantages for interview work, particularly in the field. In fact they are ideal for journalists and others who have to take notes which are later transcribed to print. However, these are all stereo recorders and suffer from the signal to noise ratio problems mentioned above.

Other limitations stem from the tiny built-in microphones used in these little machines. These have restricted frequency response and limited dynamic range, so unless the machine has an external microphone socket, there is little chance that it can be used successfully for our work. I have tried several different models and have not been satisfied with any of them.

It could be hard to find a new mono cassette recorder these days, so it might be worthwhile getting an old one reconditioned. This would require new drive belts, a new record/replay head, and possibly a new motor. All of this might cost as much as the machine did when new, but it will then be 'As New', and capable of performing better than any new stereo machine, for our particular application.

Another difficulty with portable cassette recorders is that most of them use ALC (automatic level control) recording. This was incorporated by the manufacturers to relieve the user of the tedium of setting the recording level. Unfortunately this works against us for our kind of work, because the ALC raises the level of background noise during pauses in the subject matter.

There is nothing much you can do to beat ALC if the manufacturer has not given you an ALC on/off switch; you cannot totally avoid the 'breathing' effect during pauses in your interview. However, by selecting a quiet location for the recording, there will be little sound for the ALC to pick up during the pauses, and the 'breathing' will be far less noticeable.

Also, careful use of a directional microphone will help to minimise this problem. A microphone with a narrow pattern can be pointed at the speaker's mouth. This discriminates against the background noise, which then comes in from the side. To use this kind of microphone you must keep moving the mike from interviewee to interviewer in turn, but it does help to lower the background noise during pauses.

The secret of good recording is to put down the strongest signal possible, without overloading the tape. With ALC this choice is out of our hands and the 'strongest signal' is only that which the system allows. Modern tapes can handle more signal than earlier varieties, but this ability is not used in ALC machines.

Most modern portable cassette recorders have built in electret microphones, like the Walkman-type models. As noted before these are effective enough for non critical work but are subject to handling and mechanical noise. Far better to have a separate microphone which can be selected and positioned to best suit the situation. Also, it is generally less offensive to poke a microphone at the interviewee than to poke the whole recorder at him or her!

A leather or plastic carrying case can protect the recorder, but it can also get in the way of the controls and make operation difficult. Unless it is a well designed case, it's better to leave it off. A shoulder strap is useful for carrying the machine, but don't try to record on the move with a domestic recorder.

Finally, the batteries used to power your recorder should be no smaller than standard C cells. These cells offer a reasonable service life and are not likely to die on you during a session, if they are in good condition at the start. In fact D cells are preferred for heavy duty and professional applications, but they tend to make the machine big and heavy.

To sum up, then, we are looking for a monophonic cassette recorder, powered with C or D cells. It does not need a built-in radio, or a big, fancy loudspeaker. And if it does have a built-in microphone, it must also have an 'external mic' socket which automatically disconnects the internal mike.

Stereo cassette decks

For the purposes of this discussion, the word 'deck ' refers to a separate cassette recorder, normally intended to be used as part of a hi-fi system. An integrated radio cum record player cum cassette recorder, commonly called a

Oral History

'Three in One', may possibly be usable – but is generally of too low a quality to be seriously considered for this application.

So, with that out of the way, we get to consider what is desirable in a deck for serious use for our Oral History productions.

Firstly, the deck should be able to use Chrome and Metal tapes, as well as the normal Ferro types. Both of the former types offer lower tape noise, and metal tapes can also handle higher recording levels without saturation. This results in better signal to noise ratios, a most desirable feature if the tape is to be copied several times during editing.

The mechanism should preferably be solenoid controlled. This is by far the fastest and most accurate control method. Soft touch controls are driven by the deck's motor and these too are generally quite fast and give good control. The machine's User Manual should tell you which system it uses.

If the manual is not available, you can sometimes tell the difference by the sound the machine makes during operations. Solenoids usually work with a moderately loud 'clunk' and you can feel the thump of the solenoid inside the machine. Soft touch machines make a much softer 'click' and seem to be altogether gentler in operation.

However, some soft touch systems require the motor to come up to speed before the control operates, and this delay can spoil an otherwise good deck.

Piano key operation is wholly mechanical and is too slow for our present purposes.

The mechanism must have an efficient PAUSE function. This should stop and start the tape instantly, without any backlash. If the tape moves after the pause button is pressed, or there is any delay in starting the tape when the button is released, it will be very difficult to make a neat edit with that deck.

Most cassette decks have line level input and output sockets. This is the absolute minimum. If the unit also has phono inputs, so much the better. Microphone inputs can be a useful extra, provided they can be mixed with the line and/or phono inputs and there are separate volume controls for each circuit. An output socket for headphones is also very useful, again provided that there is a volume control on the output line. (All of these ins and outs are rendered unnecessary if a separate mixer is used. This will be discussed in a later instalment).

For outdoor use, microphones should have a good windshield. Foam type windshields as shown here must be snug fitting.

If you are going to buy a machine especially for this type of work, it will serve you well to consider a dual cassette deck. These machines have two cassette mechanisms, both of which can play tapes although usually only one can record. Because of the way they are organised, it is easy to copy from one tape to another, often at double normal speed. However, it is not usual for these machines to mix line input material with the tape being copied. For this you will need a second machine and an external mixer.

All good cassette decks, either single or dual, have manual recording level controls. Some might have ALC fitted, but always with an on/off switch. So, if you are to know the level you are putting on the tape, the deck must be fitted with good, clear level meters. I still prefer analog meters (the dial and pointer type), although LED or LCD bar-graph meters are becoming more common, probably more on the basis of lower cost than on any demand by users. Either type gives an unambiguous reading so perhaps there is little to choose between them (although in theory, the newer type should respond faster to sudden peaks).

One last point about your equipment. Make sure that the deck you are using has its controls clearly marked. There is nothing more frustrating than to see the tape fast forward when you are certain that you pressed the PLAY button!

If you need to play your original mono tape in a stereo deck, say for dubbing background sounds into an interview for your final mix, always remember that the stereo deck will pick up less than the whole of the available mono signal. For this reason it is important to dub onto a Chrome or Metal tape, for the lowest possible noise level. You may find that you get better results by playing the mono tape on the mono recorder and dubbing across to the stereo deck, with an appropriate connecting lead.

Finally, should you use a noise reduction system – Dolby, ANR or DBX? My preference is to work without noise reduction up to the final mix, because it is hard to get a number of machines all aligned to the same standard. If one system is out of adjustment, it will upset all the others down the line and you will not know what correction to apply to the final mix. It's better to have NR switched off, and use quality, low noise tape throughout.

Next month I will talk about microphones, mixers and other accessories, and how to select the bits and pieces that will make easier our recording of Oral History.

Frankly Frank

Musings on matters electronic by FRANK LINTON-SIMPKINS

From distant lands and misty climes

There is something distinctly Wagnerian about Sydney's new Darling Harbour Precinct and so I arrived at the place whistling the 'Pilgrim's Chorus' from Tannhauser, to view the 1988 PC, Office Equipment and Communication Show. This was to be held, some weeks after originally planned, in the precinct's Exhibition Centre.

While I was waiting to cross the road and also resting to restore my energies (it was rather a longish walk from anywhere), the Monorail train passed over my head. I only noticed its arrival when its shadow shielded me from the sun. Then I considered that I was into the wrong Wagner opera – it shouldn't have been Tannhauser, but Lohengrin.

In that opera the hero, apart from a dead suspect relationship with a Swan, is gathering a horde of knights to fight off the Hungarians. In Sydney the new Premier is out to kill off the viability of the only cross city transport system we have in Sydney – and we without a Lohengrin, an Elsa von Brabant or any knights. Without the monorail linking the CBD with the Darling Harbour precinct only the fit will make the trip, or those with axes to grind like your card-carrying columnist, Fox Xray.

But enough of unpleasant things like politicians, and on to the show and its place in the scheme of things. As usual it was the 'Biggest ever held in Australia'. This was manifestly incorrect, and one organiser modified the original to read the biggest 'of its kind' ever held in Australia. From this I deduced that it was the biggest PC, Office Equipment and Communications show ever to be held at the Darling Harbour Exhibition Centre in the third week of March 1988.

It seems that there were some 194 exhibitors according to a report in the *soi dissant* popular press. The catalog showed a count of 175 stands, plus two catering areas. But taking the 194 as the accepted figure, then this is still more than 100 fewer exhibitors than a show held in Sydney in the early 80's – and as to floor space, I would estimate that the 1983 (America's Cup year) ACS show in Melbourne had a larger space. It will be recalled that on that occasion the old wooden part of Melbourne's Exhibition Building, the new concrete and metal and the Mirrored wall bit all held exhibitors.

So much for the carping comments; now onto the show. The new Darling Harbour Centre is far and away the best place in Sydney to hold any sort of exhibition. One recalls the famous Great Underwater Computer Exhibition at the Showground, and the others in those twin CBD saunas, the Centrepoint Exhibition Centre and the Hilton area. Neither of these places was ever intended to hold so many overheated exhibition walkers and so much machinery, and in consequence the more efficient stands all held salt tablets for their staff and stand visitors.

The Darling Harbour Centre has no such problems, but its floors are granite hard and there were no seats except at the coffee shops. It was this lack of available seats that made some contribution to the Sourceware/Wordperfect success in winning spectators to their hourly video shows. Word perfect's chairs were extra good; I have one at home, a relic of a press conference.

Now to the equipment. Here you had to make the decision: Apple Mac or IBM. After that it was 'Eenie, Meenie, Minie Mo' time as just about everything else was made out of the same chip modules and even the various electro-mechanical equipment attached was just one copy after another of a certain Japanese make (actually I think it was made in Taiwan). But if the PCs had a rather repetitive look, the office equipment section was far, far worse.

Take photocopiers. I walked past many and with only one exception on my track, they all appeared to be a Japanese designed Mita with only the slightest variation in outer cover design.

The PC and Office Equipment bit was like going to an exhibition of 375-gram tins of soup, with different labels. Only in the Communications area was there much variety to tempt the desperate seeker after novelty.

The search that I had embarked on came to little, so I pondered on the exhibition itself. Just who was there? Many of the old favourites seemed long gone. Where was ICL with its 1983 reproduction of a desert encampment? What had happened to Prime's gigantic wooden pyramid? NCR's double decked stand?

Lionel Singer wasn't evident, either; neither was Fujitsu. But Hewlett-Packard and Data General, who had attended every industry dog fight for seemingly ever, joined Linda Graham and Microsoft and stayed on the north side of the Harbour Bridge.

Could it be that the long term survivors in the industry are on to something that the new boys don't know?

Sadly I was left with almost nothing to write about with the exception of a system which uses satellites to provide a pager service. Call Skypage, the service has been operative for just on 12 months and no one has yet paged me – Ah the shame and disappointment!

Within a finite time the system will be operative in Mount Isa, and in a place called Leigh Creek in the worst part of South Australia. Leigh Creek has a climate roughly equivalent to the country around Timbuctu and it is also a major mining area. I wonder at the need for pager service out there among the racehorse Goannas, burrowing Bettongs and salty armpitted miners. But the charming lady on the Skypage stand assured me that a demand for such a service was building up out there, among the spinifex and castoroil bushes.

There was really only one story out of the PCOE&C show: the place or exhibitors centre itself. It was, you might say, an organic building. Once inside its dermis, you could watch it function. All pipes etc pass overhead, expanding and

Continued on page 132

CABLE SPECIALS

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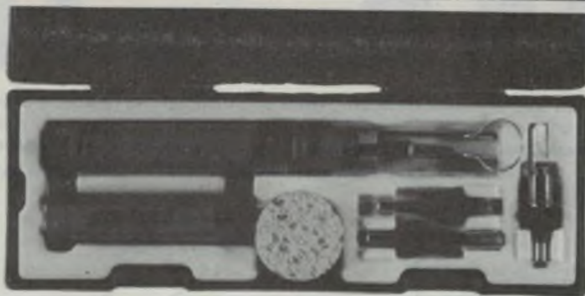

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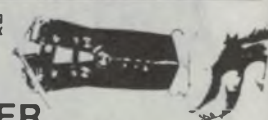

WIRE STRIPPER & CRIMPER

Geoff has been looking around for a really good crimp tool for stripping cables and crimping those connector lugs on. He's found it - the **US made PARTEX Qwik Stripper!**

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Circuit & Design Ideas

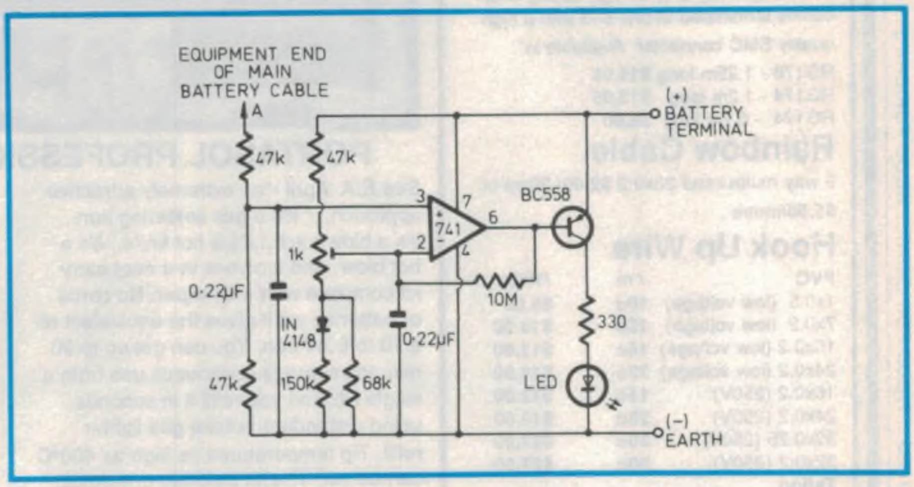
Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Car battery discharge indicator

The introduction of the alternator to auto electrical systems overcame many of the problems of battery maintenance suffered in the days of the DC generator. In one stroke it was possible to have the battery charging with the engine idling.

Since then, however many accessories have been added and only one or two of them can draw more current than the alternator is able to supply at engine idling speed. Normally this does not matter but the combination of a wet night, heavy traffic and perhaps a doubtful battery can cause considerable inconvenience when the battery goes flat quite suddenly – or apparently so.

An ammeter would show what was happening if (a) one were fitted and (b) one thought to look at it. The alternator warning light is, incidentally, useless in this context since it merely indicates that the alternator is generating current – but not whether this current is sufficient to supply all the electrical devices which happen to be operating at the time.



This circuit detects the sense of the small voltage drop across the cable from the battery terminal to all the electrical equipment (except the starter). Note that a number of modern cars split this cable about 20cm from the battery terminal and it is necessary to connect point A on the circuit diagram to the point where the cable divides (if it does so).

Because the op amp LM741 is operating at a gain of about 400 and also because of the rather harsh environment in the engine compartment, some additional temperature compensation is needed. This is provided by the 1N4148 diode and associated resistors. The LED should be mounted in an appropriate spot on the instrument panel but it is probably best to mount the unit itself near the battery to minimise the run of 'hot' leads. Only a single lead from bottom end of the 330 ohm resistor need to run to the LED, the cathode of which can be earthed locally.

The components were mounted on a PCB 37×33mm and fitted in a box measuring 40×35×20mm folded from thin sheet aluminium. This was lined with plastic sheet cut from an ice cream container lid (semi rigid and sufficiently heat resistant) to prevent any shorts to the box.

Setting up is simply a matter of adjusting the preset 1k pot so that the LED is just off with no battery load. Battery voltage should not be above about 12.5V when this is done as any surplus charge will result in an oversensitive setting because of the effect of the diode network.

Only the 330 ohm resistor needs to be ½W rating; the remainder can be ¼W.

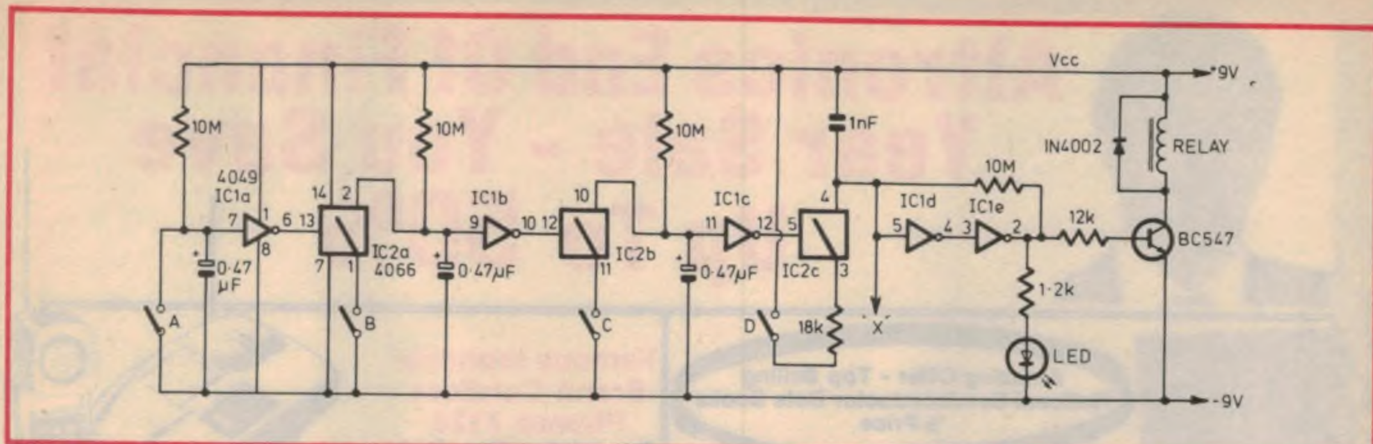
The voltage drop across a 20cm length of the usual 4mm cable will give an indication of discharge at about 2.5 amps.

Alan March,
North Turramurra, NSW.

$30

Dreamed up a great idea?

If YOU have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, perhaps, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address, or course!). Send them to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.



4-digit combination lock

This circuit provides a particularly simple and easy to build combination lock, based on two low-cost CMOS chips and operating from a 9V battery. Its only limitation is that all four digits used in the key combination must be different – you can't use a digit twice.

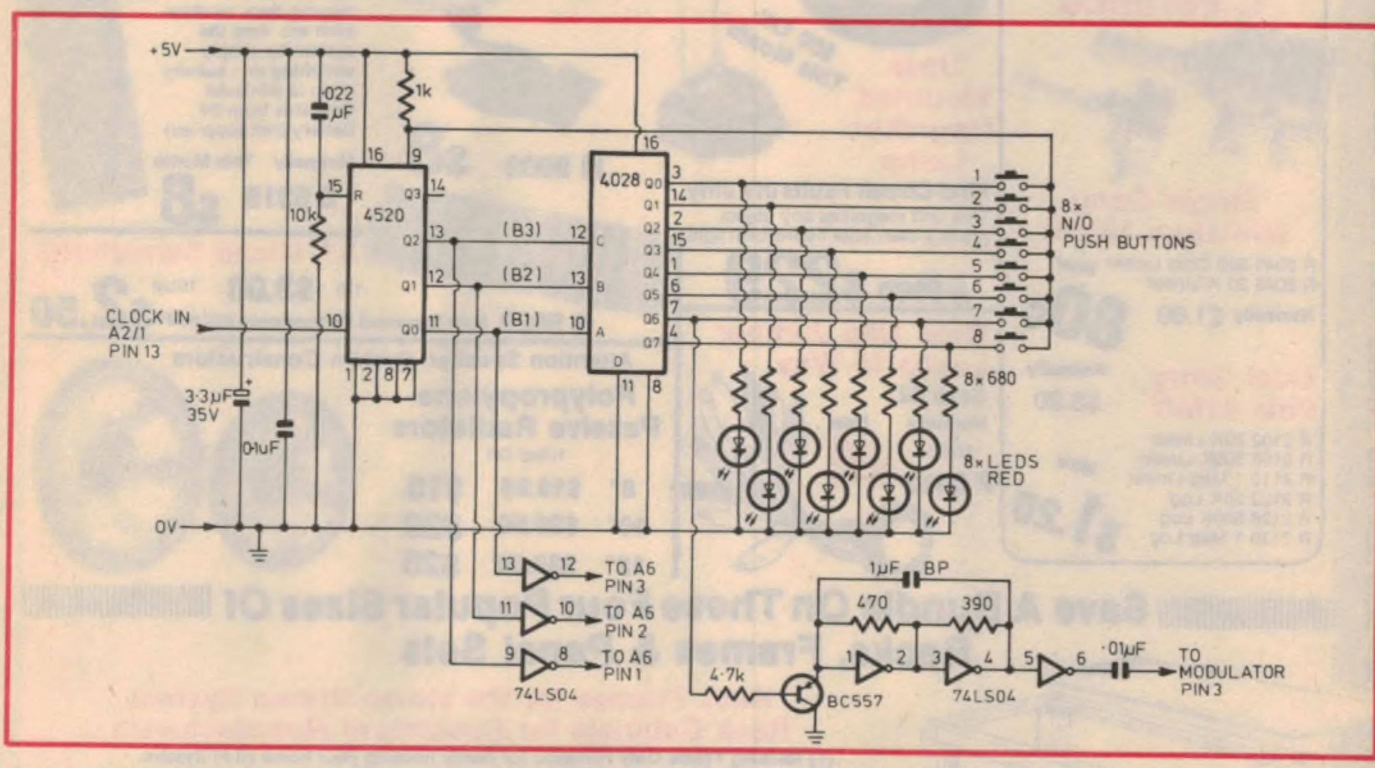
The basic idea is that the correct keys A-B-C-D must all be pressed in the correct order, within 3 seconds. If this is not done, the circuit automatically resets due to the RC time constants at the input of each 4049 inverter.

A, B, C and D are selected switch buttons on a small keypad. For example A might be the 7 key, B the 2 key, C the 5 key and D the 6 key. These connections are easily changed to modify the code combination code. Note that all key switches not used for the four active keys are connected between point X and the negative rail, in parallel. This allows any of these keys to be used for resetting the circuit.

Note too that while switches A, B and C connect to the negative rail, switch D connects to the positive rail.

Peter Liau,
North Fitzroy, Vic.

$30



Electronic BCD thumbwheel switch

This circuit was designed to replace the BCD thumbwheel switch in the October 1987 Colour Bar Generator, with pushbuttons and LED indicators.

The counter is enabled via pin 9 when any pushbutton is pressed, taking this input low via the appropriate LED. The count proceeds until this LED input goes high, via the decoder. It then stops. The three bit binary output is then taken from the counter via three inverters to the control logic on the original PCB.

The counter is reset to 0 on power up via the .022uF capacitor.

An oscillator is used to provide a sound test facility via pin 3 on the modulator. The oscillator is controlled via pin 7 on the decoder output.

LED indication is taken from each pushbutton input. The counter clock is picked up from a suitable point on the PCB. My circuit was built up on a small piece of veroboard.

Gregory Freeman,
Nairne, SA.

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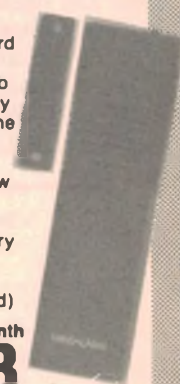

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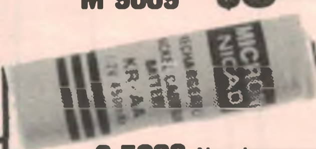

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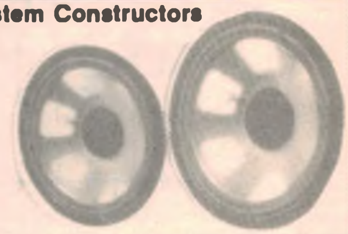

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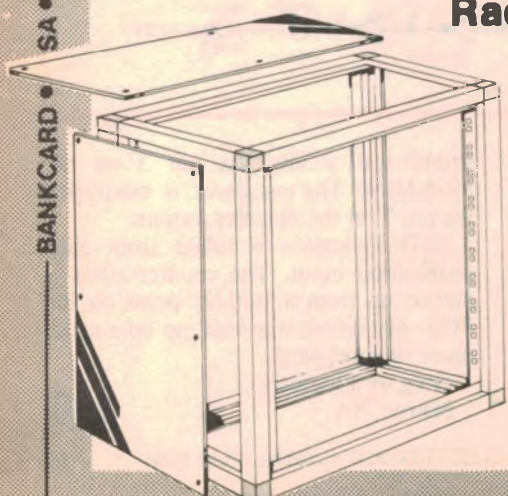

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Excellent iron, screwdriver temperature adjustable between 250 deg.C and 450 deg.C enabling very delicate soldering on low settings with surprising heat energy reserve on maximum setting.

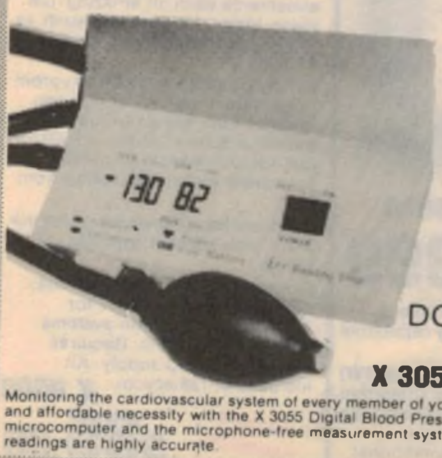
Relative temperature is indicated by LED lamp brightness. Much lower cost than a soldering station.

Normally $39.50

Why Risk Unnecessary Heart Attack?

Heart disease strikes down many people in their early 40's (or even 30's). The tragedy remains that had such victims been alerted, remedial medical, physical and dietary action could have been prescribed to avoid illness and in many cases restore full bodily health.

Blood Pressure and Heart Rate Monitor



Features:
- Non-Microphone Measurement System
- LCD Readout
- Blood Pressure Monitor
- Pulse Rate Monitor

New Model

DON'T PAY ~~$150~~

X 3055 $99.00

Monitoring the cardiovascular system of every member of your family is now an easy and affordable necessity with the X 3055 Digital Blood Pressure Monitor. A built-in microcomputer and the microphone-free measurement system guarantee that all readings are highly accurate.

Half Price

Exhilarating Sound Performance

Brilliant Digital Headphones

Incredibly Comfortable

• Utilizes newly developed flat disk vibrator copper clad aluminium wire voice coil and somarium cobalt Magnet. The resultant reproduction is outstanding • Impedance 45 Ohms • Maximum input 400 mW • Frequency Response 20Hz to 20KHz.

C 9010 $19.50

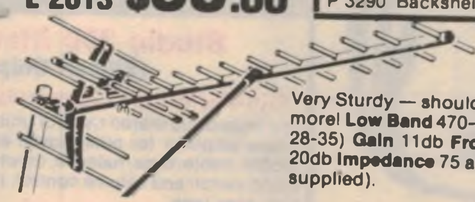
High Quality UHF 14 Element YAGI

Less Than 1/2 Price!

These high grade Yagi Antennas are from DX Antenna Co of Japan and originally sold for over $70!

We bought up an entire import shipment at distress stock rates & hence the fantastic savings to you.

L 2013 $30.00



Very Sturdy — should last for 20 years or more! **Low Band** 470-610MHz. (TV Chan. 28-35) **Gain** 11db **Front to Back Ratio** 20db **Impedance** 75 and 300 Ohm (Balun supplied).

Save Up To 50% On Top Quality D Series Connectors!
Fantastic Value

D Series Computer Connectors. Gold Plated Professional Series

Items Marked • are 1/2 Price or Less

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		WERE	NOW
P 3000	Male 9 Pin	2.95	1.47•
P 3010	Female 9 Pin	3.25	1.60•
P 3020	Male PCB Rt/L	3.75	3.00
P 3030	Fmale PCB Rt/L	4.50	3.50
P 3040	Male PCB mnt.	2.95	2.50
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P 3130	Fmale PCB Rt/L	5.50	2.70•
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P 3230	Fmale PCB Rt/L	6.90	3.90
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P 3250	Fmale PCB mnt.	6.25	3.95
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Digital Multimeter With Built-In Capacitance Meter

Not only do you get all the normal ranges of current, resistance and voltage - but also a convenient and simple to use capacitance meter in five ranges. And as if that's not enough, you also get a transistor tester. Check the features of this top quality new addition to the labtech range.

General:

Display: 3½ digit LCD, 0.5" height, with polarity & LO-BAT indication. **Overrange Indication:** 3 least significant digits blanked. **Maximum common Mode Voltage:** 500V peak. **Operating Environment** 0 deg to 50 deg. C; less than relative humidity from 35 deg C to 50 deg. C **Power:** 9V alkaline or carbon-zinc battery. **Battery Indicator:** Display indicates "LO-BAT" when less than 20% of life remains. **Dimensions, Weight** 170mm x 87mm x 42mm, 350grams.

SAVE $20

Q 1085 $119.00

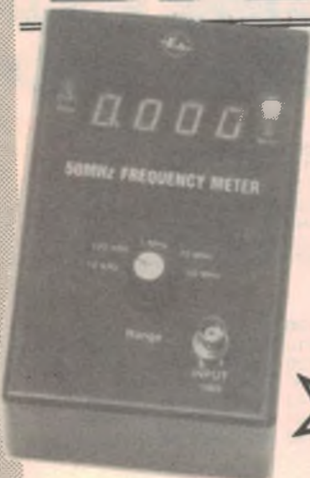
Carry Case

Q 1086 $12.50

Altronics Kits Cost More

(A Dollar Or So More!)

There are some quite valid reasons of course. Such as fully punched chassis and hardware. Beautifully screened faceplates and panels. Prototypes built, tested and proven in our lab. Easy to follow instructions **and** free helpfull advice is just a phone call away if you should ever need it.



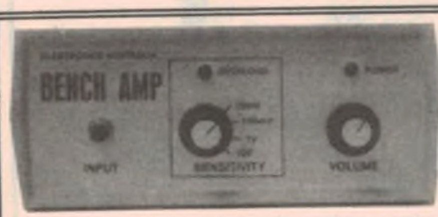
50MHz Low Cost Frequency Meter

(EA May'88)

Fantastic 50MHz Frequency Meter For The Work Bench & Tool Box For Less Than $100!

Inexpensive 4 digit 50MHz frequency counter offering high sensitivity and input impedance. Simple single PC board construction.

K 2510 $99.00



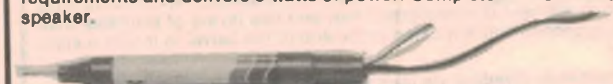
K 2100 $65.00

5W Bench Test Amplifier

(EA April'88)

Test Amplifier For All Occasions

High input impedance. 4 different input sensitivities suits virtually all requirements and delivers 5 watts of power. Complete with own in built speaker.



RF Detector Probe

(EA May'88)

Checks R.F. Circuits

Simple effective RF probe traces signals. Ideal companion to the 5W bench test amplifier.

K 2565 $12.00

Power Transistor Tester

(EA May'88)

Gain Matched, Power Transistors for Amplifier Output Stages

Super simple circuit, enables evaluation of current gain and Vbe of power transistors & Darlingtons.

K 2532 $24.95

Solar Battery Charger

(ETI Dec'87)

Charge Your Batteries Free From The Sun

Controls the charge of 12V lead acid batteries hooked to a solar cell Ideal for use on boats & caravans.

K 1680 $13.99

Brilliant Performance Stereo Pre Amp

Studio 200 Stereo Control Unit

(Silicon Chip June/July'88)

Out-Performs Commercial Units Costing $600 Plus

The Studio 200 Stereo Control Unit is companion to the studio 200 stereo power amplifier (or other power amps). It features slim 1u rackmount profile, treble, bass, balance, input selector, tape monitor switch, stereo/mono switch and volume control. Inputs Include phono, tuner, CD, VCR and tape loop.

K 5015 $229

Simple PCB Construction Virtually No Wiring

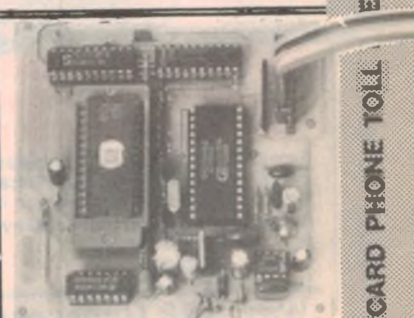
Calling All Audio Purists
This Great New Amp From Silicon Chip Is For You

Studio 200 Series 100 Watts Per Channel Power Amplifier

K 5010 $399

Features: • In-Built speaker protection • Toroidal Transformer (low hum) • Black Satin Finish • Low leakage power supply capacitors • Housed in Rugged Custom Chassis.

Specifications: • **Output Power** 100W into 8 Ohms **Freq. Res.(at 1W)** 20Hz-50KHz + or - 1db **Input Sensitivity** 870mV **Harmonic Distortion (20Hz-20KHz)** 0.1% **Signal To Noise Ratio** 100db or Better **Protection** 5A fuses plus RDE245A Polyswitch **Damping Factor** (without Polyswitches) 100 (with Polyswitches) 100. **Stability** Unconditional.



Speech Synthesizer

(ETI March'88)

This incredible "Voice" generator will store 127 messages or statements each an amazing 128 bytes long. (A sentence such as "You've left the lights on" uses only 31 bytes)

Simply programmed with an eprom programmer and PC or you can purchase the pre programmed 56 message Eprom Cat.No. K 9502 for just $20.00. Refer to ETI March '88 or request a message listing from us.

On board amplifier easily drives the 3-1/2 inch speaker supplied with the kit.

Fantastic for installing at home, behind your car dash or for interfacing with alarm systems, control systems etc. Requires external 12V DC supply. Kit includes 27128 eprom.

K 9500

Simply Fantastic!

$85.00

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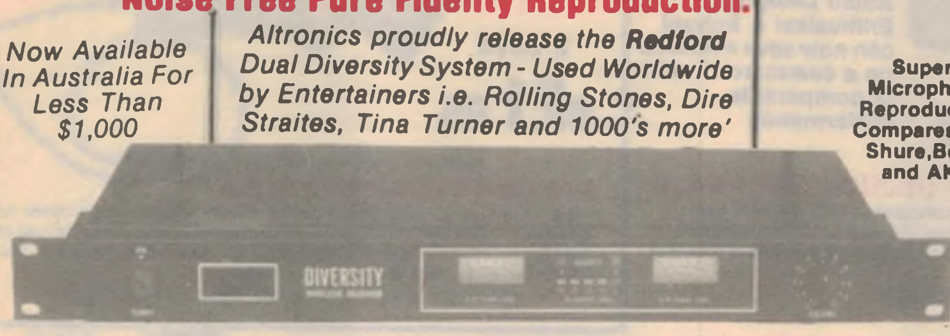
Superb *Redford* Wireless Microphone System Uses Dual Diversity Receivers for long Range, Noise Free Pure Fidelity Reproduction.

Now Available In Australia For Less Than $1,000

*Altronics proudly release the **Redford** Dual Diversity System - Used Worldwide by Entertainers i.e. Rolling Stones, Dire Straites, Tina Turner and 1000's more'*

Amazing Range of Over 200 Metres in typical applications



Superb Microphone Reproduction Compares with Shure,Beyer and AKG

Unique Microphone design completely Eliminates "Dangling" Antenna

Breathtaking performance without signal drop-out or noise interference. The Eleco Wireless Microphone System is virtually the ultimate in an Entertainers Microphone system (or for any roving microphone application for that matter!)

All the annoying wireless microphone characteristics such as "drop out", static and noise are completely eliminated by use of **auto switching dual diversity receivers**. The output of each receiver is continually monitored, with the strongest and clearest signal always selected. **Dynamic Range exceeding 100 db** is obtained by employment of a Patented special Parabola level compressor and Dynamic expander.

The operating range is a minimum of 50 metres (often this can be extended to 200 metres and more in normal circumstances)

Several Frequencies are available to aleviate cross interference when two or more systems are used in proximity.

Brief Specifications **Frequency** 202.1, 202.5, 203.7MHz (Please specify if you have a preference)

Mic Carrier Power 50mW (Max) **Mic Antenna** built-in **Dynamic Range** over 100db **S/N Ratio** better than 90db **Frequency Response** 20Hz to 16KHz + or - 3db **Mic Battery** 4 x AA cells **Battery Life** over 24 hours continuous operation. **Receiver Sensitivity** 12db/micro volt for 60db S/N ratio **Pre emphasis/De emphasis** 50us **Receiver output** unbalanced 6.3mm phone jack and balanced 3 pin cannon type. **Output Level** (adjustable) Unbalanced 0-2.5V Balanced O to + or - .3V into 600 ohms. **Receiver Power Supply** 200 - 260VAC

Prices

(A) Dual Diversity Receiver **$729.00**
(B) Entertainment Microphone (hand held type) **$349.00**
(C) Lavalier Type Microphone **$349.00**

Bonus Offer SAVE $78 Choose Receiver and Either Microphone For Just $999

Please Note 3 different operating frequencies are available (you will need to specifically nominate desired frequency only if the equipment is being used in proximity with other Systems on the 200MHz band.

Frequencies

C 0111	Dual Diversity Receiver	202.1MHz	**$729**
C 0113	Dual Diversity Receiver	202.5MHz	**$729**
C 0115	Dual Diversity Receiver	203.7MHz	**$729**
C 0121	Entertainment Microphone	202.1MHz	**$349**
C 0123	Entertainment Microphone	202.5MHz	**$349**
C 0131	Lavalier Microphone	202.1MHz	**$349**
C 0133	Lavalier Microphone	202.5MHz	**$349**
C 0135	Lavalier Microphone	203.7MHz	**$349**

AT LAST Design Quality Weather Proof Speakers And Sound Columns By *Redford*

• Rugged extruded aluminium construction • Superb powdercoat industrial paint finish • Engineered in Australia • Excellent reproduction • Superior to imports — Yet just a fraction of the price!

Wide Range Weatherproof Extension Speakers For Your Stereo System

Great For The Back Patio,Swimming Pool, Games Room, Den, Pool Room Etc.

Dimensions 260mm wide x 170mm high x 150mm D. (Mounting brackets are included)

Altronics proudly announce the release of the superb ***Redford*** Weatherproof Speaker and Sound Column Range. Imagine a wide range speaker system which is highly directional and with efficiency approaching that of reflex horns!

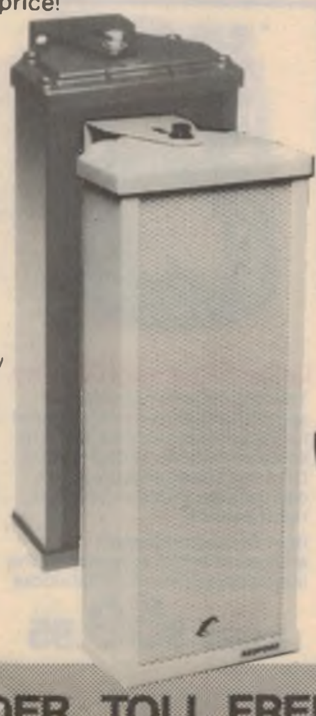
Redford is the solution for high quality sound reproduction outdoors. The Five Models to choose from "Fill the Bill" from applications on boats to high grade paging and music entertainment installations.

RUGGED EXTRUDED CONSTRUCTION

These vibration free enclosures are constructed from die extruded heavy gauge aluminium and finished with incredibly durable industrial powdercoat enamel. The speaker ends are sealed via gaskets and tough moulded "LURAN S" UV resistant end caps. The end result is "Good Looks" together with assured rugged durability for the Australian environment.

EXCELLENT REPORDUCTION

The drivers have been chosen for wide range, low distortion, mid range "presence" (essential for high grade vocal work) and high efficiency in general. **Power Capacity** for short term use, the drivers will safely handle 150% of rated power. Acoustic wadding is used to dampen Bass resonance. **Weather Proof Construction and use of "Doped Cones"** Foam plastic and cloth is sandwiched between Baffle and Front Grill to prevent water ingress. A first for ***Redford*** is the use of a patented cone moisture repellant process for all models.



10 Watt 16 Ohm (Max 15 Watt)

Single dual doped cone driver 16 ohm impedance is employed to give a generally correct volume balance with main speakers - an added bonus is your amplifier load is kept to respectable limits!! Great for back patio, Den, Boat Deck etc.

C 0938	White	**$99ea**	**$190 per Pair**
C 0940	Black	**$99ea**	**$190 per Pair**

20 Watt 8 Ohm (Max 30 Watt)

Use 2 special dual doped cone drivers for those wanting a bit more umph!

C 0943	Black	**$139ea**	**$260 per pair**
C 0944	White	**$139ea**	**$260 per pair**

100 Volt Line Models For Use With Professional PA And Music Systems

Using a "Doped" wide range drivers and fitted with grain oriented steel line transformer. Output cable allows connection to 10W/5W/2.5W with 10 watt models, 20W/10W/5W with 20 watt models and 40W/20W/10W with the 40 watt versions.

C 0941	**10W/100V line Black**	$119ea	$220 per pair
C 0942	**10W/100V line White**	$119ea	$220 per pair
C 0945	**20W/100V line Black**	$169ea	$299 per pair
C 0946	**20W/100V line White**	$169ea	$299 per pair
C 0950	**40W/100V line Black**	$225ea	$399 per pair
C 0955	**40W/100V line White**	$225ea	$399 per pair

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Lab Standard Function Generator Kit. Every Electronics Workshop, Audio Designer, Enthusiast & School can now save a fortune on a commercial unit of comparable performance

K 2540 **$155.00**

Audio Oscillator and Function Generator

This Ultra low distortion oscillator is comparable with the very best laboratory standard sine wave oscillators. As well as having very low distortion it has excellent envelope stability, square wave output & output metering.

(See EA Dec'86)

K 2570

$21.95

Low Cost Temperature Probe

Here's an easy to build probe design which adapts a multimeter or electronic voltmeter into a general purpose thermometer. It's just the shot for measuring heatsink temperatures, how hot it gets inside your car, or whether little Johnny has a fever!

Measures accurately from -20 deg.C to +120 deg.C.

Congratulations To The Design Team At Silicon Chip Magazine for this Excellent Design

K 2515 **$299.00**

1GHz Digital Frequency Meter

(See SC Nov'87 Jan'88)

This superb 1GHz Frequency Meter will out perform many other instruments twice its price.

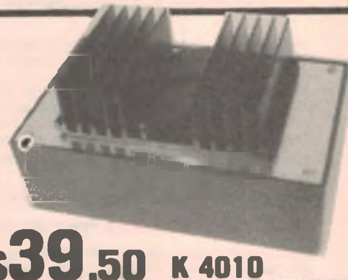
Features: Professional machined and screen printed red perspex front panel • Easy to asemble and construct • No special tools required • Bright Hewlett Packard 8 digit display • Electronic switch latching • High performance IC's • High Quality Components.

Transistor Assisted Ignition With Dwell Extension

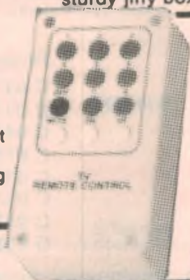
(See EA Feb'83)

Pays For Itself In No Time

Dead easy to build & (even better) there are only 3 electrical connections required to the car wiring system. Now housed in sturdy jiffy box.



