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Electronics Australia

JULY 1987

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Headphone amplifier for CD players

- Superconductors: the heat is on!
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Volume 49, No.7

Electronics Australia

July 1987

THIS MONTH'S COVER

The next generation of spaceplanes could make the Sydney to London journey a day's return hop — see story p.14. Inset is our new stereo headphone amplifier — see p.44.

Features

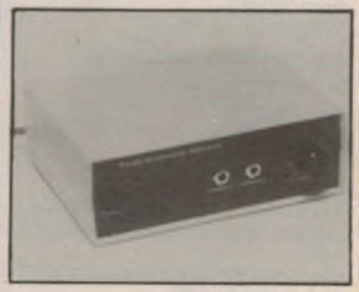
Entertainment Electronics

Projects and Technical

News and Comment

Departments

Headphone amplifier for CD players

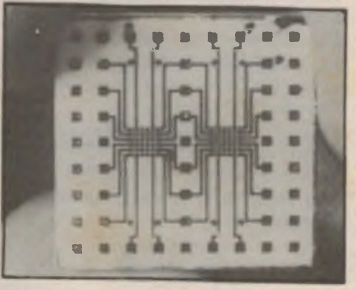


Our new stereo headphone amplifier is a high-performance unit with adjustable output level and two headphone outputs. It also features group delay compensation circuitry for those CD players that only have one D-A converter. Details page 44.

What's coming

Next month, we intend to describe a 153mm 7-segment LED readout which can be used as a basis for large display panels. See page 130 for further details.

Superconductivity: the heat is on!



Exciting progress is being made in superconducting research. We take a look at recent developments and consider the implications. See story page 10.

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Letters to the editor

No room for politics

I feel that I must protest to you at the editorial in the current (April 1987) *Electronics Australia.*

I have been a reader of the publication since No.1 *Radio and Hobbies* and it has generally maintained a neutral political stance, but your editorial would do well as a leading article in the "Herald"!

I can't understand how you could put such a political editorial in "your" magazine and I hope it doesn't occur again, as it was in bad form.

I'm not voicing an opinion one way or the other on the merits of the card.

J.A. Mead,
Bexley, NSW.

Australia Card – the contrary view

So the Editor no longer supports the Australia Card. I wonder what changed his mind? Yes Mr Simpson, I know what you said, but . . . Although publishers have been known to sell out to vested interests in the past, a respected technical journal is not the kind of organ one would expect to indulge in political propaganda.

All that having been said, as *Electronics Australia* has decided to enter the political arena, let me take a few lines to debate the views tendered by the redoubtable Mr Leo Simpson.

Firstly, in politics there are no guarantees. An extremist right-wing, left-wing or religious fundamentalist government could do here just as they have elsewhere. No laws ever invented can stop a malicious government from wilfully harming its own citizens.

Secondly, I trust that it is mere naivete that leads the Editor to assume that the Australia Card will give rise to massive oppression of free Australians. He goes on to refer to the Card as a "licence . . . where (none) was required before." Rubbish.

There appears to be a semantics problem here. The Card will be an *identity* card. That is to say, it will serve to identify people. Reference is made to the inevitability of Government departments having access to "a bank of information on births, deaths and marriages." I should sincerely hope so — if only so we can work out who is still alive!

Thirdly, the final part of the editorial was next to a silly-season piece about a neo-luddite who shot an automatic teller because it took his card from him. We are then told that in Florida, an automatic teller is worth $75,000 but a "mere-person around $3.50".

Most other countries have had identity cards for decades but civilization has not crashed down because of that. Could it be that the real reason behind the trumpeting noises from the Editor's desk is that somewhere somebody made someone an offer they couldn't refuse? Or was it just that, being April, something slipped in by mistake?

I submit that the introduction of yet one more plastic plate is nothing to get

Australia card

Congratulations are in order for your fine editorial regarding the Australia Card. I do not often agree with you but in this I believe every Australian should take a stand at this further legislative shrinking of hard won liberties.

It is a historic fact that elected governments unable to cope with changing social and economic conditions tend to lean towards limiting the freedom of its citizens.

To rid ourselves of the Australia Card after its introduction will cause much controversy, shouting and gnashing of teeth. Yet all this can be avoided with common sense at the ballot box.

On such an important matter as the Australia Card only a national referendum could, in all justice, decide whether Australians of today and those to be born in the future will be people with dignity or mere bleeps on a data bus.

M. de Bortella,
Derby, WA.

upset about. Most of us already have a wallet full of the things. Also, most of the information the Editor is getting nervous about is already on file, and is available on request by any department.

Despite the much-vaunted Freedom of Information Act much of the information is kept secret, including the existence of the files. This includes much information held by private corporations.

I do not feel therefore that the introduction of a national ID card, of itself, can cause harm to decent honest Australians. Only those with something to hide, something to gain, or suspect motivation would rush to oppose a reasonable move to sort the sheep from the goats.

Let's do less bickering over such minor political red herrings. Let us instead keep a sharp eye on whoever gets into Canberra and keep them honest.

A.E. Miller,
Kyeemagh, NSW.

Components for vintage radio sets

"Vintage Radio Restoration" strikes a chord, but some of the text in the article in April 1987 issue jars a little. May I comment:

On page 11, the text states " . . . valves present a major problem . . . no one stocks or sells them anymore." Wrong. There are some half dozen retailers who have a moderate range and two of these at least have many thousands of tubes. One of these retailers advertises in issue after issue in EA's Marketplace. Another regular advertiser (p106) offers valves from time to time. And if one is keen, mail order from the UK takes only ten days from letter to delivery for almost any tube.

Much the same comment applies to electrolytics. On page 13, the text states that " some (electrolytics) still work after forty years". Indeed they do; about 75% of them. I would venture to guess that some six of the eight discernible in the p15 photo would be reusable.

The comment " . . . obtaining these high voltage electrolytics is a bit like trying to buy new valves" is entirely correct. They have never been unavailable, but one has to shop around as only about one component stockist in three keeps them.

The suggestion is to test old electros on this basis:

continued on page 127

Editorial Viewpoint

It's great to be back!

Hello! Yes, that is a new face up there, although those of you who are long-time readers of EA may find it rather familiar. I was with the magazine for just on 20 years, until late 1979.

Why am I back? Well, there have been a few changes here at the EA editorial office. Leo Simpson, Greg Swain and John Clarke are all leaving us to pursue a project of their own. Both Federal and I are sorry to see them go, because they've obviously worked hard to keep EA in its leading position for many years.

Of course the departure of three such key people will leave something of a vacuum, to say the least. In view of my past long experience with the magazine, our publisher Michael Hannan approached me, and asked me to return.

So here I am, back at the EA helm once again and delighted at the opportunity to guide it through the next exciting phase of its long and distinguished history. As you probably know, it is one of the oldest flourishing electronics magazines in the world. Federal Publishing, Michael Hannan and I are fully committed to its continuing excellence.

To be honest, right at the moment things are actually rather more hectic than they should be because, initially, I'll be producing the magazine with very few staff — as well as interviewing for new people. So please bear with us for a month or two, if the magazine is a little rough around the edges or even a few days late.

But as soon as these temporary hassles are over, it'll be full speed ahead and steady as she goes (sorry about the corny maritime analogy!). You can look forward to better, brighter and more informative issues than ever before, to help you cope with the ever-changing progress of electronics.

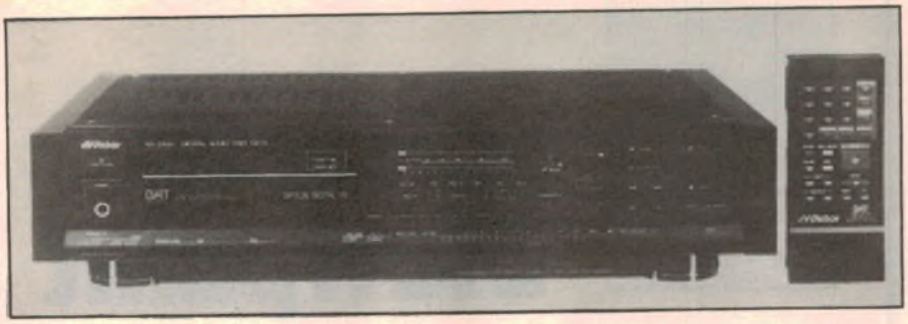
Over the last eight years, I've been able to learn a lot from people in both the electronics and publishing industries — including my ex-boss and good friend Dick Smith, who has been outstandingly successful in both areas (as well as flying that chopper!). Also my old mate Dick Levine, managing editor of the respected industry newspaper *Electronics News*, and his boss John Bragg (one of nature's gentlemen). And lots of others, too numerous to mention here . . .

It's been an excellent opportunity to see things in broader perspective, and I've come back with recharged enthusiasm and a host of new ideas. Over the next few months you should start to see the results.

By the way, I'm very interested in your ideas for improving the magazine. So please let me know what you think.

Jim Rowe

News Highlights



JVC releases it's first DAT recorder

JVC has released its first Digital Audio Tape recorder in Japan. The new unit is equipped with a long playing mode which enables continuous four hour recording or playback.

The new XDZ-1100 DAT deck uses the rotary head system decided upon by the DAT committee. Brief specifications for the new unit include: 20Hz-22kHz frequency response; 96dB dynamic range; and dimensions of 435 x 100 x 310mm (W x H x D).

The DAT recorder costs 198,000 Yen which is approximately $1,980. No details are yet available as to when the product will be released in Australia.

Anglo-Australian group to pursue cable contract

An agreement to form an Anglo-Australian consortium has been signed by Australia's Amalgamated Wireless (Australasia) Ltd (AWA) and Britain's STC PLC.

The new consortium, to be called Submarine Systems Pacific, has been established specifically to play a major role in a proposed undersea fibre optic telecommunications network in the Pacific region, estimated to be worth $1 billion.

The first system in the network will be Tasman 2, a $120 million link between Sydney, Australia and Urenui, New Zealand. This 2500km link will be the first international submarine fibre optic link in the Southern Hemisphere and is scheduled for completion in 1991.

The consortium agreement was signed at AWA's corporate headquarters in Sydney by Dr Nigel Horne, Director of Technology and Corporate Development for STC, and Mr John Hooke, Chairman and Chief Executive of AWA.

Electronics directory

Microel have released the Microel Directory of Australian electronics product manufacturers.

The directory covers companies which manufacture products in Australia that contain a substantial element of Australian electronics design capability. This includes printed circuit boards, products containing discrete active and passive components, hybrid circuits, standard linear and digital electronic circuits, microprocessor-based products and custom and semi-custom integrated circuits.

Details given on each company in the Microel directory include its contact person, address, telephone and telex numbers, the size of the company and a general guide to the products manufactured.

The database is updated regularly as new information becomes available.

Copies of the current Microel Directory are available from the NITC Secretariat for $12.50 including postage and handling. For further information, contact Mr Tom Bujna on (062) 644 302 for further information.

Toshiba develops fast 1Mb static RAM

Researchers at Toshiba Corporation in Japan have developed a 1-megabit (1Mb) CMOS static random access memory (SRAM) with a typical address access time of 25 nanoseconds (25 billionths of a second) — the world's fastest.

Utilizing 0.8μm microlithography technology, it integrates approximately 6.3 million elements (including transistors and resistors) on a 6.86 x 15.37mm^2 chip. The new RAM incorporates four NMOS transistors and two polysilicon resistors per memory cell, plus a peripheral CMOS circuit. Typical operating and standby currents are 15mA and 2μA respectively.

Toshiba plans to commercialize the chip in 1988, and it is expected to be widely used as a memory device for compact office automation equipment such as workstations, personal computers, printers and word processors. The device is especially suitable for portable equipment which requires lower power consumption or which operates on batteries.

IBM moves against the clone makers with Australian made machines

In a move to strongly reinforce its position in the marketplace, IBM has released a wide range of new personal computer products which includes eight new processors, four new CRT displays, printers, enhanced operating systems and new applications software.

The base of the new family is the IBM Personal System/2 which supersedes but remains compatible with the large existing base of IBM PC, PC XTs, PC ATs and clones. At the same time, IBM has thrown up a strong defence against the clone makers by producing machines with open architecture, which encourages third party peripheral manufacturers, but having many proprietary design features which will be very difficult to copy or reproduce.

The new machines are faster, handle much more memory, have multiple display modes, a bigger keyboard and have more integrated functions. Each machine has a universal power supply which will automatically operate from AC mains anywhere in the world.

The base machine is the Personal System/2 Model 30 which is physically much smaller than the superseded IBM PC but is more powerful in many respects. It comes standard with two 90mm disc drives each of 720K capacity. The microprocessor is the Intel 16-bit 8086 operating at 8MHz with no wait states, and 640K of RAM is standard. Integrated functions include multicolour graphics display port (supporting text and graphics), serial port, parallel port and mouse port. There are three internal slots for expansion boards although for most applications these will not be needed.

The Model 30 is also available with a single 90mm disc drive and a 20 megabyte hard disc drive.

One keyboard is standard to all models. It has 101 keys including 12 function keys which are arranged in a row along the top rather than in two columns at the side. There are three indicator lights (Num lock, Caps lock and Scroll lock) and quite a few other changes which have been made in response to feedback from users.

A big step up to better than PC-AT performance is presented by the Model 50. This uses the Intel 80286 processor operating at 10MHz. Standard RAM is 1 megabyte, optionally expandable to 7MB. Integrated functions include serial and parallel ports, mouse port and the VGA port which provides all currently available display standards such as CGA and EGA (enhanced graphics adaptor). A 1.44MB 90mm disc drive is standard, together with a 20MB hard disc.

Both the Model 30 and 50 machines are considerably smaller than the PC/XT and PC/AT machines they supersede.

Two even larger machines complete the line-up. The Model 60 also uses the 80286 processor operating at 10MHz, with 1MB RAM as standard expandable up to 15MB. The Model 60 is a vertical machine, meant to sit on the floor underneath a desk or table. It also has a 1.44MB 90mm disc drive and a 44MB hard disc. Other versions come with 70MB or 115MB hard discs. It has the same integrated ports as the Model 50 and has seven expansion slots.

The top machine in the new Personal System/2 range is the tower Model 80. This is a 32-bit machine employing the 80386 microprocessor running at 16MHz or 20MHz. RAM is 1MB or 2MB with 80 nanosecond access time. Other features are similar to the Model 60.

IBM hopes to gain a big advantage over the clone makers with these new machines. They all make extensive use of surface mount devices, programmable logic devices and proprietary ROMs which will make it much harder to copy these new machines than the superseded models.

IBM has made big investments in its Wangaratta manufacturing facility to make the Model 30. The Victorian plant will supply the Australian and South East Asian market. The investment includes all the equipment and technology needed to make and fully assemble the complex multilayer boards.

Ace winners

The three winners of the Ace April Guessing Competition drawn on the 21st May, 1987 at the EA office by Selwyn Sayers are: Ian Cuttle, 33 Grange Crescent, Cambridge Gardens, NSW 2750; Colin Bulloch, C/- Telephone Exchange, Cobar, NSW 2825; and David Robinson,

News Highlights

New course in chip programming

Engineering students at Sydney University will be using three IBM AT Personal Computers to research and develop advanced manufacturing systems as part of their studies in 1987.

Professor Hugo Messerle, Head of the Electrical Engineering School, said that Australia lacked training centres which could establish and maintain advanced technology in industry and was seriously under-engineered in comparison to Japan which has a graduate ratio eight times greater than Australia's.

The three IBM ATs will be used in a digital system design laboratory which will give students the opportunity to program and test computer logic chips.

The PC ATs will run Altera Corp Software to create and edit programs for digital systems analysis and design. The programs are then transferred to logic chips and tested.

Export order for Philips radios

Philips Australia has won a large export order from the French for its Australian designed FM-92 series of mobile port order from the French for its Aust ralian designed FM-92 series of mobile Philips' Clayton works in Victoria.

Philips has already received three large orders from France totalling nearly one thousand units. Among the first French customers are Parisian traffic police and provincial firefighters.

The French systems require different operating parameters to those in Australia and the inbuilt flexibility of the FM92 enables it to accommodate these changes without costly modification. The radios are supplied through an associated Philips company, Societe Francasie des Tech Pye (SFTE) in Paris.

The first consignment of 300 radios was freighted during May.

Business Briefs

- Vicom Australia Pty Ltd has moved to new and larger premises in South Melbourne. The new location offers expanded areas for Vicom's Research and Development. The new address is 4 Meaden Street, South Melbourne, Vic. Telephone (03) 690 9399
- Motorola has moved to new premises at 100 Asquith Street, Silverwater, NSW 2141. Phone (02) 647 2355.
- Elmeasco Instruments Pty Ltd has announced the retirement of Mr L.S. Altman as Managining Director. Mr Altman remains a Director and consultant to the group. At the same time, Mr Mike Collins, General Manager of Tech-Rentals Pty Ltd, has been appointed a Director of Elmeasco and assumes the position of Acting Chief Executive Officer.

  Elmeasco is one of Australia's largest test and measurement companies and became a subsidiary of Tech-Rentals Pty Ltd in 1984.
- Chloride Batteries Australia and Dunlop Batteries have merged to form a new company: Pacific Dunlop Batteries Industrial. Mr Brian Thorpe, who was previously General Manager of Chloride Batteries Australia Ltd, takes on the role of General Manager of the new company.

Spraypainted superconductors!

Scientists at IBM in New York have found a way to "spraypaint" large and complex surfaces with high temperature superconductor material. This raises the prospect of inexpensive, easy-to-apply magnetic shielding, computer wiring and other applications that might benefit from the material's unique properties and new found workability.