$39.50 K 4010



8 Way Remote Control

(See EA June July'86)

Convert your TV, CD, VCR etc to be operated remotely from the comfort of your armchair. Up to eight separate functions can be switched with this infrared remote control.

K 1830 **$125.00**

Control Your TV Or Stereo From Your Chair

Added Facility

Apart from above - allows for control of On/Off, Mute and volume control.

K 1840

$45.00

Touch Lamp Dimmer

(See EA April'83)

Instantly turn lamps on and off with just a light touch on a wall panel. Alternatively you can dimm or brighten the lamps to any desired level by merely touching the panel for two or three seconds - very classy! The ***Altronics*** kit is complete in every way, including satin touch plates for that prestigeous look. Please nominate plate colour.

Gold **K 6319**

Silver **K 6320**

$35.00 ea

K 1400 **$9.95**

Telephone Off Hook Indication

(See SC Nov'87)

Use where 2 or 3 phones are connected on the one line. If one extension is in use a LED will flash in each of the other extensions. Requires no external supply. Runs off the telephone line. One module required for each phone.

Regenerative Radio

(See EA Jan'88)

Step back in time and build this simple regenerative radio receiver. Using only 3 transistors, its not only fun to build, but uses Varicap tuning.

K 1150 **$55.25**

This natty service aid allows you to track down short circuits without continually blowing fuses.

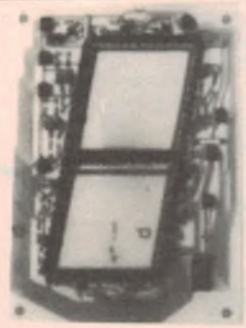
DC Electronic Fuse

(See EA Nov'87)

Replaces Any Size fuse Up To 10A

This unit simply clips across the DC fuse holder. Offers protection adjustable from 0-10A in 2 ranges. In essence its an adjustable DC circuit breaker.

K 2535 **$39.50**



Large 7 Segment Display

This large 153mm high seven segment display can be configured for use as either common anode or common cathode. Multiplexed on DC driver and arranged to have a decimal point on either the left or right hand side.

It can be used to interface equipment with existing displays for large elapsed times & digital clocks.

K 1225 **$59.95**

Low Ohms Adaptor For Your DMM

(See SC Feb'88)

Measure Accurately Down To 50 Milli Ohms!

As we all know it's difficult to obtain accurate resistance measurements below 50 Ohms or so with conventional multimeters. This natty little adaptor plugs directly into your DMM via. in-built banana plugs enabling quite accurate measurements to 50 Milli Ohms and less. Full instructions provided.

K 2518 **$24.99**

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Build it for the Bicentenary!

The 1988 Deluxe crystal radio

Here's how to build one of those fancy old-time crystal radios – the type they built in the 1920's. Not a fake antique, but a re-creation using modern parts. Build it and discover for yourself the unique thrill of 'pulling in the stations' with the simplest kind of radio!

by JIM ROWE

A crystal set – in 1988? Why would anyone bother building such a crude and elementary type of radio receiver, now that we have high-technology transistor and IC superhet receivers available for a few dollars, and capable of leaving a crystal set for dead when it comes to performance?

I'll tell you why. There's something special about a crystal set, something about the way it 'pulls in the stations' in the simplest possible *low tech* way – using only the power of the received signals themselves. Something that's down to earth and fundamental.

Building a crystal set and getting it going is probably the best possible way to get a good 'feel' for the basic principles of radio propagation and reception. Somehow it pulls back the curtains drawn by higher modern technology, and takes you back to the grassroots level. This makes it an ideal project for the newcomer to electronics, or for the old-timer trying to re-kindle their earlier enthusiasm.

It's also a great way to experience for yourself the wonder and fascination that our grandparents knew in the 1920's, when they used similar sets to 'listen in' to the first radio stations.

What better project, then, for Australia's Bicentennial year, when we're looking back over the last 200 years, taking stock of where we've come from and trying to work out where we're going?

As it happens, building a crystal set and getting it going in 1988 can be even more satisfying than it was in the 1920's, because the components available today are generally capable of better performance. Today's AM (amplitude modulation) radio broadcasting stations also have rather higher power output than they did back then, as well – giving stronger signals (important with a receiver that doesn't have any signal amplifying ability of its own!).

The only complication is that nowadays some of the parts needed to make a crystal set are not as readily available as they once were. Things like tuning capacitors and high-impedance headphones, for example. Still, there are a variety of ways around this problem, as I'll explain shortly. But before we get on to actual construction, let's take a quick look at the theory behind this most basic form of radio reception.

Back to basics

AM broadcasting stations transmit radio waves with frequencies in the range from about 550 to 1600 kilohertz (kHz). Each station radiates on a particular frequency in this range, known as its *carrier* frequency. The music, speech and other audio programme material is used to *modulate* this carrier signal, by varying its strength or *amplitude* – hence the term 'amplitude modulation' or AM.

The first step in receiving this kind of signal is to use an antenna system, which extracts energy from the radio waves to produce an electrical signal – a small voltage or current. There are two ways of doing this, one with a rod or loop antenna. This is a loop of wire, which responds to the waves passing through it to produce a small varying current.

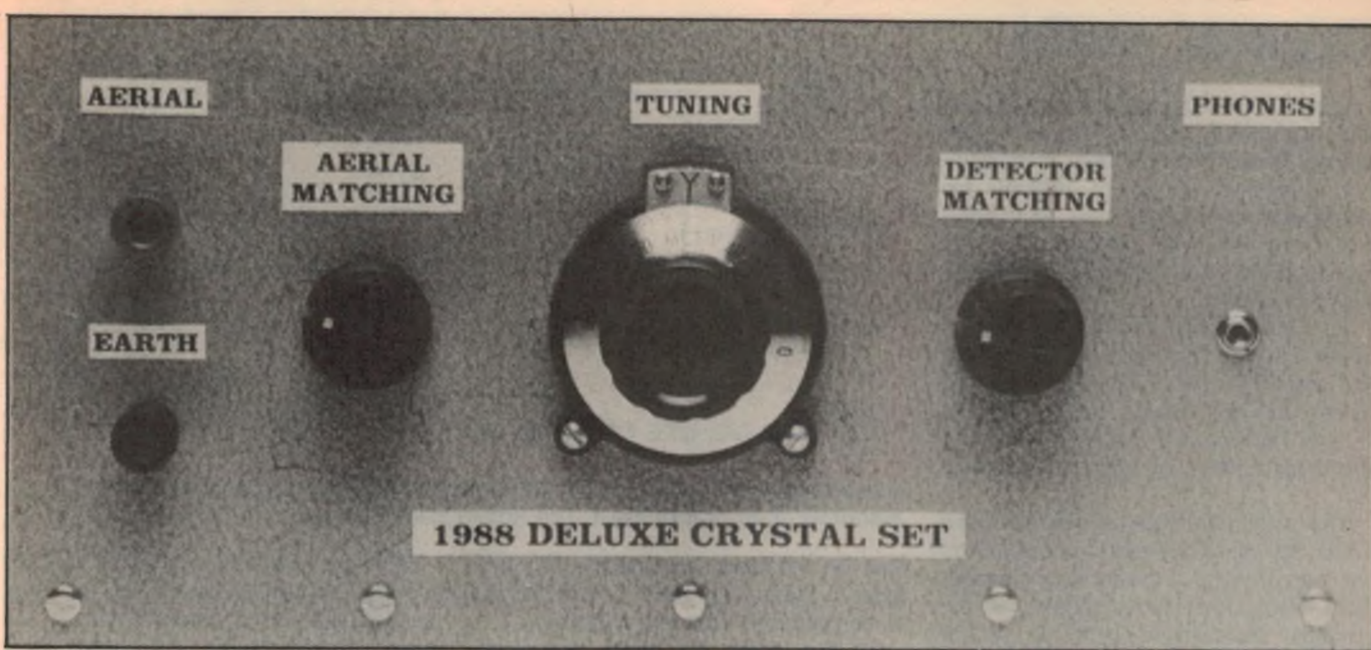
The other way is with a long wire suspended as high as possible above the ground, to form an *aerial*. Together with the earth itself, the latter forms a large capacitor, which responds to the radio waves passing through it to produce a small varying voltage.

Whichever method is used, the small electrical signals produced by the antenna system will basically consist of a mixture of frequencies – corresponding to carrier frequencies from all of the stations, jumbled together. So the next step is to separate out the carrier frequency of the station we wish to listen to.

This is done by feeding the signals from the antenna system to a 'tuned' circuit, consisting of a coil or *inductor* connected in parallel with a capacitor.

Now a key property of an inductor is that its *impedance*, or the difficulty it presents as a path to electrical signals, *rises* with frequency. The higher the frequency of the signals, the higher its impedance becomes. On the other hand with a capacitor, the impedance *falls* with frequency. And the two exhibit opposite kinds of impedance, passing current of opposite polarity for the same applied voltage.

So when an inductor and a capacitor are connected in parallel, the combina-



tion has a very low impedance at low frequencies (due to the inductor), and again at very high frequencies (due to the capacitor). But at some frequency in between, the two impedances will become equal, and because of their opposite natures the currents in each will cancel out. As a result, the impedance will rise to a peak, and the circuit is said to *resonate* at that frequency (Fig.1).

The effect of this on the jumbled signals from our antenna system is to emphasise any signals which are present at the circuit's resonant frequency, and suppress all the rest. So by making either the inductor or capacitor variable, to adjust the circuit's resonant frequency, we can 'tune' it to select only the signal from the station we want to receive (Fig.2).

At this stage we have separated the wanted signal from the others, but it is still a radio frequency (RF) alternating voltage, varying in strength with the audio modulation. If we fed it directly to some earphones we would hear nothing, because the rapid alternations give it an average value of zero – and the earphones would only be able to respond to the average value, being incapable of following the RF alternations themselves.

Luckily there is a very simple way to solve this problem, at least in principle. This is by using a rectifying diode, which is capable of passing current readily only in one direction. If we connect this in series with our earphones, across the tuned circuit, we cause the 'phones to be fed with only *half* of the original RF signal, corresponding to a string of RF pulses (Fig.3).

These pulses will still be varying in amplitude with the audio modulation, and because they all have the same polarity, they will have a similarly varying average value. It will be to this value that the earphones will respond, producing audio sounds. So in Fig.3 we have produced the simplest possible AM radio receiver, although in an extremely crude form.

Needless to say when this type of simple radio receiver was first developed about 1920, they didn't have any neatly packaged silicon or germanium rectifying diodes. The nearest they could come was a small chunk of *galena* crystal (a naturally occurring form of lead sulphide), with a small metal *cat's whisker* wire lightly touching its surface. This had been found by experiment to produce the desired signal rectification or 'detecting' action, although it was very fiddly – the slightest vibration could disrupt things.

It's from this original form of 'crystal detector' diode that the crystal set gets its name, even though lumps of galena haven't been used for many decades. Nowadays a 95-cent germanium diode does the same job, and much more reliably.

But back to our basic radio set of Fig.3. As noted earlier, this is indeed the simplest possible AM radio, but in an extremely crude and inefficient form. A more practical version is shown in Fig.4, where you'll notice that a capacitor C1 has been added in parallel with the earphones.

The idea of this capacitor is to smooth out the unidirectional pulses produced by the diode's rectifying action, to produce what is basically normal audio signals. The earphones are then able to

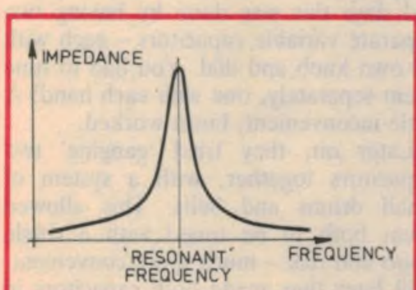


Fig.1: How the impedance of a parallel tuned circuit "peaks".

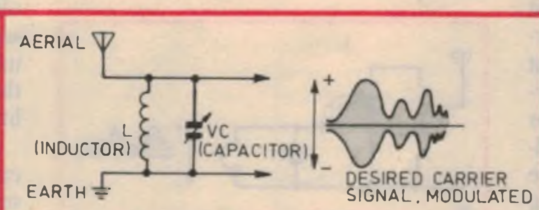


Fig.2: Using such a parallel tuned circuit to select the wanted station's RF signals from all the others coming from the aerial.

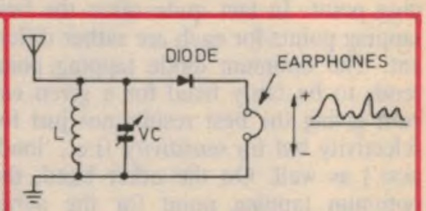


Fig.3: Adding a rectifier diode makes it possible to hear the signal via earphones, by turning it into varying current pulses.

respond more efficiently than with the circuit of Fig.3, because when fed with unsmoothed RF pulses their own winding inductance makes it difficult for much current to flow – so they don't really respond to the full average value. By smoothing out the pulses, C1 remedies this problem.

The other thing you'll have noticed about Fig.4 is that in this case neither the aerial nor the diode are connected across the full tuned circuit. Instead they're both *tapped down*, by connecting them across only part of the inductor.

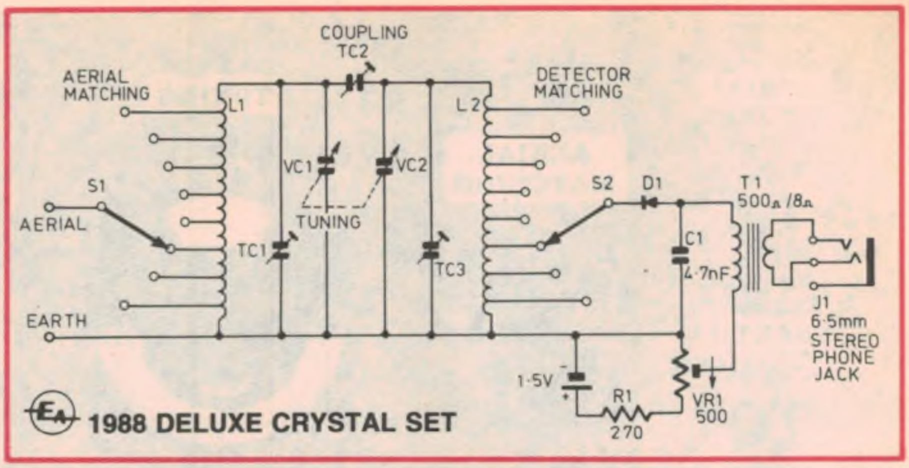
The reason for this is that both the aerial and the diode tend to 'load down' the tuned circuit, preventing its impedance from rising as it should, at the resonant frequency (Fig.1). In fact if *either* of them is connected directly across the tuned circuit as shown in Fig.3, its tuning ability or *selectivity* (the ability to select the wanted station and reject others) is very badly compromised.

The detector diode tends to load down the circuit because it is extracting power, to drive the earphones. On the other hand the aerial loads down the circuit (and also shifts its tuning) because it possesses a relatively large and 'lossy' capacitance with respect to earth.

So very early in the peace, it was discovered that for best results, both the diode and the aerial needed to be connected across only part of the inductor as shown. This reduces their loading effect considerably, as the inductor then acts as an auto-transformer, and multiplies their loading impedance – by the square of the tapping ratio. For example by connecting the diode to a tap only 10% up the inductor, its effective loading impedance across the full tuned circuit rises to 100 times its real value. Needless to say this very much reduces its effect on selectivity.

Note that the diode and the aerial are not necessarily taken to the same tapping point. In fact quite often the best tapping points for each are rather different. The optimum diode tapping point tends to be fairly fixed for a given circuit, giving the best results not just for selectivity but for *sensitivity* (i.e., 'loudness') as well. On the other hand, the optimum tapping point for the aerial varies with both the length and height of the aerial, and the frequency of the station you're trying to receive.

Quite often the best aerial tapping point turns out to be rather lower than



The complete circuit for our 1988 Deluxe Crystal Set, somewhat more elaborate than that of Fig.4. The text explains it all...

that for the diode, particularly if you're using a fairly long aerial – which tends to be desirable, with any crystal set.

At this point it's worth noting an important point about crystal sets in general. Look again at Fig.4, and you'll see that there are no batteries and no power supply. All we have is a collection of passive components.

Have you realised what this means, when it comes to the energy which vibrates those earphone diaphragms and produces the sounds in your ears? That's right, it's coming from the aerial – directly from the radio waves themselves!

This then is the reason why you need the best possible antenna system with a crystal set, to produce as much power as possible. That means a really good earth connection, and the longest, highest aerial wire you can arrange. More about this later...

Gilding the lily

So far then, we have in Fig.4 the circuit of a fairly practical crystal set. Hook it up to a decent aerial and earth, and to a sensitive pair of *high impedance* earphones (note that emphasis), and you'll get reasonable results. But not as good as it's possible to get, by going a little further – as they did in the old days.

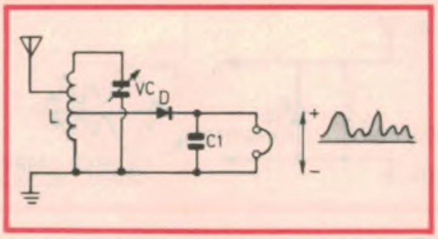


Fig.4: In a practical set, the aerial and diode connect to taps on the coil, and C1 is added.

How can you make it better? Well for a start, you can make it more selective, by adding a second tuned circuit. If one tuned circuit is fairly good at selecting the desired signal and filtering out the rest, two tuned circuits are even better.

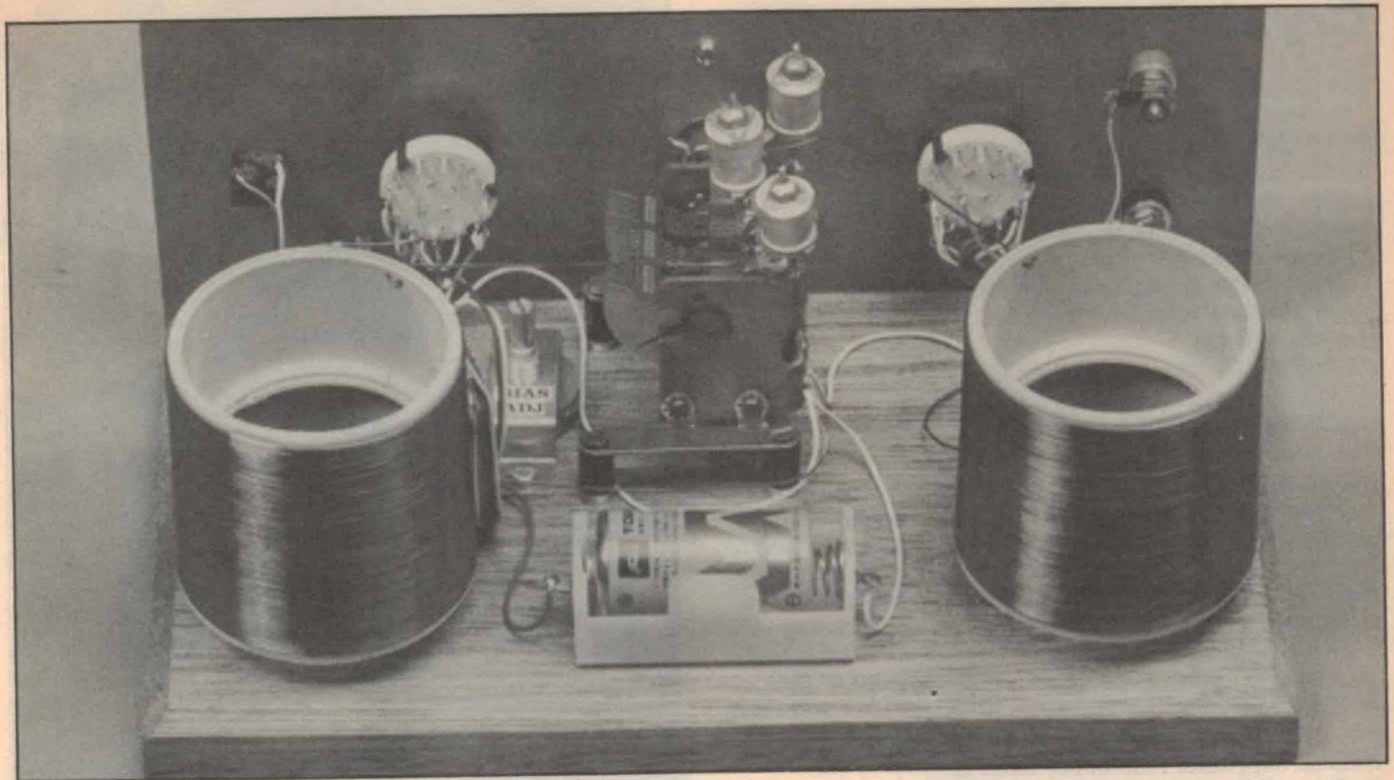
Using two tuned circuits actually makes a lot of sense. With only one tuned circuit, as in Fig.4, both the aerial and the diode must be coupled directly into it. Even though they're tapped down, they both inevitably contribute some loading and pull down the selectivity.

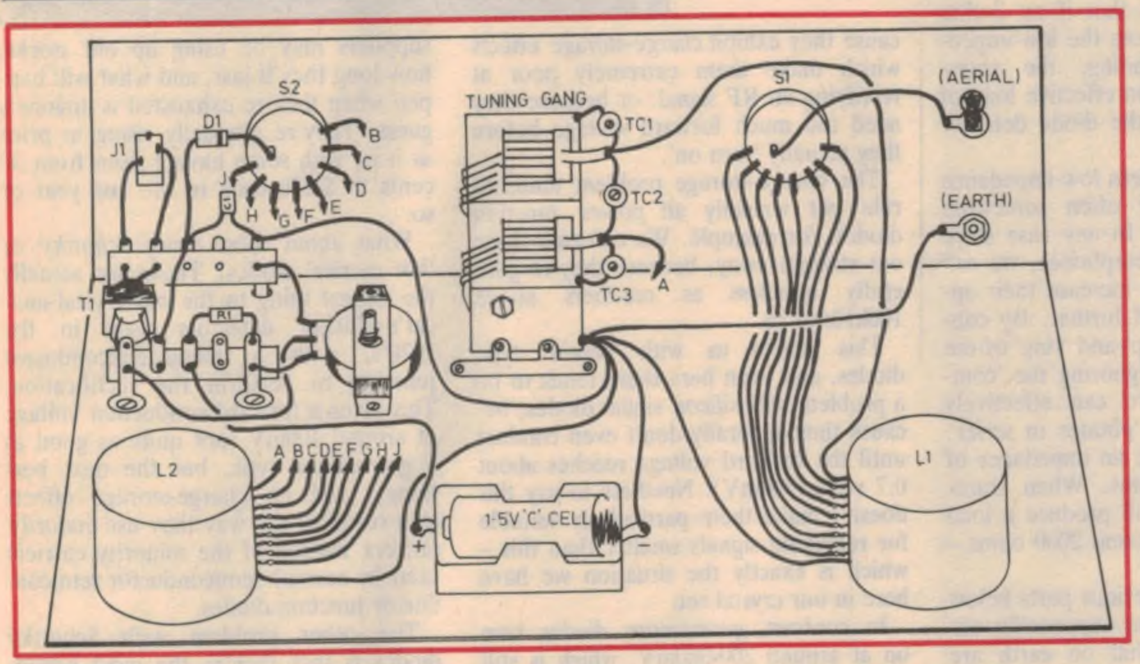
When two tuned circuits are used, there's the opportunity to have each loaded by only one of these. One tuned circuit can be connected to the aerial, and the other to the diode. This means that each circuit is more lightly loaded than the previous single one – and with both able to provide improved selectivity, there's a significant overall improvement.

But how do you couple the RF signals between the two tuned circuits? By using a *small* variable capacitor between the top of one and the same point on the other. This is then adjusted to give the best results.

Needless to say, the two tuned circuits must both be tuned to the RF carrier frequency of the wanted station. In the old days this was done by having two separate variable capacitors – each with its own knob and dial. You had to tune them separately, one with each hand! A little inconvenient, but it worked.

Later on, they tried 'ganging' two capacitors together, with a system of small drums and belts. This allowed them both to be tuned with a single knob and dial – much more convenient. Still later they made both capacitors in the one frame, with a single control shaft. Thus was born the so-called *two-*





Above: Rear view of the completed crystal set, showing most of the main parts. The 1.5V cell is used get improved results with almost any signal diode.

Left: A complete wiring diagram for the set, showing how everything is connected together. Most of L2's connections run to switch S2.

gang tuning capacitor, and its later successor the three-gang version, with three capacitors together in a common frame. More about these shortly.

For now let's look at the final circuit for our 1988 Deluxe Crystal Set, and see how it embodies what we've been discussing.

For a start, you can see that there are indeed two tuned circuits. One consists of inductor L1 and tuning capacitor VC1, and the other of L2 and VC2. The former is our 'aerial tuned circuit', and the latter our 'detector tuned circuit'. VC1 and VC2 are ganged together so that the two circuits nominally tune to the same frequencies.

To make it easy to adjust the tapping ratios of each, for optimum results, each inductor is provided with a series of taps and these are brought out to switches S1 and S2 respectively. So S1 becomes our 'aerial matching' control, and S2 our 'detector matching' control. How's that for fancy!

Trimmer capacitor TC2 is our coupling control, to adjust the degree of coupling between the two tuned circuits.

But what is the purpose of those other trimmers, TC1 and TC3?

These are to adjust the *tracking* between the two tuned circuits, especially at the high frequency end of the tuning range. Without TC1 and TC3, small differences between VC1 and VC2 – and the wiring capacitance in each circuit – would tend to make the two circuits tune to different frequencies, losing much of the benefit of having the two circuits. By adding TC1 and TC3 we can adjust the two so they tune to the same frequencies, despite these small

Crystal radio

discrepancies.

So much for the basic tuned circuits. D1 is our detector diode (more about this shortly), and C1 our smoothing capacitor. But what are those other parts which have now crept in – including of all things, a battery?

Yes, I know, crystal sets aren't supposed to need batteries. We'll get to that in a moment.

First, you'll notice that in place of the earphones, there's now a small audio transformer (T1). The reason for this is that nowadays, virtually the only earphones you can buy are of the low-impedance stereo type. These are far too low in impedance to give satisfactory operation with a crystal set, so we must use a matching transformer to increase their effective load impedance.

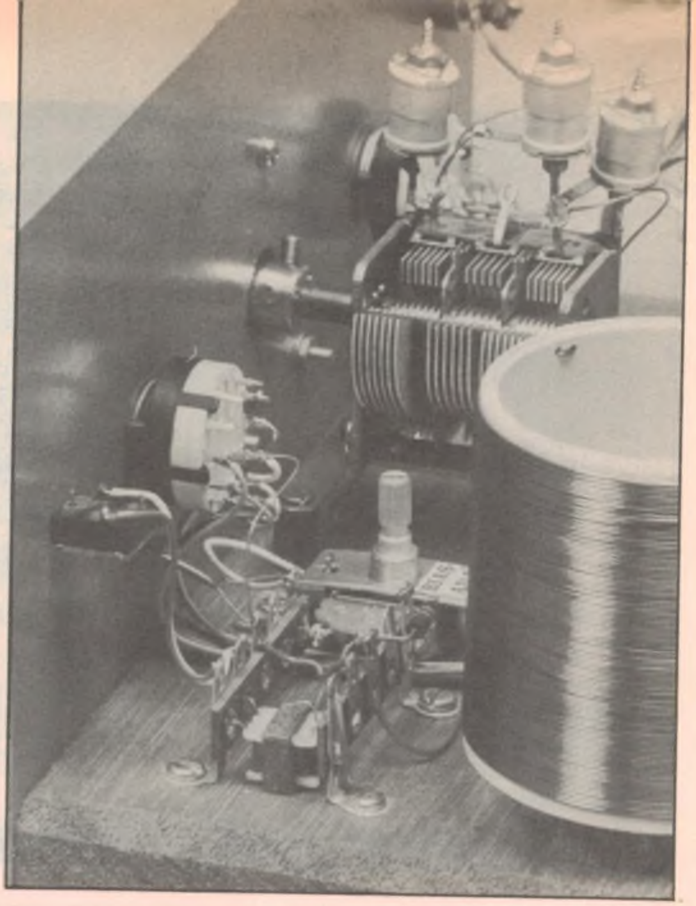
T1 is a small transformer of the type used until recently in the output stage of transistor radios, for the same basic job. It is readily available and has a nominal impedance ratio of 500 ohms to 8 ohms. This means that if an 8-ohm load is connected across the low-impedance secondary winding, the transformer will produce an effective load of 500 ohms as far as the diode detector circuit is concerned.

As it happens, modern low-impedance earphones are quite often somewhat higher than 8 ohms. In any case since we are using stereo earphones, we can pull a small 'trick' to increase their apparent impedance still further. By connecting to only the 'tip' and 'ring' of the earphone plug (i.e., ignoring the 'common' connection), we can effectively wire the two stereo 'phones in *series*. This will typically give an impedance of around 30 to 40 ohms. When transformed by T1, this will produce a load for our detector of around 2000 ohms – much more practical.

Now for those mysterious parts below C1: R1, VR1 and that supposedly unnecessary battery. What on earth are these for?

First of all, they're certainly not essential – let's get that clear. You could leave them out and simply join the bottom of T1's primary winding to the bottom of C1, and the set would still work. But not all that well, and even then only if you use a particular sort of diode: a germanium junction type.

The problem here is that we are trying to rectify very small RF signals – a few hundred millivolts if we're lucky. And many kinds of diode are very unsuited for this kind of job, either because they exhibit *charge-storage* effects which make them extremely poor at rectifying an RF signal, or because they need too much forward voltage before they actually 'turn on'.



A closeup of the wiring of the tagstrips and S2. Note that it's the cathode end of D1 (usually marked with a band of ink) which connects to the rotor lug of S2.

The charge-storage problem tends to rule out virtually all *power* junction diodes, for example. We can rule these out straight away, because they're generally hopeless as rectifiers above 100kHz or so.

This leaves us with 'signal' type diodes, and even here there tends to be a problem with *silicon* signal diodes, because they generally don't even conduct until the forward voltage reaches about 0.7 volts (700mV). Needless to say this doesn't make them particularly suitable for rectifying signals smaller than this – which is exactly the situation we have here in our crystal set.

In contrast, *germanium* diodes turn on at around 200-300mV, which is still not perfect but much closer. That's why the germanium diode is the only real choice, for a simple crystal set of the type shown in Fig.4.

The only problem is that germanium signal diodes are now not all that easy to find. Many manufacturers no longer make them, having transferred their attention to silicon.

They're still listed in the stock catalogs of most of the major parts suppliers, under a variety of type numbers: OA47, OA90, OA91, OA95, AA119 and so on. However it looks as if these suppliers may be using up old stocks; how long they'll last, and what will happen when they're exhausted is anyone's guess. They're gradually rising in price as it is, with some having risen from 30 cents to $1.50 each in the last year or so.

What about those fancy *Schottky* or 'hot carrier' diodes? These are actually the closest thing to the old crystal-and-cat's-whisker detectors used in the 1920's, with a metal-semiconductor junction to perform the rectification. This gives a forward conduction voltage of around 400mV (not quite as good as a germanium type, but the next best thing), and no charge-storage effects as a result of the way they use *majority carriers* instead of the minority carriers used in normal semiconductor-semiconductor junction diodes.

The other problem with Schottky diodes is that they're the most expensive of all: common types like the 5082-2800 sell for around $2.50 – $3.50. So in terms of both performance and price, they're very much a second choice to the older germanium types.

But back to our circuit. The fact is that even with germanium diodes, the most suitable types we can get, the turn-on voltage of 200-300mV still makes them less than ideal for rectifying very small RF signals of the type we have in a crystal set.

Luckily there's a way around this problem, and one that was discovered way back in the 1920's. If we apply a small amount of DC forward bias, along with the RF signals, the diode can be brought right to the threshold of conduction. This means that its rectification action can be optimised, even for very small signals.

So that's what the 1.5V cell, resistor R1 and pot VR1 are designed to do: provide a source of adjustable DC forward bias for the diode, to give the best possible operation (i.e., loudest and clearest reception) with small signals.

Now for the even better news. By giving VR1 the ability to provide a forward bias of up to 1V, the circuit is actually able to give good reception not just with a germanium diode, but with Schottky or even *silicon* signal diodes as well! So by pulling this old trick discovered in the 1920's, we are able to cope with the much more modern problem of diode availability.

In practical terms this means that using the diode biasing scheme shown, our final circuit can give good results even with dirt-cheap (around 10 cents) silicon diodes like the 1N914 and 1N4148, or their rather dearer brother the BA100 (around 60 cents). As well as being cheaper these are also much more readily available, and likely to remain so.

How's that for flexibility and freedom from obsolescence?

By the way, none of the energy provided by this battery is turned into audio energy. It's purely used to bias the diode to the operating point which gives most efficient detection. The energy that drives the earphones still has to come from the RF energy picked up by the antenna system.

So that's the story behind the actual *circuit* of our 'Bicentennial Special' crystal set, and how it takes advantage of the tricks discovered in the 1920's to achieve the best possible results with modern parts. Now let's look at the practical aspects of building one.

Starting construction

The most crucial aspect of this whole project, from the practical point of view, is the tuning capacitor (VC1/2). This is the big challenge, and your ability to meet it will determine the whole viability of the project as a whole. If you can get yourself a suitable capacitor, you'll almost be 'home and hosed' – the rest will be easy sailing, to mix a few metaphors.

But it isn't going to be easy. Nowadays, you simply can't buy the kind of two-gang tuning capacitor we really need for this project: one with both sections 'matched', and of equal maximum capacitance.

What can you do? Well, one approach is to scour around either your own junk boxes, if you have any, or those of older relatives and friends (especially those who dabble, or did, in radio and electronics). You'll be looking for a 'tuning gang' with either two or three sections – *at least two of them matched*. And you'll be looking for it either loose and 'naked', or buried away in an old valve or early transistor radio.

There were zillions of those old radios made and sold, and although many of them have long since 'returned to the earth' via rubbish tips, there are still a great many gathering dust on shelves in attics, garages and storage sheds. Each one is the potential source of a two- or three-gang tuning capacitor. If you can find one, your only problem may be to fight off antique radio enthusiasts wanting to restore it!

The actual physical size of your tuning gang is not terribly important. If it's a large one as used in the older valve radios, you can simply enlarge your crystal set baseboard and front panel to accommodate it.

More important is that it be in reasonable condition, with plates that aren't all buckled and bent, and the insulation for the fixed plates still intact and functional. Even a fairly thick layer of dust and dirt isn't likely to be much of a problem – you can always blow this out carefully using compressed air (perhaps at the local service station), or wash it out under the tap (drying it carefully afterwards!).

If you discover one with a slightly bent plate or two, don't despair. You may be able to bend it/them carefully back again, so that the section(s) concerned will operate properly.

The basic idea of these capacitors is that each variable capacitor section has two sets of spaced parallel plates, one set fixed in position but insulated from the metal frame or 'tub', and the other set attached to the control spindle (and therefore connected to the frame) so that they can *mesh* between the fixed plates by an adjustable amount – without ever touching them.

So with an old capacitor rescued from a radio, it's important to check (after cleaning it thoroughly, and checking for damage) that the fixed and moving plates of each section can mesh in and out, without touching. You can check this with a multimeter, set to a low or medium ohms range, and connected between the fixed (insulated) plates and the frame. If the meter shows a reading other than 'infinity', at any point over the rotation range, you have a short circuit and this will need to be removed before the gang can be used.

The capacitor shown fitted to our prototype crystal set in the pictures is actually a three-gang type salvaged from a transistor radio of the 1960's. The radio was a type with an RF amplifier stage, and although the 'oscillator' section is smaller than the others, there are still two matched sections at either end. It is the two latter sections which we used, with the smaller centre section left unconnected.

Capacitors salvaged from old valve sets are more likely to have all of the sections equal, as the practice of using smaller moving plates for the 'oscillator' section didn't come in until nearly the end of the valve era. So with these (generally larger) tuning capacitors, you'll generally be able to use even the two-gang types without any problems.

By the way, it's quite easy to tell if the sections have equal capacitance. Simply turn the moving plates until they're out of mesh, and check (a) whether there are an equal number of plates in each section; and (b) if they're the same size and shape. If the answer to both is 'yes', the two sections concerned are matched and OK.

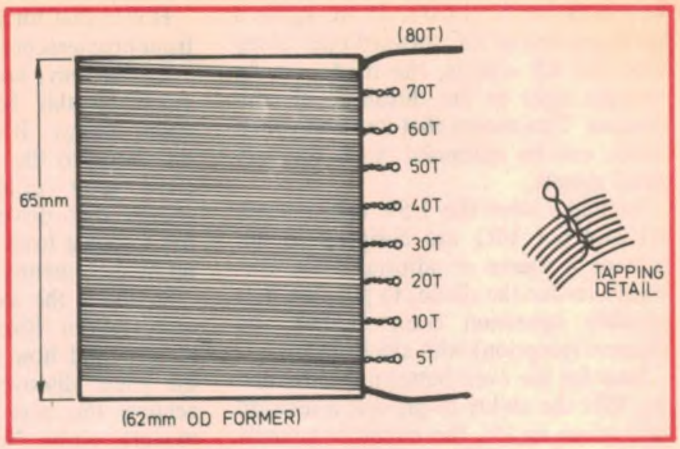


Fig.5: Details of the recommended way to wind the coils and provide them with tappings. Both are identical, and wound on PVC plastic downpipe joiners.

What if you simply CAN'T find any old tuning capacitors with two matched sections? Don't despair – all is not lost. You'll still be able to produce a working version of our 1988 Deluxe Crystal Set, although it mightn't look quite as neat or be quite as convenient to drive.

There ARE air-dielectric tuning capacitors still available over the counter, from at least two suppliers. One is Jaycar Electronics, with eight stores, which sells one listed as the RV-5740 ($5.50); the other is Lance Chapman, of 122 Pitt Road, North Curl Curl 2099, who sells a very similar unit for $3.75 or $4.75 posted (orders to PO Box 156, Dee Why 2099).

The only problem with *both* of these capacitors is that while they have two sections, the two aren't matched – one is a smaller 'oscillator' section. So you can't really use either one by themselves in our crystal set circuit. You'll really need TWO of them, one for VC1 and the other for VC2.

If you adopt this approach, you'll have two options. One is to simply have the two capacitors quite separate, as they did in the old days, with separate knobs and tuning dials. So you'll be back to the old two-handed tuning system – authentic, but a bit inconvenient. All you'll need to do is make your front panel and baseboard longer, to cope with the extra capacitor and dial.

Incidentally if you elect to do things this way, you won't need the two trimmer capacitors TC1 and TC3. Since the two tuning capacitors can be separately adjusted for tuning, the trimmers won't be needed. But on the other hand you'll need a second tuning knob and dial assembly, which is likely to cost more...

The other option would be to mount the two capacitors close together, with a mechanical linkage system so they can be turned with a single control knob and dial. This would involve say a pair of small dial drums (still available), one on each spindle, with dial cord to make the second one rotate in synchronism with the master one (i.e., the one turned by the tuning knob).

This latter approach will be a little fiddly mechanically, but it will at least give you modern one-hand tuning. And you'll still be using an authentic technique from the old days, of course.

So there you have the various tuning capacitor options. If you can salvage one from an old radio, so much the better. But if not, there's still the option of using a pair of the small unbalanced units and either tuning them separately, or ganging them mechanically.

By the way if you do use the small unbalanced units, you can connect the fixed plates of both sections together (i.e., in parallel) on both capacitors, to give them a wider tuning range.

Winding the coils

Once you've resolved the capacitor problem, the rest of your crystal set is fairly easy. The next step is to wind your two inductors or coils, L1 and L2.

These each consist of 80 turns of 24 gauge (B&S) enamelled copper wire, wound on cylindrical formers measuring 62mm in outside diameter, and 65mm long. If you're wondering what these formers are, and where you'd get them, it's simple: they're standard joining pieces for 55mm round PVC downpipe, and you can get them from most of the larger hardware stores. They cost around $1.70 each.

To wind each coil, first drill a pair of 1.5mm (1/16") holes at each end of the former. Each pair of holes should be about 3mm apart and 3mm from the end, and the two pairs should be lined up with each other in the axial direction.

Then loop the end of your wire through one pair of holes, leaving about

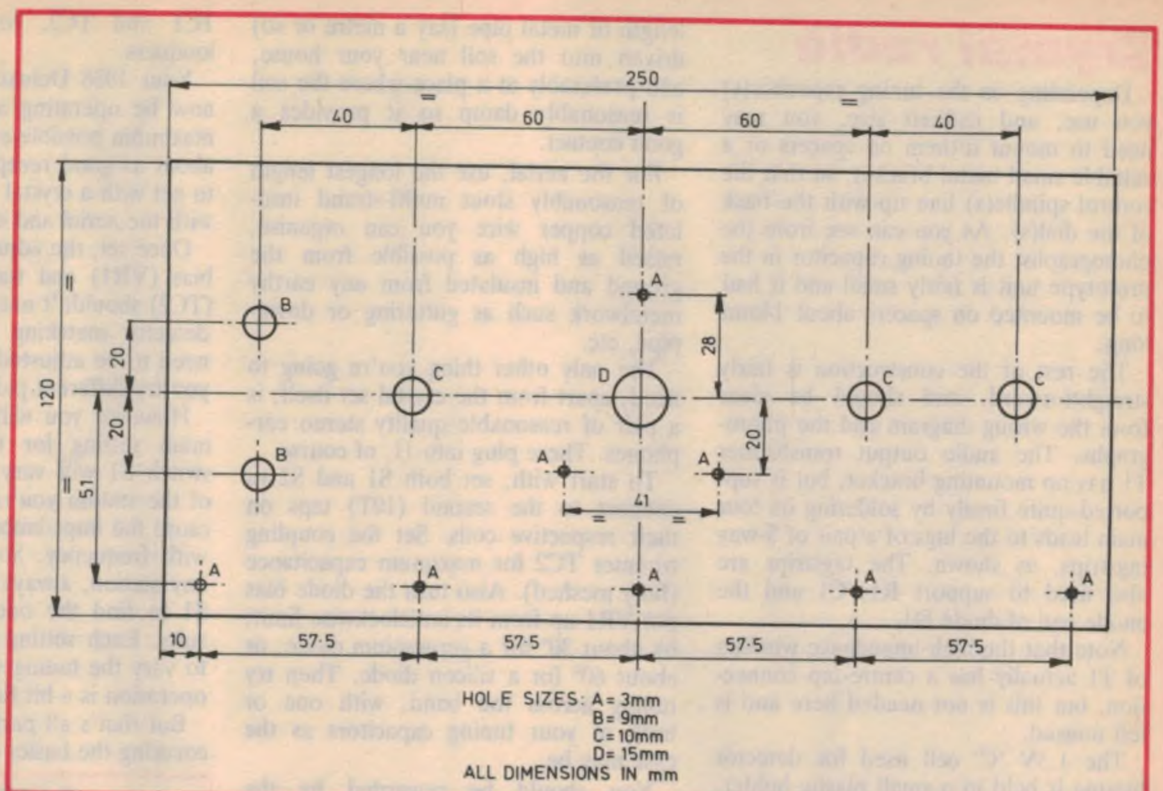


Fig.6: Dimensions and drilling details for a front panel identical to the original, apart from the use of a 6.5mm jack socket for the earphones.