The latest discovery follows just weeks after IBM's announcement that it had made the first practical thin-film superconducting from the new superconducting material.

By using a common industrial technique called plasma spraying, IBM has been able to coat items of various sizes at approximately the same rate of speed taken to spraypaint a car. The researchers believe that they are the first to quickly and easily coat complex shapes such as preformed wires, contoured and flat surfaces and even tubes made from ceramic, quartz and metals.

Initial experiments point to coatings that adhere and that are workable enough to merit optimism about their ultimate usefulness. The material, a combination of yttrium, barium and copper oxides, resembles flat black paint. It becomes completely superconducting in the temperature range of liquid nitrogen — "warm" enough to be practical for many scientific and industrial uses.

Most of the materials and wires that IBM researchers have coated have become superconducting at between 60 and 82 degrees above absolute zero.

Flat TV screen for cockpit displays

The arrival of the world's first high resolution flat, thin cathode ray tube (CRT) — just 50mm thick and so rugged that it can be dropped without breaking — will have a big impact on aircraft cockpit design.

Seen here in a Royal Navy Lynx helicopter, 200mm-wide screen can give the pilot immediate access to information on navigation, flight management, weapons and storage. It has the added benefit of low heat dissipation (less than 20W), removing the need for forced air cooling and ducting.

Developed in Britian by Mullard, the Thin CRT Electronic Display (TCED) will shortly be demonstrated in three colours and is likely to be available in full colour later in the year.

WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR C

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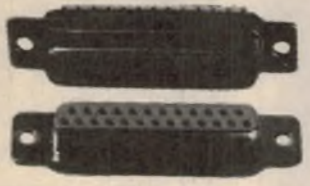

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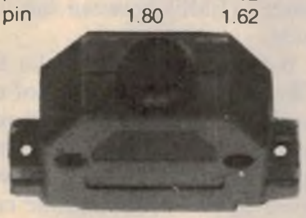
9 pin	1.80	1.62	1.25
15 pin	1.80	1.62	1.25
25 pin	1.80	1.62	1.25



Covers Plastic

9 pin	1.60	1.44	90¢
15 pin	1.60	1.44	90¢
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24 way male	9.60	8.64	4.80
24 way fem	10.00	9.00	5.00
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36 way male	8.00	7.20	5.20
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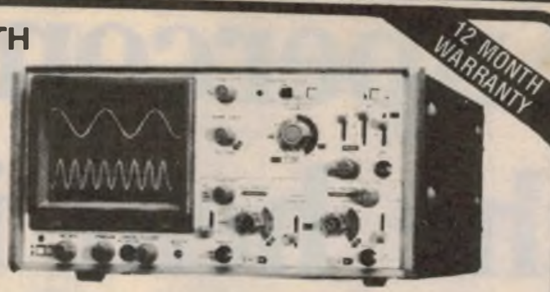

The GOS-522 is an ideal general purpose scope which we've selected because of its excellent triggering functions. Two channels with big 150mm (6") screen and internal graticule. Fast 20ns/div sweep speed for high precision. Features alternate triggering mode to ensure stable display of both channels - saves a lot of knob twiddling!! Trigger circuit is dc coupled too for low frequency signals. Trigger level lock and variable hold-off all add to ease of use. Auto, normal and single shot sweep modes. Call in for a demo, you will be delighted with the performance and the price -

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Superconductors: the heat is on!

In the last few months, researchers have learned more about superconductors than was found during the entire 75 years since they were first discovered. And a lot of exciting progress has been made, achieving superconduction at higher and higher temperatures. But the real breakthrough is probably still to come . . .

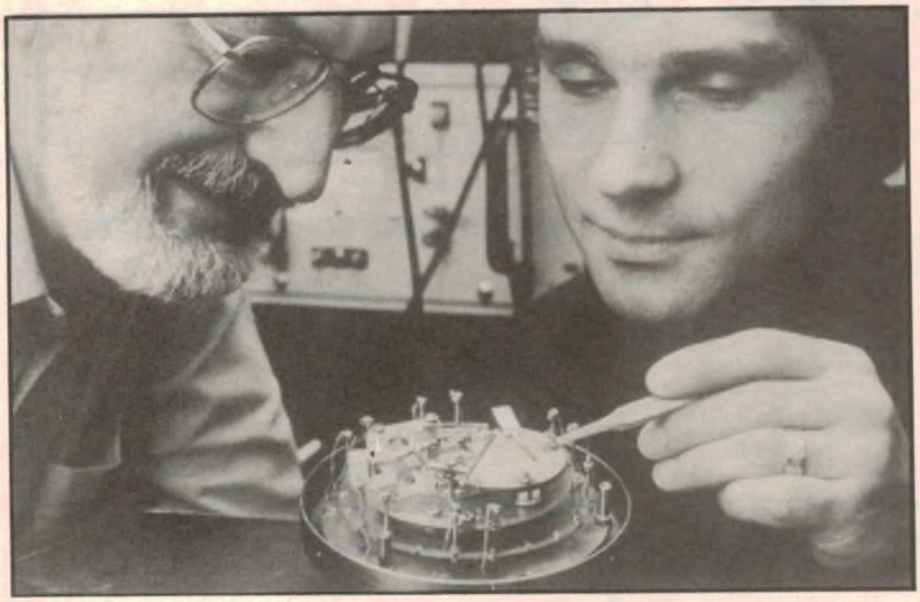
by JIM ROWE

All around the world at the moment, there are teams of excited scientists burning the midnight oil to learn more and more about superconduction — that intriguing phenomenon which causes some materials to become perfect electrical conductors when they are cooled down to a critical low temperature.

Australian scientists are in there batting with the best of them. They're working in the CSIRO, in local universities such as the ANU in Canberra, and in overseas research labs (see box). You may have seen some of the stories in the daily press.

Like me, you've probably wondered just what all this fuss is about, and whether the discoveries made to date are likely to have much practical impact. After all, we haven't done too badly so far with ordinary conductors and semiconductors: they've given us electric power, radio, TV, video recorders, microwave ovens, computers and whatever. What more could we do with superconductors?

Actually quite a lot, I've discovered — and it's a very interesting story. But let's start at the beginning.



1986 NOBEL PRIZE IN PHYSICS: Heinrich Rohrer (left) and Gerd K. Binnig of the IBM Zurich Research Laboratory adjust a sample in the chamber of an early Scanning Tunnelling Microscope (STM). Without the knowledge of materials gained using the STM, a lot of superconductor progress would not have been possible.

Early discoveries

Way back in the 1850s, when the first basic properties of electricity were being discovered, it was found that some materials (like metals) conducted a current fairly easily. All they needed was a little "persuasion", in the form of an applied electric field. This was produced by connecting a voltage or "Electromotive Force" (EMF) between the conductor's ends.

It was George Ohm who first established that for every kind of conducting material, there was a fixed relationship between the voltage you needed to apply across a length of the material, of given cross-section, and the current that flowed through it as a result. The better the conductor, the lower the voltage that was needed to produce a particular current. Conversely the poorer the conductor, the higher the voltage you needed to produce the same current.

Ohm called this property "resistivity" — the degree to which a material resisted the flow of current. It became measured in volts per amp, later called the Ohm in his honour.

Sometimes it was more convenient to think in terms of the degree to which a material "co-operated" by conducting current in response to a voltage, rather than its degree of resistance. In other words, its "conductivity". This was measured in amps per volt, first called the Mho (an anagram of Ohm!), and more recently the Siemen in honour of the pioneering German electrical engineer.

Quite early on it was discovered that the resistivity of most metals gradually decreased (ie, their conductivity increased) as the temperature was lowered. The colder they became, the easier it was to make them conduct.

But in 1911, the Dutch physicist Kamerlingh Onnes made a remarkable discovery. There were some metals, like lead, mercury and vanadium that SUDDENLY lost ALL resistivity when you cooled them down to a certain temperature. They didn't just change into a much better conductor — they became perfect conductors, or superconductors.

Once a current was induced in these superconductors, it would continue flowing in them for days on end without any further application of external energy, as long as they were kept below a certain critical temperature. This became known as the superconducting "transition" temperature (Tc).

Mind you, the transition temperatures were pretty cold — right down near absolute zero (-273 degrees C, now called 0 kelvins or K). The Tc of lead was 1.2 K (-271.8 degrees C), while that of mercury turned out to be only slightly higher at 4.2K (-268.8 degrees C). Not temperatures easy to achieve in the average kitchen, or even in most science labs for that matter!