120mm free as the connection for that end of the coil. The idea of looping the wire through the two holes is to anchor it firmly, so that you can then wind the coil itself.

The wire is wound as tightly and as closely as possible, and if you do this you'll find that 80 turns will just nicely fill the length of the formers between the pairs of holes.

In between, though, you need to provide for the tapping points. These should be at 5, 10, 20, 30, 40, 50, 60 and 70 turns respectively, with the 5-turn tap nearest the end which will ultimately be connected to earth.

The easiest way to make the tapping points while you're winding the coils is to bend the wire up at the point concerned, and form it into a small loop or narrow 'U' shape, about 10mm long. Then using a pair of needle-nosed pliers, twist the 'U' a couple of times until the twists reach the former again. Then simply continue winding, leaving the twisted loop pointing radially outward. Later you can scrape the enamel from the end of the loops, and solder the leads to them from S1 and S2.

When you reach the 80th turn, cut the wire about 120mm further on, and loop the end through the two end holes as before to anchor it firmly. You may like to add a dob of nail polish at each end, diagonally opposite the loopings, to make sure the coil will be held in place securely. Details of this recommended coil construction are shown in Fig.5.

Once the two coils are completed, the next step is to make up your baseboard and front panel. To a certain extent the exact size of these will depend on your particular solution to the tuning capacitor problem. With the small capacitor we were able to use, a suitable size for the baseboard turned out to be 250 x 140mm, with the front panel 250 x 120mm. The baseboard was made up from 18mm thick maple and the front panel from 1mm hammertone-finished steel, but you could use any similar materials that are available.

To support the two coils, I cut off two 56mm lengths of 40 x 18mm maple, giving the ends a slight curvature to make each piece a snug fit inside the coil formers. Then I attached the two pieces to the baseboard, using PVA glue and brass screws (screwed upwards from the bottom of the baseboard). As you can see from the photographs, the coil formers slide down on these, resting on the small central ridge which runs around the centre of each former (a legacy of their intended use as a downpipe joiner).

Finally the baseboard with its two small mounting blocks was given a coat of 'Estapol' before continuing with the construction, both for protection and to improve the appearance. While the Estapol was drying, I was able to drill and ream the various holes in the front panel, and make up the small bracket used to mount the diode biasing pot VR1.

The front panel hole sizes and locations used in the prototype unit are shown in Fig.6, for those who wish to copy it, while details of the pot mounting bracket are shown in Fig.7. The

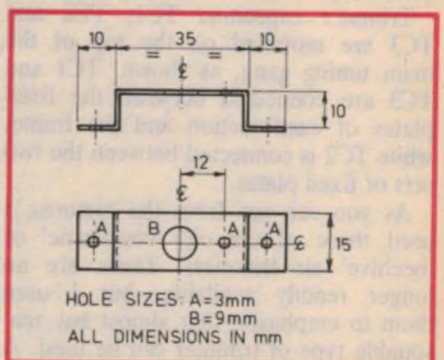


Fig.7: Details of the small bracket used to mount the bias pot.

bracket was bent up from a scrap of 1mm aluminium sheet.

Note that I have used a small vernier dial assembly for the tuning on the prototype. This type is readily available, being of Japanese 'Sato' manufacture, and with only an old-type 0-100 scale it gives the set a suitably *olde-worlde* look. Dick Smith Electronics sells it as the H-3900, and although it costs $11.55, this isn't unreasonable when you consider that it combines a knob, a dial and a reduction drive.

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Depending on the tuning capacitor(s) you use, and its/their size, you may need to mount it/them on spacers or a suitable small metal bracket, so that the control spindle(s) line up with the back of the dial(s). As you can see from the photographs, the tuning capacitor in the prototype unit is fairly small and it had to be mounted on spacers about 14mm long.

The rest of the construction is fairly straightforward, and should be clear from the wiring diagram and the photographs. The audio output transformer T1 has no mounting bracket, but is supported quite firmly by soldering its four main leads to the lugs of a pair of 5-way tagstrips, as shown. The tagstrips are also used to support R1, C1 and the anode end of diode D1.

Note that the high impedance winding of T1 actually has a centre-tap connection, but this is not needed here and is left unused.

The 1.5V 'C' cell used for detector biasing is held in a small plastic holder, mounted at the rear of the baseboard between the two coils.

The connections between the various tapping points on the coils and the corresponding points on S1 and S2 can be made in multiway ribbon cable, of the type used for computers, etc. This gives quite a neat job.

Trimmer capacitors TC1, TC2 and TC3 are mounted on the top of the main tuning gang, as shown. TC1 and TC3 are connected between the fixed plates of each section and the frame, while TC2 is connected between the two sets of fixed plates.

As you can see from the pictures, I used three of the old 'concentric' or 'beehive' air trimmers. These are no longer readily available, but I used them to emphasise that almost any reasonable type of trimmer can be used. A range of from 3-4pF minimum to around 30-40pF maximum would be fine, for all three. The modern ceramic or plastic dielectric type as available from most suppliers are quite suitable.

Getting it going

When you have the set completed, getting it going is fairly simple.

As noted earlier, as with any crystal set you're going to need a really good aerial and earth to feed the set with the strongest possible signals.

In the case of the earth, this means a good connection to your water pipes – if they're of the metal variety. If they are of the newer PVC type, you'll need a length of metal pipe (say a metre or so) driven into the soil near your house, and preferably at a place where the soil is reasonably damp so it provides a good contact.

For the aerial, use the longest length of reasonably stout multi-strand insulated copper wire you can organise, raised as high as possible from the ground and insulated from any earthy metalwork such as guttering or downpipe, etc.

The only other thing you're going to need, apart from the crystal set itself, is a pair of reasonable quality stereo earphones. These plug into J1, of course.

To start with, set both S1 and S2 to connect to the second (10T) taps on their respective coils. Set the coupling trimmer TC2 for maximum capacitance (fully meshed). Also turn the diode bias pot VR1 up from its anticlockwise limit, by about 30° for a germanium diode, or about 60° for a silicon diode. Then try tuning across the band, with one or both of your tuning capacitors as the case may be.

You should be rewarded by the sounds of at least a few of your local stations, at least faintly.

Select one of these near the low frequency end of the dial (i.e., with the tuning capacitor plates near to fully meshed), and adjust the tuning control(s) for the loudest reception. Then try switching S1 and S2 up and down from their initial settings, to see if you can improve the signal loudness and/or clarity. You may well have to readjust the tuning when you do this, as aerial matching in particular will tend to change the tuning.

By this stage you should have been able to improve the signal quite noticeably, unless the initial settings were already very close to optimum.

Now try adjusting the detector bias pot VR1 up and down from its initial setting. Again there should be a fairly clearly defined 'best position' for the pot, where reception is both loudest and clearest.

The next step is to go back to the coupling trimmer TC2, and slowly reduce its capacitance setting while listening to the signal. At a particular point, you'll hear the signal level start to drop. When this occurs turn the trimmer back up again, just enough to restore the signal volume. This will be the correct setting.

Finally, move the tuning control(s) up to a station near the high frequency end of the band (plates nearly out of mesh). Then adjust the two other trimmers, TC1 and TC2, for maximum signal loudness.

Your 1988 Deluxe Crystal Set should now be operating at very close to the maximum possible efficiency, and giving about as good reception as it's possible to get with a crystal set in your area and with the aerial and earth you're using.

Once set, the adjustments for detector bias (VR1) and tuned circuit coupling (TC2) shouldn't need to be altered. The detector matching switch S2 shouldn't need to be adjusted much either, unless you try different pairs of earphones.

However you will find that the optimum setting for the aerial matching switch S1 will vary with the frequency of the station you're trying to tune, because the impedance of the aerial varies with frequency. So for best results on any station, always try a few settings of S1 to find the one that gives best results. Each setting of S1 will also tend to vary the tuning slightly, of course, so operation is a bit fiddly.

But that's all part of the fun of rediscovering the basics of radio reception! EA

PARTS LIST

1	2-gang tuning capacitor, 300-400pF maximum per section, with matched sections (see text)
2	PVC formers for coils, 62mm diameter x 65mm long (see text)
1	reel of 24 gauge (B&S) enamelled copper wire
2	1 pole 8-position rotary switches
2	control knobs, for switches
1	tuning dial assembly (or possibly two - see text)
2	Screw terminals, red and black
1	6.5mm stereo phone jack
1	'C' battery holder, and 1.5V cell
2	5-way tagstrips
1	500Ω/8Ω transistor output transformer
1	500Ω linear carbon pot
1	Signal diode, germanium or silicon or Schottky (see text)
1	270Ω 1/4W resistor
1	4.7nF metallised polyester capacitor
3	3-30pF or similar trimmer capacitors

Plus hookup wire, length of ribbon cable for coil connections, screws, wood for baseboard and coil mounting pieces, sheet metal for front panel and pot mounting bracket, etc.

NEW FROM JAYCAR - AUSTRALIAN MADE UTILITY BOXES

Jaycar are proud to announce a new range of Australian made storage cases, one of which will actually replace an imported parts drawer.

Interlocking Parts Drawers

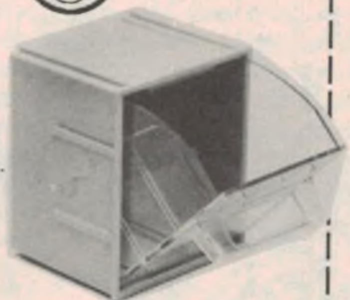
A two drawer case, with 3 removable plastic insert boxes in the lower drawer. These are ideal to remove from drawer to find that nut or resistor, without taking out the complete drawer. Side and top/bottom keying system allows you to use just a few, or build a whole wall of drawers as your parts expansion dictates. Flange on the rear of the case has two screw holes for easy mounting. Slide handles also takes identity cards, which are supplied.
Size 137(D) x 97(H) x 85(H)mm. Beige colour.
Cat. HB-6305

$5.95

10 up $5.50 ea

MADE IN AUSTRALIA

Component Drawer



Large see through drawer which has fall forward opening action, rather than usual drawer action. Interlocking both vertical and horizontal, can be fastened to wall, beige in colour. Unlimited uses.
Removable compartments for easy cleaning.
Size 11(H) x 103(W) x 83(D)mm.
Cat. HB-6308

$5.95

10 up $5.50 ea

NEW '88

Utility Box

Ideal system for the serviceman, or mobile workshop, or just to keep all those resistors and capacitors tidy. Also ideal for fishing tackle boxes and many other uses. Six of these utility boxes will fit snugly into the carry case pictured. Size of utility box 188 x 115 x 36mm. Colour opaque white.
Cat. HB-6310

$2.29

10 up $2.10 ea

Utility Carry Case

Specifically designed to hold 6 utility boxes snugly to give a 30 compartment totally portable parts storage system.
Size 365 x 210 x 80mm. Colour white.
Cat. HB-6312

$17.95

SPECIAL INTRODUCTORY OFFER
6 - UTILITY BOXES AND A CARRY CASE FOR ONLY $28.95 - SAVE $2.74.

PASSIVE INFRARED DETECTOR PRICE BREAKTHROUGH PULSE COUNT PIR FOR UNDER $100

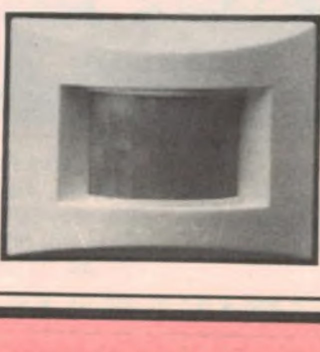
It had to happen, and Jaycar is the first to offer you a quality PIR with pulse count for under $100.
Jaycar was the first to offer pulse count PIRs way back in February 1987. Since then we've sold thousands! Pulse count virtually eliminates false alarms.
Here's how it works.
The circuit first senses an alarm (pulse 1) and then goes into alarm standby mode for 30 seconds duration. If during the 30 seconds standby mode a second alarm event occurs (pulse 2), the detector goes immediately into alarm, and the standby period will be extended for another 30 seconds. If there is no second alarm pusle during the 30 seconds standby mode the detector returns to normal condition.
Features:

- Coverage 12 metre x 12 metre
- Detection angle 110°
- Detection beamss - 38
- Adjustable angle
- Tamper proof protected
- N/C and N/O output

Cat. LA-5017

ONLY $99.95

NEW '88



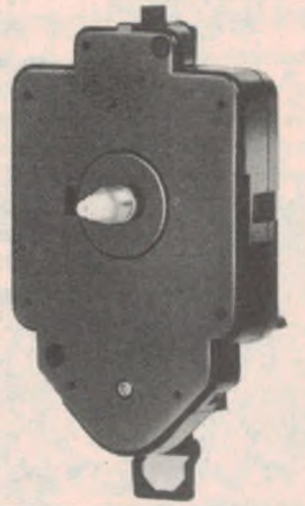
12 VOLT PLUG PACK BARGAIN

Famous Arlec brand 240 volt to 12 volt DC plug pack at 1 amp. It has a twin lead about 2 metres long on the 12V side, and plugs directly into 240V outlet. These normally sell for about $40. We have purchased a quantity from an OEM and can pass them on to you for about 1/2 price.
Cat. MP-3022

ONLY $19.50
SAVE 50%

DIRT CHEAP!!

CLOCK MOVEMENT WITH BUILT-IN PENDULUM DRIVER



This module measures 87mm long x 55 wide x 35mm deep and uses 1 x AA battery. Clock movement is supplied with 3 sets of hands, and pendulum is a suspended arm within the module which swings back and forth. A suitable pendulum can be attached to the bottom of the arm.
Fit your own custom clock face. Great for novel applications.
Available sometime in June.
Cat. XC-0103

$22.95

NEW '88

Quartz Crystal Clock Movement

NEW MODEL EXTRA FEATURES SAME PRICE

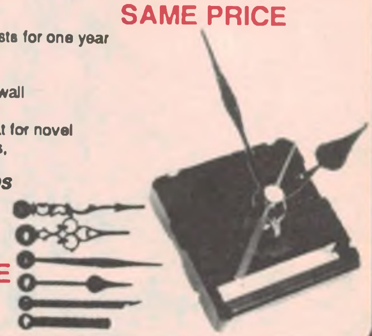
- Very compact
- Powered by 1.5V AA battery that lasts for one year
- ± 15 second/month accuracy
- NEW MODEL
- Bonus metal hook to hold clock on wall
- Bonus on/off switch

Fit your own custom clock face. Great for novel applications such as fitting to pictures, boxes, photographs etc.
SUPPLIED WITH 3 SETS OF HANDS

$12.95

Cat. XC-0100

NEW SHIPMENT DUE IN JUNE



TERMINATOR PIR WITH PULSE COUNT

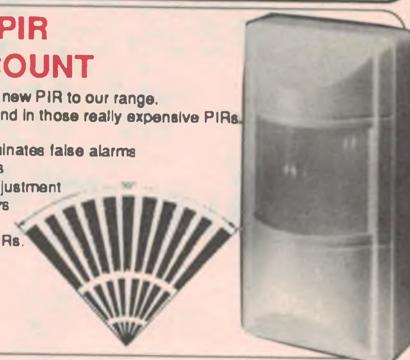
Jaycar are proud to announce a new PIR to our range.
The Terminator has features found in those really expensive PIRs.
FEATURES

- Pulse count which virtually eliminates false alarms
- 48 detection beams in 3 ranges
- Sliding PC board for pattern adjustment
- Optional lens for use in hallways
- Tamper proof protected
- Plus all the usual features of PIRs.

Cat. LA-5018

$119.00

Halway Lens Cat. LA-5020
$3.95



8" TWINCONE SPEAKER BARGAIN

We have made another speaker scoop purchase. This time from New Zealand of all places. These are made in NZ and are very high quality. There is one small catch although, they are 4 ohm.

10 WATT
$8.95
10 up $8
Cat. CE-2322

20 WATT
$13.95
10 up $12.95
Cat. CE-2323

NEW RE-DESIGNED VIFA SPEAKER KITS FOR 1988

Call into any one of our showrooms for an audition (not Concord)

SA-50 Unbelievable sound from such small speakers. Measures only 26(H) x 17(W) x 195(D)cm. Incorporates a 5" woofer and D19 dome tweeter. See AEM magazine for a full review, May edition. Complete kit with cabinets only:

$399

SA-70 Upgraded EA60/60 speaker kit incorporating 8" woofer and D19 tweeter. Complete kit with cabinets only:

$499

SA-100 Upgraded AEM6102 speaker kit. Uses new design crossover, and they do sound better. Complete kit with cabinets:

$799

SA-130 Upgraded AEM6103 speaker kit. New design crossovers, new slimmer cabinets, upgraded dome tweeter. Complete kit and new designed crossovers are excellent value at:

$1199

See our catalogue for full details.

NEW'88

DIRT CHEAP!!

CASTORS

Another scoop surplus stock buy. Set of 4 castors to suit speaker boxes, TV's or anything for that matter. Castors are mounted on a 37mm square metal bracket which is simply screwed to the speaker box etc. by 4 self tappers. (Screws not supplied) Originally used on colour TVs.
Cat. HP-0838

SET OF FOUR

$5.00

FUEL CUTOUT SOLENOID

Who needs a noisy car alarm, after you have installed one of these in your vehicle. It's operated from a hidden switch. Simply turn it on when you leave your car, and if your car is stolen, it won't go very far without any petrol. Supplied with instructions, pre-wired switched, hardware and even two alarm stickers. Quality M&D Alarm brand. Add to this our deluxe red light flasher kit - KJ-7000 $19.95, and who needs an alarm?
Cat. XC-2050

$69.95

DUMMY CAMERA BARGAIN

We all know that shoplifting and vanalism cost a small fortune very year. It has been demonstrated that television surveillance cameras in the right environment can discourage this activity.
This is where you come in.
We have made a great purchase of realistic-looking Dummy TV Cameras. They are Australian made, are supplied with adjustable swivel mounting bracket, fixing screws, flashing LED circuit board and 2 flashing LEDs. One red LED is mounted in a bezel on the front of the camera to add reality and the other - would you believe - is mounted BEHIND the dummy cameras lens! It looks really corny when it flashes and you COULD disconnect that LED but if a thief was ignorant of the cameras operation it may make the camera look more realistic to him. Also supplied is the 2 x D cell nylon battery holder to power the flasher circuit. A fake cable wallplate is also supplied as well as a very conspicuous 210(W) x 160(H) self adhesive sign which says "THESE PREMISES ARE PROTECTED BY TIME-LAPSE ANTI-THEFT CAMERAS" The text of the sign is in orange-red fluorescent ink against a black background.
BUT HURRY! We have around 300 of the cameras at this below normal manufacturers price. We do not ever expect to be offered similiar stock again.
Cat. LC-5310

1 - 4 pieces	$49.95
5 - 9 pieces	$42.95
10 - 19 pieces	$39.95
20+ pieces	$37.95 each

MORE NEW SPEAKERS

MIDRANGE

Quality 5" sealed back midrange with large magnet. Made in NZ.

Power Handling	System 100 watts rms
Freq. Response	350 - 7.5kHz
Resonant Freq.	400Hz
Sensitivity	90dB/1W - 1 metre
Impedance	8 ohm

Cat. CM-2078

$19.95

MIDRANGE

Same as CM-2078 speaker except that it has a metal surround.
Cat. CM-2079

$24.50

5" WOOFER/MIDRANGE

High quality NZ made speaker with large magnet.

Power Handling	20 watts rms
Freq. Response	80 - 15kHz
Resonant Freq.	80Hz
Sensivity	90dB

Cat. CW-2104

$18.95

NEW'88

DRY TRANSFER LETTERING

Quality lettering sets, available in 4 different styles. Can be used on most smooth surfaces including metal, glass, plastic, wood, cardboard and paper. Ideal for lettering on rack cabinets, control panels, etc. Simply position the letter and rub with the cap of a ball point pen or soft pencil. Made in Holland.
STYLE 1 Black lettering 4mm high. Capital letters, lower case letters, numbers. Sample MNuv 123 - Cat. NL-4100
STYLE 2 Black lettering 6.5mm high. Capitals, lower case, numbers. Sample DEZ sti 982 Cat. NL-4102
STYLE 3 Silver letters with black shadow 7mm high. Capital letters and numbers. Sample GHJUS 367 Cat. NL-4104
STYLE 4 Flourescent yellow on black background. Capitals and numbers. Sample AJP14 Cat. NL-4106

ALL ONE PRICE $2.99 per sheet

BASIC CIRCUITS

Featuring more than 300 worked examples and 900 practice problems. Electric Circuits is written for electrical/electronics students in colleges and technical institutes. The text covers electricity and the structure of matter, basic and complex circuits and vectors, DC and AC measurements, complex networks, and much more. Practice problems include schematic diagrams and emphasising alternate solutions.
Topics covered include:

- Electricity and the Structure of Matter
- Ohm's Law and Electrical units
- Resistance and Conductance
- Energy and Power
- Simple Series Circuits
- Simple Parallel Circuits
- Complex Networks and Kirchoff's Laws
- DC Network Theorems
- Capacitance and Capacitors
- Magnetism and Electromagnetism
- Inductance and Inductors
- Sources of Electromotive Force
- DC Electrical Measurements
- Sine-Wave Forms
- Complex Algebra and Electric Vectors
- Basic AC Circuits
- AC Network Theorems and Bridge Circuits
- Power in AC Circuits
- Resonance
- Simple Linear Circuits and Nonsinusoidal Voltages
- Polyphase Circuits
- Transformers
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- Appendices include: Values of Exponential Functions, Units, and Mathematics.

Hard cover - size 260mm x 180mm - 888 pages
Cat. BH-0904

$69.95

NEW'88

NEW BOOKS FOR '88

Active Filter Design

This comprehensive text provides both students and engineers with a clear understanding of the hows and whys of active filter design. Commonly used filtering terms are given, and a broad array of filter circuits are examined. Aids for determining which filtering circuit to use in a given application are supplied. The discussion then progresses through to the final theoretical chapters which deal with mathematical approximations in a clear, concise manner. Also included are illustrations and descriptions of basic filters, the advantages and disadvantages of filter types, general transfer functions, and normalisation and scaling.
Soft cover. Size 225 x 150mm.
133 pages
Cat. BH-0900

$22.95

NEW'88

IBM PC & PC XT USERS REFERENCE MANUAL Second Edition — $45.00

Expanded to include the features of the more powerful PC XT, this revised edition contains the most up-to-date information available on the IBM PC. From system setup through using DOS and programming techniques, this book provides users with clear, step-by-step explanations of IBM PC hardware and software - complete with numerous illustrations and examples. It covers the IBM PC and PC XT collectively and also highlights the differences between these systems.
Includes: • comparisons between the PC and XT • using DOS 3.1 • upgrading your PC to an XT • information on the customised hardware configurations of the PC and XT
• explanations on how to load programs on a fixed disk and how to organise directories.
Soft cover - size 235mm x 180mm - 479 pages
Cat. BH-0902

TELEPHONE DIVERTER

New Model available in June

This professional quality product will automatically transfer incoming calls to another telephone number, anywhere. Your business will not lose any important calls if you move, as incoming calls can be diverted to your new office address. Two telephone line are required while the YT-6510 is not Telecom approved it is a very well made product.
A 7.5V AC adaptor is provided.
Cat. YT-6510

$199

DIAL DRUM/CORD PACK BARGAIN

This will probably be your first and last chance to ever buy assorted dial drums. As used in the old day tuners, they are ideal for the hobbyist who likes experimenting. This pack contains $37.75 worth of dial drums and dial cord and you can have one for only $5. You will not see dial drums again - especially at this clearout, once in a lifetime price. Your junkbox needs some dial drums for the future.

WHAT YOU GET

	Value
108mm dial drums x 2	$5.50
54mm dial drums x 10	$15.00
57mm dial drums x 2	$3.00
40mm dial drums x 10	$12.50
2.5 metres dial cord	$1.75
	$37.75

ALL FOR ONLY $5.00
Cat. HM-3130

DON'T MISS OUT
LAST CHANCE - EVER

NEW LITHIUM BATTERY No. CRD 2325

As used in IBM and other computer clocks.
3 volt.
Cat. SB-2530

$7.95

LOWER PRICES ON HITACHI MOSFETS FOR 60000 AMP

	WAS	NOW	CAT
2SJ56	22.95	14.95	ZT-2450
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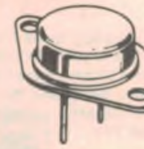

DIRT CHEAP!!

MULTIMODEM II SALE

WAS $349
JUNE SPECIAL
ONLY $249
SAVE $100
Cat. XC-4822

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SAVE $50
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DISCOUNTED KITS AT CLEAROUT PRICES

SAVE $$$$$$$$$$

Cat	Description	Mag	WAS	NOW
KA-1687	Electronic Rain Guage	EA March 87	$49.95	$29.95
KA-1688	Electronic Stroboscope	EA Aug 87	$13.95	$6.95
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KE-4728	Phone Ring Tone Customiser	ETI June 87	$29.95	$20.00
KE-4715/6	Intelligent Modem Kit with Power Supply	ETI 85/6	$428.00	$249.00

DIRT CHEAP!!

Philips 8" Woofer

AD80652/W8

Ideal for small sealed enclosures. Maximum enclosure volume is 25 litres. Great bass.
Recommended crossover frequency 2,500Hz.

Freq. Response	50 - 4kHz
Resonant Freq.	39Hz
POwer Handling	50 watts rms
Flux Density	1.2T
Total Moving Mass	17.5g
Compliance	
- Spkr. Unmounted	1.02mm/N
Voice Coil Height	10mm
Cone Diameter	25mm
Magnet Mass	450 grams
Mass of Speaker	1.15kg

Paper cone and polyester surround
Cat. CW-2115

NORMALLY $49.50
JUNE SPECIAL
ONLY $39.50
SAVE $10.00

TURN YOUR SURPLUS STOCK INTO CASH!!

Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

CALL GARY JOHNSTON OR BRUCE ROUTLEY NOW ON (02) 747 2022

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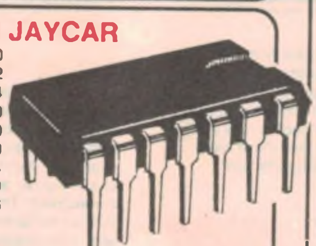
We have available a small range of HC series LS for a limited period.



GENUINE FM DIVERSITY WIRELESS MIC/ GUITAR LINK SELLOUT

You would DIE if you knew where we bought this shipment of brand-new genuine US-made NADY wireless PA gear from! Suffice to say that they lost a fortune to liquidate this current model merchandise. ONCE AGAIN their staggering loss is YOUR GAIN.

OFFER No1 — SAVE AROUND $200

Genuine NADY MODEL 201GT Guitar wireless microphone link which includes FM "True Diversity" receiver, bodypack transmitter with high impedance input (suitable for guitar pickups, bass, sax, etc). The body pack accepts a standard 6.5mm plug and the audio lead acts as the antenna, neat! The body pack measures 96 x 60 x 203mm and weighs only 70 grams. It requires a 9V alkaline battery. Both transmitter and receiver are crystal locked and offer 20-20,000Hz ±3dB frequency response and 120dB (max SPL A-weighted) dynamic range. Output is line level 600 ohms. Minimum adverse operating range 200 feet, line-of-sight 1500 feet. Elsewhere you will pay $800+ for this system in Australia. But, while they last you will be able to get this product from us for only $599! That's right, you WILL SAVE around $200 over the normal price in Australia! (Australian rec. retail $799).
(If more than one is ordered, they will be supplied as separate frequencies).
Cat. DT-5020

$599 INC tax

OFFER No2 — SAVE AROUND $300

Genuine NADY 201HT microphone wireless system comprising of YD-04 microphone (virtually identical performance to Shure SM-58), integral antenna (no dangling wires) low battery light and professionally rugged. Measures 222(L) x 36(Dia)mm weighs 238 grams. Use 9V cell. Included of course is the 201 "True Diversity" receiver matched to the same frequency. System performance and range similar to 201GT above. (You see this system used by TV entertainers in the US all the time!)
(If more than one ordered or 1 x 201GT and 1 x 201HT ordered they will be supplied on different frequencies).
Cat. DT-5030

$699 INC tax

NEW'88

Construction project:

Two Chip FM Receiver

Here is a simple and inexpensive FM broadcast receiver, using only two chips - and one of those is the audio amp!

by MARK CHEESEMAN

While many designs for small AM receivers have been published in *Electronics Australia* over the years, both for the medium wave and shortwave bands, there have been far fewer FM broadcast receivers. The reason for this is simple. An FM receiver (even a mono one) tends to be a far more complex device than its AM counterpart.

The simplest form of AM receiver is the crystal set, which consists of an adjustable tuned circuit, followed by a simple diode detector. This works for AM, because the audio program content is reflected in the shape of the RF envelope. However for FM demodulation, it is necessary to detect changes in frequency, which is a more complicated procedure.

The first thing which needs to be done in most FM receivers is to translate the frequency of the desired signal to another frequency, known as the *intermediate frequency*, or *IF*. This IF remains constant irrespective of the frequency of the station actually being received. This is done so that the signals which the demodulator 'sees' swing about the same centre frequency.

To achieve this, the signal from an oscillator, called the *local oscillator*, is mixed with the incoming signal from the antenna. The frequency of this oscillator is adjusted by the tuning control, such that the frequency of the desired signal differs from that of the local oscillator by an amount equal to the IF.

The upshot of all this is that the desired signal is shifted in frequency to that of the IF. All other signals are shifted by the same amount, and will end up on different frequencies. These unwanted signals are then filtered out by the next stage: the *IF filter*.

This leaves only the desired signal, which is then passed through a limiter, which basically clips the signal so that the output amplitude is almost constant, regardless of the input signal strength. The result of this is that any amplitude modulation component on the output signal is virtually eliminated, thus blocking a lot of the noise and interference which so often plagues AM signals.

This greatly cleaned-up signal is then (finally!) demodulated by an FM detector circuit, to be fed to an audio amplifier in the usual way.

FM on a chip

The TDA7000 chip from Philips is perhaps worthy of a special mention, not just because it contains all the active circuitry required for an FM receiver in a single chip, but also the rather clever way in which the input signal is demodulated.

The receiver is a single-conversion superhet design, as described above, with an IF of around 70kHz. However, this choice of IF could create problems with wide-band FM signals, as their signal deviation is 75kHz. To overcome this problem, the local oscillator of the TDA7000 is shifted in frequency in time with the incoming signal, but not over as great a frequency. Using this rather unusual technique, the deviation of the IF signal is reduced to 15kHz.

The use of such a low IF has the advantage of allowing the use of active filters in the IF strip, eliminating the need for inductors in these filters. In fact, only two inductors are used in the whole receiver, one for the local oscillator circuit, and the other for the tuned antenna circuit.

The tuning of the radio within the FM broadcast band is governed by the frequency of the local oscillator, which in turn depends upon the inductance and capacitance of the tuned circuit. The design presented here can accommodate various different values of tuning capacitor, by altering the number of turns

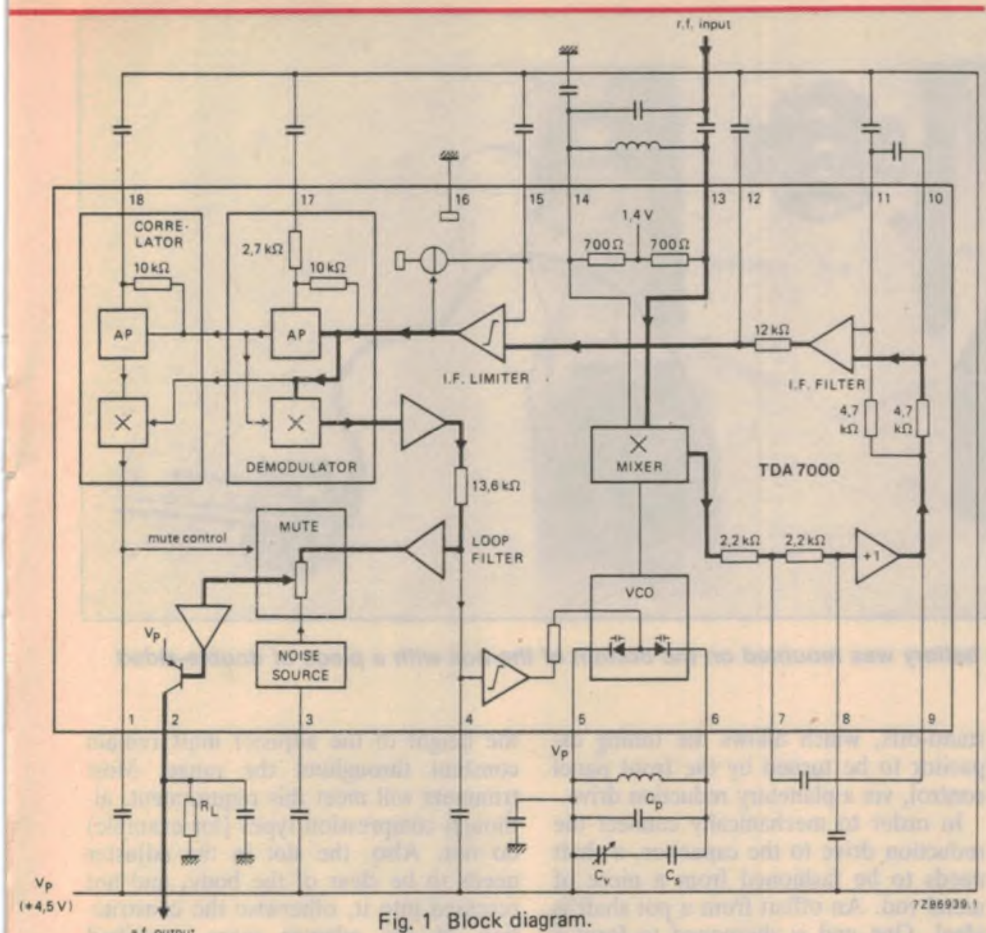


Fig. 1 Block diagram.

The "innards" of the TDA7000. A minimum of external components is required.

on the inductor, and by the inclusion of 'padding' capacitors of various values in series or parallel with the variable tuning capacitor.

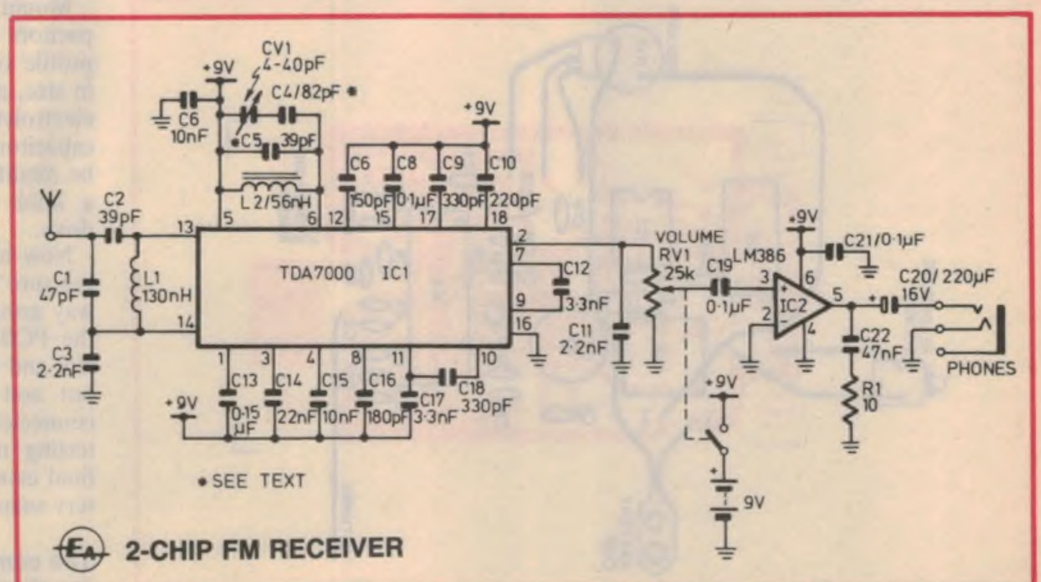
The TDA7000 chip also contains a muting circuit, which silences the receiver when the signal strength of the signal to which the receiver is tuned falls below a pre-set threshold.

The RF signal is introduced to the IC through pins 13 and 14. The IC can accommodate a balanced or unbalanced input, although an unbalanced connection is used here. L1, C1 and C2 form a tuned circuit which connects the antenna to the chip. L2, CV1, C4 and C5 are the main frequency determining components for the local oscillator circuit. For further details of the TDA7000 see Fig.1.

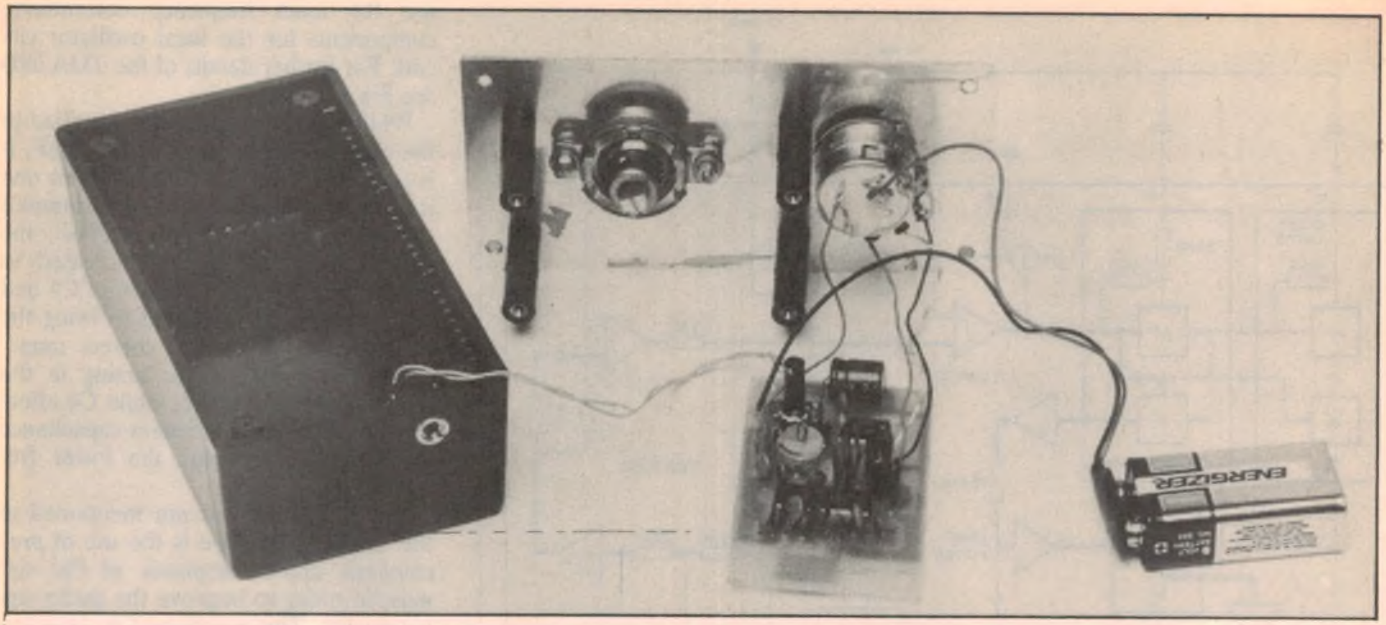
While the tuning capacitor specified in the parts list has a range of 4 to 40pF, it is possible to use other values if this one is not easily obtainable. If (for example) the maximum capacitance is 20pF, the inductance of L2 can be increased to compensate for this. Capacitors C4 and C5 may need to be altered to bring the tuning limits within the correct range. C5 primarily effects the tuning in the upper end of the range, while C4 effectively reduces the maximum capacitance of CV1, to determine the lower frequency end.

One thing that was not mentioned in the description above is the use of *pre-emphasis* and *de-emphasis* of FM signals, in order to improve the audio signal quality. This is achieved by boosting the high frequency components of the transmitted signal before transmission, and cutting them by the same amount in the receiver. Since white noise contains more energy per octave as the frequency increases, the result of these procedures is a significant reduction in the signal to noise ratio at the audio output of the receiver.

For this reason, C11 is placed in parallel with RV1, resulting in a de-emphasis time constant of 50us. The audio signal is then amplified by an LM386 power amplifier chip, which has a preset gain of 20. This amplifier is connected to the headphone socket, although the output power is adequate to drive a small loudspeaker, with a slight reduction in battery life. Power is derived from a nine volt transistor battery, with a current drain of about 14mA.



Most of the discrete components are capacitors and inductors, as these are difficult to build into ICs. IC2 forms the audio amplifier to power the headphones.



The complete unit prior to assembly. The battery was mounted on the bottom of the box with a piece of double-sided tape.

Construction

The entire circuit, with the exception of the volume potentiometer mounts on a PC board (coded 88fm5), measuring 74 x 44mm. This should be checked carefully for breaks in the copper pattern, or copper bridges between the tracks. This applies especially to the inductor etched onto the back of the board. A magnifying glass can be useful for this, as it only takes a very thin crack or bridge to cause tuning problems.

The housing used for the prototype is a plastic jiffy box with an aluminium lid, measuring 41×68×130mm. The PCB is mounted behind this using stand-offs, which allows the tuning capacitor to be turned by the front panel control, via a planetary reduction drive.

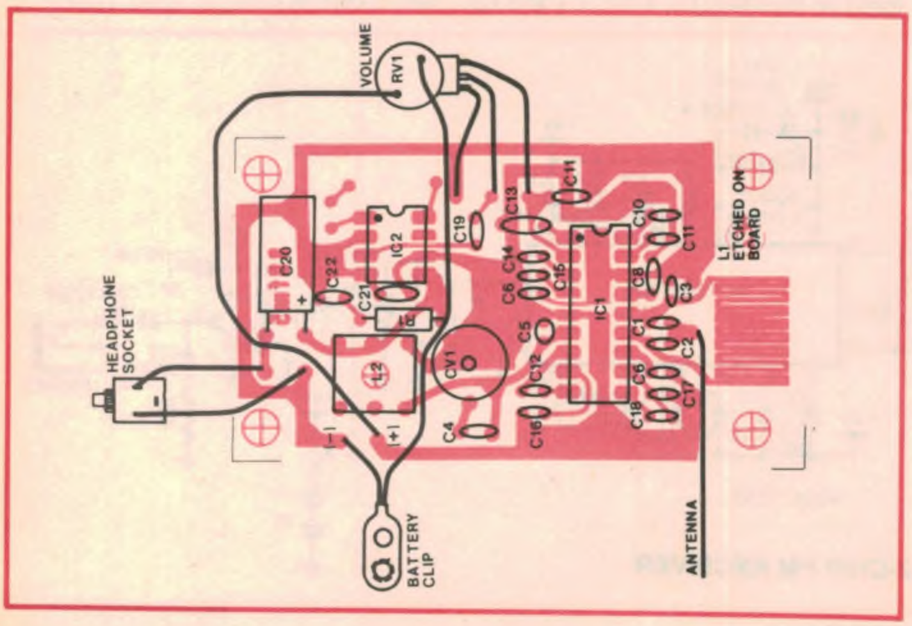
In order to mechanically connect the reduction drive to the capacitor, a shaft needs to be fashioned from a piece of metal rod. An offcut from a pot shaft is ideal. One end is sharpened to form a flat blade, similar to the business end of a screwdriver. The other end is then inserted into the back of the reduction drive, and when properly adjusted allows the tuning capacitor to be turned by the control on the front panel.

For this reason, the trimmer capacitor chosen for this project needs to meet certain physical criteria. The first is that the height of the adjuster must remain constant throughout the range. Most trimmers will meet this requirement, although compression types (for example) do not. Also, the slot in the adjuster needs to be clear of the body, and not recessed into it, otherwise the construction of the adapter piece described above will be very difficult.

Before mounting any components on the board, drill the four mounting holes to clear the screws in the spacers which you intend to use. Also drill a single hole about 3 or 4mm in diameter where marked below the space for L2, to allow it to be adjusted after the board has been mounted behind the front panel.

Mount the resistor (singular!) and capacitors first, starting with the lower profile ones and working your way up in size, and watching the polarity of the electrolytic. Next, mount the trimmer capacitor on the board. This will later be modified to allow it to be rotated by a knob geared down by a planetary drive.

Now mount the two ICs, again making sure that they are inserted the right way around. Also attach flying leads to the PCB for the antenna, volume control and headphone socket. The volume pot and headphone socket should be connected at this point also, as some testing needs to be performed before final assembly. Finally, connect the battery snap to the PCB and power switch.



The component overlay and interwiring diagram.

The coil assembly should now be commenced at this point by first glueing the plastic former to the base using a drop of super-glue or something similar. Wind 7 turns of 26 B&S enamelled wire around the former, and strip the insulation from the ends before soldering them into the terminals on the base. Also make sure that the wire is soldered to the terminals on the base that are closest to the tuning capacitor, as the other four are not connected. Apply a little glue to the layer of wire in order to prevent unwanted movement after assembly.

Now turn your attention to the mechanical details. Using the front panel artwork as a guide, drill the holes in the lid for the tuning reduction drive and the volume control.

Enlarge the hole for the reduction drive to 20mm using a chassis punch or file. This will allow the mounting flange of the drive to fit through the panel. Next, using the reduction drive as a template, mark out and drill two holes to clear 6BA screws, to support the reduction drive. These holes should be countersunk from the front, using a large drill bit twisted between the fingers. Do this just enough for the countersunk heads of the screws to lie flush with the top of the panel.

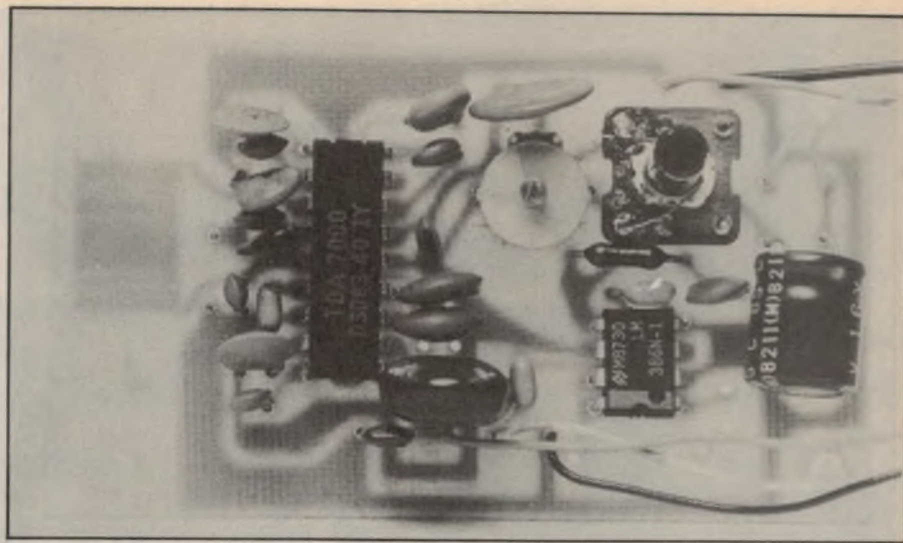
Then, insert these screws into the holes, and secure them with nuts and shake-proof washers behind the panel. Make sure that these screws are secure, as it will be virtually impossible to tighten them once the stick-on front panel is attached.

Four more holes need to be drilled to support the printed circuit board, and these should be drilled next. Probably the easiest way to determine where these holes should be drilled is to make a photocopy of the PCB artwork. This should then be stuck face-down on the front-panel, with the position where the tuning capacitor will be mounted aligned with the hole for the reduction drive.

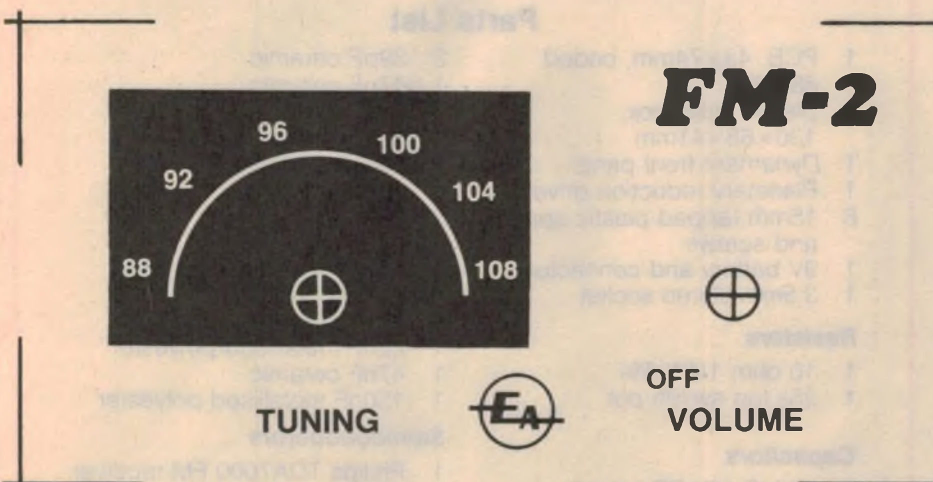
The planetary reduction drive attached to the tuning control serves two purposes. The first is to enable more accurate control over the tuning, as it would otherwise be rather sensitive. The reduction ratio of the drive is of the order of 6:1. The other reason is to enable the tuning capacitor, which is only a trimmer, to be adjusted using an ordinary control knob. The reason that a more conventional tuning capacitor has not been used is that they are difficult to obtain, especially in the low capacitance range required to cover the VHF region.

The operating frequency is indicated by a cursor attached to the flange of the reduction drive, which rotates in unison with the capacitor. This can be fashioned from a piece of clear perspex, with a line scored along its length. This is then attached to the drive with a couple of small screws.

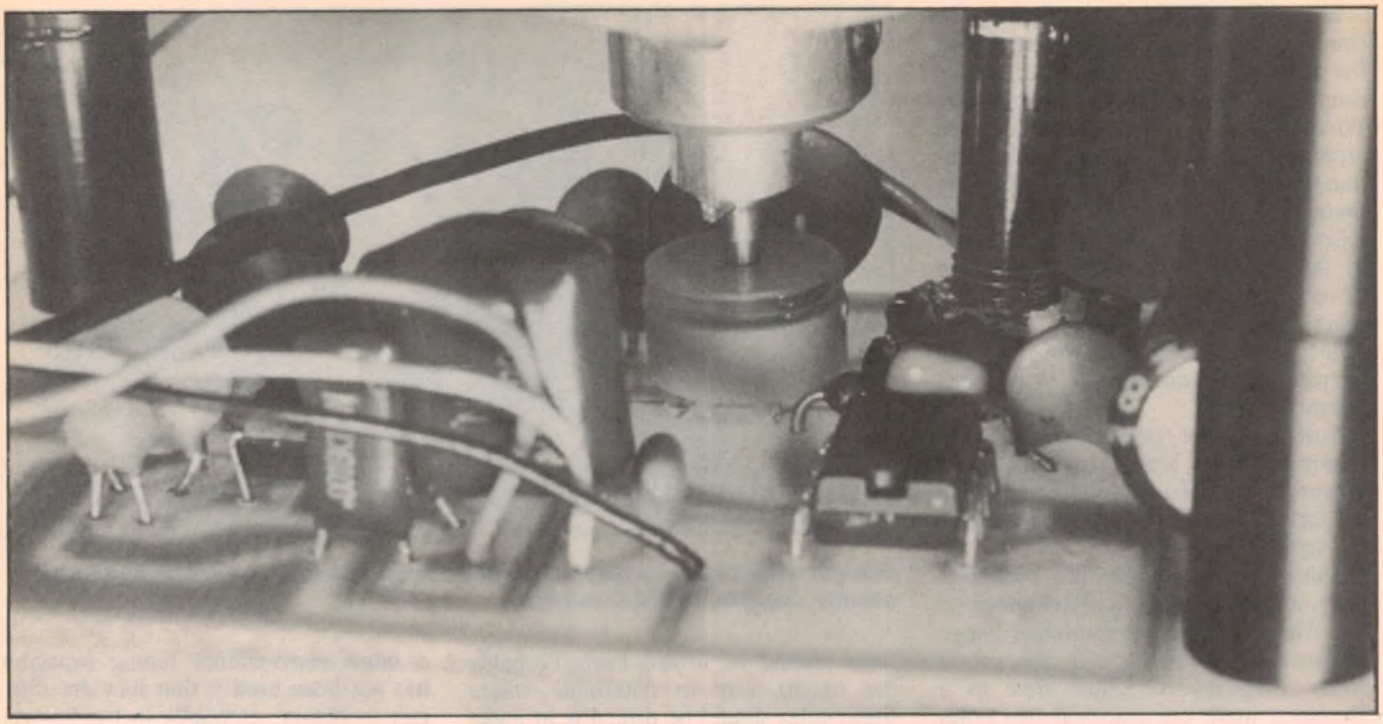
The PCB needs to be securely held behind the front panel in order for the tuning mechanism to work correctly. To achieve this, four 30mm long tapped spacers are used. If you have difficulty in finding spacers this long (as we did!),



Use this view of the completed printed circuit board in conjunction with the overlay diagram, to aid assembly.



Reproduced above is the actual size artwork for the front panel, and on the right is the PCB pattern.



Close-up view of the coupling between the reduction drive and the tuning capacitor.

use 15mm spacers, and glue pairs of them end-to-end with a strong adhesive, such as super-glue, to make 30mm ones. These should then be attached to the front panel, but not to the PCB until after the tuning has been calibrated.

Setting it up

The only setting up required is the adjustment of the tuning coil and possibly one or both of the padding capacitors in the tuning circuit (C4 and C5). Connect the radio to an antenna and apply power. Tune around *slowly* using a tuning tool or small screwdriver, until a station near the low end of the band is found. It is useful to have the front panel artwork handy for this so that the tuning frequency can be readily checked.

If this station appears higher on the dial than it should, wind the tuning slug out a bit and try again. Conversely, if the station is too low, wind the slug in. If you cannot adjust the slug over the required range, the value of C5 can be altered slightly in order to bring the tuning into the range required. If the slug is screwed in as far as it will go, and the tuning is still not right, increasing the value of C5 slightly will bring the tuning down, and it should then be possible to correctly tune the radio. Of course, if the opposite is the case, C5 should be lowered in value.

Now tune in another station, this time at the other end of the band, and again observe the position where it appears on the dial relative to where it should be. If it is too low (that is, the stations are all cramped up at the low end of the dial), try reducing the value of C4 a bit. If you cannot tune the upper end of the band, the same capacitor should be increased in value slightly, possibly by adding a small capacitor in parallel with C4.

It is now time for the final assembly! Rotate CV1 until the plates are fully meshed. Now, rotate the reduction drive until the pointer is horizontal and pointing to the low frequency end of the dial. Then insert the adaptor piece which you made earlier into the drive, but do not tighten it at this point. Carefully assemble the board and front panel, guiding the adaptor into the slot of CV1. Tighten the grub screws on the drive to prevent the adaptor from moving.

Then secure the board to the spacers already attached to the front panel with the screws provided. Also mount the volume control, followed by the headphone socket. Finally, connect up the antenna and you're ready to roll!

Parts List

1 PCB, 43×74mm, coded 88fm5
1 plastic utility box, 130×68×41mm
1 *Dynamark* front panel
1 Planetary reduction drive
8 15mm tapped plastic spacers and screws
1 9V battery and connector
1 3.5mm stereo socket

Resistors

1 10 ohm 1/4W 5%
1 25k log switch-pot

Capacitors

1 220uF 16V PC mount electrolytic
3 100nF monolythic ceramic
1 4/40pF horizontal mount trimmer
2 39pF ceramic
1 47pF ceramic
1 82pF ceramic
1 150pF ceramic
1 180pF ceramic
1 220pF ceramic
2 330pF ceramic
1 2.2nF ceramic
1 2.2nF metallised polyester
2 3.3nF ceramic
2 10nF ceramic
1 22nF metallised polyester
1 47nF ceramic
1 150nF metallised polyester

Semiconductors

1 Philips TDA7000 FM receiver
1 LM386 audio power amp

Miscellaneous

Super-glue, suitable knobs, antenna, off-cut from pot shaft.

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Construction project:

Multi-mode video card for AT compatibles

Here's another state-of-the-art design for a plug-in card suitable for IBM PCs and compatibles (including AT type machines), based on a new super-VLSI chip. This time it's a video display/graphics adaptor, providing monochrome, colour, Hercules and CGA-compatible high definition colour graphics modes – all with literally only a handful of parts on a very short PC board.

by JIM ROWE

When the original IBM PC first came out six years ago, there were two video display adaptor cards for it: the monochrome display adaptor (MDA) and the colour graphics adaptor (CGA). One was basically for display of text and simple graphics in no-nonsense monochrome, the other for text and medium-resolution graphics in colour. From memory both cards were IBM 'full slot' length, and jam-packed with dozens of ICs (although the MDA did include a printer port as well).

But that's the way it was for a while – you either used the MDA or the CGA, depending on taste and budget. Then along came Mr Hercules, with his improved monochrome graphics adaptor, and things started to change.

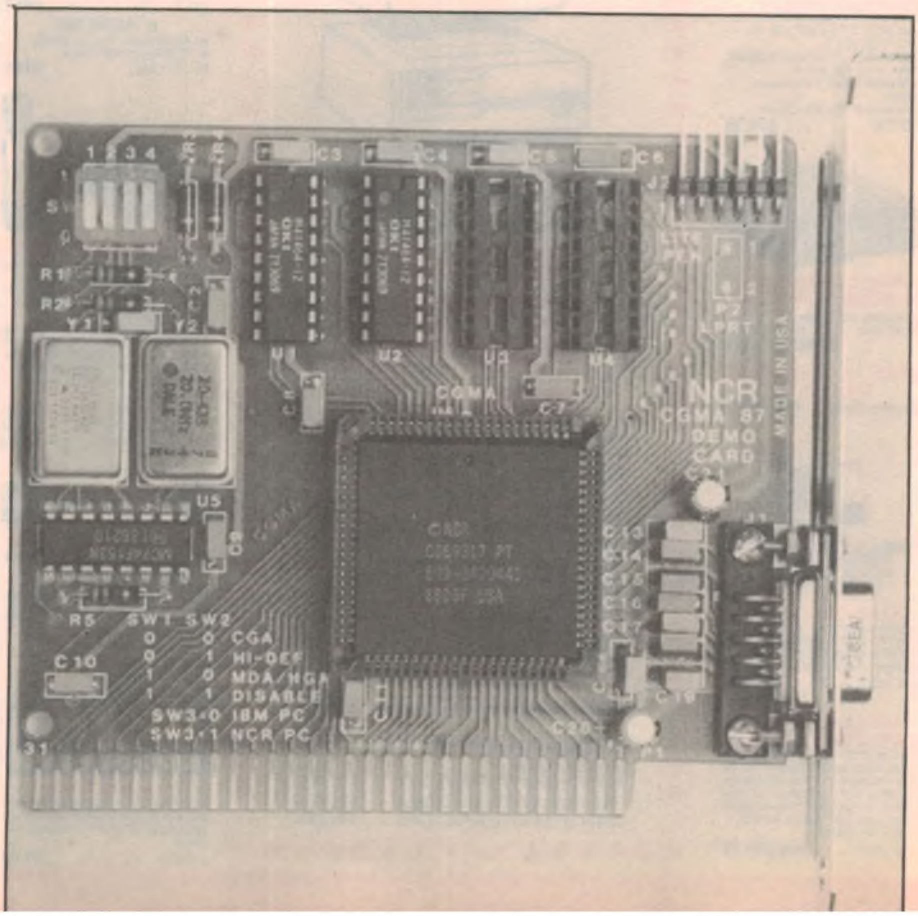
Not only did video cards get more powerful and flexible, with a plethora of display modes, but thanks to the development of fancy new VLSI chips they also started to shrink.

Nowadays there's a very wide range of cards to choose from, some of them offering the ability to emulate the original MDA and CGA, the Hercules card (HGA) and sometimes other fancy cards as well. About the only one that doesn't seem to be emulated on most of these cards is the newer *Professional Graphics Adaptor* (PGA) – presumably because it's either too complicated, or as yet not popular enough.

The only problem with some of these 'commodity' video cards is that they won't necessarily give correct operation with the newer generation of AT-level machines. Many of these machines run at 8MHz, 10MHz or even 12MHz, and some of the display cards can't keep up. They can cause problems by forcing the processor to enter additional *wait states*, 'twiddling its thumbs' until the video card has digested data for display.

Building your own video card hasn't been all that practical until now, mainly because the specialised VLSI chips needed for a small-chip-count circuit have been hard to get. In any case, fully wired and tested video cards have been readily available at quite reasonable prices, giving little incentive for building one.

But things have now changed. The multi-mode video card design described in this article can be built up for rather



The completed card. As you can see it is very compact, thanks to the 72C81 CGMA chip.

less than any comparable wired and tested card. At the same time, it's fully compatible with AT-level machines, so there needn't be any doubt on that score.

Best of all, the card is exceptionally easy to build. In fact it must surely be about the easiest PC-compatible card yet described – the kind of project that uses literally only a handful of parts, and can be wired up in an hour or two at most.

There are actually only four ICs in the basic design, plus a couple of crystal oscillator modules, a DIP switch to set the display modes, five resistors and a few capacitors. That's it!

It all fits on a tiny 'short slot' IBM-type card, measuring only 102mm long. Almost unbelievable, when you compare it with those original MDA and CGA cards...

Make no mistake, though. Despite this apparent simplicity, it's a full multi-mode display and graphics adaptor. It will operate as an MDA, a CGA, a Hercules HGA or a double-resolution CGA – and in either alpha or graphics modes. See Table 1 for a summary of the full range of display modes supported. It's quite impressive.

By the way we at *EA* can't claim the credit for developing the project. The complete design comes from the Microelectronics Division of NCR, based in Colorada Springs, USA. The design has come to us via NCR's Australian representative Energy Control International, of Sumner Park in Queensland, and to make things especially easy for those who want to build it up, Energy Control is making complete kits available by mail order. For details of the kit price and address for ordering, please see the data panel which accompanies the parts list.

Star of the show

You guessed it, most of the card's functions are performed by another of those all singing, all dancing super-VLSI wonder chips. In this case the chip is NCR's new 72C81, which the company describes as a *Colour Graphics and Monochrome Adapter* (CGMA) – which more or less means that it provides pretty well all of the circuitry needed for our complete colour/mono video graphics adaptor.

Essentially all that's needed apart from the 72C81 itself are a few memory (RAM) chips for the actual screen memory, a source of video clock pulses and a TTL-type video monitor, as

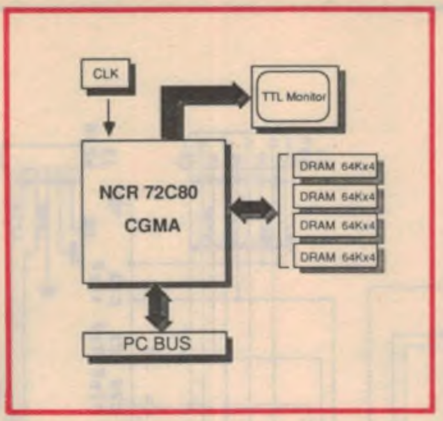


Fig.1: A simplified block diagram showing the card's main functions.

shown in the simplified block diagram of Fig.1.

In reality you do need another clock oscillator or two to cover the various display modes, and a few other parts, as we'll see shortly. But the 72C81 is certainly the star of the show, doing just about everything except sweep the floors and make the coffee.

NCR doesn't tell you a great deal about what's actually inside the 72C81, in its data sheets. However here's a summary of what I've been able to glean about it:

Fairly obviously it's a state-of-the-art ASIC (application-specific IC) device, made using the new 'Megacell' technology (see our article last month, *Meet the VL16C452, a bunch of Megacells*). This involves designing new VLSI devices by slotting together existing and proven designs for subsystem modules.

The 72C81 is a CMOS single-chip device, which comes in one of the new 84-pin PLCC (plastic leadless chip carrier) packages. It combines an industry standard 6845-type video screen controller, plus display character ROMS and virtually all of the buffer circuitry for interfacing to the PC bus, the video display RAM and the video monitor. The pin connections for the 72C81 are shown in Fig.2.

It provides full software compatibility with the IBM MDA and CGA, plus the Hercules HGA. In addition, it provides a special CGA-compatible 'high definition' colour graphics mode, with 640×400 pixel resolution to improve both text and graphics clarity. This is achieved by means of special 'mapper' circuitry inside the 72C81, which intercepts I/O accesses to the internal 6845 video controller and inserts new parameters which are correct for high resolution operation. This gives higher resolution display, while still ensuring compatibility with software designed for a CGA.

The various display modes are selectable either by software commands, or by control voltages applied to a pair of control pins on the device itself (M1 and M2). These are sensed by the 72C81 during its power-up reset sequence. Table 2 shows the way the logic levels on M1 and M2 control the display modes; note that when both pins are at logic 1, the device is disabled. This allows the processor to access another video adaptor, if there are more than one fitted to the system.

In colour alphanumeric modes, two bytes are used to define each character image. The first or *character* byte is used to look up the actual character image data itself, stored in ROM. This data is then serialised and shifted out to the colour encoder. The second or *attribute* byte then controls the encoder, to define things like the colour of the character, the colour of the background and the screen border colour if CGA mode is selected. The attribute byte also controls character blinking, intensity and normal/reverse display.

In colour graphics modes, the display memory is organised in a packed-pixel format with each byte representing four or eight pixels, depending on the mode selected. In 320×200 CGA graphics mode each byte represents four pixels, with two bits per pixel. Data read from the display memory is shifted as bit

Mode	Type	Alpha Format	Charac. Cell	Screen Resolution	Buffer Start	Colors	Page Size
CGA	Alpha	40 x 25	8 x 8	320 x 200	B8000	16	2048
CGA	Alpha	80 x 25	8 x 8	640 x 200	B8000	16	2048
Hi-Def	Alpha	40 x 25	8 x 16	320 x 400	B8000	16	2048
Hi-Def	Alpha	80 x 25	8 x 16	640 x 400	B8000	16	2048
MDA	Alpha	80 x 25	9 x 14	720 x 350	B0000	3	4096
CGA	Graphic	40 x 25	8 x 8	320 x 200	B8000	4	16384
CGA	Graphic	80 x 25	8 x 8	640 x 200	B8000	2	16384
Hi-Def	Graphic	40 x 25	8 x 16*	320 x 400 *	B8000	4	16384
Hi-Def	Graphic	80 x 25	8 x 16*	640 x 400 *	B8000	2	16384
HGA	Graphic	80 x 25	9 x 14	720 x 348	B0000/ B8000	2	32768**

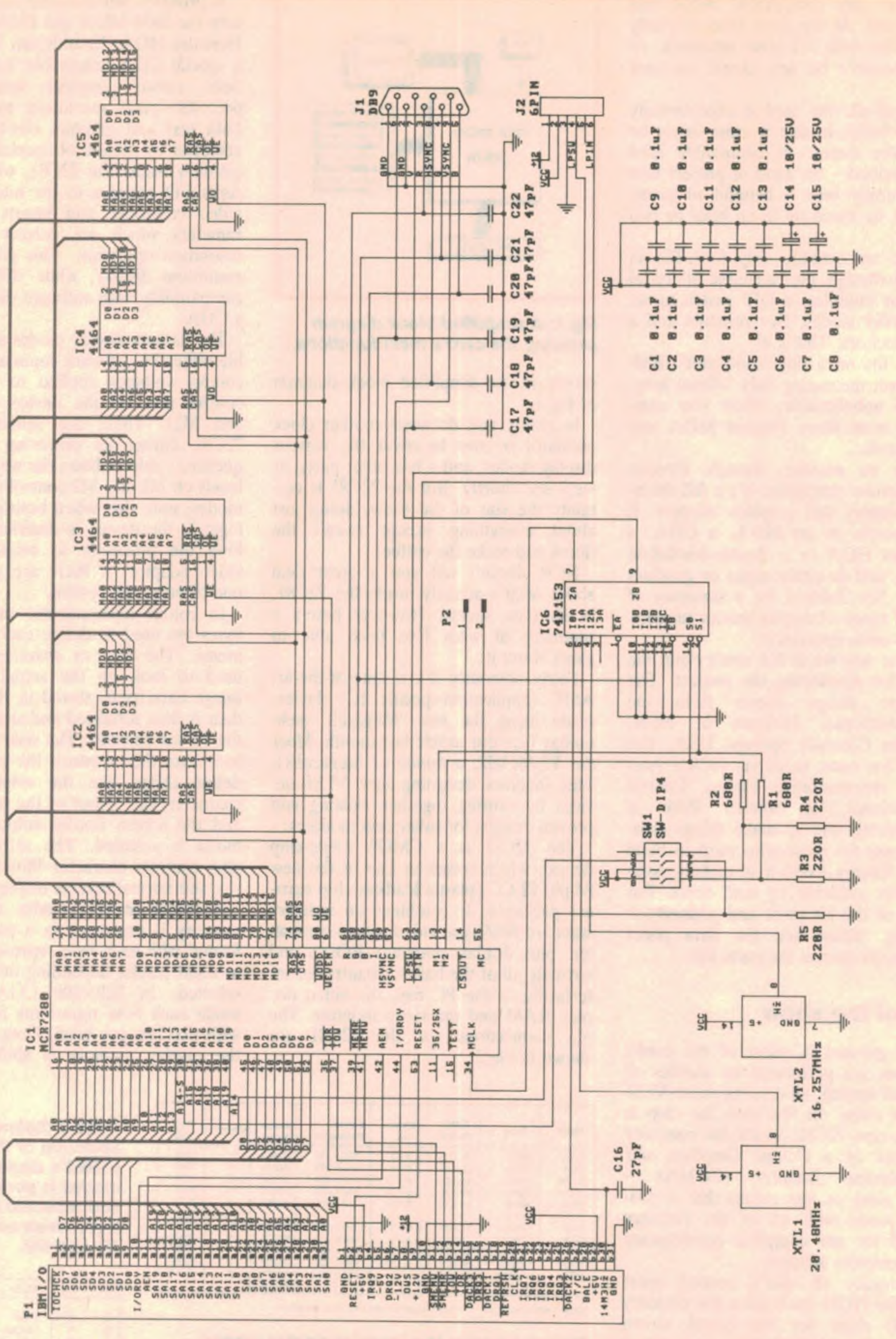
* Scan Double Displayed ** 2 page support in Hercules and Text Mode

Table 1 (above): The range of display modes supported by the new card. It's very flexible.

Table 2 (below): Selection of the CGMA's display modes is performed and reflected by the logic levels on pins M1 and M2.

M1	M2	Mode
0	0	CGA
0	1	Hi-Def
1	0	MDA/HGA
1	1	Disable

MULTI-MODE VIDEO GRAPHICS CARD



The complete circuit for the display adaptor card. As you can see, the CGMA chip itself does almost everything.

Multi-mode video card

	Monochrome	CGA Mode	Hi-Def Mode
Horizontal scan rate	18.432 KHz	15.750 KHz	25.000 KHz
Vertical scan rate	50 Hz	60 Hz	57 Hz
Video rate	16.257 MHz	14.318 MHz	20.000 MHz
Displayable colors	3	16	16
Character size	7 x 9 pixels	5 x 7 pixels	7 x 9 pixels
Character cell size	9 x 14	8 x 8	8 x 16
Maximum resolution	720 x 350	640 x 200	640 x 400

Table 3: The main scan[...]ameters for the CGMA chip's various display m[...]

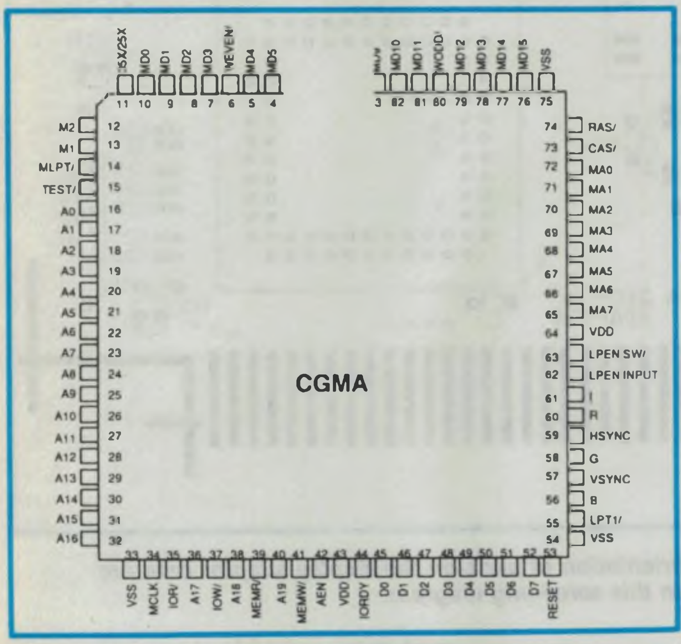


Fig.2: Pin connections for the 78C80/72C81 CGMA chip, which comes in an 84-pin PLCC package.

Which display monitor?

Although the CGMA card described in this article will operate with a normal IBM-compatible monochrome monitor in its MDA/HDA mode, and a similarly compatible RGB colour monitor in its CGA mode, you'll need a special monitor in order to take advantage of the card's other high definition colour mode.

The ideal kind of monitor to choose is one of the type which is capable of automatically locking to any of a range of horizontal and vertical scanning rates – this will allow operation of the CGMA card in *any* of its modes, and switching between them under software control.

We tried out the prototype card with an NEC "Multisync II" type JC-1402HMR monitor, kindly made available by NEC Home Electronics Australia. The Multisync II is a high resolution 14" colour monitor with 30MHz video bandwidth, a tube with 0.31mm dot pitch, and a potential resolution of 800 dots by 560 lines. It locks automatically to any horizontal scan rate between 15.5 and 35kHz, and any vertical rate between 50 and 80Hz.

Needless to say it worked very happily with the CGMA card in all of its display modes, and gave excellent results.

For further information on the Multisync II contact NEC Home Electronics at 244 Beecroft Road, Epping 2121, or phone (02) 868 1811.

pairs to the colour encoder. The colour of the displayed images is specified separately via the 72C81 (6845) Colour-Select Register (I/O address 3D9).

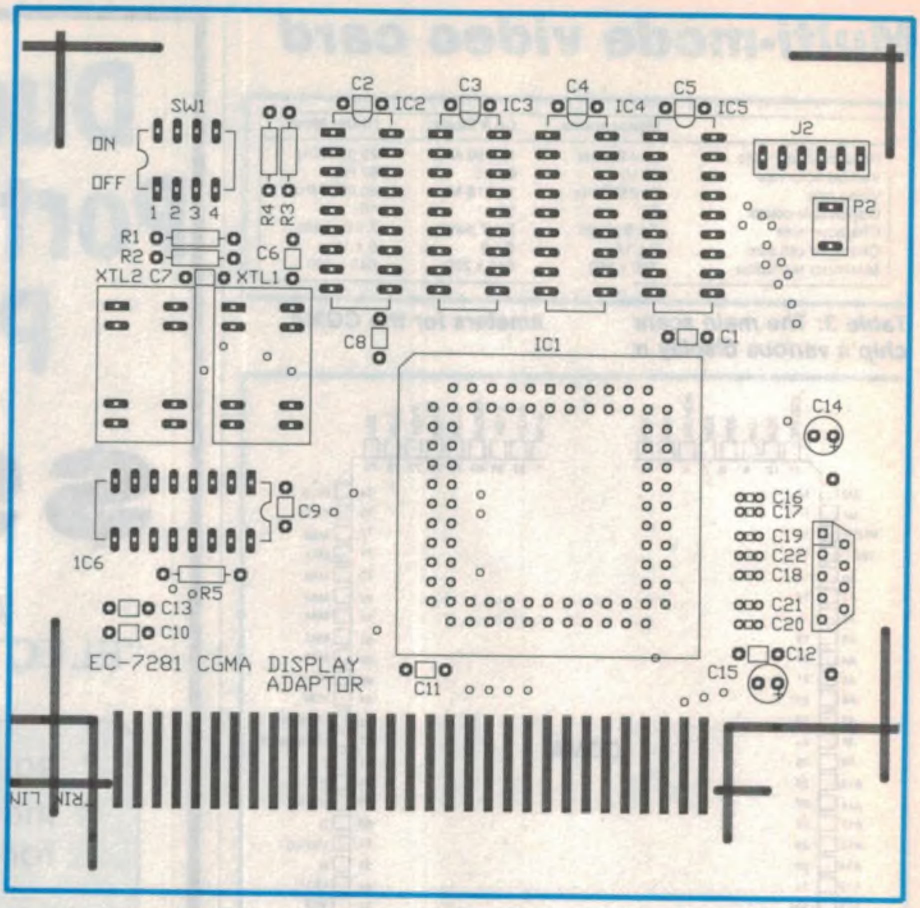
Monochrome alphanumeric modes operate in a similar manner to colour modes except that the 8×14 pixel cell character ROM is selected and an additional horizontal pixel is added for each character, resulting in a 720-pixel wide display (80 characters). In addition, the colour encoder outputs video data on the G output and intensity control on the I output, with the available attributes being blink, blank, underline, reverse video and intensify. Vertical sync output is also inverted in monochrome modes.

In monochrome graphics mode, data from the display memory is serialised and displayed in a 720×348 pixel format.

Essentially the 72C81 responds to both Memory and I/O accesses. Memory operations are used to write and retrieve the actual information to be displayed, to and from the video RAMs. On the other hand I/O operations are used to specify the manner in which this information is displayed.

In order to set up a specific video display, video is blanked by writing to the 72C81's Mode Control Register (I/O address 3D8), the appropriate timing and display parameters are loaded into the internal 6845 register, the display memory RAMs are loaded with the data to be displayed, and video is re-enabled. This process is normally performed by the computer's BIOS routines, or by application programs themselves in the case of those which write directly to the display adaptor.

The scanning parameters for the 72C81 operating in the various display modes are shown in Table 3.



The placement and orientation of parts on the display adaptor card are shown quite clearly in this screening diagram.

Circuit details

As you can see from the circuit schematic for the new video card, there isn't a great deal of circuitry outside the 72C81 CGMA chip itself (U6). There is provision for up to four 4464-type DRAM chips (64K×4 bits) for the video memory buffer, although only two (U1 and U2) are needed for most applications. Adding the other two provides a second 'page' of video RAM, allowing the buffer to be written into by the processor at any time, without additional wait states and without producing snow or video breakup.

DIP switches SW1 and SW2 are for setting the CGMA's display mode, during power-up reset. These connect directly to the M1 and M2 pins (13 and 12) discussed earlier, and also to the control inputs of a 74F153 dual 4:1 multiplexer chip (U5).

One section of the multiplexer is used to select the appropriate video dot clock input for the CGMA (pin 34), for the various display modes. The 14.318MHz system clock is used for CGA mode, while the 16.257MHz and 20.000MHz clocks generated on the card itself by Y1 and Y2 are used for the MDA/HGA and Hi-Def colour modes respectively.

The other section of the multiplexer chip is used to gate the monochrome video output, which appears on the 72C81's 'G' output (pin 58) in MDA/HGA mode. The second section of the multiplexer therefore connects the G output to pin 7 of the video output connector only when SW1 and SW2 are set for MDA/HGA operation.

Note that the M1 and M2 pins of the CGMA chip are not just inputs, but outputs as well. During power-up reset

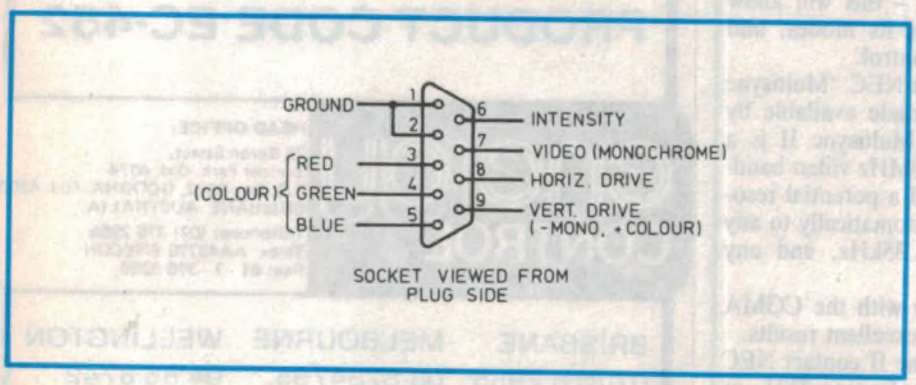


Fig.3: Pin connections for the adaptor's DB-9 monitor output connector, which produces TTL compatible signals.

they act as inputs, reading the settings of SW1 and SW2 to set the initial operating mode of the 72C81. But after this initialisation, the two pins become outputs which reflect the actual display mode bits stored in the 72C81's extended control register.

Resistors R1, R2, R3 and R4 are used to 'decouple' switches SW1 and SW2 from the multiplexer control pins and the CGMA M1/M2 pins, so that the CGMA pins can have ultimate control over the multiplexer. So if the 72C81's display mode is changed by software commands, at some stage after the initialisation sequence, the multiplexer will automatically change along with it.

Switch SW3 is used to configure the card for use either with standard IBM-compatible computers, or with NCR's own machines. For IBM-compatibles the A14 system address line is not brought to the CGMA A14 input, which is instead tied to logic 0 via resistor R5. However for use in NCR machines, SW3 is used to bring the system A14 line in, to give it control over the CGMA. I haven't been able to find out the reason for this – presumably it's due to minor differences between the NCR and other IBM compatibles.

Video and sync drive signals for the monitor come directly from the CGMA chip (apart from the monochrome V signal), and appear at the usual DB-9 connector. This type of connector is now used by most common 'TTL drive' monitors intended for IBM-compatible computers, whether they are monochrome or colour. The standard DB-9 video connections are shown in Fig.3.

Apart from the usual supply line bypass capacitors and capacitors used to dampen any ringing on the video and sync drive outputs, that's about all there is on the card. Although there is a light pen connector (J2), with the standard IBM connections.

One final point is that the 72C81 chip does actually provide decoded I/O address signals to enable parallel printer port circuitry. These appear on pins 14 and 55, being designated MLPT and LPT1 respectively. Both are active low outputs, and go low when the processor accesses I/O address ranges 3BC-3BE and 378-37F respectively. So the first could be used to enable an MDA-configuration printer port, while the second could enable a CGA-configuration port. On the current card these outputs are not used.

Construction

Construction of the card should be very straightforward, as Energy Control is making available complete kits. These include a quality double-sided PCB, provided with a silk-screened pattern showing the position and orientation of all parts. Using this as well as the photograph shown, of the complete card, you should be able to assemble the card quite easily in an couple of hours.

I suggest that you mount the passive components first – the resistors and capacitors – followed by the IC sockets. Note that the big 84-pin PLCC socket for U6 must be orientated with its chamfered corner adjacent to C8. This socket also has 84 fairly fragile pins, so

Continued on page p112

PARTS LIST

1	PCB, 110 x 101mm
J1	DB-9 socket, PCB right-angle mount
J2	6-way right-angle PCB pin header
SW	4-pole DIL switch
Y1	16.257MHz DIL crystal oscillator module
Y2	20.000MHz DIL crystal oscillator module
Integrated circuits	
U1-2	64K×4 bit DRAM (4464/100ns or similar)
U3-4	64K×4 bit DRAM (optional, as U1-2)
U5	74F153 dual 4:1 multiplexer
U6	72C81 colour graphics/monochrome adaptor (CGMA) chip
Resistors	
R1,2,5	680 ohms 1/4W
R3,4	220 ohms 1/4W
Capacitors	
C1-19	10nF monolythic, 100V
C20-21	10uF electrolytic, 16VW

Miscellaneous

84-way PLCC socket for U6; 18-way DIL sockets for U1-4; PC-type card mounting bracket; DB connector mounting screws

NOTE: A complete kit for this project will be available from Energy Control International Pty Ltd of 26 Boron Street, Sumner Park 4074, or telephone (07) 376 2955. The cost of the kit is $119.00 plus $23.80 sales tax, plus $6.50 for packing and postage anywhere in Australia.

New 30W stereo amplifier project – 1

Design considerations

What performance level and features do we really need from a do-it-yourself amplifier? You may find the answers a little surprising.

by ROB EVANS

There's no doubt about it, stereo amplifiers are popular do-it-yourself projects. Over the years, thousands of constructors have experienced the satisfaction of their latest project taking centre stage in a hifi system. Somehow the blood, sweat and burnt fingers make an amplifier you've built yourself better than any unit bought across the counter.

Yet it's more than a matter of pride, for building an amplifier makes sound economic sense. It can not only cost much less than an equivalent commercial unit, but in many cases will offer superior performance.

A prime example of these benefits is the successful Playmaster series of amplifiers, which have provided readers with low cost, high performance designs for many years. These have ranged from quite low powered designs with basic features, to high power monsters with very comprehensive facilities.

So, amidst the array of possible directions we may take in amplifier design, we need to carefully consider which performance parameters and facilities are needed, whilst maintaining a low overall cost. If this task is successful, the result is a versatile amplifier which is kind to the ears, as well as the wallet.

History

Over the years, the Playmaster amplifiers have provided us with a wealth of knowledge on practical amplifier design for the home constructor. There are a few distinct areas of concern, where extra planning is required for an effective design.

For instance, an amplifier with an elaborate construction technique is a problem just waiting to occur. Regardless of a constructor's mechanical ability, it is just far too easy to make mistakes. Building the amplifier may become a long, arduous procedure. The most trouble free designs in the past have been those with the *least* interwiring and mechanical work.

Another area that can be a source of headaches is the stability of high power designs. At high power levels, circuits tend to become less tolerant of component variations and physical layout. It may only require a bit of extra inductance here, a little less capacitance there, and off she goes! This is not a problem for commercial manufacturers, for they generally source their components with a known tolerance from one supplier. But by and large, for home construction the low and middle power designs have always resulted in fewer grey haired constructors.