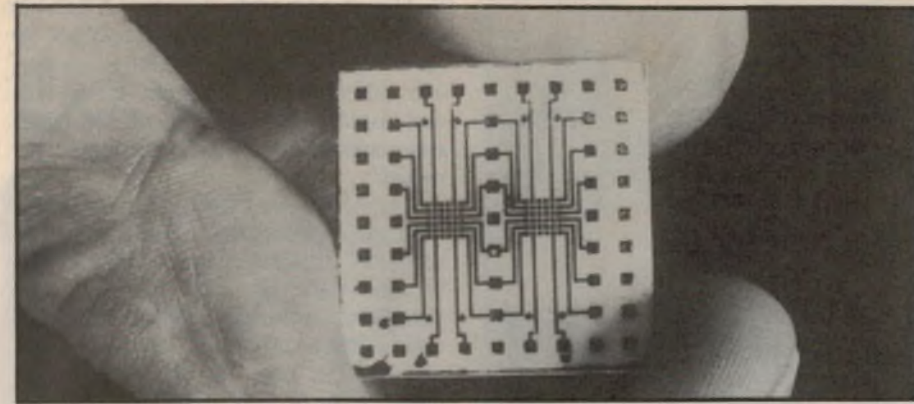
Still, it was all very interesting. Particularly as no one could come up with the faintest idea as to why these materials should suddenly lose all resistance, at any finite temperature!

Even more interesting was the fact that while they were superconducting, the materials totally repelled a magnetic field. In fact it seemed to be impossible for a magnetic field to exist inside them. This was dubbed the "Meissner effect".

Around 1930, it was discovered that the rather rare metal niobium had an even higher Tc, becoming superconducting at 9.2K. Then shortly after, it was found that certain compounds of niobium — the oxide and the nitride — had even higher Tc values. The nitrite of columbium was higher again, with a Tc of 14K. This discovery was even more mysterious in a way, because unlike metals, these compounds were virtually insulators at normal temperatures.

Progress was very slow from then on, at least in terms of finding materials with higher Tc. As late as 1985, the highest temperature superconductor that had been produced was an alloy of niobium and germanium, with a Tc of 23.3K. Achieving this temperature requires the use of liquid helium, which is very expensive.

Still, even this allowed the development of superconducting electromagnets for very worthwhile applications such as computerised automatic tomography (CAT) scanners, which use nuclear magnetic resonance to scan the human body for cancer and other problems.



CLOSE-UP OF A CERAMIC substrate patterned with high-temperature superconducting wires made using a new IBM plasma spray technique. The ability to make such wiring patterns from superconducting material is an important step towards adapting the material for possible future use in computer chips.

Superconductivity was starting to look much more interesting, and from around 1980 the big international research organisations began to give it greater attention.

Warmer superconductors

The developments started to come faster early in 1986. At the IBM research labs in Zurich, in January 1986, researchers Alex Muller and George Bednorz produced a superconducting ceramic material with a Tc of 35K — a big step forward. The ceramic was basically copper oxide, combined with barium and lanthanium oxides.

It soon became clear that the copper oxide based ceramics developed by Muller and Bednorz were a whole new class of superconducting materials. A team at the University of Houston led by Paul Chu discovered that a copper-barium-lanthanium oxide ceramic would superconduct at temperatures as high as 60K, if subjected to very high pressures.

Then Chu's team came up with a

Sydney visit by Australian superconducting researcher

A few weeks ago Sydney was visited by Dr Gregory Clark, an Australian physicist who has been working at IBM's Yorktown Heights research centre for the last few years. During his visit Dr Clark gave a talk on the current status of superconducting research, at the CSIRO's National Measurement Laboratory in Lindfield, a northern Sydney suburb.

Although the talk was mainly for CSIRO scientists, I was lucky enough to attend, along with a few other outsiders. It was most enjoyable, hearing of the recent breakthroughs direct from one of the leading participants.

Dr Clarke works in the Yorktown Heights team investigating superconducting thin films, and ion implantation to produce circuit patterns. He gave us an excellent rundown on the work being done in this area, along with a very clear and open discussion of overall progress with the new superconducting ceramics. There was even a demo, showing chunks of the new material levitating between the poles of a magnet, in a container of liquid nitrogen.

Australian researcher Dr Greg Clark.

It was most enjoyable, and really brought home the impact of recent developments. My thanks to Dr Clark for his talk, and to the nice people at IBM Australia for the invitation.

Jim Rowe.

BY ADAPTING A TECHNIQUE called plasma spraying, IBM scientists Richard Guarnieri and Jerome Cuomo and their research team were able to coat a variety of large and small objects with high-temperature superconducting material. The objects shown here include spirals, a large panel, and spherical vessels.

slightly different ceramic, still with copper and barium oxides, but this time with yttrium instead of lanthanium. In February this year, they reported that this ceramic had a Tc of around 90K — well above the temperature of liquid nitrogen (77K).

Within days, teams at IBM's research labs in Yorktown Heights, New York and in Almaden, California had duplicated the results. They were also confirmed by other laboratories all around the world, where scientists were by now working at an almost feverish rate, hoping to achieve even higher Tc figures.

Things are still just as hectic. Since February, superconductivity has attracted a huge amount of research activity and attention. In Japan alone, more than 50 different research laboratories are said to be giving it top priority, with boffins using sleeping bags so they can catch up on sleep without going home.

In fact it has become quite a joke in many research labs, that you can easily recognise the people working on superconductivity, because they're the ones with dark rings around their eyes!

According to IBM researcher Dr Gregory Clark, US interest in the subject has become so great that you can now buy videotape tutorials explaining the latest advances. And the American Chemical Society has apparently set up an 800-prefix telephone hotline, so you can call up from anywhere in the US and listen to a recording of the latest superconductivity breakthrough rumours!

Teams like Dr Chu's group at IBM's Almaden facility have been trying all sorts of different copper oxide-based ceramic materials, with elements like strontium, calcium, scandium, ytterbium and lutetium substituted for barium and yttrium. But generally all of these materials seem to have transition temperatures within a few degrees either side of 90K.

Dr Clark says that most researchers have begun to feel that this is about the best that will be achieved with copper oxide based materials, and that the next big jump probably won't happen until a different type of material is discovered.

There has been a report that researchers at the University of Houston and the University of California at Berkeley have achieved a Tc of 240K, but no details of the material used have been forthcoming, and there seems to be some doubt about the validity of the results.

Right at the moment, then, things seem to have slowed down in terms of raising the transition temperature. But there's no slowdown in terms of research activity, and information about superconductivity itself is building up at an almost mind boggling rate.

IBM research labs are playing a key role in a lot of this pioneering research, building on the original work by Muller and Bednorz in Zurich, and also the work by their colleagues Gerd Binnig and Heinrich Rohrer, who won a 1986 Nobel Prize for their development of the scanning tunnelling microscope (STM).

In fact the STM has come up with some fascinating pictures of the surface of superconducting materials, showing their atomic structure very clearly.

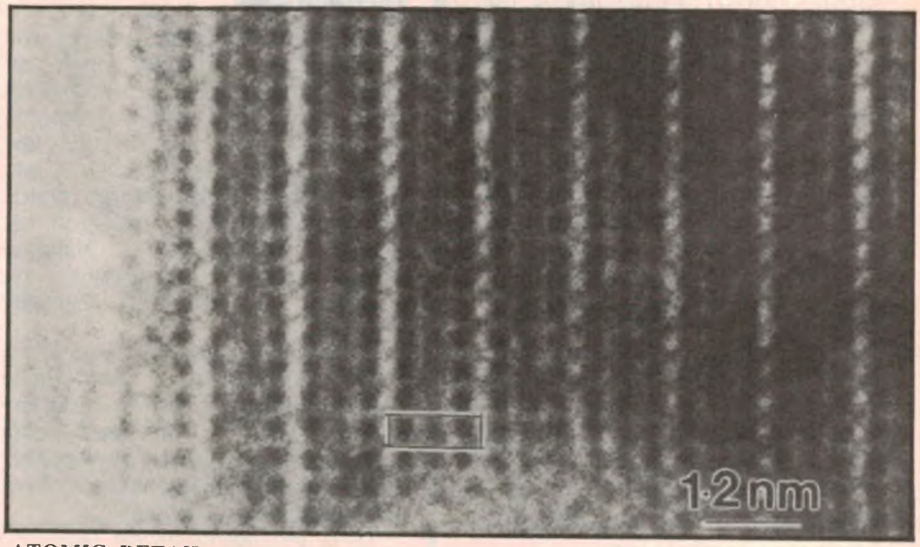
Surprisingly enough, despite all the data that has been gathered, as yet no one has been able to come up with a theory to explain just why and how superconduction actually happens. Apparently the theory side of things is still wide open.

So in that respect, we're no further ahead than old Kamerlingh Onnes back in 1911. Still, the pieces of the puzzle are coming together at a rapid rate, so it probably won't be too long now before a workable theory emerges.

Problems

There are still quite a few problems when it comes to making the new copper oxide-based ceramic materials, too. They're quite tricky to make, even in the research lab. One batch will be fine, but the next batch made in the same way may refuse to superconduct at all.