The facilities offered by past Playmaster designs have naturally been influenced by current audio fashion – ranging from 4-channel simulation, to elaborate FET signal switching. However, regardless of how seductive a trend may be, we must consider the value of these facilities carefully. An inbuilt spectrum analyser may be great for watching Bach, but would be of limited use in the long term.

Power to the people

It is interesting to note that Playmaster amplifiers in the range of 20 to 40 watts have been by far the most popular over the years. Hundreds of Twin Twenty-Five and Forty-Forty amplifiers have proven to be both reliable, and easy to build. This is more than an indication of good design, for when it comes down to it, few of us really need high power amplifiers.

Most of our listening is at an amplifier power of a few watts, with any frivolous moments easily handled by a 25 watt unit. Even the wide dynamic range of a Compact Disc (CD) player is not too much of a problem, once we learn the appropriate volume control setting.

So, experience shows us that normally, the limited power of a modest amplifier is a small sacrifice, given the benefits in cost and reliability. Granted, the well-heeled audio enthusiast may have exotic, inefficient loud speakers and listen at ear shattering levels, but in this case the heart of the system is often an equally exotic high powered amplifier.

In this context, we should note that the traditional technique of measuring continuous amplifier power has taken a bit of a battering recently. Power is not what is seems! The dynamic headroom style of testing is considered to be far more representative of the available power when listening to music. These tests are set out in the IHF-A-202 Standard, and involve a 20 millisecond tone burst of +20dB relative to a continuous 1kHz sine wave, at intervals of 500 milliseconds.

With the wide dynamic range of uncompressed CD material, the transient power of an amplifier is at least as important as sheer continuous grunt. After all, who spends a relaxing evening listening to continuous sine waves?

If you are a member of the fraternity that delights in shattering windows (or loudspeakers!) with sheer output power, the solution is not necessarily moving to a higher powered amplifier and replacing the speakers. The current trend is towards active sub-woofer systems.

Adding a sub-woofer to an existing system will vastly increase its effective power capability by relieving the main amplifier/speaker combination of the low frequencies, where most of the musical energy lies. When correctly balanced, such a system is capable of excellent (if not spectacular!) results. It is a neat solution to an upgrading problem and has a number of fringe benefits – both financial, and physical.

The physical benefits may be seen by what you *don't* see. That is, the original system remains unchanged while the sub-woofer may be hidden out of sight (since the low frequencies are largely non-directional), or arranged as a coffee table that rattles the cups!

The financial benefits are realised when you consider the cost of upgrading the existing amplifier/speaker combination, versus the cost of an additional mono amp and sub-woofer box.

So there we have the question of power. If we are realistic about the common listening levels, use a design with reasonable headroom and bear in mind that a power upgrade via a sub-woofer system may be elegant, we have a much clearer direction in our amplifier design: for most users, an output power of around 30W per channel is more than adequate, and the best compromise in terms of cost and complexity.

Facilities

Having established some of the general design principles for this amplifier, we may now turn our attention to the more specific features, such as its facilities.

An amplifier's facilities will bear a strong relation to its overall cost, because as with most electronics design, the price of the case hardware tends to dominate that of the electronics. Therefore, we have to arrive at a careful balance between what facilities are truly useful, and the overall cost of the unit.

There is a current trend towards an extremely spartan appearance in amplifiers; the European designs in particular may have little more than a volume control and an input selector. However, this is more of a fashion consideration than financial trimming! The new influence in selecting amplifier facilities is in fact the CD player.

The high quality of CD recordings is such that we rarely need to make corrective adjustments to the amplifier's frequency response curve. Therefore, we may dispense with the traditional low and high-pass filters for example, and there is continuing debate over the need for tone controls and their performance limitations.

The tone control stage may be of little

Design considerations

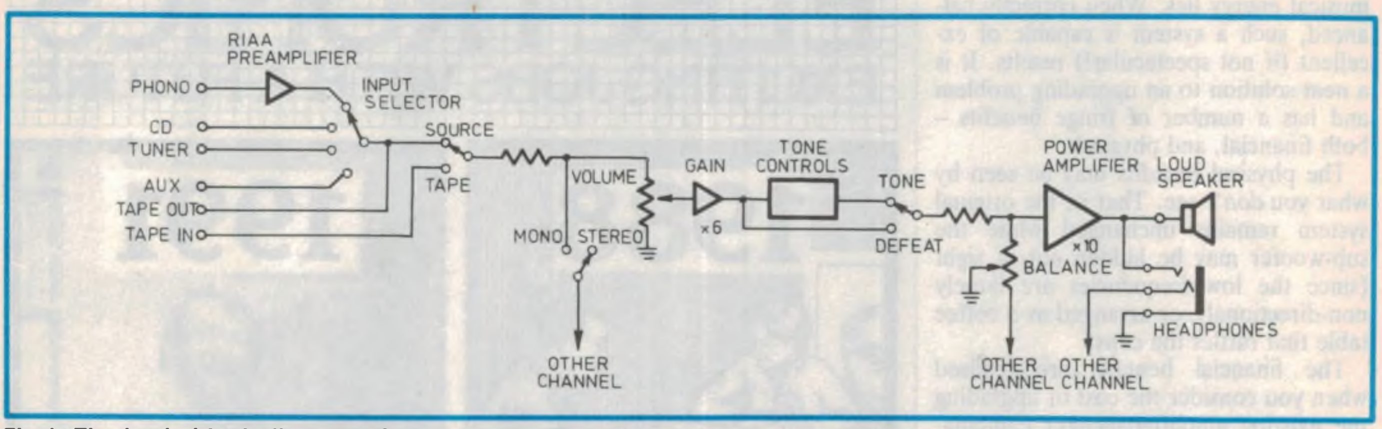


Fig.1: The basic block diagram of our new amplifier. Its features have been chosen as a balance between cost, and what is truly useful.

use to a highly accurate CD signal, but other signal sources are not so well blessed. Correction may be required to brighten up a rather dull tape, or to reduce the effects of a badly pressed record (remember the large black discs?). In fact some conditions may require a little judicious adjustment to correct for inadequacies in the loudspeakers. Of course, there are those amongst us who simply adjust for the sheer "thump-tizz" factor!

Fortunately, all preferences may be catered for by the inclusion of a tone defeat or bypass switch, which passes the signal directly to the power amplifier rather than via the tone control stage. This will also ease the purist's conscience by removing any anomalies the tone controls may have at their null positions.

Another facility included in recent designs is a subsonic filter, which is designed to sharply attenuate any signals below about 20Hz. This is a little different from the older style of high-pass filter which had a gentle roll off from a higher frequency, and was designed to reduce turntable rumble. However, it tended to compromise the sound quality, whereas the lower cut off point and steep slope of the subsonic style filter can rarely be detected.

This type of filter may be included in our design as a permanent feature, by carefully choosing the component values where any stages are AC coupled. By arranging a cutoff point in the range of 10 to 20Hz, the loudspeakers may actually survive the CD version of the 1812 Overture!

Not all traditional facilities are under threat. The humble mono switch is still extremely useful for all the odd signal sources we encounter, such as mono televisions and even musical instruments. Also, a headphone socket is handy for high quality private listening.

The other peripheral connection we may consider is a second set of loudspeaker sockets. This may be great for running your old speakers in another room, but on the whole the added cost and complications of extra wiring, switches and hardware is not really worth it for the added versatility.

Inputs

The function of a stereo system has slowly changed over the years. Once, it may have comprised a turntable, amplifier and speakers only, with little need for a wide array of inputs. But current systems tend to be more of a composite entertainment facility, with the amplifier acting as the hub to a variety of signal sources.

Nowadays a versatile amplifier should provide inputs for a turntable, radio tuner, CD player, cassette deck, and an auxiliary unit (such as the sound from a video player or television). Naturally, this could be expanded even further with more auxiliary inputs and tape facilities, but the above list is an effective compromise between cost and versatility.

Another popular input in recent years has been a moving-coil pickup facility. This requires another pre-amp within the amplifier to cater for the moving coil's extremely low output voltage. Once again, with the focus shifting towards CD players as a primary music source, the added expense of this function is difficult to justify.

Finally, we may see all the inputs and facilities of our proposed amplifier summarised in Fig.1, the overall block diagram.

Performance

As well as the amplifier's power, we need to consider its noise, distortion and overload capabilities. Once again, the advent of CD players has changed some of the areas under scrutiny, due to the high output and quality of CD signals.

Consider the situation when the tone controls are bypassed. The signal is applied almost *directly* to the power amplifier stage, via minimal electronics. So if the signal source is a high quality CD, the amplifier's performance tends to be limited by the power amp alone. Therefore, we must consider the power amp's noise (and distortion) levels more carefully than in previous designs, where the pre-amp stages tended to be the limitation.

The other factor of concern is the overload capabilities of the early stages in the signal chain. A typical driver stage may have gain of 6, which would yield 12 volts from a rated CD signal of 2 volts. This has a peak value of about 16 volts, and may be severely clipped by a gain stage. However, providing we have a reasonable supply rail (typically plus and minus 12 volts), and the volume control is *before* these stages, the power amp will be the first stage to clip when its input level reaches (typically) about 1.5 volts.

One of the main challenges of stereo amplifier design is to obtain a high performance, yet stable power amplifier stage. It must resist thermal runaway at high ambient temperatures, and not break into oscillation regardless of load conditions. To achieve this aim, we need to carefully consider the PCB layout, thermal coupling between devices,

Continued on page 145

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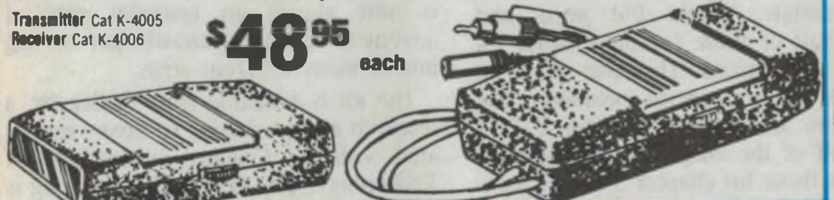

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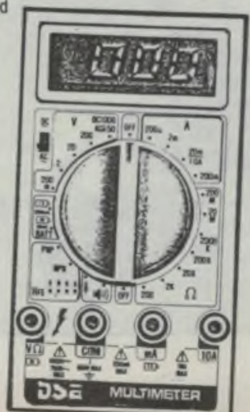

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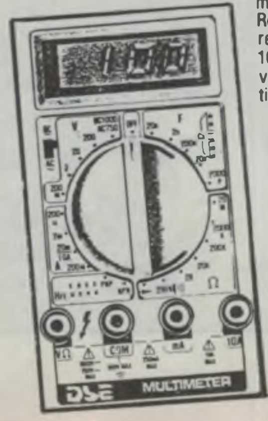

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DICK SMITH ELECTRONICS

Kit teaches basic micro interfacing

A new teaching kit for the IBM PC and compatibles has been designed by a lecturer at the Queensland Institute of Technology, to help science teachers, technicians and students in both engineering and science to get 'hands on' experience with basic microprocessor interfacing techniques.

The kit consists of three main items: a buffered interface card (half length) for IBM PCs or compatible computers, a "proto board" with a bag of components for wiring up various experiments, and a textbook entitled *Computer Interfacing Techniques in Science*. There's also a ribbon cable, to connect between the interface card in the computer and the proto-board experimental circuits.

The idea is that by using the kit, your PC becomes the heart of an educational system, which can be used to get first-hand experience in the various techniques used to interface microprocessors to external electronic circuits.

Designer of the kit is John A. Davies, a lecturer in Physics at the Queensland Institute of Technology (QIT), in Brisbane. Mr Davies explains that the current kit has evolved from work he first started back in the 1970s, producing an *Electronics for Schools* course in conjunction with the Queensland branch of the Science Teachers' Association.

The textbook that forms part of the current course actually dates from 1985, and talks primarily about 8-bit computers based on the Z80 – specifically the low-cost Sinclair models. However to adapt the material for use with the current kit and 16-bit IBM compatibles, an MS-DOS disc is included. This gives additional material describing the use of the kit, plus 16-bit versions of most of the programs given in the book for use with the various experiments.

By the way, the textbook itself was actually reviewed in the January 1986 issue of *EA*. Co-author with John Davies is Dr Paul E. Field, professor of Physical Chemistry at Virgina Polytechnic Institute and State University, in Blacksburg, Virginia. The book was published in the USA by Scott, Foresman and Company.

The background assumed by both the book and the kit seems to be a reasonable understanding of both basic electronics and basic computer operation. After an initial introduction to basic interfacing concepts, it first provides a chapter reviewing basic digital electronics concepts. Like the later chapters this includes a series of experiments, to provide practical insights. In this case the experiments don't actually involve the computer, just an IC or two on the proto-board with other components.

Later chapters deal with microcomputer fundamentals, simple input and output ports, digital conversions and analog conversions. These also have experiments, in most cases designed to be linked to the computer via the interface cable and card.

The floppy disc provided with the book as part of the kit gives 16-bit versions of the programs required for experiments for the chapters on micro fundamentals, simple I/O ports and about half of those for the chapter on analog conversions. This also seems to apply to the components included in the kit: there are parts for chapter 2, 3, 4 and half of the chapter 6 experiments, but not those for chapter 5 (digital conversions). I gather that the remaining programs and components will be available shortly, on application.

Apart from that, the kit seems well thought out, and designed to provide good down-to-earth practical insight into microprocessor interfacing. Along with the half-length interface card, which fits into pretty well all normal PCs, PC/XTs and PC/ATs, there's a 64 x 14 proto-board, a ribbon cable with 37-way D-type and 28-way DIL connectors, to interconnect the two. There's also a 28-way DIL socket to mate with the cable, a tube of ICs, a small bag of components and about 10 lengths of hookup wire in assorted colours.

To make it easier to provide the experiments with basic input and output ports, there's also two small fully wired PCB modules – one a simple 8-bit input port, with an 8-way dip switch, the other a simple 8-bit output port with eight LEDs. Both have pins on the underside to mate with the proto board grid holes.

Overall, the kit should be of considerable value to anyone seeking this kind of knowledge, including serious hobbyists. Interfacing micros to other circuits is now almost an essential part of anyone's electronics knowledge, coming into so many different areas.

The kit is available from Q Search, a research and marketing company associated with the Queensland Institute of Technology. The address for ordering is GPO Box 2434, Brisbane 4001, or telephone (07) 223 2747. Price of the kit is $350, which seems quite reasonable considering the materials and parts that are included. (J.R.)

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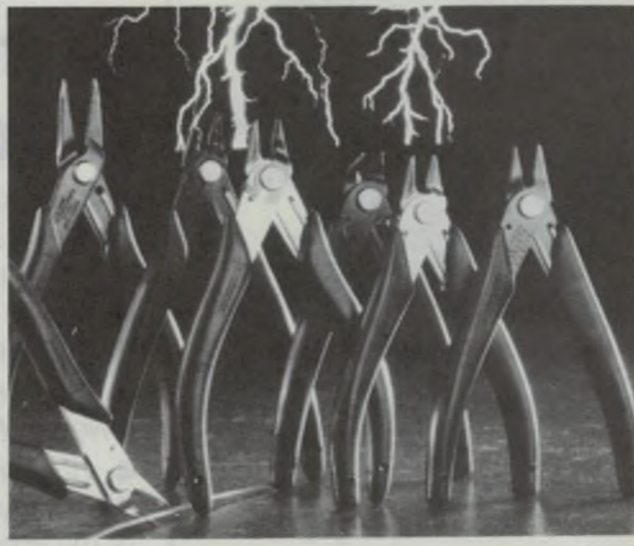

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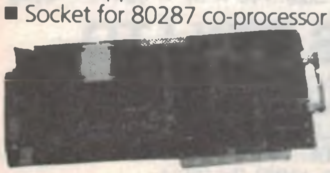

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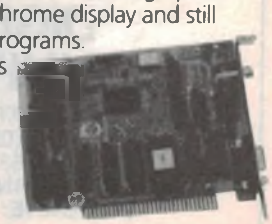

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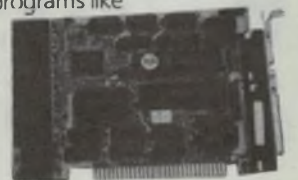

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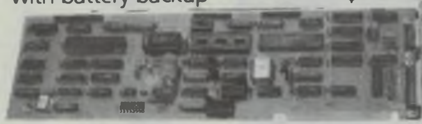

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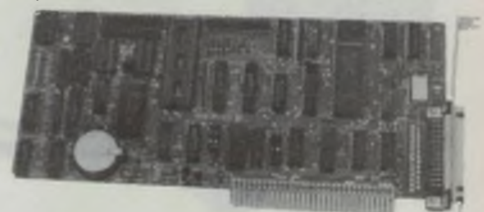

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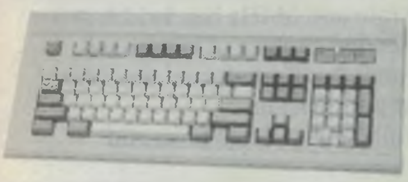

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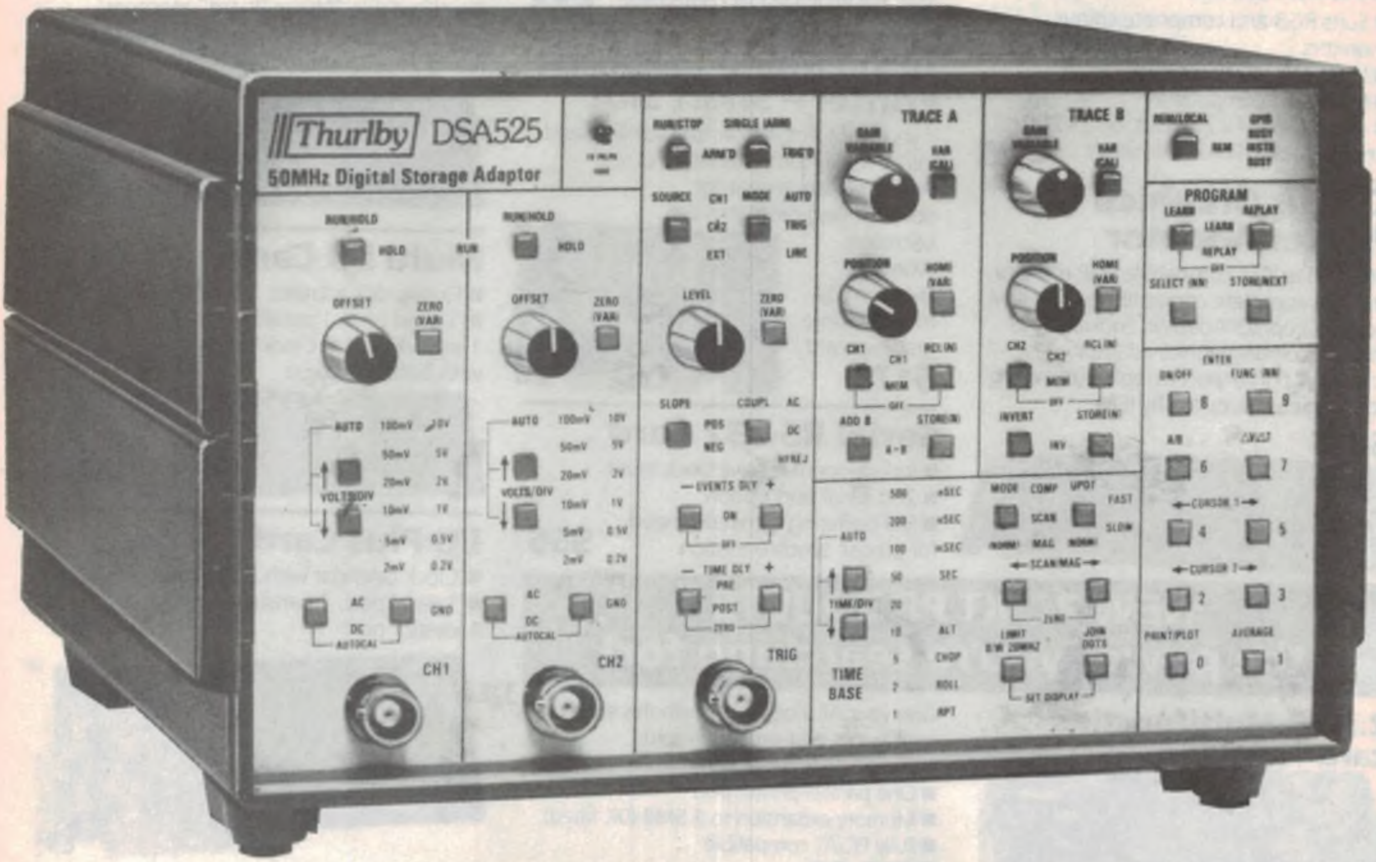

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Test & Measuring Feature:

A better way to compensate counter timebase oscillators

The performance of crystal oscillators in portable test instruments such as frequency counters can be improved markedly by 'mathematical' compensation for any drift, using a microprocessor. The resulting MTCXO has stability virtually equivalent to that of an oven-based oscillator, at a fraction of the cost and with zero warmup time.

by JAN HERWE and BO LUNDBERT Philips T & M, Kista, Sweden

Long term stability and good ageing characteristics are important in the selection of crystals for timebase oscillators in accurate frequency counters and timer/counters. But however good these properties, crystal resonance frequency is inevitably temperature dependent – and characteristics of each crystal are different.

A typical uncompensated crystal oscillator for example will have a stability of only 10^{-5} over the range 0 to 50°C. So while such units are used in low-cost counters, for any increased level of accuracy, some effort has to be made to control or compensate for changes in the ambient temperature.

An economic approach is provided by the analog temperature-compensated crystal oscillator (TCXO). In this case, an NTC (negative temperature coefficient) circuit is used to control the output of the oscillator. However, this provides only a moderate solution – residual deviations after compensation are in the order of 10^{-6} over a temperature range of 0 to 50°C.

More effective is the oven oscillator. Frequency stabilisation is obtained here by keeping the crystal at a constant temperature. This is achieved in practice by enclosing the crystal, and even the oscillator circuitry, in a small oven. The oven is maintained at a fixed temperature – for example at 70°C – within limits of only .01 to 0.1°C at ambient temperature variations of 0 to 50°C. Stabilities here can approach typically 10^{-7} to 5×10^{-9} for temperature variations from 0 to 50°C.

However, oven oscillators are expensive, require time to reach operating temperature and consume power, making them less suitable for portable and/or inexpensive instruments.

Philips Test & Measurement has recently come up with a new inexpensive approach: the MTCXO, or mathematically temperature-compensated crystal oscillator. This produces results equivalent or close to that of the oven oscillator – but at a price nearer that of the much cheaper TCXO.

The MTCXO functions by measuring the temperature dependency of the crystal in each unit, and storing the variations from the nominal frequency in a memory chip. These figures are then used by a microcomputer in the end equipment to compensate readings by measuring the temperature at which measurements are made.

Extensive crystal expertise

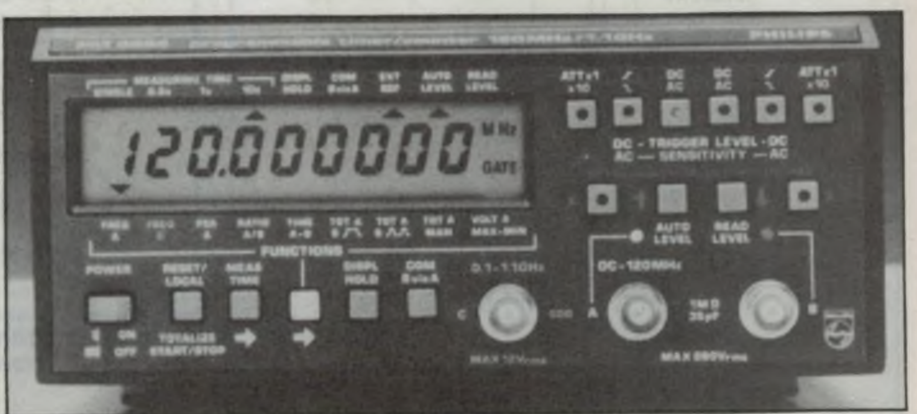
The crystal's temperature stability depends critically on the angle of cut from the original crystal face and its purity. Philips has built up an extensive expertise in this area of the last 20 years and its Elcoma components division is a major world supplier of crystals.

As crystal oscillators are used extensively in instrumentation, Philips Test and Measurement has become particularly competent in building high stability crystal oscillator units. Extensive automated test facilities, using computers with specially developed software to analyse measuring data from tested crystals, allow thorough checking of all individual timebase units.

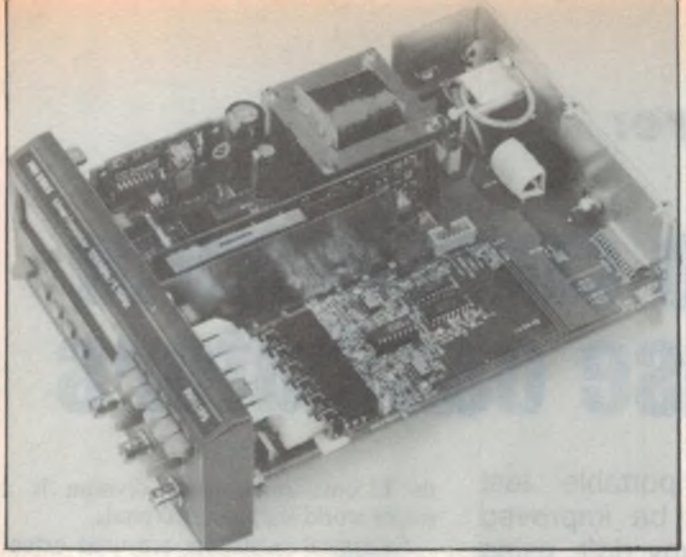
It is these highly automated facilities which are used to measure the temperature dependency of each MTCXO unit. The temperature curve is quantified over the range 0 to 60°C with one point per degree on average. The resulting variation measurement figures are placed in a non-volatile EAROM.

In MTCXO operation, measurements are made using an inexpensive uncompensated frequency reference. Measuring results are then *mathematically* compensated by determining the operating temperature for each reading and calculating the reference frequency deviation at that temperature.

The calculation is made by a microprocessor. The calculated compensation is derived from the EAROM look-up table, individually programmed in the factory. Stability is increased further at any temperature by using linear interpolation.



The current Philips PM 6660 series of programmable 120MHz/1.1GHz frequency meters incorporate an MTCXO in their timebases.



Inside the PM 6665 frequency counter, with the MTCXO on the small vertical PCB at upper left, just behind the LCD display.

Temperature/frequency conversion

An effective and accurate way to measure the crystal oscillator's temperature is by temperature-to-frequency conversion. This method allows measurement of temperatures with high resolution and good reproducibility. And the counter itself can be used to measure the frequency output of the temperature-to-frequency converter at no additional hardware cost.

Fig.1 shows the basic circuit of a modern microprocessor-based counter. As can be seen, it consists of two main elements – a one-chip microcomputer and high-speed LSI 'counter on a chip'. These two devices are responsible for the complete logic and counting functions of the instrument.

The only other elements are the front-end circuitry, fully integrated display system, the oscillator and the EAROM. All circuits are linked by a serial bus.

Basic circuit of the MTCXO is shown in Fig.2. The temperature of the oscillator crystal is measured using a thermistor which is a part of a separate 'temperature' oscillator. The resulting figure is used to select the correct compensation from the EAROM.

To avoid any ageing problems in the temperature-sensing circuit, readings are taken with and without the thermistor connected. The difference in readings is used to determine the crystal temperature.

As explained earlier, the output of the temperature-to-frequency converter can then be measured by the counter itself. The results are used by the microcomputer to calculate the frequency compensation at the operating temperature.

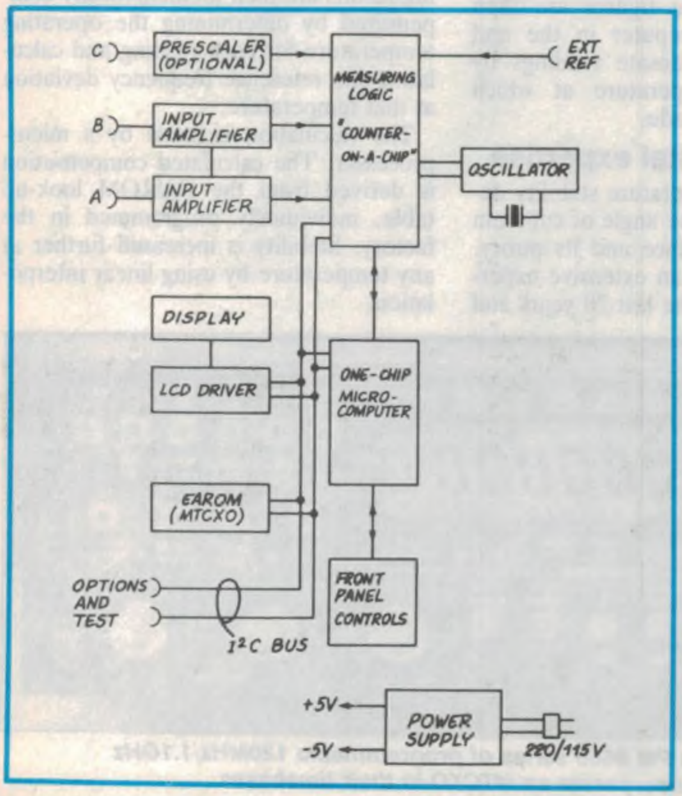
The MTCXO is also provided with an additional voltage regulator to ensure stable operation despite supply voltage variations.

Stability achieved

Performance of the MTCXO compares well to oven-based oscillators. Typical stability against temperature changes from 0 to 50°C is 10^{-7}, whereas guaranteed stability is 2×10^{-6}.

The result is the provision of a high performance timebase for frequency counting at much less than oven-based oscillator costs. This performance is available immediately at switch on – and its minimal power consumption extends field operation on internal battery packs.

Initial applications of Philips MTCXO is in a range of economical frequency counters and timer/counters offering a high level of performance for telecommunications and general purpose laboratory and field applications. The PM 6660 series operates to 120MHz as standard or 1.1GHz optionally for stand alone use or in systems with an optional GPIB (IEEE 488/IEC 625) instrument bus interface.



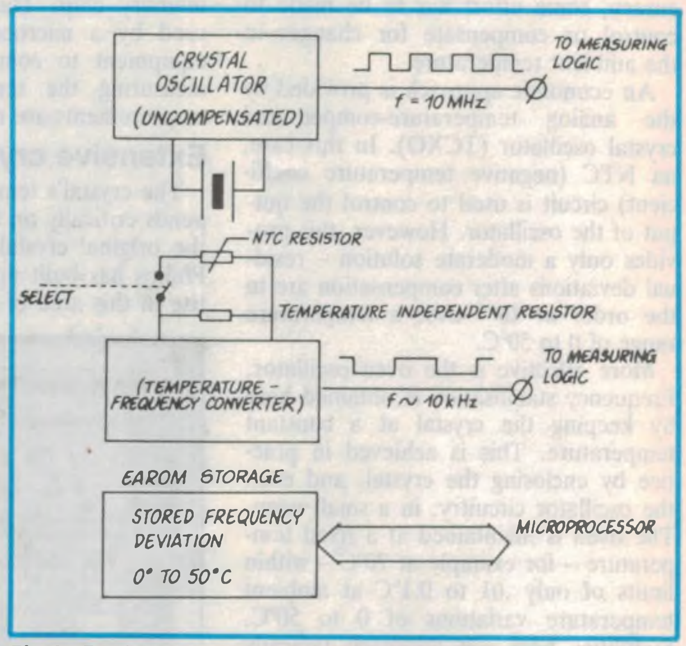


Fig.2: Basic arrangement used in the MTCXO system. The crystal compensation data is stored in the EAROM.

Fig.1: Block diagram of a modern counter with micro controller and MTCXO timebase.

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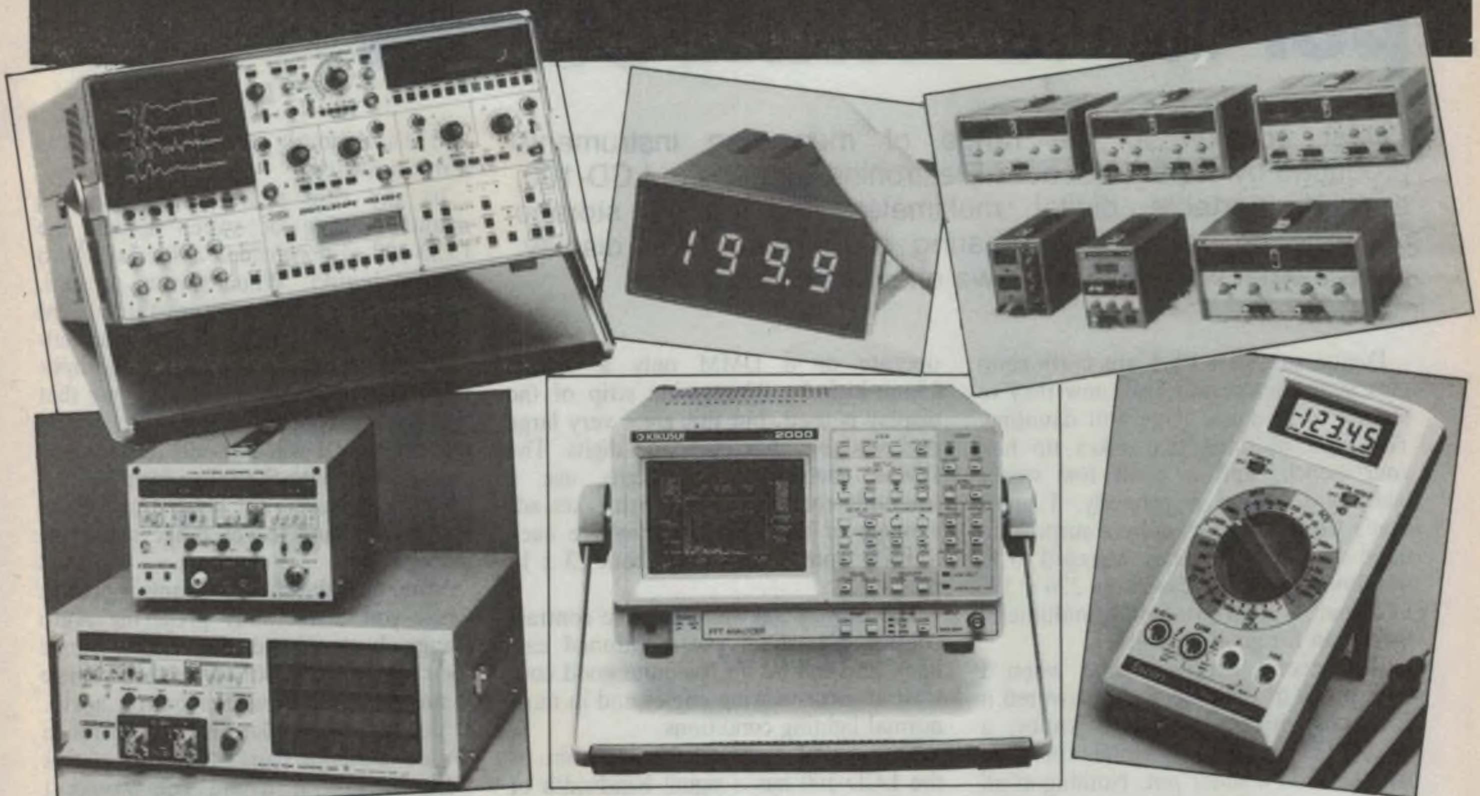

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Test & Measuring Feature:

Leader's new LCD-100 portable DMM/scope

Latest addition to the range of measuring instruments produced by Japan's Leader Electronics Corp is the LCD-100, a very portable digital multimeter and digital storage oscilloscope combination sharing a common LCD display. Here's what we found when we checked one out...

Digital storage scopes are fairly complex instruments, and until now they've tended to be fairly large and daunting. The kind of thing that takes up half your bench, and a good few weeks learning to drive it properly. I guess that's why it came as quite a surprise to discover that Leader has managed to fit one into a portable case only 226 x 136 x 38mm – with a digital multimeter thrown in for good measure!

The second surprise came when I took it out of the case and discovered it had only three unobtrusive knobs, a modest 16 buttons, a couple of slide switches and a slider pot. Nothing at all daunting, in fact. Within about 15 minutes I was driving it like a pro, with only a few of those minutes spent reading through the driving manual to find out the functions of the few not-so-familiar buttons.

It really is an impressive little unit, and one that shows ample evidence of very thoughtful design.

In a sense the key to the instrument's compact portable form is the use of an LCD display screen. This has an active area of 108 x 38mm, divided into 192 x 64 pixels overall.

For scope operation, an area of 160 x 60 pixels is used for the actual waveform display, with the further 32-pixel wide vertical strip at the left-hand end used for display of all main operating and measurement parameters. The waveform display area is divided into four major divisions high and 10 major divisions wide, with each major division correponding to 10 pixels and measuring about 9.7mm (i.e., each pixel is about 0.97mm square).

When the instrument is switched to operate as a DMM only a central 15mm-high by 92mm-wide strip of the display is used, but this gives very large and readable characters and digits. The DMM characters and digits use a smoothly rounded font, which takes advantage of the fact that they are each formed from a matrix of about 23 x 15 pixels.

The display has an adjustable contrast control (the slider pot mentioned earlier), and can be set for quite good contrast at most viewing angles and in most normal lighting conditions.

The digital storage scope section of the LCD-100 has a signal bandwidth of 200kHz – not dramatic, to be sure, but plenty for a lot of low frequency work including audio, power and control engineering applications.

Input sensitivity is 10mV per major screen division, with a standard 1M/30pF input impedance. The usual input attenuator provides 11 calibrated ranges in 1:2:5 steps, down to 20V per division, while the x1/x10 divider probe provides an effective further three ranges down to 200V/division. The vertical input connector is a BNC socket, and there's the usual choice of AC or DC input coupling (centre ground).

The horizontal sweep section provides a total of 21 sweep ranges, from 5us/-division to 20s/division again in 1:2:5 range steps. Unlike the vertical sensitivity these are not selected via the usual rotary switch, but via two 'Time/-Div' pushbuttons, marked *slow* and *fast*. Although slightly unfamiliar, this is quite convenient as the actual range in use is displayed at the side of the display itself – right at the top left-hand corner, in fact. You soon get used to it, and it's obviously just as convenient as a rotary switch.

In any case apart from the usual manual setting of sweep speed, the LCD-100 also provides a special 'Auto Range' button. When this is pressed, the instrument will measure the current period of the input signal, and automatically select what it regards as the optimum sweep speed for it – i.e., one that will display from two to six cycles across the display. It will only do this for any signal falling into the range from 50Hz – 200kHz, however; for lower frequencies it opts out, and leaves range setting to the operator.

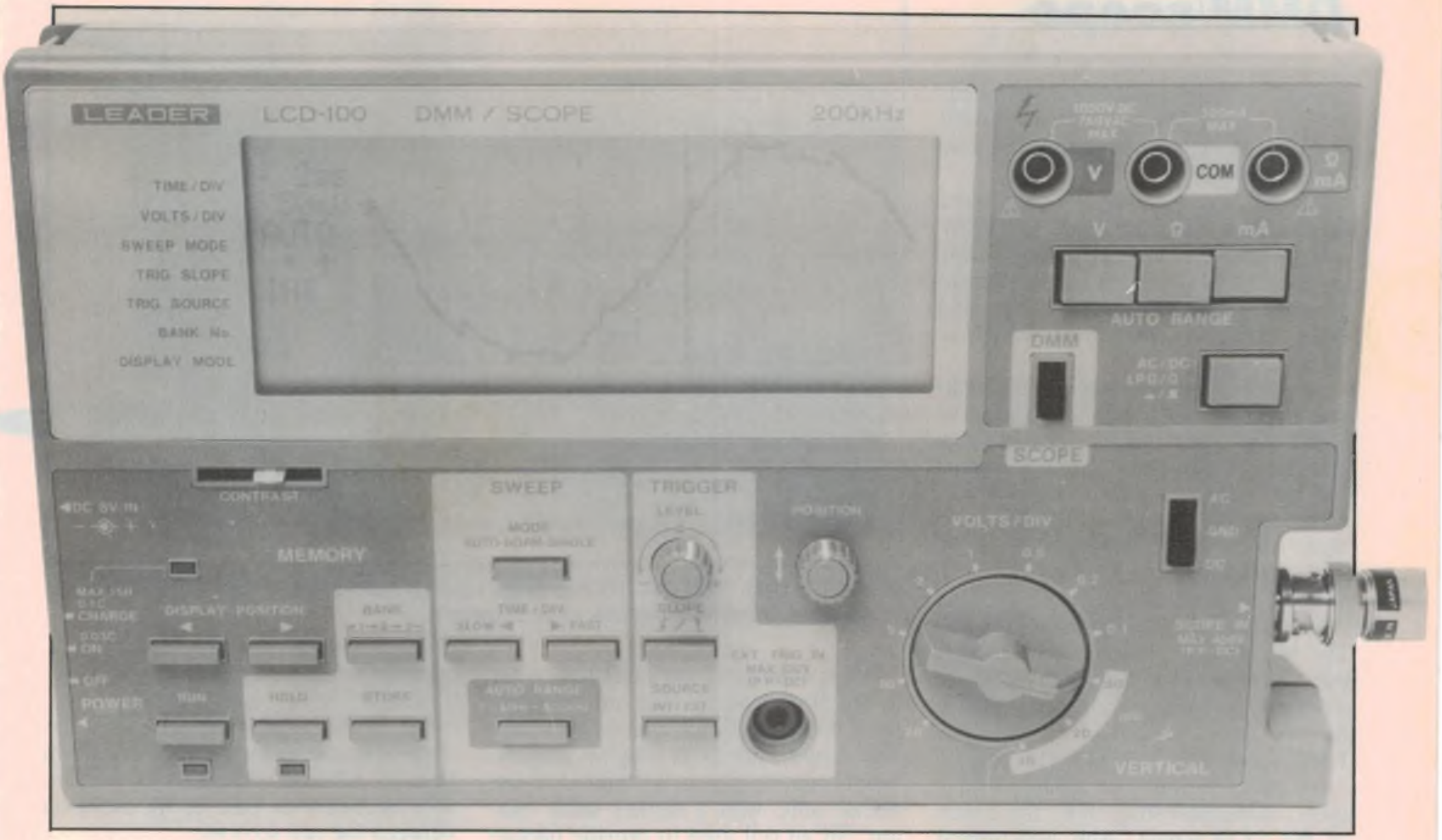
Note that this function only operates when you deliberately press the Auto Range button, and the sweep range then stays fixed until you either change it manually, or press the button again. It doesn't try to adapt the sweep range on a continuous basis – which is just as well, because if it did you wouldn't know where you were!

There are three basic sweep modes, all fairly familiar: Auto, Normal and Single shot. Auto is the usual free-running mode, while Normal and Single shot are triggered. The only small difference here from other scopes is that for sweep ranges of 50ms/div and slower, the triggering circuitry automatically disables itself and the sweep circuit operates in continuous 'Roll Sweep' mode. To freeze the display it is then necessary to press the Hold button.