Apparently even good batches at this stage only consist of about one third superconducting material itself, with the rest of the material not effective. As a



ATOMIC DETAIL: shown here magnified approximately 20 million times is the first STM picture, taken by IBM scientists, of the atomic structure of the new high-temperature superconductors. The vertical columns of lighter spots consist of copper and oxygen atoms and these are flanked by dark vertical columns of barium atoms. Inside the columns of barium atoms are atoms of yttrium, a rare earth element. The box encloses three atoms that form the basic unit cell which is repeated throughout the material. It is 1.2 nanometres or 1.2 billionths of a metre long.

result, quite a bit of work is being devoted to improving fabrication techniques.

A team at IBM's Yorktown Heights lab has developed a technique of growing thin-film single crystals of superconducting ceramic, using plasma spraying at 5200K. This has produced probably the most pure superconducting materials to date, with the ability to carry about 100 times the previous levels of current before superconduction stops.

Another team at Yorktown Heights is working on ways to produce practical electronic components and connection patterns in this kind of thin film ceramic single crystal, to pave the way for superconducting "ICs". This team has developed an ion implantation technique, which injects selected areas of the ceramic with atoms of elements which effectively "poison" the superconductivity, to produce insulating regions.

Other teams are looking at ways to form the new materials into flexible and malleable wires and cables. This is quite a challenge in itself, as being basically ceramics they tend to be very stiff and brittle.

The net result of all this research work and the knowledge it has produced already is that we can look forward to a big boost in the application of superconductivity to solving real-world problems, even though room-temperature superconduction may still be a way off yet.

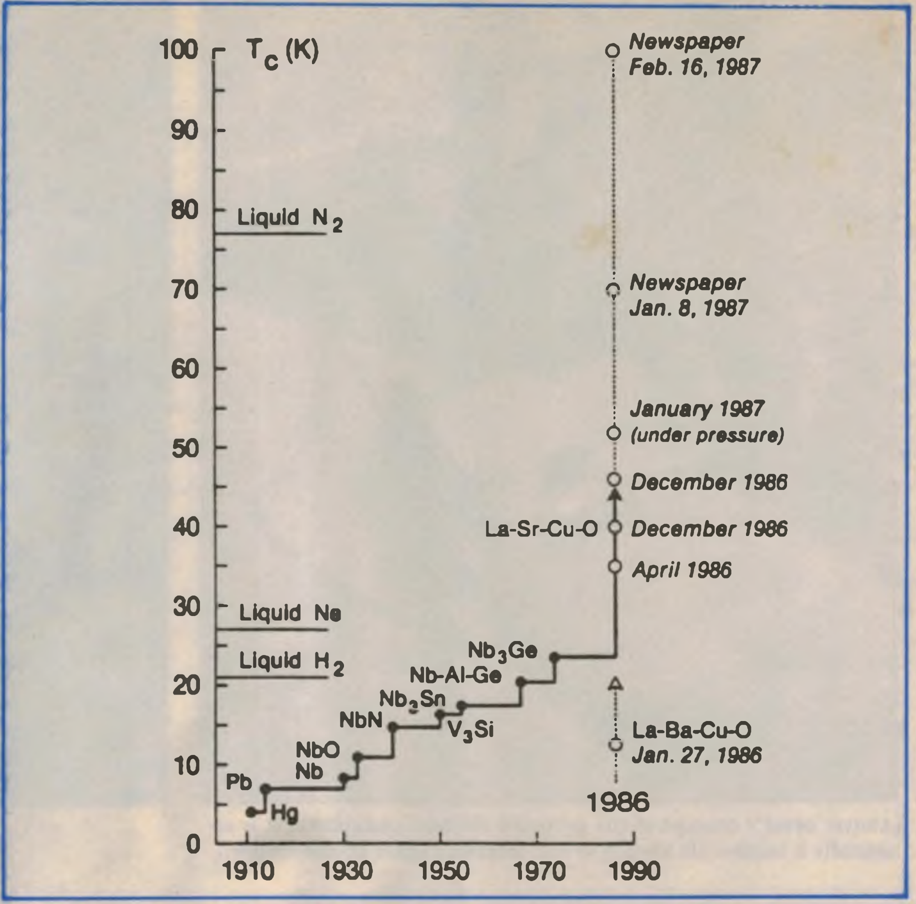
Consider the CAT scanners that have proved such a boon in medicine, for example. A major part of the high cost of these machines is the cooling system needed to achieve liquid helium temperatures, for the superconducting magnets needed to produce the intense magnetic field for nuclear magnetic resonance (NMR).

You can expect a dramatic drop in the cost of CAT scanners before long, because the cost of achieving the liquid nitrogen temperatures needed for the new 90K superconducting ceramics is about 1000 times lower. So the benefits of CAT scanning will soon be much more accessible, even in developing countries.

We may well see a resurgence in the use of superconduction in computers, to achieve the ever-higher speeds being demanded for complex real-time simulation and high resolution graphics. Already IBM researchers seem to have turned their attention back to the Josephson junction, a superconducting high speed switching element that was abandoned about four years ago on the grounds of high cost and impracticality.

In the long term, of course, superconduction at normal room temperatures and higher could bring even more dramatic developments — from levitating trains to pocket computers more powerful than today's most powerful Cray, and perhaps even hand-held satellite terminals.

Keep your eye on superconduction, then. It seems to be a technology whose time has finally come.

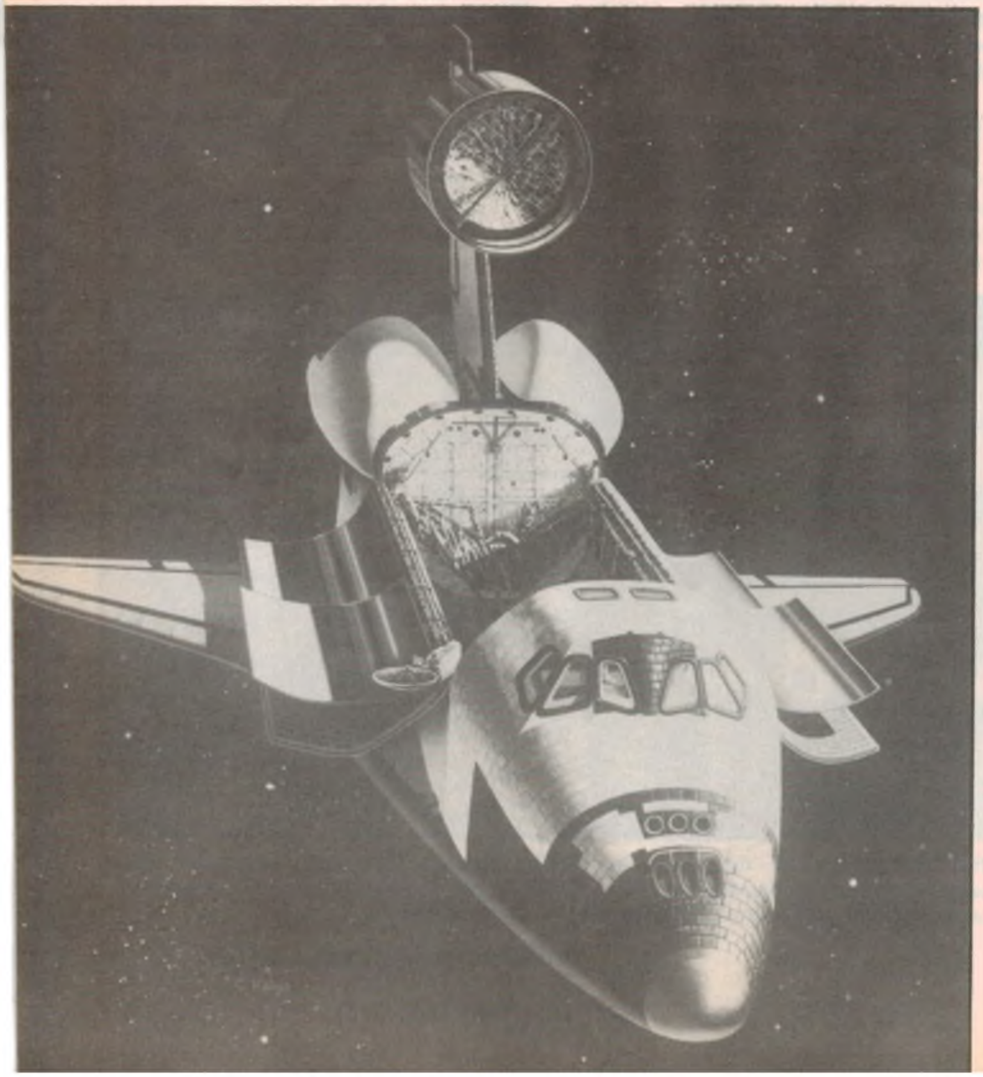


PROGRESS IN SUPERCONDUCTOR RESEARCH: this graph shows how the critical temperature (Tc) for superconductivity has dramatically increased in recent years, from 23.3K in 1985 to a reported Tc of around 90K in 1987.

IBM RESEARCHERS Alex Muller and George Bednorz dramatically raised the critical temperature for superconductivity from 23.3K to 35K in early 1986. Their copper oxide based ceramics produced a whole new class of superconductors.

Sydney to London in three hours

Above: artist's concept of the proposed *Hermes* spaceplane. It is essentially a small-scale version of the American space shuttle (below).



by IAN GRAHAM

The first flight between Britain and Australia in 1919 took almost a month. Captain Ross Smith and his brother, Lt. Keith Smith, who made the historic flight, could scarcely have imagined that their journey time might be slashed to only three hours by the end of the century. But that is exactly what aerospace designers in Britain and America are suggesting.

The *Challenger* space shuttle disaster had far-reaching effects on the space industry worldwide. Following the accident, the three remaining orbiters (*Columbia, Discovery* and *Atlantis*) were grounded for at least two years while the cause of the accident was determined and the necessary re-design and development work carried out to improve shuttle safety. This hiatus in shuttle flights released funds that were previously committed to shuttle-based projects.

This unexpected availability of extra funding allied to the dramatic reduction in launch capacity and consequent disruption of international space programs led several nations to increase their efforts to develop their own independent space transportation systems.

Costly compromise

We have all become accustomed to the hardware configuration adopted by

Britain's *HOTOL* spaceplane could cut the London to Sydney time to around three hours.

NASA — a manned orbiter launched with the aid of an external fuel tank and two solid rocket boosters.

That arrangement has become synonomous with "space shuttle" to most of us. However, it is far from satisfactory and certainly not the only hardware configuration. It was a compromise between low development costs and low operating costs. Earlier, more ambitious designs proposed in the 1960s would have cost much more to develop, but would have been far less expensive to operate. After initial enthusiasm, they were dropped because of budgetary restrictions or disagreements between the developers.

Research teams working on shuttle designs in several countries now acknowledge that the next space shuttle will have to be cheaper, easier and more convenient to operate. That is, it must be fully reusable (no "throw away" fuel tanks or rockets), be capable of using virtually standard airport facilities, and not require months to prepare for each flight as NASA's shuttle does.

European shuttle

Two design proposals have come to the fore in Europe, offering different solutions to the problem. The European Space Agency has been developing more powerful versions of the successful Ariane rocket to launch heavier satellites.

In 1976, the French national space agency, CNES (Centre Nationale d'Etudes Spatiales), proposed the development of a small manned space shuttle to be launched on the nose of the next and most powerful model, Ariane 5.

An artist's impression of the vehicle depicts it as a small scale version of the American space shuttle. It's smaller, because the French have opted for a much smaller pressurised payload bay. Large payloads would still have to be launched by Ariane rockets.

The project, known as *Hermes*, was adopted by the European Space Agency at the end of 1986 — that is, although the project was instigated by the French, it has now been taken up by ESA as a Europe-wide project, attracting funding and technology input from many of the Agency's participating countries.

Nevertheless, *Hermes* has been criticised as little more than a cut-down NASA shuttle with more up to date computers and avionics — old technology that cannot compete commercially with the next generation of spaceplanes.

The British company, British Aerospace, believes that the more advanced technology of its *HOTOL* launcher is much more economically competitive with the spaceplane that will be developed in America in the near future — the *National Aerospace Plane* (NASP), also known as *Orient Express*. Britian's *HOTOL* (HOrizontal Take-Off and Landing) is a fully reusable vehicle. Intended initially as an unmanned satellite launcher, it could also be converted for passenger travel. In this case, the payload bay would simply be replaced by a pressurised passenger cabin.

By skipping out of the atmosphere and dropping back in again shortly before landing, a spaceplane could cut the Sydney to London travel time (excluding immigration and baggage reclaim) to around three hours (by *HOTOL)* or Washington to Tokyo in two hours (by *Orient Express*), making a day trip around the world a real possibility.

Air-breathing rockets

HOTOL's revolutionary feature is its propulsion system. To keep the vehicle's take-off weight to a minimum, its engines use oxygen from the atmosphere as a propellant. Of course, at high altitudes there is not enough oxygen in the air to fuel the engines. At this point, the engines switch to an onboard oxygen supply, which also fuels

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Another proposed concept for *HOTOL*. *HOTOL's* revolutionary engines will use oxygen from the atmosphere as a propellant during the initial boost phase before switching to an on-board oxygen supply.

the engines outside the atmosphere.

The centrally mounted payload bay is of shuttle dimensions (much larger than Hermes), sitting between the forward hydrogen tank and rear oxygen tank. This arrangement has the advantage of producing the minumum shift in centre of gravity during a flight. As *HOTOL's* weight on landing is only fifth that at take-off, it doesn't make sense to carry a heavy undercarriage built to withstand the stresses of take-off all the way to orbit and back. So, *HOTOL* will take off from a separate trolley or sled and will land on its own lightweight retractable undercarriage.

It is estimated that *HOTOL* will cost around four billion pounds ($A9.4 billion) to develop. It is unlikely that a British government will approve funding of that level and so *HOTOL* is unlikely to be built unless some international collaboration can be arranged.

Ideally, British Aerospace would like *HOTOL* to be taken up by ESA in the same way as *Hermes*. A proof-of-concept study is under way and both British Aeropsace and Rolls-Royce hope that it will lead to "Europeanisation" of the project.

Paradoxically, Britian is also committed to contributing to *Hermes*, possibly because it is questionable whether ESA will see any benefit in supporting two spaceplane projects. If *HOTOL* is not taken up by ESA, involvement in *Hermes* could be Britian's only remaining opportunity to gain invaluable experience of spaceplane technology outside the USA.

If current forecasts are accurate, *Hermes* is expected to fly by 1996-7, whereas the more advanced technology required to be developed for *HOTOL* means that it is not expected to enter service until 2005 at the earliest.

US expenditure

NASA and the Pentagon are expected to boost their current expenditure of almost $US50 million per year on spaceplane research to several hundred million US dollars a year for *NASP*. They estimate that it will cost around $US2 billion to build a single prototype.

By the time that *NASP* enters service, it will have cost a great deal more than *HOTOL*. One reason for this is that *HOTOL's* designers will avoid using expensive shuttle-style thermal protection by limiting its speed to Mach 5 (five times the speed of sound) inside the atmosphere. *NASP* will be capable of flying at Mach 25 (orbital velocity) inside the atmosphere.

Whilst *HOTOL's* role has been clearly defined as that of a satellite launcher, with the possibility of passenger operations at a later date, *NASP's* role has yet to be specified. Its military applications are not difficult to speculate on — a lifting vehicle for SDI (Strategic Defence Initiative, or "Star Wars") hardware, a quick reaction reconnaissance platform, etc. But its civilian role has not yet been quantified.

Will they, or won't they?

Soviet spokesmen discount talk of a Soviet space shuttle. They say that inexpensive, mass-produced rockets make a space shuttle unnecessary. Current intelligence reports,if correctly interpreted, contradict this. The Royal Australian Air Force has photographed a small scale shuttle-type vehicle being recovered in the Indian Ocean after it had made a single orbit of the Earth. There have been four such orbital test flights. And a site claimed to be a shuttle launch facility has been photographed by the French *Spot* satellite at the Baikonur Cosmodrome complex near Tyuratam, Soviet Central Asia.

Suggested applications for the Soviet shuttle range from the obvious to the fantastic. It is said to be a service and transport vehicle for space stations like Mir and its successors, or alternatively, it may be developed as an weapons platform, able to swoop down from orbit on unsuspecting American warships! In reality, it is probably being developed for the self-same reasons as NASA's shuttle, the *Orient Express*, *HOTOL* and *Hermes* — as a satellite launcher and to transport men and materials into Earth orbit.

Whilst *Hermes* and, it appears, the Soviet shuttle are natural extensions of existing shuttle technology, vehicles like *HOTOL* and the *Orient Express* represent a new technology that will take us into the next stage of space transport. The cost savings and greatly improved performance they offer are vital to transport the numbers of people and quantity of hardware into orbit that will be required to construct and maintain the large orbital structures (space stations and free-flying unmanned platforms) that are envisaged for the first quarter of the 21st century.

Whether or not businessmen or holiday-makers will also be using them to hop around the world depends largely on how economical the vehicles are to operate and, with *Challenger* still fresh in our minds, how safe they are perceived to be by the travelling public.