Otherwise, and on the higher sweep ranges, the triggering options are quite standard: positive or negative slope selection, an adjustable level control and a choice of either internal or external triggering. External trigger input is via a 3.5mm jack socket.

Not surprisingly the less familiar controls are involved with the scope's digital memory functions. Here there are four main buttons, marked 'Run', 'Hold', 'Store' and 'Bank'.

The Run button is basically used to begin acquiring and displaying input sig-



Outside view of the LCD-100, with a slightly noisy sinewave frozen in memory.

nal data, either continuously in Auto or roll sweep modes, or in response to triggering in Normal or Single shot modes. So with this button pressed, the scope tends to act fairly normally.

It is when the Hold button is pressed that the digital memory action becomes obvious, because this stops the sampling of new data, and simply causes repetitive display of the current set of data in the working memory. So the display simply 'freezes', and will be retained for as long as you like – until the instrument is turned off.

Should you want to keep the stored data longer than this, it can be stored in one of the scope's three battery-backed memory banks. This is done using the Store button, but only after you've called up one of the three memory banks using the Bank button. The latter is cyclic in its operation, calling up first B1, then B2, then B3, then B1 again and so on. As before the bank being displayed is indicated at the left of the LCD display, so there's no ambiguity.

In fact Leader seems to me to have come up with a very simple and logical operational approach to the scope's digital storage functions. It works just as your intuition tells you it should – which is just the way things ought to be, of course, but somehow it doesn't seem to happen all that often!

The other two buttons associated with the memory section of the scope share a common legend 'Display Position', with arrows pointing left and right respectively. From an operational point of view these work rather like the usual horizontal shift knob on a normal scope, although in reality there's a slight difference.

The LCD-100's working (display) memory and three memory banks all store 256-word signal samples, whereas the LCD screen itself is only capable of displaying 160 of these words (160 x 60 pixels). Normally it is arranged to display the middle 160 words, but what the two Display Position buttons let you do is slide the 160-word wide display 'window' either way through the memory, to view the normally unseen samples at either 'end'.

So that you can see where you are, the display shows a dashed vertical cursor line which indicates the 'centre' of the memory being displayed. This is normally in the centre of the screen as well, but moves either way if you use the Display Position buttons to slide the display window along.

The DMM part of the instrument is functionally quite separate from the scope section, with its own input connectors: the usual recessed banana jacks, on standard 19mm centres.

In fact the circuits of the two parts of the LCD-100 are electrically quite isolated from one another. Even the two input 'common' connections can be connected to points different in potential by as much as 1000V peak (DC + AC), so it really is as if you have two entirely separate instruments. They just share a common LCD display, that's all. Quite a flexible arrangement when it comes to making measurements on complex circuitry.

The DMM provides voltage and current ranges for both DC and AC, along with 'normal' and 'low voltage' resistance ranges – the latter to allow more accurate in-circuit measurements around at least silicon semiconductor junctions (the voltage used is less than 450mV). Basic full-scale reading on all ranges is 3199, making it a kind of slightly unusual but quite practical '3-1/2 digit' instrument.

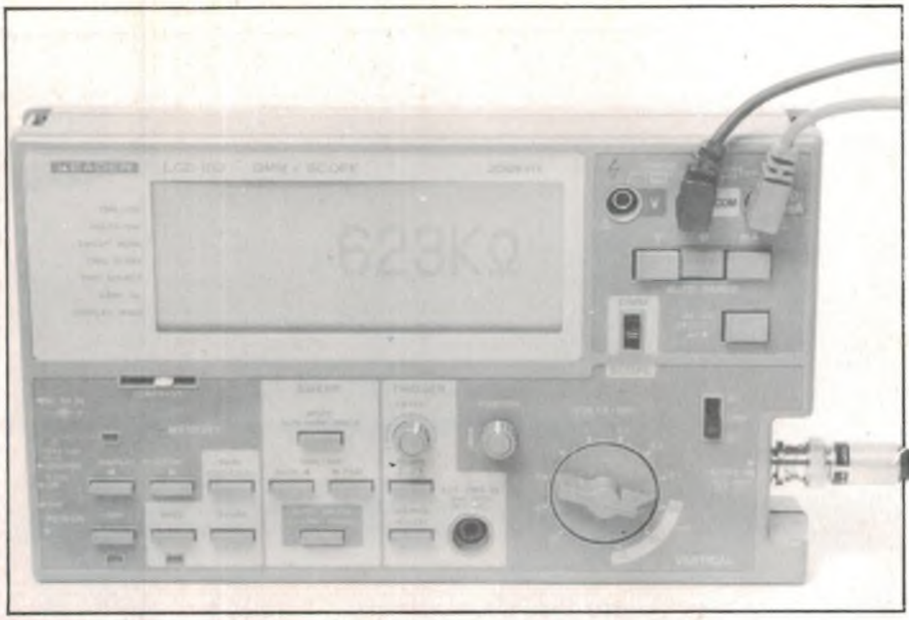
There are only four control buttons, three of which set the basic measurement modes: V, Ω and mA. The fourth button selects between AC and DC for voltage and current ranges, or between normal and low voltage measurements for the ohms ranges. The instrument is full auto-ranging, and also has auto polarity selection.

For DC voltage measurement there are 5 ranges, from 320.0mV to 320.0V and with a final reduced range having an FSD of 1000V. Rated measurement accuracy up to 32V is +/-0.35% +/-3 digits, falling to +/-0.6% +/-3 digits at 1000V.

One fewer ranges apply for AC voltage, with a most sensitive range of 3.200V full scale and the highest range going to 750.0V. These ranges are rated for the frequency range 40 – 500Hz, with a rated accuracy of +/-1.0% +/-5 digits up to 320V, falling to +/-1.2% +/-5 digits at 750V.

Single ranges apply for both DC and AC current (yes, I know that's repetitive terminology, but it's now accepted). This measures from 0.0mA to 319.9mA, in both cases. Rated accuracy for DC is +/-1.0% and for AC +/-1.5%, again +/-3 digits in both cases.

As noted before the DMM display uses a horizontal strip along the centre of the LCD screen, with well-formed digits 15mm high. They're very easy to read.



In DMM mode, the LCD-100 has large easy to read digits 15mm high. Contrast is somewhat better than this shot suggests.

Power supply for the LCD-100 comes in the first instance from no less than *three* different sets of internal batteries. The scope and LCD display sections mainly run from a set of three AA-size NiCad cells, with a further small 'button' NiCad cell used to provide backup power for the scope's memory banks. This will typically retain data in the memory banks for about a month, even if the main battery is exhausted.

The DMM circuitry runs not from the scope's NiCad battery, but from its own pair of AA-size cells. This is presumably necessary as part of the isolation between the two sections.

The LCD-100 comes with its own plug pack-type mains adaptor/charger, delivering a nominal 8V DC. This provides trickle charging (0.03C) of the main battery when the unit is operating, or full charging (0.1C) when it is not. Nominal charging time is 10-15 hours, and the instrument will operate for around 2.5 hours on a charge. When the battery is nearing exhaustion the LCD-100 flashes a 'Battery Low!!' message on the screen, to prompt you to reach for the charger.

All in all then, the Leader LCD-100 is a very neat and businesslike little instrument. It is solidly made, and very straightforward to drive. My impression is that it should be a great asset for anyone needing a compact low frequency digital storage scope and DMM combination – particularly field servicing people.

The only somewhat sobering aspect about it is the price. At $1300 plus tax, it's not exactly cheap. But where else can you get a digital storage scope and DMM combination of any size, for a comparable price?

Further details on the Leader LCD-100 are available from Australian distributors AWA Distribution, at Unit C, 2-8 Lyon Park Road, North Ryde 2113. (J.R.)

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Test & Measuring Feature:

New digital scope has built-in printer

A new digital oscilloscope from BBC-Goerz/Metrawatt extends the capabilities of digital image storage and analysis considerably, with features including a built-in graphics printer and extended bandwidth by means of non-linear interpolation.

by DR J. HEMETSBERGER BBC-Goerz/Metrawatt, Vienna, Austria

Most of the digital oscilloscopes available on the market today are in effect analog oscilloscopes which have been converted for digital operation. After short intermediate digital storage, the signals are transformed back into analog signals and processing continues in a conventional way.

The new BBC-Goerz/Metrawatt Digitalscope SE571 adopts a different approach, by functioning as a purely digital instrument. After conversion, further processing of the input signals is exclusively digital. Functions possible with this concept include numerical averaging, addition, multiplication, interpolation and so on. The digital image generation on a video display unit with an internally generated measuring raster ensures a drift free signal display.

As shown in Fig.1, the Digitalscope SE571 has replaced the conventional oscilloscope circuit by a microprocessor system which simulates the oscilloscope function. The system consists basically of analog and digital inputs, a keyboard on the front panel as an input device, an optional parallel interface and a monitor and graphics printer as output device.

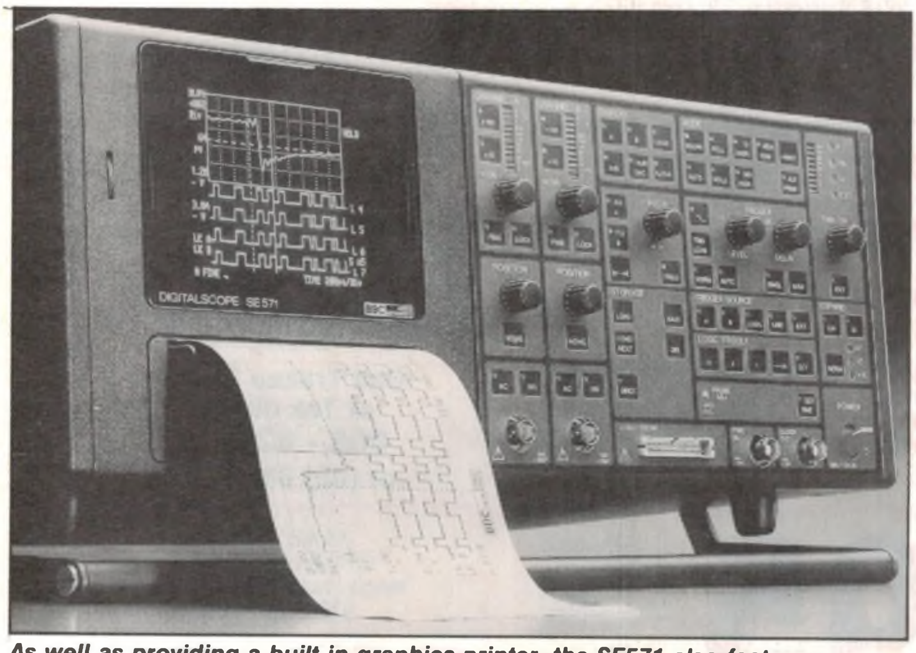
There are three function modules which work together: the recording circuit, the control and processing unit (CPU) and the output units (monitor, graphics printer).

Input amplifiers, A/D converters, a fast memory and a time-base controller form the recording circuit. The recording bus links the modules together. Except when determining the measurement parameters, the recording process functions independently of the CPU.

The signals pass to the A/D converters by way of the input amplifiers. The digital data generated therein are 'shifted' into the fast memory until the trigger system finally stops the data flow, with the result that the signals are 'frozen' in the memories. The recording circuit now informs the CPU about the newly available data.

As soon as the control program permits, the data are transferred from the fast memory by means of direct memory access (DMA) – a very fast data transfer process – to the working memory of the microprocessor system. When the data transfer has ended, the input circuit is free for new signal acquisition. Recording and processing can therefore take place in parallel.

Further processing of the data and their preparation for display is carried out by the CPU (microprocessor system). When the processing has ended, the data are transferred (also by means of DMA) to the video controller during the image flyback. The video controller operates autonomously, i.e., it displays stored signals cyclically until it receives new signals from the control unit. When hard copies are required, the video signal is diverted temporarily to the graphics printer.



As well as providing a built-in graphics printer, the SE571 also features non-linear interpolation for higher effective bandwidth.

Hard copies

Although the conventional 'transient' oscilloscope image offers many advantages, it is frequently required to record the signals on paper.

Traditionally, images have been recorded by photographing them with the oscilloscope camera. Although the instantaneous developing camera reduced the difficulty of photographing to an acceptable level, the cost per exposure is still relatively high. A more recent trend

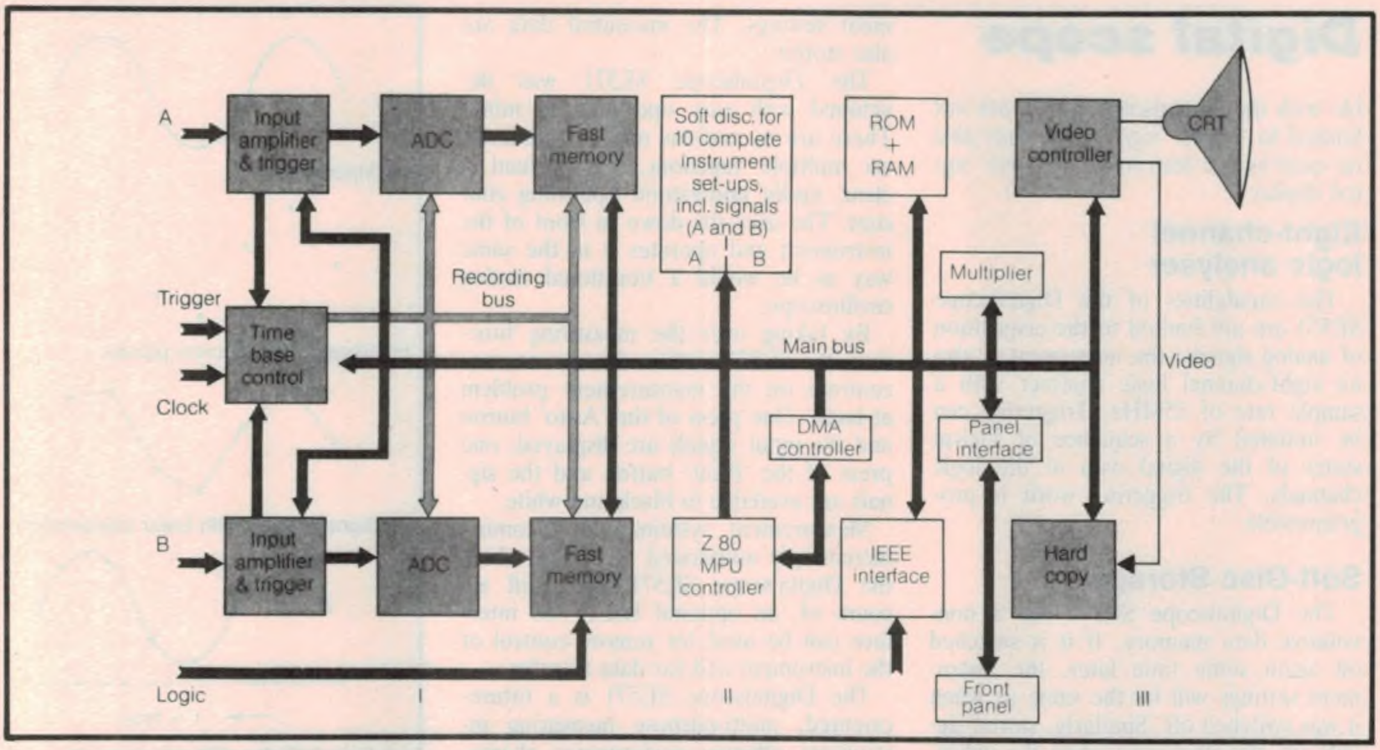


Fig.1: Block diagram of SE571, showing the main functional sections.

has been to document the signals on external printers. However, such printers are unwieldy and printout takes longer.

It is here that the Digitalscope SE571 comes to the fore: its recording device is integrated – there is a very flat graphics printer built in below the screen. The printer, which operates quietly and quickly, is in a constant state of readiness. Output of an image takes about 10 seconds.

The high cost per image obtained with conventional copying processes and the time they require to produce the images can usually only be justified when the pictures are required for long-term documentation.

Hard copies produced with the Digitalscope SE571, however, cost very little and the graphics printer is so easy to use that the print-out of interim signal traces can be justified as an aid to working. The 'interim images' can be compared repeatedly with values obtained from measurements currently in progress.

The hard copies are, of course, also suitable for long-term documentation, being scaled and containing the date and time of the actual measurement.

SI Interpolation for Effective Storage Utilisation

The Digitalscope SE571 does more with the stored data than conventional digital-storage oscilloscopes. Appropriate numerical evaluation of these data not only raises the upper frequency limit of the signal, but also permits storage of longer signal segments.

This statement sounds paradoxical since, according to it, the measured data must contain more than is shown by their simple graphical display – and this is also the case.

With digital signal acquisition, the signal is sampled periodically, with relatively long 'measurement gaps' between the individual sampling points. The stored data thus represent discrete points passed through by the measured signal.

The question now is how to reconstruct the signal trace between these points and to find out the real variation of the signal.

The answer can be found in the adjacent values. The sampling theorem of Claude Shannon (1949) provides the basis for calculation of the curve between the discrete points. Providing the signal has a limited bandwidth and the sample rate is at least double the highest frequency contained in the signal, this procedure, which is designated 'non-linear SI interpolation', yields the most reliable curve between the points. The digitising effects require, in contrast to theory, that the sample rate be set to about 2.5 times the highest signal frequency.

If, when using the Digitalscope SE571, the signals are extended along the time axis, the discrete points of the measured signal will be displayed further apart. The Digitalscope SE571 interpolates the signal shape between these points. Two methods of interpolation are possible:

- Linear interpolation
- Non-linear SI interpolation

In the case of linear interpolation, a straight line connects adjacent discrete points (Fig.2). Linear interpolation is the simplest method of interpolation and is recommended for use with signals which change abruptly (e.g., square-wave signals).

For sinusoidal signals, the non-linear SI interpolation yields better results. Here, the original signal shape between the discrete points is determined numerically. And non-linear SI interpolation makes far better use of the memory content: reconstruction of a sine curve with linear interpolation requires about ten points per cycle, whereas the non-linear SI interpolation yields the same result for only about 2.5 points per cycle. As less memory is required per signal cycle, longer signal segments can be stored. Put differently, linear interpolation requires ten sampling points for the acquisition of one signal cycle, while non-linear SI interpolation requires the same number of sampling points for the acquisition of about four cycles. In other words, the 'bandwidth' has been increased.

The two types of interpolation possi-

Digital scope

ble with the Digitalscope SE571 are not limited to 'frozen' signals, but may also be used by the instrument for 'live' signal display.

Eight-channel logic analyser

The capabilities of the Digitalscope SE571 are not limited to the acquisition of analog signals; the instrument is also an eight-channel logic analyser with a sample rate of 25MHz. Triggering can be initiated by a sequence of logical states of the digital data in the logic channels. The triggering word is programmable.

Soft-Disc Storage

The Digitalscope SE571 has a non-volative data memory. If it is switched on again some time later, the instrument settings will be the same as when it was switched off. Similarly, stored signals are also preserved when the instrument is switched off.

The instrument also features a large reference memory – the 'soft disc'. This is another non-volatile memory, but with a capacity of ten complete instrument settings. The measured data are also stored.

The Digitalscope SE571 was developed with easy operation in mind. There are no tedious menu commands, no multiple functions, but instead a clear, easily understood operating concept. The user sits down in front of the instrument and operates it in the same way as he would a traditional analog oscilloscope.

By taking over the measuring function, the SE571 enables the user to concentrate on the measurement problem at hand. One press of the 'Auto' button and the input signals are displayed, one press of the 'Print' button and the signals are available in black and white.

Measurement systems are becoming increasingly automated – a trend which the Digitalscope SE571 takes full account of; an optional IEEE 488 interface can be used for remote control of the instrument and for data transfer.

The Digitalscope SE571 is a future-oriented, multi-purpose measuring instrument offering performance characteristics beyond the ordinary.

Further information on the instrument is available from Kent Instruments (Australia), PO Box 333, Caringbah NSW 2229 or phone (02) 525 2811.

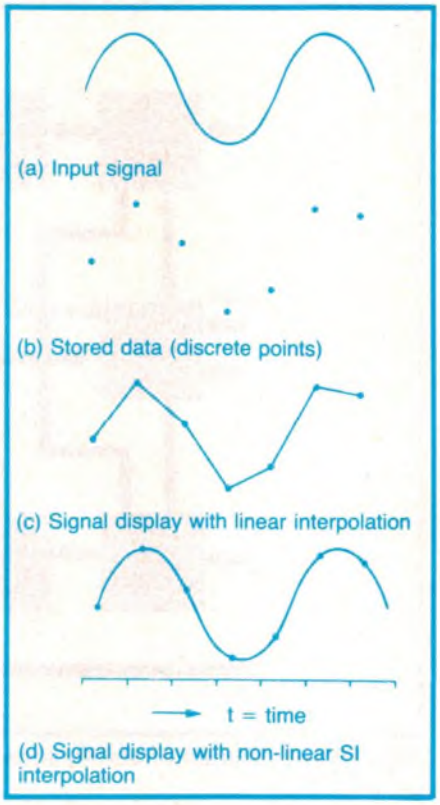


Fig.2: Display of signals using both linear and non-linear interpolation techniques.

Video card

Continued from page 93

take care not to bend any when you're passing them through the PCB holes. They're pretty well all needed, and removing the socket later to rescue one could be very difficult!

You can then add the DIP switch assembly, at the top left of the card looking from the component side. Note that the 'off' sides of the switches should be on the lower side, nearest R1.

Then add the DB-9 connector, first passing its pins through the holes in the PCB and then screwing it to the card before soldering them. After this you can screw it to the rear panel/mounting strip.

The light pen connector strip can also be mounted at this stage, by soldering its tails to the board. Then the final stage of the soldering operations is to fit the two clock oscillator modules, Y1 and Y2. The 16.257MHz module goes in the Y1 position, and the 20.000MHz module is Y2. Note that these modules have one square corner on the base flange, with the other three corners rounded. The correct orientation for the modules is with the square corners to the upper left, looking at the component side of the card and with the edge connector at the bottom.

Finally you can plug the ICs into their sockets. Take special care with U6, of course, as it's the most expensive. Make sure its chamfered corner is orientated towards the upper left (i.e., towards C8), before you plug it in.

Using it

Your multi-mode video display adaptor card should now be complete.

There's only one adjustment to be made, before you plug it into your system. That's to set up the DIP switches.

SW1 and SW2 are set up to suit your video monitor. If this is a standard IBM-compatible RGB colour monitor, set the two switches both off for normal CGA operation. On the other hand if you have a standard IBM-compatible monochrome monitor, set SW1 on and SW2 off for normal MDA operation.

If you have a special hi-res RGB colour monitor capable of running at the 25kHz scanning rate (perhaps as well as the normal CGA rate of 15.750kHz), you'll be able to set SW1 off and SW2 on, to take advantage of the 72C81's special 'hi-def' CGA-compatible mode.

The only time you'd need to set both SW1 and SW2 on together is to temporarily disable the card, when another display adaptor is being used.

SW3 will normally be left in the off (0) position, to suit the majority of IBM and compatible computers. The only time it should be set to the on (1) position is when the card is to be used in NCR machines.

DIP switch SW4 is not connected.

In most cases there won't be any need for special programming when the card is used, because it emulates the standard CGA or MDA/HGA. The same tends to apply even when the hi-def colour mode is used (with a suitable monitor), as this appears to the BIOS and other software as a standard CGA.

The only need for special programming will be if you need to be able to flip the CGMA between its various modes, during program operation. This involves a good grasp of 8086/88/286 assembly level programming, and is beyond the present article. So if you do need to go further, I suggest you get a copy of the 72C81 data sheets and application notes from Energy Control.

Apart from this, it will normally be a matter of plugging it into your computer, connecting up your monitor, turning everything on, loading your desired program, and watching the pretty pictures! EA

Test & Measuring Feature:

New T & M Products

Precision counting scales

Computronics International has released the range of Techko electronic precision scales in Australia. Available in both counting and non-counting versions, these quality instruments provide very economical answers to many weighing and counting applications.

Full scale indication ranges from as low as 100 grams up to as much as 10,000kg with a resolution of better than 1/10000.

The fully CMOS microprocessor circuitry allows battery operation, making the scales portable and ideally suited for stocktakes, counting of small parts in manufacturing, retail and wholesale packaging. Based on a temperature compensated quad strain gauged single point load cell, accuracy is within +/−1 digit.

Digital tare and auto zero tracking makes for very simple operation. Digitally calibrated, the scales feature non volatile memory and a four digit LCD display.

For more information contact Computronics, 31 Kensington Street, East Perth 6000 or phone (09) 221 2121.

32-ch analysing recorder

Yokogawa has recently released a new 32 channel Analysing Recorder. The model AR3200 is an all-in-one digital waveform analyser which digitally measures and records waveforms on up to 32 channels.

The unit features a large memory of 10M bytes and is very suitable for laboratories and equipment/machine testing plants.

Applications are wide - voltage, current, temperature, vibration, displacement, pressure and sound in the electrical equipment, machinery and automobile fields.

Further information is available from Parameters, 25-27 Paul Street North, North Ryde 2113 or phone (02) 888 8777.

Digital thermometer

The Jumo hand-held, fast response digital thermometer type TDAT/TDAW is a convenient pocket size instrument with very fast response for checking measurements on surfaces, in liquids, gases and loose materials.

It uses precision thermocouples to DIN43710 or resistance thermometer probes to DIN43760, which can be interchanged ensure rapid adaption to different applications.

The instrument comes in a neat plastic high impact strength black housing 148×79×38mm, with weight of 250g including battery.

Versions with LED or LCD display are available depending on the type of battery used (i.e., rechargeable or disposable).

Temperature ranges from −100°C to +800°C are well within the capability of this Jumo product, which is manufactured in West Germany.

For further details contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044 or phone (02) 516 3655.

Microwave network analyser

The new HP 8720A network analyser is an integrated measurement system that measures magnitude, phase and group delay of transmission, as well as reflection coefficients of electrical networks over the frequency range of 130MHz to 20GHz. All system components - including a swept synthesised source, receiver, display and test set - are packaged into a single 27cm high (10.5″) unit.

By integrating the system, HP not only has lowered the price, but simplified installation that now consists of simply connecting the analyser to a power source. In addition to the HP 8720A, all that is needed to make a measurement are test-port return cables and a calibration kit.

For further information contact Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn 3130 or phone (03) 895 2895.

Lab analysis software

Analog Devices' plug-in data acquisition boards for the IBM PC work with UnkelScope application software to perform laboratory analysis. UnkelScope, developed by Unkel Software, Inc (Lex-

ington, MA) is available directly from Analog Devices distributor Parameters.

UnkelScope, a data acquisition and analysis package for the laboratory, provides data analysis and oscilloscope functions. The package operates with Analog Devices' RTI-800 analog input board and RTI-815 multifunction board. The RTI-800 features 16 analog input channels, 16 digital I/O channels and 3 frequency/timer channels. The RTI-815 offers the same features along with 2 analog output channels.

For further information contact Parameters, PO Box 261, North Ryde 2113 or phone (02) 888 8777.

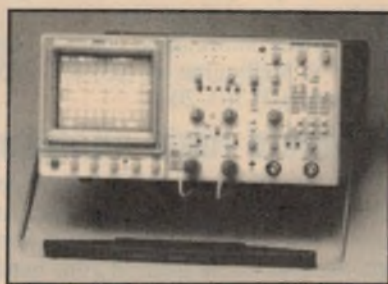
Humidity/temperature meter

TPS has released the new model LC83 digital Humidity/Temperature meter.

The lightweight, portable meter has a low power drain LCD for ease of reading even in direct sunlight. The humidity sensor uses a high precision, thin-film capacitance sensor for fast, accurate response and is independant of air movement past the probe. The temperature sensor is a solid state silicon type.

The ranges are 0 to 100% Relative Humidity (RH) and 0 to 60°C, making it suitable for use in nurseries, glass houses, air conditioning maintenance and any other application where an accurate measurement of temperature or relative humidity is required.

Further details from TPS, 4 Jamberoo Street, Springwood 4127 or phone (07) 290 0400.



100MHz scopes with auto setup

The Tektronix 2245A' and 2246A PaceSetter oscilloscopes are the first 100MHz scopes to offer cursors, readout and automatic setup. Additionally, the 2246A allows users to store/recall up to 20 front panel setups, making it an ideal scope for repetitive testing or service applications.

Tektronix' aim in introducing the PaceSetters is to bring easy-to-use, automated features to everyone from high tech industrial users to students and hobbyists.

Both oscilloscopes feature auto setup of the front panel. This means that time usually spent turning knobs for new waveform setups is saved. The user simply pushes a button and the instrument automatically sets itself up and displays the waveform.

Time/voltage measurements are convenient as well. The 2245A has cursors and a CRT readout for easy reading and measurement of time/voltage data. The 2246A goes one step further with 'smart' cursors that automatically follow changes in the voltage, trigger, and ground level of the displayed waveform. This means easy setup of single shot triggering, peak voltage and DC measurements.

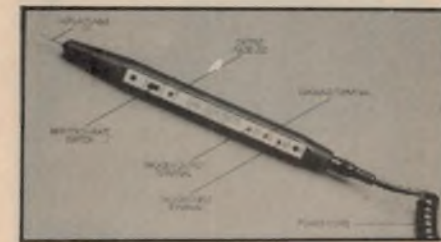
Both scopes offer 100MHz capabilities that can make high-speed measurements from four channels, two of which are optimised for logic signals. They have horizontal and vertical accuracy of 2% to assure precise measurements and a sensitivity of 2mV for capturing low-level signals.

Further information from Tektronix Australia, 80 Waterloo Road, North Ryde 2113. Phone (02) 888 7066.

PCB short finder

The SF-110 from OK Industries is claimed to be one of the most unusual products on the market today. it allows the user to find shorts in PC boards and other circuits literally in seconds.

Simply follow the suspect trace with



the shortfinder.

If there is a short the SF-110 will emit a tone, which will increase in frequency as you approach the short. The SF-110's response is exponential, giving the operator greater resolution in the critical area close to the short.

The unique 'zero intercept response' curve guarantees accurate response to true shorts while rejecting false shorts such as high leakage currents and capacitor resonances.

The SF-110 never requires calibration or maintenance, and is battery powered for complete portability.

Further information from Electronic Development Sales, 92 Chandos Street, St Leonards 2065 or phone (02) 438 2500.

Low cost uP testers

Elmeasco Instruments announces the introduction of a family of compact, powerful, inexpensive digital testers for stand-alone troubleshooting of microprocessor-based products and systems.

The Fluke 90 Series is a self-contained testing device that clips onto the processor in the Unit Under Test (UUT), including soldered-in microprocessors. It does not emulate the processor in the UUT, but instead 'cycle steals' and overdrives the control and bus lines to exercise and test the circuitry. This allows the UUT to continue to run and operate normally while diagnostics are being executed, which facilitates testing for intermittent problems.

The 90 Series is pre-programmed with a battery of tests that find UUT problems quickly, including the powerful QuickTrace probe test. Quicktrace automatically identifies and displays unknown nodes and allows bus lines to be tracked through the UUT.

For more information contact Elmeasco Instruments, PO Box 30, Concord 2137 or phone (02) 736 2137.

T&M Products

Harmonic analyser

Electricity authorities are placing increasing emphasis on the effect of their industrial users equipment on the quality of supply. With the introduction of DC drive motors and similar thyristor controlled equipment there is a requirement for AC harmonic analysis.

Tech-Rentals now offer the Elcontrol SV1 harmonic analyser which will accept current or voltage inputs. The frequency range is from 40 to 3400Hz and the highest sensitivity is 0.5%. The analyser includes a printer which may be set to record harmonics which exceed a preset threshold. The values are displayed as percentages and voltages together with the value of the fundamental.

For current analysis clamp-on current transformers are provided up to a value of 3000 amps. The instrument is portable having a weight of 4kg.

For further information contact Tech-Rentals in Melbourne on (03) 879 2266, or Sydney (02) 763 2066.

Handheld logic analyser

The 'LogicBridge 136' is a new concept in logic analysers. Handheld and battery powered, it places digital waveform analysis in the palm of your hand.

The unit performs as an intelligent 3-channel logic problem yet it is also able to store and display waveforms like a logic analyser. Basically it is a dedicated logic instrument for those involved in the design, repair or maintenance of digital electronic circuits and equipment.

Fast waveforms can be easily identified by taking a 'logical snapshot'. Not only can this save hours of lab work, but with such a facility, data can be retrieved from memories for later review and analysis.

The waveforms are viewed and measured on a custom high resolution LED display which simulates binary level signal/channel traces as displayed on a logic analyser's CRT. The effective real time bandwidth of the Model 136 is 10MHz, but the glitch catcher function allows for the capture of pulses down to 50 nanoseconds.

Further details from Emona Instruments, 86 Parramatta Road, Camperdown 2050, or phone (02) 519 3933.

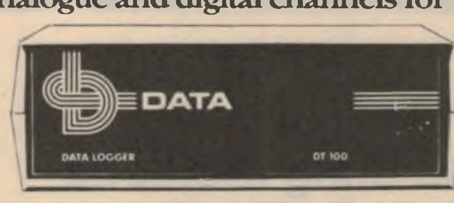
Solar powered pH meter

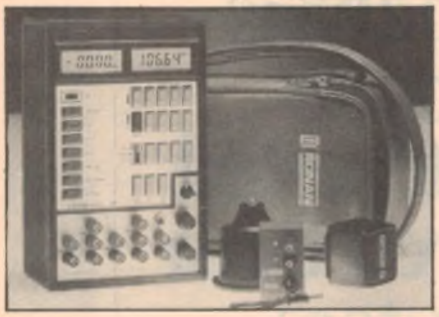
A compact solar powered pH meter has been introduced by Extech Instruments.

The pocket sized meter features a large ½″ LCD display and a replaceable electrode with 1m of cable that makes it easy to immerse in any solution. The electrode is terminated with a miniature BNC connector. It also features calibration, slope and temperature adjustment screws to maximise accuracy of 0.02pH and resolution to 0.01pH.

The solar pH meter is powered by average laboratory or outdoor light conditions, eliminating the inconvenience of buying or replacing batteries. The complete kit includes the solar pH meter, a rugged polymer bodied combination pH/reference electrode, and foam padded pouch carrying case.

For further details contact Australian Measurement & Control, PO Box 216, Port Melbourne 3207.





Portable calibrator

Ronan Engineering provides a portable calibrator which allows simultaneous indication of input and output values. The X86 portable calibrator can both supply and measure signals such as thermocouple, frequency, volts, millivolts, milliamps and ohms.

Pushbutton selection of range and value is combined with a sequential recall ability, allowing four automatically programmable step changes in output values. This feature is very useful for in-circuit testing and for remote signal verification.

Specifications stipulate 10 microvolt resolution on 100mV input range, with an accuracy of 0.01% of range +/−0.02% of reading. Input to output isolation is rated at 300V RMS.

Further information is available from Ronan Engineering, Unit 10, 8 Leighton Place, Hornsby 2077 or phone (02) 477 7344.

Cellular option for FM1200 CSM

IFR Systems has announced the release of a cellular option for its popular FM1200 series communications service monitor.

The new facility has been designed to utilise the AMPs system used in Australia, and handles all necessary testing procedures in either automatic or manual modes.

Further information on the new FM1200 cellular option can be obtained from Vicom offices throughout Australia or by phoning (03) 690 9399.

Dual trace 60MHz oscilloscope

The Leader LBO-2060 is a delayed sweep dual-trace CRT readout oscilloscope that operates at 60MHz/5mV.

The instrument simplifies waveform observation by displaying various control settings, such as VOLTS/DIV and TIME/DIV, on the CRT as well as displaying numeric readings of waveform amplitudes and periods using a cursor function.

Major features include:

- 150mm rectangular CRT with internal graticule and 12kV acceleration voltage.
- One-touch selection of 500uV/div (5MHz bandwidth)
- X 10 MAG, sweep rates expandable up to 5ns/div, and 60MHz waveform display in three cycles.
- ALT TRIG function to obtain stable waveforms of two asynchronous signals.

Further information is available from AWA Distribution, Unit C, 2-8 Lyon Park Road, North Ryde 2113.

HV AC tester

The Rod-L M100/M500 Series of AC Hipot Test Instruments is intended for production, receiving inspection and laboratory applications. Each instrument in the series performs safe and efficient testing, and in full compliance to UL, VDE, BSI, CSA and other standards.

The test cycle is fully automatic. Both the voltage ramp and test time are easily programmed by setting potentiometers. Two different ramp/test time combinations are selectable by a front-panel switch. This allows testing to two different test requirements without recalibrations.

All control circuitry is solid state and enables the M100/M500 to shutdown the high voltage and to discharge the device under test in 2 milliseconds at the end of every test – pass or fail.

For further information contact Maceys's Electrical Accessories, 8/9 Foamcrest Avenue, Newport 2106.

Vintage Radio

by PETER LANKSHEAR

Getting started

This is the first appearance of a new regular column in EA, designed to provide both interesting reading and useful reference information for anyone interested in the fascinating (and rapidly growing) hobby of collecting and restoring old radios. The column will be conducted by well-known and very experienced NZ collector Peter Lankshear, and here's Peter's opening introduction:

It is with great pleasure that I have accepted EA's invitation to host a monthly Vintage Radio column. My credentials are that I belong to the generation that grew up with radio, and from a very early age I found electronics an absorbing hobby. Later, I became one of those fortunate few who make a career of their hobby, and after a working lifetime, my interest is still with electronics, especially early radio.

From its earliest days, radio has had a strong hobby element, and vintage radio, in which there is a widespread and growing interest, is a natural extension.

The aim of this column is to provide information and communication for collectors, historians, restorers, in fact, anyone interested in any aspects of the pre-semiconductor era of electronics.

One of the great merits of vintage radio as a hobby is its wide range of disciplines. Among the practical subjects I hope to cover are collecting, servicing, restoring, cabinet repairs, displaying and rebuilding or making of components. Historical topics will include people, organisations, models and developments. There are very knowledgeable collectors who only collect valves, for example. One of my own favourite subjects is analysis of the design and engineering that went into valve radios.

Naturally, I will endeavour to present topics of general interest, but the wide range of experience amongst readers of EA does mean that there will be times, hopefully infrequently, when an article cannot have universal appeal. This type of column is two way. Any feedback from readers will be valued because it will enable me to find out which topics are of the greatest interest. There is a lot about the Australian scene that I as a New Zealander would like to learn about. For example, I would like to have more information as to which American and British receivers were commonly sold in Australia.

The widespread appreciation of techological artifacts is a relatively new phenomenon. Yesterday I observed the reaction of a group of teenage girls when a restored 1925 open tourer car drove past. I heard remarks such as "neat" and "I'd love to have one like that." Their parents at the same age would not have wanted to have been seen dead in such an old "bomb".

Fortunately, early radio equipment is now widely recognised as worthy of preservation. A decade ago, when the writer first began to take a serious interest in vintage radio, the few enthusiasts involved were generally older people who had been associated with electronics in some way, and there was a concern that the technology would die with their generation. Happily, it seems now that this will not be the case. I am very encouraged by the increasing number of young people who are becoming increasingly involved in our hobby, and are mastering what to them are ancient techniques.

Inevitably, some misconceptions have arisen. I have lost count of the number of times I had been told that "you can't get valves today", or "no one can repair radios today". Both of these statements have been fostered by an industry very involved in the "planned obsolescence" philosophy. Valves are still surprisingly plentiful, and whilst repair of valve radios is not commercially viable, increasing numbers of enthusiasts are learning the necessary skills.

An interesting concept of valve radios has developed. Invariably, the remark is made "Ah, yes, valve radios had a much better tone than these plastic transistors". Nostalgia does help, but of course the real reason for the improved sound was ample audio power feeding a large speaker.

Be that as it may, we have the unusual situation of an old technology being regarded by the layperson as being superior to its successor. It is rare to find an indifferent attitude to older receivers. Whilst there can be an ambivalence to collections of old bottles or postage stamps, radios are regarded quite differently. Radio has been for half a century or more, a central part of households. Along with television, it occupies a special place in family life. Older people, when seeing a display of early sets will say "We had one like that" and the younger generation will say something like "My grandmother had one of those". Somehow, I can't imagine a collection of washing machines or early lawnmowers creating the same enthusiasm!

An increasing number of people who have no intention of becoming collectors are having the old family radio, or one that they have acquired, refurbished. Hopefully this column will be of help to them as well as the serious enthusiast.

Collecting

Interest in vintage radio is not confined to collecting receivers. Some readers will be interested in old books, magazines and data. Valve collecting can be absorbing, whilst one local collector here in New Zealand has a large collection of headphones. Others do not have the space or the inclination to possess equipment, but many do – and be warned, the subject can be additive.

Collections can start in many ways. Some years ago, a friend of mine, who now owns a fine and large display, found an old Crosley receiver which had been dumped and even had weeds growing through it. With some knowledge of cabinet making, and wanting something to do, he took it home and restored the tired old cabinet to its former glory. Then he located another, and another. By then he was hooked. He learned to service the electronics, and now, not only does he have a separate building housing his collection, but he supplements his retirement pension by repairing valve radios.

Other collections have started by the finding of a radio at a garage sale or in a shed. My own collection started when on impulse I purchased a 1930 Majestic TRF console from an auction room. It looked so good when it was cleaned up that I put it in my office, and it has proved an "ice breaker" for visitors.

Where to find them

I can only speak from experience of hunting for radios in New Zealand, but I imagine that the situation is much the same in Australia. Advertisements in the newspaper Wanted columns are not particularly helpful. If you do turn something up, there can be some pretty wild ideas about values.

Second hand shops in country towns are a good starting place, but don't expect superb models at giveaway prices. Keep an eye on auction rooms. If no other collector is bidding you may get a good radio at a reasonable price. Unfortunately, some antique dealers are beginning to take an interest and can drive prices up. Garage sales and farm sheds are also good places.

I have found the most rewarding approach is to let it be known to friends and relatives that you are in the collecting business. You may not get instant results, but it is surprising what turns up when you least expect it.

Finally, join one of the Vintage Radio Societies where there is often wheeling and dealing. If secretaries of societies would write to me courtesy of EA about their organisation, I would be pleased to publish details.

Here are two that I do know about:

Historial Radio Society of Australia,
C/- Rex Wales,
24 Park Lane, Mt. Waverley,
Victoria 3149, Australia.

New Zealand Vintage Radio Soc.
C/- Bryan Marsh,
20 Rimu Road, Mangere Bridge,
Auckland, New Zealand.

Part of the author's own collection of vintage receivers.

What to collect

At first the newcomer tends to grab everything that comes his way. This is not unique to radio of course; after a while experience brings discernment and his (or her) choices become more selective.

But what is collectable? I suppose that it is anything that appeals and can be accommodated is eligible. Even some of the early transistorised radios are now 30 years old.

Age is not the only criterion for collectability. Originally, rarity, novelty, innovation, appearance, market leadership, performance and advanced design are also desirable characteristics, but then so are just plain ordinariness, personal association or because you like it.