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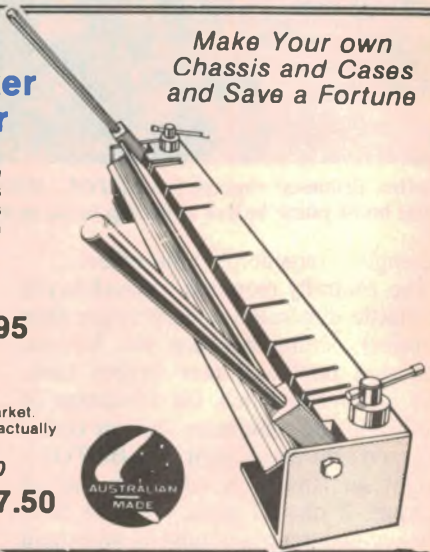

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S 5400 200mm x 175mm $1
Normally $1.95 each

Alarm Stickers

WARNING
ALTRONICS SURVEILLANCE ALARM SYSTEM FITTED HERE

Up to Incredible 1KM Range

Professional Megaphone PA

A 1990
~~$109.50~~ **$99**

SPECIFICATIONS:

Power Output	20 Watts max
Effective Range	Approx 400M (up to 1KM in ideal conditions)
Power	8 Pcs Cell (not included)
Dimensions	230 Diam 360 Length
Weight	1.5K (less batteries)
Shoulder Strap	Supplied

MICRON T2440

Electronic Temperature Controlled Temperature Selectable Soldering Station

The MICRON T 2440 soldering station, offers the ultimate in controlled temperature hand soldering. 320°C, 350°C, 380°C, 410°C (608°F, 662°F, 716°F, 770°F and 824°F) fixed temperatures are selectable by rotating the detained rotary switch freely without changing heater or tip.

Heat Capacity Full 48 Watts • Temperature Control +or - 3 deg.C • Zero Voltage Switching • Grounded Tip • Low Voltage Element 24V • Chrome Plated Tip. T 2440

Normally ~~$119.95~~
This Month **$99.00**

• FOR DESPATCH P&P CHARGES AND ADDRESS DETAILS PLEASE REFER TO OUR AD. ON PAGE •

Why Pay **$49.95**

NOW $30

Ultrasonic Insect and Pest Repeller

Pestrepeller is effective in controlling mice, rats, roaches, fleas, flies crickets, silverfish, waterbugs, moths ants and most other common pests. Laboratory research has shown ultrasonic sound waves attack the auditory and nervous systems of most common pests causing them pain and discomfort. **Specifications— Dimensions:** 100 x 90 x 80 **Power Supply** adaptor supplied 240/9V **Frequency Range** 30KHz to 65KHz variable **Output Level** 130db.

Desk Mounted Lamp Magnifier

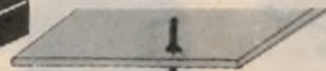
A 0980 **$189**

If you have trouble with fine PCB work or component identification but still want both hands free, this is for you. We thoroughly recommend this quality Australian made product.
TECHNICAL INFORMATION Illumination: 22W Fluorescent **Weight:** 8.16kg **Lateral Extension:** 254mm **Vertical Extension:** 254mm **Fixing:** Heavy table base (grey & ivory) with two chrome plated flexible arms. Cat A 0980

Microwave Leak Detector

A 0900

~~$19.95~~ **$16**

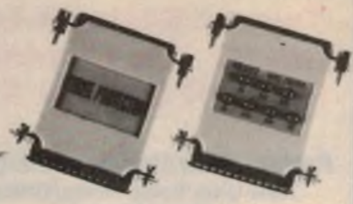


MATRIX/P.C.B. PINS

TIN PLATED

Pack of 1000 Buy Bulk and Save

H 0806 0.9mm **$25.90**
H 0810 1.2mm **$25.90**



QUALITY IMPORTED RS-232 ACCESSORIES

Surge Protector

D 1510 **$19.50**

The RS-232 Surge Protector is used to protect RS-232 ports from the possibility of costly damage from large voltage peaks caused by lightning or other power problems. The surge protector used Metal-Oxide Varistors (MOV) to protect pins 2,3 and 7. The MOV's will suppress any voltage above 26 volts without affecting the normal RS-232 voltage levels.

Jumper Box

D 1520 **$9.95**

The RS-232 Jumper Box is used to make custom RS-232 interfaces. It consists of a small board with a connector on each end.

Mini Tester

D 1500 **$19.50**

This Tester indicates the presence of all important interface lines by LED illumination when signal is active.

Null Modem

D 1530 **$9.95**

The RS-232 Null Modem is used to replace a set 25-pin RS-232 connectors with transit DATA and receive DATA CROSS CONNECTED (Pin 2 of each connector goes to pin 3 of the other connector). Pins 1 and 7 are connected straight through. Each connector is set up in the loop back mode with pins 4 and 5 shorted together and pins 6,8 and 20 shorted together. The RS-232 Null Modem is used when the proper operation of a set of modems is in doubt. It also is handy when Transmit DATA and Receive DATA need to be reversed.

Telephone Pickup

Super nifty little pickup coil with suction pad, lead and 3.5mm plug. Great for recording or amplifying phone conversations.

A 0485 .... **$2.95**

Amazing Price On Micron Data Tape

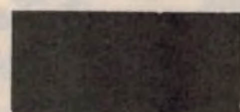
1-99 **90¢**
100 Up **60¢ each**

Cat. D1141 *Be Quick*

GENTLE ACTION HEAD CLEANER

Suits all Beta Video Players. Why risk expensive damage with inferior units.

A 9300 ~~$12.50~~ **$8.00**



VELOSTAT

Great For storing all IC's. Protects CMOS LSI's etc. from static damage. Stores up to 150 IC's on one sheet.

H 0600 *Only* **$3.95** **Save $1**

Push Button Telephone

With memory Re-Dial Great for use as a 2nd phone around the House or Office. This nifty little phone has all the features of units selling near twice the price! Last number Re-Dial memory and Mute Key. Rings On/Off switch and Dialing indicator

A 0490

~~$25~~ **$20**

Video Tape Repair Kit

A 9315

~~$7.95~~ **$5**

A VHS/BETA Video Tape Repair Kit. No need to throw out your damaged tapes—this nifty splicing kit can save you a fortune (if you've got small children this kit will save you several fortunes!!) All accessories included for joining tape and refixing leader ends etc. Cat No. A 9315

Mini Headphones

Fitted with 6.5mm Stereo plug light weight and comfortable. Amazing performance for low cost phones.

C 9001

$7.95

High Performance Mini Headphones

Superb light weight High Fidelity Stereo phones. Super comfortable to use. **Somarium Cobalt Magnets.** Frequency response to 20KHz. Weight 42g.

C 9005

$17.50

CANNON TYPE CONNECTORS

Rugged reliable connector for every-day use.

	WERE	NOW
P 0960 3 Pin Line Male	$5.50	$4.80
P 0962 3 Pin Chas.Male	$4.25	$4.00
P 0964 3 Pin Line F.	$5.50	$4.80
P 0966 3 Pin Chas.F.	$5.98	$5.12

SILKY QUIET 240V COMPT FANS

F 1020 80mm Diam. **$24.50**

4 or More **$21.00**

Mylar Stereo Phones with Dynamic Mic.

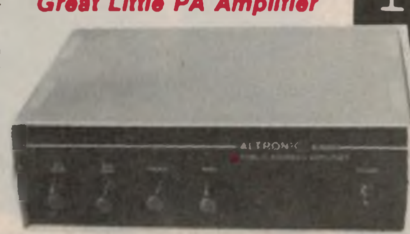
Simply Brilliant Mylar Stereo headset and Dynamic Mic combination. **Phones** 30-18KHz 28 Ohms, 6.5mm Stereo Jack Max. input 400mm **Mic.** 84db, 600 Ohms, 6.5mm Mono Jack.

C 9050 .... **$29.50**

SAVE $ $ $ SAVE $ $ $ Great Little PA Amplifier

This natty little amplifier includes some remarkable features which, until now have only been available on very expensive commercial items e.g. Balanced Mic Input- This enables you to run very long microphone leads without troublesome interference or hum pickup. **Balanced line output** - This enables you to run the speaker lines right alongside the microphone line without instability. **Constant voltage design** allows you to switch on one speaker circuit or all circuits together without any noticeable variance in output sound level.

Output Power is a genuine 30 watts into either 100V line or 4 Ohms.



A 2000 .... **$259**

Twenty Systems Left Only At The Incredible Price Of $69 Per Set!

Protect Your Home for Just ~~$99~~

New Ultra Sonic Home/Office Alarm System

Fantastic system for this price. Frankly we were amazed at the performance of this very compact system.

Very simple to connect and operate — New Technology has enabled very compact overall dimensions (master unit only 180 x 100 x 65) hence ideal for concealing among book shelves etc.

Look At The Features:

Exit Delay	30 - 35 secs.
Entry Delay	10 secs
DC Source	
Battery Backup	9V Nicad Rechargeable (additional Cost S 5024 $17.50)

Auto Reset 3 minute operate cycle and auto reset.
Range Reliable to 30ft. (9M)
Low Battery Indicator Included.