One thing is clear, monetary value has little relationship to desirability. Fortunately, vintage radio does not have a little black book of prices. Each transaction is a stand alone, and between collectors, swapping rather than trading is very common.

Be cautious

A word of caution to the new collector who might be tempted to pay out good money for a radio: be sure of what you are buying. A couple of personal examples will hopefully show that care is necessary.

On holiday, I was visiting a well known "stately home" which does have many priceless treasures and artifacts. In fact the trustees pride themselves on the authenticity of their collection. I was most impressed by a beautiful HMV radiogram of the early thirties. Externally, it was in mint condition. The custodian told me the family had purchased it new and that it had been overhauled by an expert a few years ago. As the tour party moved on, I took a quick look at the rear. The "overhaul" comprised of an amateurish aluminium chassis fitted out with much later noval valves, utterly ruining the value of the set as a collectors item.

On the other side of the Tasman, I was visiting a friend on Queensland's Gold Coast. Knowing my interest, she insisted that I should admire a "lovely old radio" in a nearby home. Sure enough, it was an impressive 1931 RCA tallboy console. Thoughts of shipping costs crossed my mind as I turned the set around. However, I had to tactfully try and conceal my disgust when the chassis came into view. The valves, instead of being classic 24A's and 27's, had been changed to much more modern octals! Most experienced collectors have similar horror stories to tell.

If you are confronted with an apparently valuable veteran, check its authenticity very carefully, and if you have any doubts, get advice or try and do some research. Be suspicious, and take nothing at its face value. Of course, it can be a challenge to "demodify" a set, but such activities aren't recommended for the novice.

The limitations of storage space can be encountered surprisingly quickly. Even mantel radios take up a deceptive amount of room, and the average workshop, garage or den soon becomes filled. Locations around the house for discrete storage of a few sets are limited. The most tolerant of housewives is likely to object to more than one console, handsome as they may be, in the living room. Ingenuity overcomes many problems, and more than one collector has traded his car for a smaller model when his collection overflowed into the garage!

In later articles, I hope to describe some collections and display methods, but meanwhile, may I suggest that you scout about and locate some of those receivers. EA

Books & Literature

Occam programming

A TUTORIAL INTRODUCTION TO OCCAM PROGRAMMING, by Dick Pountain and David May. Published by BSP Professional Books, 1987. Soft covers, 235 x 153mm, 108 pages. ISBN 0 632 01847 X. Recommended retail price $32.95.

In case you haven't heard of Occam, it's a programming language which was developed to cope with the special requirements of parallel or 'concurrent' computing systems – where things happen at the same time, rather than sequentially. Needless to say parallel computers do require a rather different kind of programming than traditional 'do this-then this-then this' Von Neumann computers.

Just why a new programming language for parallel programming was named after William of Occam, the 14th-century originator of the famous philosophical Razor, I've never seen explained. I can only guess that perhaps it was because the developers thought it was the simplest possible solution to a ticklish programming problem.

The authors of this introduction to Occam the language are well qualified. Dick Pountain is a well-known UK author on computers and software, and UK correspondent for *Byte* magazine, while David May is Transputer architecture manager at INMOS, the UK company which developed both the Transputer array computing element (specifically intended for parallel computing), and himself one of the designers of Occam.

In this book they've produced an accessible introduction to this fairly esoteric language. It doesn't assume extensive knowledge of either other high-level computing languages, or assembly/machine code programming – just a familiarity with the general concepts of computing.

This being the case, it should be of interest and value to anyone seeking to gain a grasp of this emerging new area within computing. Especially engineers who find themselves asked to develop projects based on Transputer arrays!

The review copy came from Blackwell Scientific Publications, 107 Barry Street, Carlton, Victoria. (J.R.)

Data for hobbyists

ELECTRONIC HOBBYISTS HANDBOOK, by R.A. Penfold. Published by Bernard Babani, 1987 (BP233). Soft covers, 264 x 195mm, 88 pages. ISBN 0 85934 178 X. Recommended retail price $16.00.

R.A. Penfold is well known in the UK electronics industry, having written many books and articles over the years. In this new book he has brought together a lot of basic reference data, designed to be of particular value to the hobbyist or student just starting out.

There's all sorts of useful stuff, from resistor and capacitor colour codes to connections for the common RS-232C and Centronics printer ports on personal computers. Along the way you also find things like CMOS and TTL IC pinouts, standard power supply circuits, circuit symbols, op-amp data and configurations, data on transistors, FETs and other semiconductors (including base connections), useful circuits, the Morse code, amateur radio abbreviations, the Q and SINPO codes, and so on. All handy stuff, and brought together in a compact reference.

Although it's written nominally for the UK market, there's very little that doesn't apply to the Australian or NZ situation. In fact the only items I could find were listings of the amateur and CB band frequencies, which are a little different from those here.

In short, a book that should be particularly useful for the hobbyist's reference shelf – especially if you're fairly new to electronics. At the quoted price of $16.00 it seems good value.

The review copy came from Federal Marketing, which is offering it to *EA* readers via its mail-order service – see the advertisement elsewhere in this issue. (J.R.)

Audio servicing guide

AUDIO AMPLIFIER FAULT-FINDING CHART, by Chas. E.Miller. Published by Bernard Babani, 1987 (BP120). Soft covers, 179 x 121mm, folds out to 640 x 450mm. ISBN 0 85934 095 3. Recommended retail price $4.00.

Not really a book, this one, but something that should actually be of more use – especially for newcomers to electronics, and servicing in particular. Basically it's designed to help track down faults in amplifiers, and fix them once you've done so. The author is apparently an audio repair technician of many years' standing, and has based the chart on his considerable experience.

Basically all you have to do is choose which kind of fault you have, and then follow the arrows. The chart then leads you step by step, to check out the various possibilities in logical fashion.

In places the chart itself may seem a little cryptic, but there's a long guide to its use down the side, which makes most things quite clear. My impression is that it will be found of considerable use by anyone who hasn't done much servicing, especially on audio amps. And it's scarcely expensive!

The review copy came from Federal Marketing, which is offering the book to *EA* readers via its mail-order service – see the advertisement elsewhere in this issue. (J.R.)

An introduction to hifi - Part 19

Amplifiers & loudspeakers

by NEVILLE WILLIAMS

Impedance - power rating - sensitivity - basics - baffling - wide-range concepts.

In the preceding chapters, amplifiers have been considered mainly with respect to the source signals which need to be selected and processed. But the load to which the amplified signal must be fed is also important, and this chapter opens with a discussion of the relationship between a power amplifier and the associated loudspeaker system.

There are many facets to this relationship, some relatively routine, others more complex.

For example, in setting up a hifi system, it is wise to allocate carefully expenditure on the respective items, especially avoiding the situation where, having selected an over-pretentious amplifier, it becomes necessary to settle for an unduly modest (el cheapo?) loudspeaker system.

If there has to be a compromise, it is generally better to err in the other direction if only because, these days, it is easier to realise adequate performance figures from a modestly priced amplifier than it is from modestly priced and specified loudspeaker components – drivers, dividing network and enclosure.

But price and performance notwithstanding, the basic electrical specifications of a loudspeaker system must be compatible with those of the amplifier with which it is to be associated.

A few years back, amplifiers were commonly designed and specified by the manufacturers to operate into a load (i.e. loudspeaker) impedance of 'not less than 8 ohms' or '8 ohms minimum' – being therefore suitable for use with any of the then available 8-ohm or 16-ohm loudspeaker systems.

These days, most amplifiers are designed to operate into a minimum load of 4 ohms, with most present-day loudspeaker systems presenting a nominal impedance of 4 ohms or 8 ohms.

For maximum power transfer, the loudspeaker system should present an impedance equal to the lowest figure for which the amplifier is rated. In most cases, this would be 4 ohms although, in practice, 8-ohm systems are widely used with 4-ohm amplifiers with little discernable difference under normal listening conditions – typically a loss of 1 to 2dB in measured power output.

In fact, with 4-ohm amplifiers fitted with Main/Remote loudspeaker switching, there is a possible advantage in deliberately choosing 8-ohm loudspeakers. If and when extra loudspeakers are installed, both Main and Remote units can be operated simultaneously without stressing the amplifier, the two 8-ohm systems presenting a nett parallel impedance of 4-ohms.

(The subject of loudspeaker impedance will be examined in greater detail at a later stage, with special reference to the likely difference between its 'nominal' and actual value).

Power handling

Another performance rating which warrants mention at this point is the power handling capability of a loudspeaker system – a rating that would seem to be no less basic than impedance. In the context of domestic hifi, however, it is anything but precise, being little more than a guide figure.

It is normally quoted in watts, but should not be taken to mean that the system in question can be relied upon to handle any prolonged continuous signal at the stated power level, without exhibiting mechanical or thermal overload. Much would depend on the frequency and/or waveform of the signal and, at the bass end of the spectrum, the adequacy of the baffle system – a matter which has yet to be discussed.

For domestic hifi loudspeakers, the power handling capacity is more likely to relate to the maximum undistorted input power level of ordinary speech and music, referred to as 'IPM' or integrated program material. While hifi loudspeaker systems should certainly be capable of handling the rated IPM level without risk of physical damage, most are rated more conservatively on their ability to handle it without exhibiting subjectively obvious distortion.

On this basis, it is reasonable to suggest that the power rating of a loudspeaker system should be at least equal to that of the amplifier to which it is connected. However, it also suggests that a pair of 50W watt loudspeakers would be in no immediate danger of damage or burn out, if coupled to a 60+60W stereo amplifier – provided the amplifier was operated within its normal power rating.

In fact, in his now historic book 'Loudspeakers', G.A. Briggs of Wharfedale suggests (p.15) that it is not unreasonable to select a modestly rated loudspeaker system, provided it is demonstrably able to produce the maximum level of clean sound likely to be required in the particular listening environment. Nor is there any objection to

Selected from our files, this now historic picture from A&R dramatises better than most the contrast between large, medium and miniature loudspeaker systems.

using it with a more generously rated amplifier – provided the level is not pushed beyond the sound pressure level actually required.

The point is often made in other literature that hifi loudspeakers are at less risk from large amplifiers, sensibly operated, than from small amplifiers allowed to run into sustained overload. The stated reason is that overload conditions generate abnormal transient levels, which particularly endanger tweeters.

Ratings notwithstanding, however, loudspeaker systems are always at some risk from higher-powered solid-state amplifiers (e.g. 50+50W or more) which are inadvertently operated under conditions of gross overload or instability, or due to a malfunction which might place a large DC potential across the voice coils. It is for this reason that fast-acting protective circuitry of one kind or another is often included in the amplifier, or installed externally, to protect both the output stage and the loudspeakers.

Sensitivity

Yet another important parameter of loudspeaker systems is their sensitivity, or the efficiency with which they convert or 'transduce' the electrical energy delivered by the amplifier into acoustic energy, or sound. The more efficient a given loudspeaker system, the lower the power required from the associated amplifier to produce the required sound pressure level in the listening room.

An ideal loudspeaker would be 100% efficient, producing one watt of acoustic power for every watt of audio drive. For reasons that will become apparent later, the efficiency of practical loudspeakers is much lower than this. In fact, for a domestic cone type dynamic (moving coil) driver, a figure of 5-10% would be nearer the mark. That means only 50 to 100 milliwatts of acoustic power are produced for every watt of drive from the associated amplifier.

To measure and express efficiency or sensitivity, the most common approach is to set up the loudspeaker or system to be tested in an anechoic (echo-free) chamber or something approaching free space. It is then fed with a 400Hz tone or, better still, a 'pink noise' (modified white noise) signal at a drive power level of 1 watt. The acoustic output is measured by means of a calibrated microphone set up on axis 1 metre from the front face of the system, the resultant figure being expressed as the SPL (sound pressure level) in dB produced for 1 watt of electrical input.

While the exact reading may be influenced by various secondary factors, the convention allows loudspeakers to be directly compared, at least in broad terms. In so doing, however, one must be alert for possible discrepancies – for example, in the placement of the microphone at 0.5 or 2 metres away instead of 1 metre.

(An alternative approach, adopted by some manufacturers, is to quote the drive power needed to produce a specified SPL at 1 metre spacing, usually 96dB. The figures can be converted to the above convention by working out the dB relationship of the required drive to 1 watt and subtracting that number of dB from 96).

Typical figures

A few very large and very heavy loudspeaker systems used by rock and pop groups boast a sensitivity of 100dB or more (e.g. the JBL E130 has 105dB, as featured in *EA*, Jan.'81). While such units are very expensive to buy and/or replace if damaged, they are nevertheless a better investment for a pop group than the much larger (huge ?) amplifiers that would be needed to drive less sensitive loudspeakers for equivalent acoustic output.

The JBL E130, for example, can handle 300W of audio drive. For the same acoustic output, the drive power would need to be doubled for every 3dB reduction in effective sensitivity of alternative drivers: 600W for 102dB; 1200W for 99dB and so on!

It is neither necessary nor practical to use such bulky and highly specified drivers for domestic hifi equipment but, while the sensitivity and power figures are of a quite different order, the same basic consideration applies: the lower the sensitivity of the loudspeaker system selected, the greater the drive power required from the amplifier for a given sound pressure level in the listening room.

In the context of domestic hifi, the 30cm Wharfedales, Goodmans, American Jensens and de-luxe Australian

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Rolas of the mono era were regarded as more efficient than most, with a sensitivity of something over 90dB.

While the occasional large and expensive modern system may equal or better this figure (e.g. Technics' huge SB-10,000, in *EA* Nov.'80, p.32) most present-day floor model stereo loudspeaker systems are 85dB or more (e.g. the B&W 801 illustrated on the same page).

The long-running KEF-104 series was rated at 12.5W of pink-noise drive for an SPL of 96dB at 1 metre – the alternative method of rating. Reducing the drive from 12.5W to 1W would be equivalent to a power reduction of 11dB, which would bring the SPL down to the same 85dB, as for the B&W system.

For reasons which will be explained later, progressively smaller hifi systems tend to fall below this again, in some cases to around 80dB.

For example, the Australian-made Audiosound 8025 system reviewed in *EA* for January '86 combines small dimensions and wide response with a rated sensitivity of 84dB - 2.83V RMS across 8 ohms. While this would not necessarily indicate either inferior or superior sound to that of its less sensitive 'bookshelf' competitors, it would certainly be easier to drive.

Amplifier power

A couple of typical figures will serve to illustrate the bearing all this has on amplifier power ratings.

At the end of the valve era, a typical hifi enthusiast – the writer, for example – may well have been using a 17+17W ultralinear stereo amplifier driving a pair of generously baffled 30cm twin-cone Wharfedale, Goodmans, Rolas, etc. In a large listening room (70-90 cu.m.) the sound pressure level available from such a combination was normally ample, if not downright uncomfortable.

To obtain the same SPL in a similar listening room from a pair of modern semi-compact (less cumbersome?) high-performance multi-driver systems, the amplifier power would need to be increased by 5 or 6dB (3 to 4 times) to compensate for the likely reduction in sensitivity.

On this basis, a modern 60+60W solid-state amplifier, with good headroom for loud passages, as mentioned in the last article, makes no more than good sense for the present-day hifi enthusiast, maintaining the status quo – with a bit to spare.

If available and affordable, a higher rated power output can be regarded as a bonus. Not to provide a higher level of sound, as such, but to reduce the risk of overload and the possible clipping of the transient peaks which are preserved by some modern recordings – by compact discs in particular.

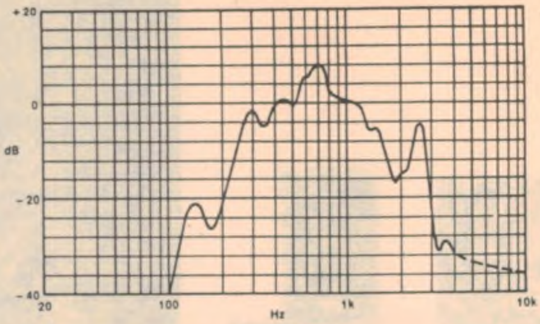


Fig.1: The frequency response of a typical old-time magnetic horn loudspeaker – horrendous enough, without even considering the accompanying distortion.

Loudspeaker basics

The vast majority of present-day domestic loudspeaker systems use one or more 'dynamic' drivers – a name given to moving coil loudspeakers in the late '20s to distinguish them from the older style 'magnetic' horn and cone loudspeakers. (By way of interest, Fig.1 shows the frequency response of a horn speaker from the mid '20s).

Fig.2, reproduced by permission from 'More About Loudspeakers' by G.A. Briggs, is a section drawing of a typical large moving coil driver, involving a die-cast housing, steel faceplate, backplate and centre polepiece, assembled manually in the traditional manner.

The cone is slightly flared rather than straight-sided, for smoother upper-middle response. It is flexibly supported around the edge by concentric corrugations, and around the apex by an external corrugated ring or, in some models, by a flexible, bakelised cloth 'spider'.

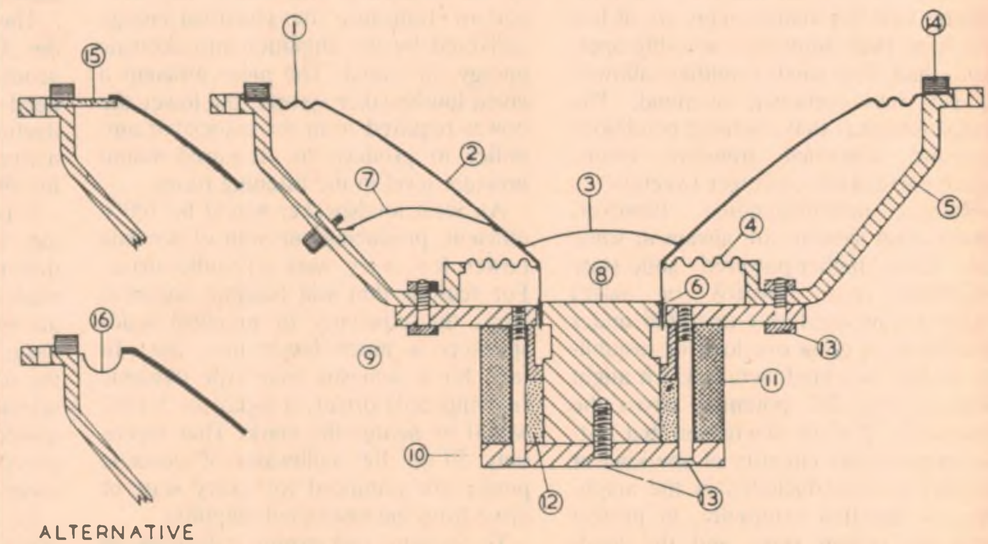


Fig.2: Key to numbers: 1 corrugated surround; 2 cone; 3 centre dome; 4 centring device; 5 diecast frame; 6 voice coil; 7 voice coil lead(s); 8 centre polepiece; 9 faceplate; 10 back plate; 11 magnet; 12 filling & sealing; 13 assembly bolts; 14 felt ring; 15 foam or other flexible surround; 16 roll surround.

Other edge support methods, as illustrated, include a ring of cloth or foam or a large, specially moulded and impregnated single corrugation, described as a 'roll' surround.

The voice coil (6) involves several layers of fine copper or aluminium wire, wound on a non-magnetic cylindrical former and cemented to the apex of the cone. It must be of critical dimensions and accurately supported in the narrow magnetic gap between the inner (8) and outer (9) polefaces, so that it can move back and forth without fouling any part of the rigid structure.

Special durable, flexible leads (7) carry the signal current from a pair of fixed connectors on the housing to the moving voice coil.

Early 'electro-dynamic' loudspeakers used a large 'field' coil around the centre polepiece to energise the magnetic circuit, comprising some thousands of turns and fed with direct current from the power supply. With the emergence of better technology, it became possible to produce more practical and efficient drivers using permanent magnets (11) and these are now virtually universal.

In operation, signal current from the amplifier creates an alternating magnetic field around the voice coil, which interacts with the fixed magnetic field in the air gap between the pole faces, causing the voice coil to vibrate back and forth in sympathy with the signal. The movement is communicated to the cone, which also moves back and forth, setting up air pressure waves, or sound waves in the surrounding air.

Practical aspects

So stated, it sounds like a relatively straightforward proposition but, in reality, it is not an easy one to put into practice over the full audio spectrum – ranging, as it does, from around 30Hz to 16,000Hz (16kHz) or more.

Median frequencies – say between 250 and 5000Hz – are probably the easiest to cope with. For a domestic listening situation, they can be handled quite well by a fairly light, fairly hard, gently flared moulded pulp cone of about 15cm effective diameter, and a voice coil and suspension system of careful but not specially demanding design. Such an assembly would distribute the median frequencies fairly evenly throughout a typical listening area. (See Fig.3)

For higher frequencies, above about 5kHz and especially up to and beyond 10kHz, a cone and voice assembly suitable for median frequencies tends to be unduly large and heavy, and too sluggish in its response to cope effectively with very high frequency signal components.

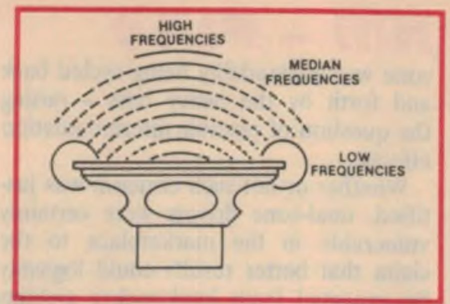


Fig.3: The natural sound propagation pattern for a large unmounted loudspeaker. Baffling is necessary to prevent loss at low frequencies.

To operate efficiently in the upper register, and radiate over a suitably wide angle, a cone and voice coil assembly should ideally be very light and quite small, with an effective cone diameter in the range 2.5 to 5cm.

By contrast, cones and voice coil assemblies required to cope with the low (or bass) frequencies have to satisfy criteria of exactly the opposite kind.

At low frequencies, the cone travels backwards or forwards for a longer period during each alternate half-cycle, and therefore through a greater distance. The suspension system and housing has to accommodate this often considerable amount of movement, without exceeding mechanical or elastic limits.

Again, to communicate or 'couple' low frequency – therefore large wavelength – sound energy more effectively to the surrounding air, the cone itself should ideally be large and substantial, with an effective diameter of 26cm or more.

Baffling needed

But that is not the end of the matter, as will be apparent from Fig.3. At low frequencies, the cone tends mainly to 'pump' the air back and forth around the edge of the housing, with very little in the way of a low frequency pressure (therefore sound) wave being propagated into the actual listening area.

To counter this problem, any cone type loudspeaker which is required to reproduce low frequency sound must be suitably 'baffled' – i.e. mounted on a large rigid panel, or in a cabinet or enclosure of one type or another, which can isolate or otherwise control air pressure effects at the front and back of the cone.

Baffle systems have been the subject of spirited debate ever since the introduction of dynamic loudspeakers, which made a sustained bass response possible and therefore worth arguing about! Typical concepts behind enclosure design will be discussed at length in a later article. The need is merely noted at this point for the sake of continuity.

Full-range loudspeakers

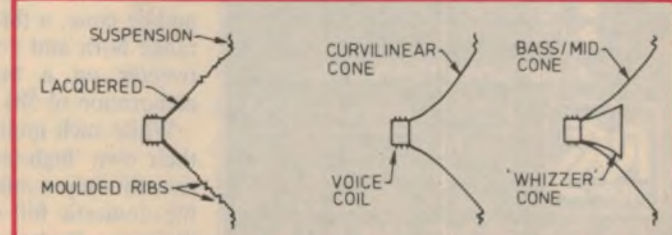
Despite the conflicting requirements for high, medium and low-frequency reproducers, designers have directed a great deal of effort, over the years, to the creation of 'full-range' loudspeakers capable of at least nominally flat response across the audio spectrum, along with acceptably low distortion and good sensitivity. The 30cm (12-inch) Wharfedales, Goodmans, Rolas, etc. mentioned earlier are familiar examples.

Great care was taken with the design of the main cone and suspension to ensure that the assembly had ample free travel to handle the deep bass. Again, in the quest for smooth response over the middle register, the cones were variously ribbed and/or lacquered near the apex (Fig.4a) and/or moulded to a *curvilinear* shape (Fig.4b), depending on the ideas and facilities of the particular manufacturer.

Most models were fitted with a supplementary 'tweeter' or 'whizzer' cone (Fig.4c) to reinforce propagation from the upper middle frequencies to the top end of the range. Such drivers, with two concentric cones sharing a common voice coil, are sometimes referred to as 'coaxial' types although, as noted later, the term can have other connotations.

While full-range loudspeakers of this general type were usually well ahead of less pretentious contemporary models in terms of overall performance, they were often criticised for being 'rather too bright', 'a bit too forward', e.t.c. Critics were also concerned that, while reproducing the high frequencies, the whizzer

Fig.4: The performance of cones is influenced by texture, weight and rigidity, lacquer impregnation and/or moulded ribs .



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cone was unavoidably being cycled back and forth by the heavy bass – raising the question of possible *intermodulation* effects.

Whether or not such criticism was justified, dual-cone drivers were certainly vulnerable in the marketplace to the claim that better results could logically be expected from loudspeaker systems involving multiple drivers, each optimised for a particular segment of the frequency range. In practice, the single-driver, whizzer-cone approach is limited mainly, these days, to economy 'hifi' and to automotive systems, where space is at a premium.

Concentric loudspeakers

An alternative concept involved the combination of two or more independent drivers in a single assembly – typically one with a deep, 30cm cone to handle the bass and lower-middle frequencies, fronted by a cone type 'tweeter' for the higher frequencies, the latter supported on a bracket bridging the front of the housing (Fig.5a).

Dividing networks

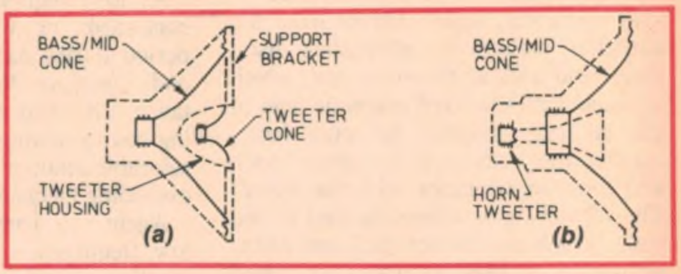
With both 5a and 5b, it is necessary to attenuate the signal drive to the tweeter below some specified 'cross-over' frequency, both to protect it from high amplitude low frequency drive – which it could not cope with – and to avoid exciting spurious resonance modes below its intended frequency range.

At the very least, this involves including a selected value of capacitor in series with one of the signal leads to the tweeter. In practice, a variously complex LCR network (comprising inductance, capacitance and resistance) is commonly used, to provide a steeper roll-off below the stipulated frequency.

Similarly, a series inductor, or other more complex network, is required to feed the main driver, largely to prevent the high frequency signal being absorbed by a voice coil and cone assembly that is too heavy or sluggish to do it justice.

Like most other resonant and band-pass circuits, loudspeaker frequency dividing networks do not abruptly interrupt the drive to each unit at a particular frequency. Rather their effect is to 'roll off' the effective response on either side of a nominated 'cross-over' frequency.

Fig.5: Low and mid/high range cone drivers assembled in (a) concentric and (b) coaxial configurations.



Carrying the idea a stage further, some manufacturers opted for a deliberately large diameter voice coil to drive the main cone, with a cylindrical rather than a solid centre pole-piece. The latter was so shaped, internally, that it formed one section of a small horn through which a tiny separate tweeter at the rear projected the high frequencies. This gave a true *coaxial* driver system (Fig.5b).

Variations on this general theme included a tiny streamlined tweeter fronting concentric bass/middle register cones (a combination of 4c and 5a); twin tweeters fronting a single large cone (an elaboration of 5a); and even a 'triaxial' loudspeaker combining a large bass/-middle cone, a through-the-magnet mid-range horn and a miniature horn super-tweeter on a bracket out front (an elaboration of 5b).

While such multiple-drive designs had their own 'high-tech' sales appeal they, too, fill only a minor role, nowadays, in the domestic hifi scene. However, they do raise a further point:

The choice of cross-over and the steepness of the roll-off is dictated by the nature of the respective drivers, the design objective and the cost and complexity which is appropriate to the particular system.

This whole matter will be discussed in greater detail in a subsequent article but, in passing, two other points can be mentioned.

Firstly, the sensitivity of the individual drivers needs to be of a similar order, to ensure proper balance between the bass, mid-range and treble sound.

Again, care is necessary to ensure that the respective drivers are connected in correct *polarity* to the drive lead from the amplifier, so that their acoustic outputs will be in the correct phase relationship, particularly in the cross-over region, where both are contributing to the acoustic output.

(To be continued)

Designing Common Emitter Amplifiers

Here's a simple explanation of how to design a standard common emitter amplifier stage. The author takes you through step by step, making the procedure easy to understand - even for newcomers and 'old timers' who still haven't been able to come to grips with newfangled transistors.

by ELMO JANSZ, VK7CJ

Linear analog amplifiers are required to fulfill three basic requirements. These are:

(a) The output signal must be an exact replica, other than in amplitude, of the input signal.

(b) The amplifier's input circuit must match the equipment driving it, and prevent unwanted signals entering the system.

(c) The amplifier's output circuit must match the load it is driving and produce as little distortion as possible in the output signal.

In this article we shall look at transistor circuits using NPN type devices. These circuits can be duplicated using PNP type devices with the power supply connections reversed.

Amplifiers can be divided into three broad classes. These are called Class A, Class B and Class C.

In Class A, the active device, in this case the transistor, conducts during the complete input cycle. In engineering terms this is called a conduction angle of 360°. For Class B, conduction is for half the input cycle, i.e, a conduction angle of 180°, while for Class C conduction is for less than 180°.

Of the three types, Class C is the most efficient, with Class B taking second place, but the increased efficiency is offset by the limited conduction angle, and these configurations are used only in special applications such as power amplifiers.

In this article we shall look at Class A type circuits.

Since we are going to use a transistor as the active device, let us first examine the possible ways in which a transistor can be placed in a circuit. The three possible configurations are shown in Fig.1.

Circuit (a) is called the common-emitter configuration, circuit (b) the common-collector or *emitter follower* configuration, and circuit (c) the common-base configuration.

The common-emitter is the most popular of the three, so let's have a closer look at this one.

Bipolar junction transistors have been used in the above circuits and for these devices a small current change in the base emitter circuit produces a large current change in the collector circuit. This current change produces a corresponding voltage change in the output circuit, which comprises the resistor Rc in parallel with whatever is connected across the output terminals – refer to Fig.1(a).

A measure of the ratio of the collector current to the base current is called the β (beta) or h_{FE} of the transistor, and its value can be obtained from manufacturer's data sheets. Specifically, h_{FE} has two values – a DC value and an AC value, but these are very nearly equal for small signal applications and this is what we shall assume here.

Reasons for biasing

Biasing is the name given to the fixed DC voltage connected between the base and emitter terminals. Bias causes a steady current to flow in the base-emitter circuit, when no signal is applied to the circuit. Bias is applied to a transistor for two reasons:

(a) A voltage of more than 0.7V is required across a PN junction to make it conduct. This assumes that the transistor is made out of silicon. For germanium this figure is about 0.3V.

(b) To avoid distortion due to the rectifying properties of the base-emitter junction.

Amplifiers which satisfy these requirements are called *linear* amplifiers.

In Fig.1(a) the biasing network comprises the resistors R1, R2 and Re.

An important function of any transistor bias circuits is to prevent the development of a *thermal runaway* condition. This is an extreme condition that can occur in the transistor and eventually damage it.

In the circuit of Fig.1(a) there are two PN junctions which are involved; one is the base-emitter junction, which is forward biased and the other is the collector-base junction which is reverse biased. This gives rise to two distinct components of collector current: the collector current due to normal transistor action in the base-emitter junction and the other is a smaller leakage current. Both currents flow through the reverse biased collector-base junction.

The leakage current is temperature dependent, and as the transistor's temperature tends to be dependent on its current, there is a potential for positive thermal feedback. Here are the mechanisms which can take place:

(1) The leakage current increases with

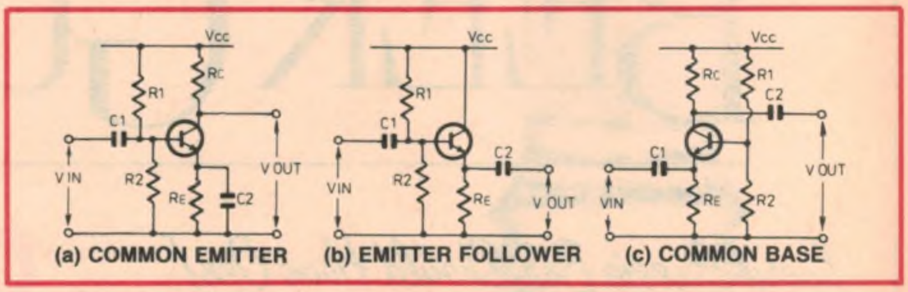


Fig.1: The three basic amplifier configurations used for bipolar transistors, shown here with NPN transistors.

temperature.

(2) The leakage current adds to the base current, which is amplified by the transistor, causing an increase in the collector current.

(3) The increase in collector current causes a further increase in temperature.

(4) The increase in temperature causes the leakage current to increase further.

This cycle can be repeated, until the transistor is destroyed. The bias network must be designed to overcome this problem, by breaking the link between leakage current and its base-emitter bias.

A second function of the bias circuit is to allow for parameter spreads between individual transistors. Transistors cannot be manufactured with fixed values for their parameters, but rather with a range of values or tolerance. A good example is the gain or β, which typically can vary between 200 and 800 for samples of what is nominally the same device. The bias network has to compensate for this, so that when one device is replaced by a similar device no circuit changes are necessary.

Bias circuit design

There are several types of bias circuits that are possible, but the most popular is called *voltage divider* bias and comprises the resistors R1, R2 and Re in Fig.1(a). We will now determine the values of these components, step by step.

Let us draw Fig.1(a) again for convenience (Fig.2). We assume a maximum DC collector current of 2mA and a DC supply rail voltage Vcc = 10 volts.

Step 1:

It is usually best to drop about 10% of the rail voltage across Re.

10% of 10V = 1V

Now for Class A operation, the quiescent collector current level should be half the maximum value. In other words, here it should be 2mA/2 or 1mA. The collector current is approximately equal to the emitter current for

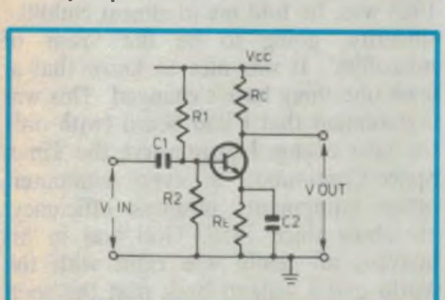


Fig.2: The common emitter amplifier configuration, as discussed here.

this type of circuit, therefore

$I_E = I_C = 1mA$

From Ohm's Law it is now very easy to determine Re, which is equal to 1V/1mA. This is of course equal to 1kΩ.

Step 2:

Now to determine the value of Rc, the collector resistor. For a class A amplifier stage this should have a value such that close to half the supply voltage Vcc appears across the transistor's collector-emitter terminals, with the quiescent current flowing.

Note that the voltage V_{CE} across the transistor's collector-emitter terminals will be the supply voltage Vcc minus the drops across both Rc and Re.

Since our supply voltage here is 10V,

$V_{CE} = 10V/2 = 5V$

And our quiescent current, from step 1 is 1mA. So from Ohm's Law,

5V = 1mA.(Rc + 1kΩ)

or

Rc = 5V/1mA − 1kΩ
= 5kΩ − 1kΩ
= 4kΩ

Here a value of 3.9kΩ would be close enough.

Step 3:

Assuming that the transistor is made out of silicon, the voltage drop across the base-emitter junction will be near enough to 0.7V. Therefore, the voltage at the base, i.e., the junction of R1 and R2 with respect to ground, will be equal to the voltage across Re plus the voltage across the base-emitter junction of the transistor. I.e.,

$V_b = V_{be} + V_{Re}$
= 0.7 + 1.0
= 1.7V

Step 4:

Let us assume that we are using a transistor with a β value ranging from 200 to 800.

If Ic is the collector current and Ib the base current, then β = Ic/Ib. Or swinging this around, Ib = Ic/β

The maximum transistor base current required will therefore be for a device with the lowest β. In this case Ic = 1mA and the lowest β is 200, so

$I_{b(max)}$ = 1mA/200 = 0.005mA

This is called 'worst case' design and we shall calculate R1 and R2 to correspond to this value. This will automatically give correct results for transistors with higher β, because these will draw *lower* base currents than 0.005mA (5uA).

Step 5:

The current drawn into the base is supplied by the resistive voltage divider formed by R1 and R2. For good regulation, i.e, for the voltage at the junction of R1 and R2 to remain constant irrespective of the current Ib, we must make the current through R1 and R2 much larger than Ib.

A good rule of thumb is to make this about 10 times Ib under worst case conditions.

In this case the current through R1, R2 = 10 × .005 = .05mA

It is now quite easy to work out the value of R2, for the voltage at the base of the transistor is 1.7V as calculated above and this is also the voltage across R2. Therefore by Ohm's Law:

R2 = 1.7V/0.5mA = 34kΩ

In this case 33kΩ would be close enough.

The voltage across R1 = 10V − 1.7V
= 8.3V

Therefore R1 = 8.3V/.05mA
= 166kΩ

Again, 150Ω would be close enough.

Step 6:

The input impedance of the circuit is given by the following equation.

Zin = (R1 // R2)//(β.Re)

where // means in parallel with and Re is the resistance between the base and emitter of the transistor and is given by:

R = 25/Ie(mA) in ohms

with Ic = 1mA, Re works out to be 25 ohms.

Let's put these numbers into the above equation and calculate the input impedance of Zin.

R1 = 150kΩ   R2 = 33kΩ

Therefore, R1 // R2 = 150kΩ // 33kΩ
= 27kΩ

For β = 200 × 25
= 5kΩ

Zin = 27kΩ // 5Ω
= 4.22kΩ

Step 7:

The only two components we have not discussed so far are the two capacitors C1 and C2, which are the least critical components in the circuit.

C1 is used to couple the input signal to the base of the transistor and isolates the DC potential at the junction of R1 and R2 from the input equipment.

Now let's see why we have C2.

A portion of the output signal appearing at the collector of the transistor can find its way into the resistor Re. This would lead to a loss of gain in the amplifier. We require to prevent this, or in other words to make the resistor Re ignore any voltage at signal frequency.

The problem is overcome by putting a capacitor C2 in parallel with Re and selecting its value so that at signal frequencies its impedance is very small and short circuits Re. That is, at signal frequencies the total impedance from the transistor emitter to ground is practi-

Common Emitter Amps

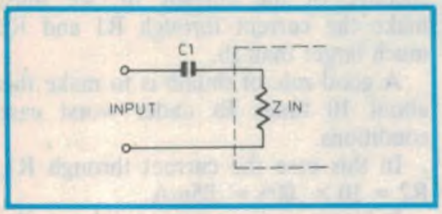


Fig.3: The input of an amplifier can be represented as shown.

cally zero. Any signal component that finds its way into this portion of the circuit will produce approximately zero voltage at signal frequency, preventing a loss in gain of the amplifier.

Calculation of C1 and C2.

The input to the amplifier can be represented by Fig.3.

The reactance of the capacitor C1 and Zin form a voltage divider, and it is clear that the reactance of C1 should be considerably smaller than Zin at the lowest frequency to be handled.

Let this frequency be 50Hz.

Therefore, for Xc to equal Zin,

Zin = $1/(2\pi.f.C1)$

4.2kΩ = $1/(2\pi.50.C1)$

C1 = 0.75μF

Finally let's calculate the value of capacitor C2.

At the lowest frequency of operation, this should have a reactance equal to about 1/10 to 1/20 of RE – say 1/10 in this case.

i.e., $1/2.50.C2 = 1k\Omega \times 1/10$

So, $C2 = 10/(2\pi.50.10^3)$

$= 31.8\mu F$.

So about 50μ should be sufficient.

That's all there is to it! Fig.4 shows a BASIC program that can be used to calculate R1, R2, Re and Zin. It was written for an Apple II+ personal computer, but can be adapted for other computers quite easily.

```
200  REM VCC IN VOLTS, IC IN MA.
205  VCC = 10
210  IC = 1
215  BETA = 200
220  REM  CALC EMITTER RESISTOR IN KOHMS
225  RE = 1 / IC
230  PRINT RE
235  REM  CALC INTRINSIC B-E RESISTANCE OF TRANSISTOR
     USING RT(OHMS) = (25 MILLIVOLTS)/IC(MA,DC)
240  RT = 25 / IC
245  REM  CALC R1 IN KOHMS.
250  R1 = (VCC - 1.7) / ((10 * IC) / BETA)
255  PRINT R1
260  REM  CALC R2 IN KOHMS.
265  R2 = 1.7 / ((10 * IC) / BETA)
270  PRINT R2
275  REM  LET RB = R1//R2
280  REM  // MEANS 'IN PARALLEL WITH'
285  RB = (R1 * R2) / (R1 + R2)
290  Z = BETA * RT * .001
295  REM  CALC INPUT IMPEDANCE IN KOHMS.
300  ZIN = (RB * Z) / (RB + Z)
305  PRINT ZIN
```

Fig.4: The author's BASIC program, for calculating component values.

Frankly Frank

Continued from page 56

contracting before your very eyes. The people pour in through the doors, and for the first time in years at one of these shows the people did pour in. Then a sort of peristalsis set in, and the humans were passed through aisles. The image one gets is of a warm and pulsing alimentary canal, with others in parallel. Finally the building's gastric contents were expelled by the process and a new lot ingested.

Just as an afterthought I spoke to a nice young man who was selling microfilm equipment on one of the stands. 1988 was, he told me in almost childlike sincerity, going to be the 'Year of microfilm'. It was nice to know that at least one thing hasn't changed. This was a statement that I had heard (with only the year changed to preserve the Time-Space-Continuum) at every computer, office equipment, business efficiency, etc show since 1958. God was in his heaven, all really was right with the world and I walked back past the soon to be gelded Monorail up the hill into the city.

New Products

Aerosol sprays

Arista Electronics now has revised its original range of 10 electronic sprays, rationalising to a new '6 pack' of the most popular aerosols.

The improved formula range includes a dust remover (S0228) which is for removing dirt and dust from electronic circuitry etc, with a powerful jet of compressed air; a safety cleaner (NS221) for cleaning circuit boards from excess flux and other impurities; a contact lubricant (LC223) to protect potentiometers, switches and relays against corrosion; a spray graphite (GR229), which will turn any surface into a conductive one; a hyper refrigerant (HR225) for aiding in the detection of faulty joints and componentry on printed circuit boards; and a lubricant cleaner (NL222) which is a combination of safety cleaner and contact lubricant.

New packaging and the increased size (300 grams) of each can makes the Arista range of aerosol sprays very competitive.

For further information and the name of your nearest stockist contact Arista Electronics, 57 Vore Street, Silverwater 2141, or phone (02) 648 3488.

PC-based CAD system

Micro CADAM Cornerstone provides many of the features of Lockheed's CADAM computer-aided design system, in a simple PC-based CAD system.

Mouse based, the system is said to require no significant adaptation from conventional drafting techniques. All work is shown directly on the PC display screen. Features include automatic 'undo' to recover from accidents, zooming, automatic generation of isometric views from standard orthographic projections, and compatibility with desktop publishing and CAD systems using HPGL or CGI metafiles and .DXF files, as well as compatibility with full-scale CADAM systems.

The Micro CADAM Cornerstone package includes a self-study course. It runs on the PC-AT or compatibles, as well as the Personal System/2 models 30,50,60 and 80. It also supports a wide range of standard printers, plotters and displays.

For further information contact IAS Pty Ltd, 3 Shearson Crescent, Mentone 3194, phone (03) 584 8088.

Smith Chart forms

Anybody who has been involved in radio frequency or transmission line design will be aware of the Smith Chart conceived by Philip Smith of the Bell Laboratories in the 1930's and the many uses to which it can be put.

One inherent shortcoming of the original Smith Chart design was that it only allowed the manipulation of either impedance or admittance values by rotating values through 180°, to convert from impedance to admittance or vice versa. There is a way to overcome this shortcoming, however and Stewart Electronic Components is now stocking a dual coordinate Smith Chart form.

The form, printed on high quality bond paper has the impedance coordinates in their normal red and the admittance coordinates in a pale green. Ideally suited to any application involving matching networks, this form should save much time and many potential inaccuracies through the continual process of rotating values through 180° degrees.

The dual coordinate Smith Chart form is available from stock in single sheets (Stock No. BX900) for 60 cents each plus 20% sales tax. Packs of 100 (Stock No. BX900C) are available for $48.60 plus 20% sales tax. All orders should include $2 for postage and handling.

Further details from Stewart Electronic Components, 44 Stafford Street, Huntingdale 3166 or phone (03) 543 3733.

Low cost LQ printer

Epson Australia has released the LQ-500, a compact 24-pin impact dot matrix printer providing true letter quality at an economical 9-pin price.

It has a range of enhancements and new features including letter quality print speed of 60 characters per second, input buffer size of 8K, choice of two fonts, selection of print enhancements such as double-height, double width or italic characters as well as super- and sub-scripts, outline and shadow printing and a reduced noise level to 62dBA.

Options include three additional fonts, cut sheet feeder and interfaces which allow connection with most popular PC systems today.

Wirewound resistors

Allen Bradley has announced the introduction of wirewound fixed resistors to complement its already extensive range of hot-moulded carbon, metal film and surface mount products.

Four new types are available:

- Type WW – power wirewound with wattage ratings from 0.4W to 12 watts at 25°C. Resistance range is 0.1 ohms to a maximum of 200k on the 12W version. Standard tolerance is ±2PPM/°C.
- Type WA – aluminium housed chassis mount, in wattage from 5W to 50W. Resistance range 0.1 ohm to 180k ohms. Standard tolerance is ±1%.
- Type WL – ultra low resistance range, from 0.005 ohms to 0.2 ohms. Standard tolerance 5% and 3% with 0.5% available.

Most types are available with non-inductive windings. For more information contact Allen-Bradley, 56 Parramatta Road, Lidcombe 2141.

Anti-glare VDT screen

With so much current interest in possible health hazards associated with video terminals, VDT Antiglare (Australia) can supply a range of VDT filters designed for those who wish to protect themselves.

The Glareban range of filters is made from tough, high quality optical glass with a built-in neutral density filter. Dip coating provides both sides with anti-reflective coatings, to keep annoying reflectance down to below 2%. This is claimed to be less than half the figure typically provided by mesh or single vacuum coated filters. Models are available for most terminals and screens.

The Reach Micromesh range of filters is designed to provide not only optical filtering, but shielding from electrostatic fields as well. Again a variety of models is available to suit various screen configurations, and also to provide different degrees of filtering.

Further information is available from VDT Anti-Glare (Aust), 8 Dowling Ave, Springvale North 3171.

Mobile radio fax

The JRC JAX-110/120 mobile radio facsimile system is designed to connect to any type of mobile/base radio system or radiotelephone system. It offers speedy transmission at 2400bps, giving 30 second transmission of an A6 standard text (104 x 148mm). The receiver includes a special error correction circuit to enhance received image clarity.

Other features include break-in synchronisation, addressee-designated selective calling and automatic reception.

Further information from ACL Special Instruments, 27 Rosella Street, East Doncaster 3109 or phone (03) 842 8822.

Copier has 'the edge'

Toshiba's new BD-7610 copier will copy edge-to-edge, that is if the material to be copied runs to the edge of the page, this copier will capture the image right to the edge of the paper.

The BD-7610 prints at speeds up to 30 copies a minute and can handle copy sizes ranging from A5 all the way up to A3. It can zoom from 65% (which is a reduction size, through the lens) up to 154% of the original, in 1% continuous increments.

Features include automatic exposure interrupt key (for those urgent copy jobs) and one-day dual page copying. It also has the ability to copy on non-/standard sizes, letterheads, transparencies, in fact onto almost any type of paper.

For further information contact Toshiba Copier & Facsimile Division on (02) 887 6054.

Toroidal inductor kit

To assist engineers in their design and construction work, Pulse Engineering has recently released its SMPS (Switch Mode Power Supply) Inductor Kit.

The kit contains 18 sizes of inductors ranging from 20mH to 450mH and having current capacities of between 2 and 10 amps.

The inductors are characterised for general purpose use and ripple filters. They are of single layer design and can be used as differential mode inductors in EMI filters. Special mounting holders are also available for PCB mounting.

Details of the kit and the complete range of pulse inductors is available from Clark & Severn Electronics, PO Box 129, St Leonards 2065.

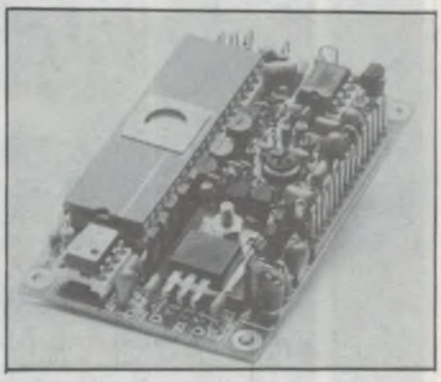
Products...

Tape/slide synchroniser kit

Eagle Electronics has released a new addition to the popular Velleman range of electronic hobby kits, the K2565 Tape/Slide Synchroniser. When assembled the kit allows you to record tone pulses on an audio tape or cassette, which are later detected to drive a relay for actuation of a slide projector or other device.

The kit provides all parts for the basic PCB module, which requires a 9-13V DC power supply. Assembly instructions are included. The approximate price is $25 plus postage and packing if applicable.

Further details from Eagle Electronics, 54 Unley Road, Unley SA 5061 or (08) 271 2885.



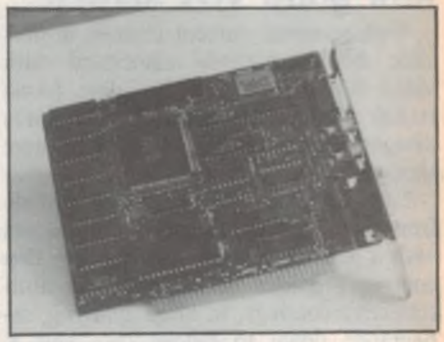
CTCSS module

An Australian company, GSA Technology, is producing a CTCSS module that can encode and decode at the same time. The small module is field programmable for all 38 EIA sub-audible tones.

Intended for mobile radio use, the module designated GSA2310 also includes a Time Out Timer (TOT), Transmit Inhibit, and repeater tail suppression. A high pass filter is also included on the PCB to ensure that no sub audible tones get into the radio's audio amp.

Larger systems are catered for by the facility to link serial control from an external microprocessor. The model GSA2320 will encode and decode different tones at the same time.

Further information from GSA Technology, 511 Keilor Road, Niddrie 3042.



Low cost EGA card

Electronic Solutions has just dropped the price of its advanced IBM PC compatible EGA card – the 'PEGA' card. Previously selling for $499, the price has been dropped to only $299, which ES claims makes it the lowest priced EGA card in Australia.

Facilities on the PEGA card include complete compatibility with software written for all the other video cards, including Colour Graphics (CGA), Hercules Graphics and Plantronics 'ColourPlus' modes; and external switches for configuration from outside the system. An easy to use utility supplied with the card allows users to switch between modes.

Flicker free scrolling is performed in all modes. 256K of RAM is installed.

For further information contact Electronic Solutions, PO Box 426, Gladesville 2111.

Dipped mica capacitors

Cornell Dubilier offers what it claims is the widest range of dipped mica capacitors available.

The types CD6 and CD7 are miniature styles, ideal for use in delay lines and IF transformers. The types CD5 through to CD42 are larger and higher rated dipped mica capacitors.

All types feature an exclusive Cornell Dubilier dipping process to impart high moisture and humidity resistance.

The reel pack thin dip style radial

lead (CD515) is packaged to make it compatible with radial leaded automatic insertion equipment and EIA STD RS-468.

Cornell Dubilier type CDA-15 are thin dipped silvered mica capacitors designed to meet electrical requirements of modern electronic equipment, where size is critical. Applications are found in a diversity of high-grade ground, airborne and space borne devices, such as computers, jet aircraft and missiles.

For further details please contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044.

Clip gun for cable fixing

A new clip gun introduced into Australia from Sweden is likely to revolutionise the installation of cable for communication applications – telephone, intercom and security systems, fire alarms, data transmission, process controls and similar.

The Bowmaster-Clipson Clip Gun can be used to fix cable up to 50% faster than the old method of loose cable clips and hammer, and eliminates sheath damage.

The patented clip-gun is like a stapling gun which uses impact-resistant plastic clips with pre-positioned tacks. Preloaded magazines hold 20 clips, which come in three sizes to cater for 3 to 5mm diameter cable, 3×5mm flat cable to 5 to 7mm diameter cable.

The gun features a strong impact mechanism which incorporates a pressure roll system to provide constant pressure. The strike can be repeated if necessary, for example in very hard wood, achieving a perfect result every time.

For further information contact Bowthorpe Australia, 105 Cawarra Road, Caringbah 2229 or phone (02) 525 2133.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Stepper motor IC handles up to 2A

The direct control of electric motors through integrated circuits previously required extensive precautionary measures since the windings act as inductive stores and discharge when the motor is switched off. Some control ICs employ integrated freewheeling diodes to protect the sensitive chip against the damaging effects of discharge currents: their maximum rating is about 0.5A.

By improving the chip's isolation layers, Siemens has now extended the maximum current ratings for motor control ICs using freewheeling diodes up to 1A (TCA1560A) and 2A (TCA1561A). The freewheeling diodes ensure that even at currents as high as this inductive loads will not produce harmful voltage peaks on the control chip.

The new components – TCA1560/61A – control and regulate current in the windings of bipolar stepper motors. Both chips operate at the same voltage level selectable between 10 and 38V. All control inputs except the current set point terminal are designed for interfacing with microcomputers. The two outputs are arranged in a push-pull configuration. Inductive voltages are led off by two diodes connected to ground and system power.

The TCA1561A is mounted in a high-performance plastic package equipped with cooling fin and nine terminals (SIP); the TCA1560A is available in an 18 pin plastic package (DIP).

For further information contact Electronics Components Department of Siemens, at 544 Church Street, Richmond, Vic 3121. Telephone (03) 420-7315.

PIN photodiode has insulated cathode

For the detection of optical signals in public telecommunications and industrial applications, Siemens has introduced a PIN photodiode in a metal case with an insulated cathode (the anode is insulated anyway). The user is therefore free to decide which of the two terminals his circuit technique requires to be grounded. The component, designed for 800 to 900nm (first optical fibre 'window') has a $1mm^2$ radiation-sensitive area, with peak sensitivity at 850nm.

The PIN photodiode is available for data rates to at least 565Mbit/s (SFH2012). The SFH2012A is intended for the lower range (a minimum of 200Mbit/s). Another fast PIN photodiode in the Siemens range is the SFH202/202A, which is identical to the new diode (850nm, $1mm^2$, TO 18) except that the cathode is electrically connected to the case.

For further information contact the Electronic Components Department of Siemens, 544 Church Street, Richmond 3121.

ISD completes first GaAs course

Adelaide based Integrated Silicon Design (ISD) in conjunction with the Centre for Gallium Arsenide VLSI Technology at the University of Adelaide, has successfully completed Australia's first fully-fledged training course in Gallium Arsenide IC Design.

The inaugural course was held at CIMA in Melbourne and was presented by Dr Kamram Eshraghian and Dr Donald Griffin. The course included in-depth analysis of GaAs technology for devices, process and design methodologies. Both microwave and digital design methodologies were addressed.

The course was well received by industry, which sees GaAs as a leading edge into state-of-the-art high performance systems such as satellite communications, fibre optics and high speed instrumentation.

Further courses are planned with advanced courses to follow.

Pulse, tone diallers

Rohm Company has announced a Pulse Dialler chip BU8992, designed for use in telephone handsets to replace the conventional rotary dial with a pushbutton dial. The device is adaptable to different rotary dial specifications with simple modifications.

It will connect directly to a telephone, allows the use of the standard 2-of-7 keypad and is manufactured using CMOS technology.

Rohm company has also announced a Dialler chip BU8302A, which combines tone and pulse dialler functions on a single chip. The chip requires no external power supply and directly connects to a telephone line, it has low standby current and is capable of last number redialling.

For more information regarding both the BU8992 and BU8302A dialler chips, contact Fairmont Marketing at Suite 2, 208 Whitehorse Road, Blackburn 3130 – or phone (03) 877 5444.

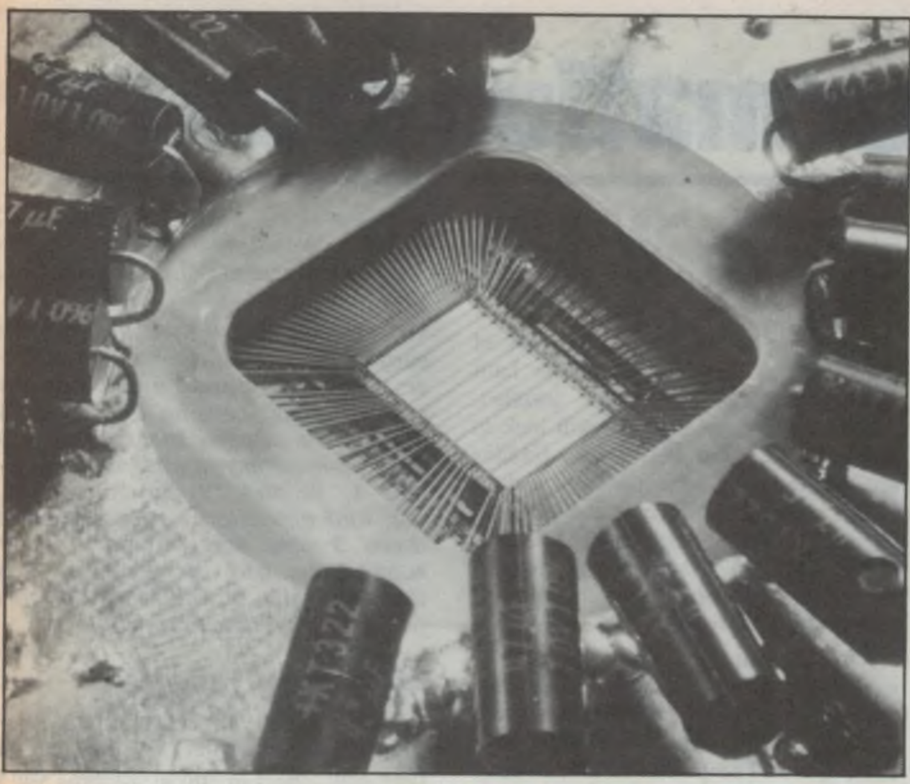
TI/Intel agree on ASICs

Texas Instruments and Intel have announced an agreement on application specific integrated circuits (ASICs), which will improve the design and development of high technology equipment.

The agreement includes development of a common cell library, a common gate array macro library, and provision for common testing, packaging, and design rules. The companies also have agreed to develop compatible ASIC CMOS process technologies, which will facilitate alternate sourcing.

'Systems manufacturers are faced with a wide array of vendors and design options, and few standards exist,' said Jack C. Carsten, Intel senior vice president and general manager of its ASIC Components organisation. 'This agreement can help avoid customer confusion by establishing new ASIC standards'.

TI's semiconductor Group Australian Manager John Robinson said the agreement allowed customers to design TI and Intel components into their products with a high probability that they would be able to migrate to TI/Intel ASICs.



Above: As noted in this column last month, IBM has announced what it claims is the fastest DRAM chip yet produced, with an access time of 20 picoseconds. Here is a prototype chip being tested at IBM's Yorktown Heights research laboratories, in New York.

ZVC opto triac drivers

TRW Optoelectronics division has just released two new zero voltage crossing optically coupled triac drivers.

The OP1340 comes in a TO-5 hermetically sealed package and the HCC340 in a hermetically sealed leadless chip carrier package.

The OP1340 consists of a gallium aluminium arsenide IR emitting diode and a monolithic integrated circuit containing a photodiode and a zero voltage bidirectional triac driver, mounted in a six pin TO-5 hermetic package. The device is intended to be used for low power DC control of power triacs which in turn control resistive, inductive or capacitive loads powered from 220V AC. Zero voltage crossing ensures that the device will not turn on until the line voltage reduces to 15 volts, typical.

The OP1340 has 1000V DC electrical isolation and is screened to MIL-STD-883 class B standards.

For further information contact Total Electronics, 9 Harker Street, Burwood 3125.

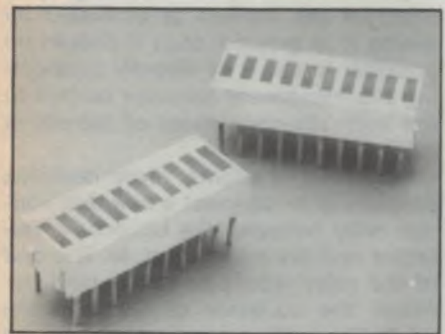
Chip for solid state disks

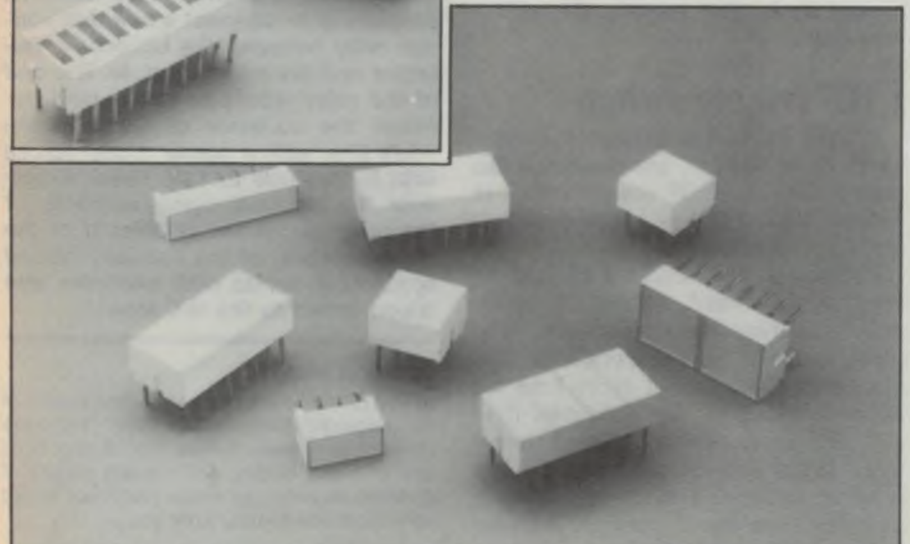
NEC's new uPD42601 'Silicon File' chip is specially designed for solid state disks. It features very low power consumption to ease battery backup requirements.

Other highlights include:

- File capacity: 128K bytes
- Self-refresh: 30uA (max)
- 512-bit page-mode cycle: 200ns (min)
- Package: 18-pin DIP; 20-pin ZIP; 26-pin SOJ

Further information is available from George Brown Group offices or the George Brown Group, marketing division, 456 Spencer Street, West Melbourne 3003.





New LED arrays from HP

Hewlett-Packard has introduced eight new light bars and one 10-element array in its line of bright aluminium gallium arsenide (AlGaAs) components.

These products are designed for battery-backup applications where power conservation is at a premium, or in high-ambient conditions when extra intensity is needed.

The new HLCP-X100 series of AlGaAs light bars is pin-for-pin compatible with the HLMP-2000 series of high-efficiency red (HER) light bars, but has more than three times the intensity.

Although the HLCP-X100 series is specified for low-current operation (at 3mA), the parts can be driven at normal currents of 20mA to provide high intensity in applications where sunlight viewability is valuable.

The rectangular light sources are configured in single-in-line and dual-in-line packages, in either single or segmented light-emitting units.

For further information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064.

Information centre

Inverter hum

After reading the item on Inverter Hum in Information Centre for March 1988, I detected that M.B. of Cronulla had struck the same problem that I had with my 300 watt inverter and Toshiba CD player (240V only).

The problem was solved quickly by providing a strap from the CD player (metal case of '–' terminal off spkr) to the car's ground. This has reduced the noise to a slight hum, not that noticeable.

I would say that this should solve M.B.'s problem, also could you please pass this info on to him/her, or maybe publish it in the magazine for others with this problem. (P.L., Bass Hill, NSW)

• ***Thanks for writing P.L. Tying the CD player metalwork and inverter case together might well help, as you suggest.***

Colour bar generator

Having built the TV Colour Bar Generator of October 1987, a problem arose. This is that the 5MHz oscillator would not reliably start on this frequency, but on a frequency of 7.5MHz instead.

The cure was to remove the 270pF capacitor (C1), unsolder the 5MHz crystal and replace it with a wire link. Then resolder the crystal in the position vacated by C1 (the hole spacings are the same).

These changes seemed to do the trick and no starting problems have arisen since. (T.O.W., Ingleburn, NSW)

• ***You do not seem to be alone in experiencing this problem. It would seem that the problem could be arising because the crystal may be overdriven. Your solution seems to be sound, although another possible solution may be a trimmer capacitor in series with the crystal. However, since the circuit works with the modifications which you have performed, we see no reason why you shouldn't leave it as it is now.***

Colour bar generator – 2

Having built the 87/TV/10 Colour Bar and Pattern Generator from a kit, like Mr Wynn of Keilor in Victoria. I have had problems with a different modulator.

Thanks to the advice in his letter published in the March issue, I was able to remedy the matter by fitting a 6.2 zener diode.

Not being too skilled in the art of electronics as yet, I have another fault which has me completely puzzled. When switched on, nothing will lock in the patterns. However, I was fiddling around when, by accident, I put a short circuit across a .02uF ceramic bypass capacitor, C4 (bypassing pins 2, 3 and 16 of the 74123 to ground. To my amazement when I looked at the screen, everything was working as specified.

After a suitable period of time, I switched off the test set but when switching on again the same thing happened. I re-applied the short and it came good. The puzzle is that it keeps working fine with the short removed.

Could ypu please give me some idea of what to look for or check.

I would add that the frequency changes at pin one of the above IC, becoming lower in the correct operating mode. (W.H.B., Sunbury, Vic.)

• ***In shorting this capacitor, you are actually shorting the 5V supply line – not a good idea. It sounds as if your crystal oscillator (based around crystal X1) is not starting reliably. Initially, try placing a small trimmer capacitor (say 40-100pF) in series with the crystal, and adjusting this until the oscillator starts reliably. Failing this, another solution may be to leave the crystal as is, and replace C1 with a wire link.***

UHF remote switch

I have built the ultrasonic burglar alarm of April 1987, and combined this project with the UHF remote switch of January 1987. The unit has worked perfectly since installation.

Recently I have decided to add an external relay board, to drive the car indicators during on/off transition. The problem that I have experienced with this combination is that every time the alarm is turned on, the indicators flash and the alarm triggers. The external relay board has been mounted in a separate box and a piece of insulation tape has been placed between the pole face and the relay armature to minimise vibrations but, it has not cured the problem. Would you have any suggestions on this matter? (J.F., Tullamarine, Vic)

• ***It seems likely that the sudden surge when the extra relay and blinkers turn on is causing a glitch on the power supply, causing the alarm to trigger. We suggest that you bypass the non-inverting inputs of IC1 (i.e., pins 1, 12 and 13) by connecting, say, 10nF capacitors between each of these 3 pins and ground. Further suggestions may be available from Branco Justic of Oatley Electronics who deisgned these projects.***

Movement detector

I have built your Ultrasonic Movement Detector project in the August 1984 issue. As I'm still at school I can't afford too much to buy as much electronics as I would like, but I have another alarm module with N/C and N/O inputs, so I would like to know if there is any way I could modify or add on something to make the ultrasonic detector's output activate the alarm module? (J.C., Granville NSW)

• ***The Ultrasonic Movement Detector should be able to be used with your alarm module. If the normally-open input of the module is activated by taking it to ground, then it should be possible to use it by directly connecting the movement detector output to the normally-open input of the alarm module.***

Otherwise, a slightly more complex solution is to connect a suitable voltage relay between the Ultrasonic Detector and the alarm module. The coil of the relay would be connected between the collector of Q3, and the +12V line, with a power diode across with its cathode to 12V. Then, simply wire the normally-open contacts of the relay across the N/O input of the alarm module, or the normally-closed contacts in series with whatever else is connected to the N/C input.

Can you help?

At the EA office we have reference copies of the magazine going back to 1927 – but none of our first 5 years before that. If you have any of these historic but missing copies of *Wireless Weekly*, our editor Jim Rowe would very much like to hear from you...

What was it?

This month's mystery object would have been instantly recognisable by radio enthusiasts of the late 1920's, even though most of it was normally not visible. It was made in Australia, and cost around 1 pound.

(Answer next month)

Answer for May

The component pictured last month was a 'Kuprox' copper-oxide rectifier unit, first of these to appear in Australia in September 1928. Copper oxide rectifiers were the first practical 'solid-state' power rectifiers, and were widely used in battery chargers and power supplies until they were superseded by silicon diodes in the 1960s. The ability of a copper/copper oxide junction to rectify was discovered by Branley, in 1874.

WARNING!

MOTOROLA MJ15003/4 POWER TRANSISTORS: It has been drawn to our attention that some devices sold recently as Motorola MJ15003 and MJ15004 product have conflicting date coding on the packages, and do not meet the performance specifications for these devices. There is a strong suspicion that they may in fact be different TO-3 power transistors of lower rating, illegally re-labelled by overseas suppliers (possibly in Hong Kong). Similar cases have occurred in the past.

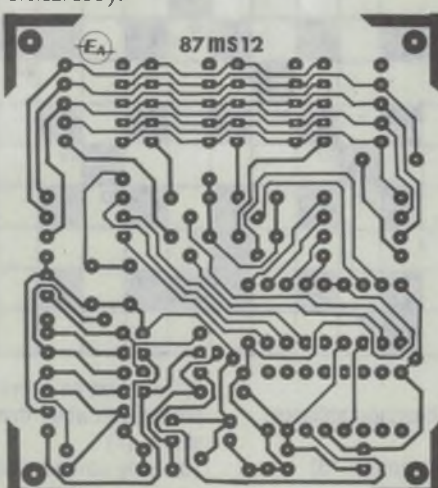
Our information is that the dubious devices are in obsolete *aluminium* TO-3 packages, with inked date codes of 8715 (MJ15004) or 8713 (MJ15003). Readers who have transistors which correspond to this description are advised to return them to their supplier, and seek either guaranteed-genuine devices or a refund.

NOTES & ERRATA

DUAL TRACKING POWER SUPPLY (February 1987): The specified transformer (22-0-22 volts) may produce an unregulated supply as high as 35 volts DC. This is the upper limit for the 7805 regulator, and may cause it to drop out when under load. To reduce this voltage to a safe level with existing units, wire two power diodes in series with the regulator's input lead.

If this power supply is to be constructed from scratch, rather than a kit, use a 20-0-20 volt transformer (such as an ARLEC 5755) with the standard circuit. (File: 2/PS/64).

JOGGER LOGGER (December 1987): Due to an oversight, the PCB artwork as published was not the final version. This results in the two least significant digits being swapped over, and the 'a' and 'c' segments also being reversed. The correct version is reproduced here, but for those who have already built one, the cure is simple. Cut the tracks connecting R9 and R11 to the displays. Using two short pieces of hookup wire, re-connect the resistors to the display so that they are swapped over. That is: R9 should be connected to the uppermost pin on the display, and R11 to the pin third from the top. The other change is to swap the tracks connecting IC3 to Q3 and Q4. Again, cut these two tracks at a convenient point, and re-join them so that Q3 is now connected to pin 10 of IC3, and Q4 to pin 11, as shown in the circuit diagram in the original article. (File: 3/MS/133).



50 and 25 years ago..

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

June 1938

Breville sales folder: We have received a very attactive and informative sales folder from Breville Radio, setting out their range of console receivers for the season. There is a wide selection of models, both broadcast and triple-wave types for AC operation, as well as AC/DC vibrator, and battery power.

Radio clock that works: By inserting it in series with the lead to your receiver, this clock will switch on and off as often as you like, according to the manner in which it is preset. It is only a matter of pressing a button, at the same time rotating a bakelite ring to mark the times the radio is required to start and stop, and the clock will automatically do the switching as required. It has a mechanical movement.

The news in different versions: We are all accustomed to the manner in which overseas news is served up to us by our favourite daily newspaper, but what contrasts does the short-wave listener discover when he listens in and hears the news of some particular political event as it comes to him from the radio stations of countries in Europe. Another excellent example of this has been observed recently, when lengthy news broadcasts on the German-Czech situation could be heard from Berlin and Praha.

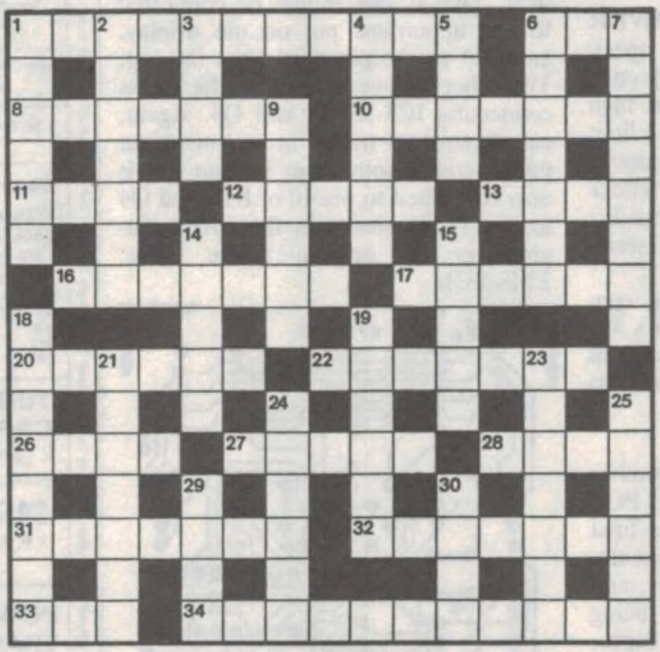
RADIO, TELEVISION and HOBBIES

June 1963

Signature by radio: The other day, reported Allan Murray in the BBC *New Ideas* program, a London merchant banker signed a share transfer certificate and slipped it into a machine on his desk. When he took it out again seven minutes later it had been countersigned by an American banker in New York.

The machine was a new British electronic device called Mufax. In less time than it would take to dictate the contents of any document by telephone it can send or receive a facsimile copy. All the London banker had to do was dial his colleagues telephone number in New York, then switch over to the machine, which transmitted the document at the rate of 500 words per minute. At the other end of the line a similar machine reproduced the certificate on electrosensitive paper. The American banker added his signature, and when this was flashed back to London in the same way the deal was completed.

JUNE CROSSWORD



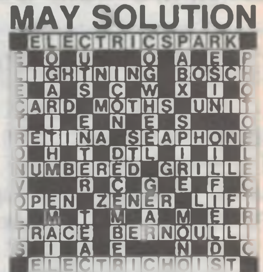
DOWN

1. Generate a magnetic flux. (6)
2. Black substance used to show effect of charge. (7)
3. Usual container for a gas discharge. (4)
4. Phase instability. (6)
5. Soft high-density metal. (4)
6. Soft low-density metal. (7)
7. Having spin. (8)
9. Low-frequency turntable fault. (6)
14. Individual signal. (5)
15. Domestic cycle rate. (5)
18. Current unit. (8)
19. Temporary link for a special broadcast. (4-2)
21. Change direction of wavefront. (7)
23. Italian, first in electrophysiology. (7)
24. Term (relatively polite) for the ABC. (6)
25. Elementary particle that decays into a proton. (6)
29. Printers do it. (4)
30. Musical instrument digital interface. (4)

ACROSS

1. Domestic heating appliance. (8,3)
6. Delay in response. (3)
8. Term for an overvoltage protection circuit that uses a shunt. (7)
10. Early communications satellite. (7)
11. Such are modern films. (4)
12. Substance that Greeks called elecktron. (5)
13. CD plants don't want this. (4)
16. Again assemble an EA kit. (7)
17. Illumination control unit. (6)
20. Initial surge. (6)
22. Potential output of cell. (7)
26. Period of useful service. (4)
27. Such a portable radio would need trimming! (5)
28. Thomas ---- Edison. (4)
31. Expert in computer systems. (7)
32. Said of impinging electrons causing secondary emission. (7)
33. Briefly, a common control. (3)
34. Skilled tradesperson. (11)

MAY SOLUTION



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Amplifier Design

Continued from page 96

power supply decoupling and output stability networks.

Physical construction

As previously mentioned, a straightforward construction technique will produce a much higher proportion of amplifiers that *work*. Not only is construction faster and simpler, but fault finding (if required) is far less traumatic.

The best way to simplify construction is by the use of one large PCB holding all of the electronics, input/output sockets, controls and switches. If possible, everything except the power transformer and mains wiring should easily mount on the one board.

This single PCB technique may be taken a step further by running copper tracks rather than shielded wire to the input and output connectors. By taking special care with the position and shielding of these tracks, we may eliminate any crosstalk or induced hum problems.

Conclusion

So there we have our guidelines for a new amplifier. By critically assessing new audio trends and learning from past designs, we are able to establish what is required of a high performance, low cost amplifier. Next month, we plan to describe just such a project. EA

Letters

Continued from page 7

formed at the negative plate and reacting easily with the lead sulphate. After charging, the battery was thoroughly rinsed out and refilled with sulphuric acid at full charge strength. It worked and restored some capacity to the motor-cycle battery I tried it on, for at time, but it eventually shorted out from the mechanical damage to the plate.

I hope this may be of interest to you and your other contributors.

Frank Walker,
Kew, Vic.

Comment: Many thanks for the clarification, Frank. EA

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A great many of our readers buy the magazine every month, and we're very grateful — it keeps us in business. But I'd like to take a few minutes of your time to explain why, if you're one of those people, taking out a subscription helps us even more to provide you with a better magazine. Perhaps surprisingly, it also helps save some trees. And right now, thanks to a special deal I've been able to organise, it will save YOU quite a bit of money.

Jim Rowe, EA's managing editor

As editor of EA, I know that our readers are a pretty bright bunch. Generally you're also reading the magazine not just because you're interested in electronics as such, but because you're keen to keep up with it for your job. That means you're mainly interested in finding a magazine that will give you the most timely and informative articles, at the best possible price.

If you *are* a regular reader, I don't really have to tell you that this is exactly what you get with *Electronics Australia*. We've been striving to give you these things for the last 65 years, ever since the magazine began. It's made us the Aussie electronics magazine with by far the largest paid circulation and readership.

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How can we afford to give you such a cut? I'll let you into a secret. For every reader who takes out a subscription, instead of buying the magazine off a news stand, that's roughly one LESS copy of the magazine we have to print.

Sound crazy? I can assure you it's true. For every magazine we sell on the news stands, on the average we have to print and distribute 1.9 copies. Because of the wastage in Australia's far-flung distribution system, it's almost impossible to achieve a better sales percentage than this for news-stand sales — at least for special interest magazines like EA, appealing to a relatively small proportion of the population. With smaller magazines again, it's even worse.

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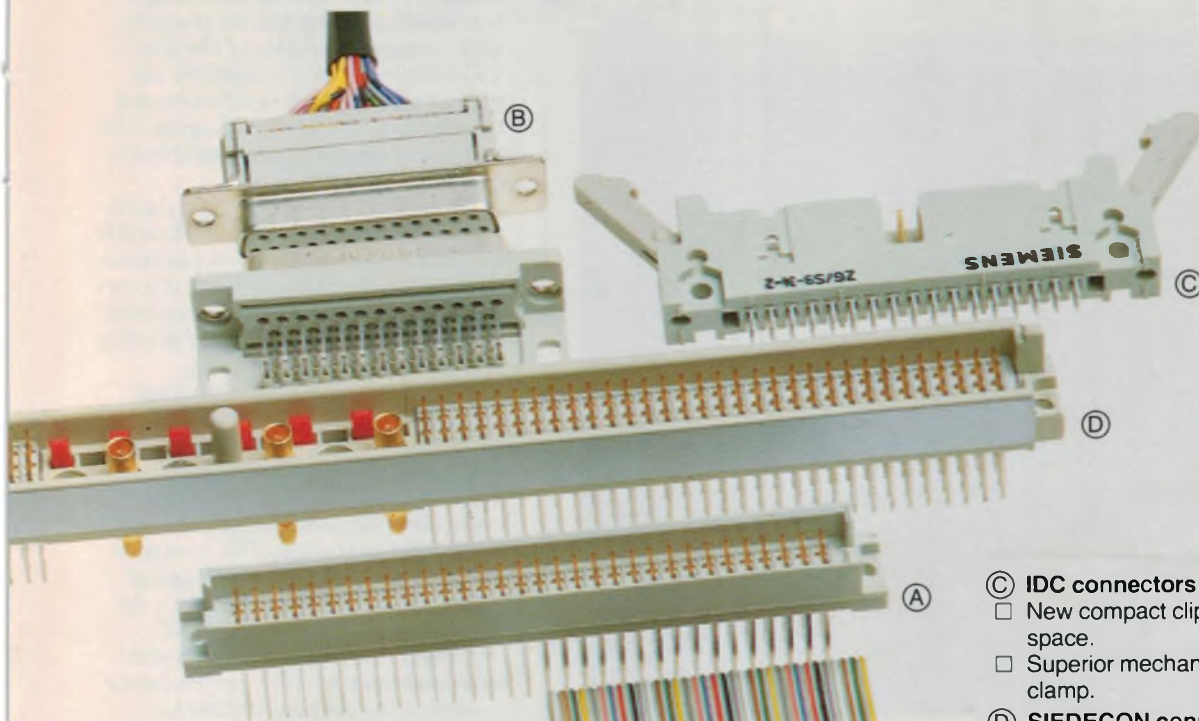

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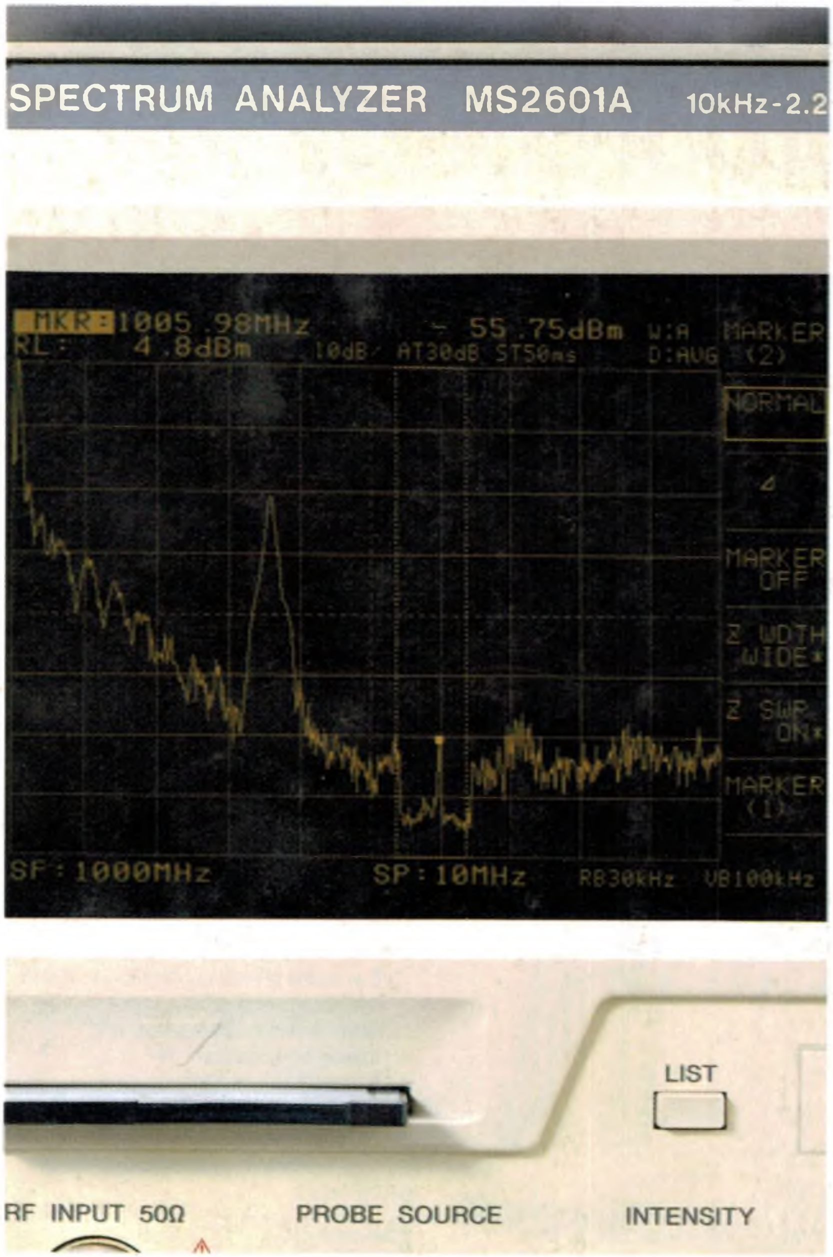

The all-new spectrum analyzer smartly pinpoints signals with more precise results.

Now you can do it all with the new MS2601A Spectrum Analyzer: locate the signal peak instantly in a user-specified range even in crowded spectra with the world's first ***zone marker****, track the signal through repeated sweeping within the zone, and average the levels of the zone. The detected peak is digitally displayed with 0.05dB resolution and in optimum RBW. You'll agree — the analysis is simpler, faster and more precise than ever.*

The MS2601A offers highly accurate signal analysis up to 30Hz RBW and automatic calibration guarantees ***1dB total level accuracy****. A new* ***scroll*** *function shows the spectrum beyond the screen, smoothly moving up to two divisions each way.*

What's more, advanced digital processing enables faster measurement and display menus simplify operation. Plus, new ***Plug-in Memory Cards*** *make complex operations easy and fast by storing up to 48 sets of data. The compact, portable MS2601A has a range of 10kHz to 2.2GHz at −130 to +20 dBm (dynamic range of 75dB).*

Choose the smart spectrum analyzer with greater cost-performance — choose the Anritsu MS2601A.

MS2601A Spectrum Analyzer

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