Accessories Included for the one Low Price
4 Sets Reed Switches for Window/Doors
1 Roll fig "8" cable
1 External Type Horn Speaker
1 AC/DC plug pack adaptor

Now there is no excuse for not Protecting yourself, your family and all your hard earned possessions!

S 5310 Only ~~$99.00~~

Out performs our main competitors system which, incidently sells at around $50 more for the comparable system and accessories.

Strobe Signal Lamp

Uses Xenon Strobe tube for High energy strobe flash output at a rate approx. 1 per second. Fantastic light energy output for the DC power used. DC input 12V 320mA Dimensions 97 dia.90H

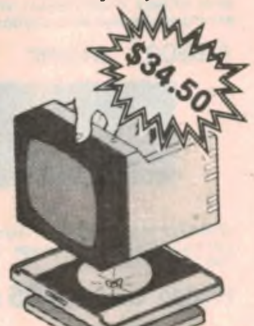
S 5455 Blue **$24.50**

Universal Monitor Stand

With Pan & Tilt Adjustment

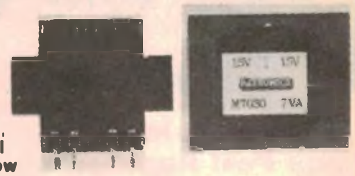
This brilliant monitor stand enables you to swivel left/right and tilt up/down i.e. to position monitor to any desired position. Hence viewing position is enhanced and screen glare eliminated. **Cat.D 1100**

Why Pay $50



MAINS TRANSFORMERS

PCB Mount Mains Transformers



7/9 VA Rating. Super Compact, wound on Grain Oriented Steel Core for High efficiency and low temperature rise.

POWER RATING:

7VA Load Full voltage +3% -0%
9VA Load Full voltage +6% to -8%

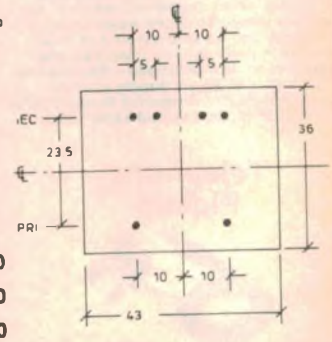
Model Prim/SEC's

M 7012	240/6+6
M 7015	240/7.5 + 7.5
M 7018	240/9+9
M 7024	240/12+12
M 7030	240/15+15

Overall Height 35mm
Length 43mm
Width 36mm

1—9	**$12.50**
10—24	**$11.00**
25 Plus	**$10.00**

PINOUT VIEWED FROM UNDERNEATH



Million Diode Sellout! From 1.5¢ each

Altronics have just purchased around 1 Million (yes million) factory fresh premium quality IN914/IN4148 diodes. These became surplus to Fairchild Australia as the factory supplied bulk, loose pack diodes instead of the tape/reel diodes ordered. So unless you are a manufacturer with automatic component insertion equipment, these fine quality diodes represent the diode bargain of all time!! **Cat. Z 0101**

1-99	**3¢ ea**
100-499	**2.5¢ ea**
500 plus	**1.5¢ ea**

World Class Build Yourself Kits

Build These Fantastic New Playmaster HiFi Loudspeakers

$449

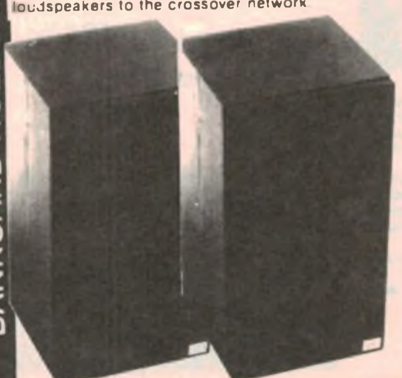
See Electronics Australia Sept '86 — **full kit K 5090**

If your budget won't run to the $600 to $800 needed for a fully imported pair of equivalent speakers, these are the ones to go for.

Some extracts from Electronics Australia Magazine — Each woofer has a foam roll surround and a doped paper cone with an effective (piston) diameter of about 155mm. **The Tweeters** "the Tweeters are exotic little beasties" (Editor EA Magazine) each is a 19mm soft dome unit with a ferro-fluid damped voice coil for high power handling and a very smooth frequency response. Its resonant frequency is around 1.7kHz.

Power Handling (60 watts plus RMS!) In an average sized lounge room and driven by the Playmaster Sixty-Sixty or an equivalently rated amplifier, these speakers will deliver enough sound volume to satisfy the most power crazed enthusiast.

Construction Only the most basic of tools are required to assemble these loudspeakers. Even if you are a rank amateur at carpentry you will have no problems putting them together. You don't need special clamps or jiggs and all timberwork has been precisely machined. You do have to be able to use a soldering iron though, to connect the loudspeakers to the crossover network.



The reproductive purity of these speakers simply amazed us. The secret, of course is the DANISH VIFA Drivers. VIFA drivers are used in many top selling imported systems such as Bang & Olufsen, Rogers, Mission, Jamo DCM Timewindow etc.

Don't Be Mislead

The Altronic 60-60 Kit is the genuine product as per the construction article. It employs the genuine Toroid Power Transformer — the resultant low noise obviates any necessity for additional D.C. supply electrolytics as one of the other kit suppliers feels are necessary with his kits!! There is absolutely no need to pay more than the Altronics price for the fantastic 60-60 amp.

'Sixty-Sixty' Integrated Amplifier Kit

(EA May,June,July '86)

Features:

• 60 watts per channel into 8 ohm loads • Very low noise on all inputs - better than CD performance • Very low distortion • Excellent headroom • Tape monitor loop • Tone controls with centre detent and defeat switch • Mono/stereo switch • Toroidal power transformer • Easy-to-build construction • Very little wiring.

Performance Specification

Power Output — 8 ohms 62W **Distortion** - Less than .0% at 1kHz. **Frequency Response** - Phono Inputs - RIAA/IEC equalisation within + - 0.5db from 40Hz to 20kHz Line Level Inputs — -0.5db at 20Hz and -1db at 20kHz **Input Sensitivity** - Phono 1kHz -4.3mV • Line Level - 270mV. **Hum & Noise** - Phono - 89db • High Level Inputs - 103db. **Tone Control** - **Bass** - + -12db at 50Hz **Treble** - +-12db at 10kHz. **Damping factor** - At 1kHz and 30Hz - greater than 80 **Stability** — Unconditional.

K 5060 **$299**

"This New Amplifier offers a standard of performance far ahead of anything we have previously published and ahead of most commercial Integrated Stereo Amplifiers".

"It is half to one third of the cost of an Imported Amplifier with equivalent power output and performance". *Says Leo Simpson Managing Editor Electronics Australia Magazine.*

Beginner constructors can Build this Amplifier Kit — It looks terrific and will last you a lifetime.

Save $200 or more on comparable performance commercial units

SERIES 5000

INDIVIDUAL COMPONENTS TO MAKE UP A SUPERB HIFI SYSTEM!

By directly importing and a more technically orientated organisation, ROD IRVING ELECTRONICS can bring you these products at lower prices than their competitors. Enjoy the many other advantages of RIE Series 5000 kits such as "Superb Finish" front panels at no extra cost, top quality components supplied throughout. Over 1,500 sold!

For those who haven't the time and want a quality hi-fi, we also sell the Series 5000 kits assembled and tested.

POWER AMPLIFIER

WHY YOU SHOULD BUY A "ROD IRVING ELECTRONICS" SERIES 5000 POWER AMPLIFIER

- 1% Metal Film resistors

SPECIAL, ONLY $399 SAVE $50

... and developed by ... ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms (per channel)
POWER AMPLIFIER: 100W RMS into 8 ohms (+ – 55V Supply)
FREQUENCY RESPONSE: 8Hz to 20Hz +0 – 0.4 dB 2.8Hz to 65KHz, +0 = 3 dB. NOTE: These figures are determined solely by passive filters
INPUT SENSITIVITY: 1 V RMS for 100W ouput
HUM: 100 dB below full output (flat)
NOISE: 116 dB below full output (flat, 20KHz bandwidth)
2nd HARMONIC DISTORTION: 0.001% at 1 KHz (0.0007% on Prototypes) at 100W ouput using a + = 56V SUPPLY rated at 4A continues 0.0003% for all frequencies less than 10KHz and all powers below clipping
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100W (50Hz and 7KHz mixed 4:1)
STABILITY: Unconditional

Cat. K44771 .... **$449**
Assembled and tested $599
packing and post $10

PREAMPLIFIER

THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRONICS" SERIES 5000 PREAMPLIFIER

- 1% Metal Film

SPECIAL, ONLY $359 SAVE $40

... believe that dollar for ... commercial unit available that sounds as ...

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15Hz – 130KHz +0 – 1dB. Low-Level input-conforms to RIAA equalisation + = 0.2dB
DISTORTION: 1KHz 0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V) 92dB flat 100dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected 86dB flat/92dB A-weighted MC input, master full with respect to full output (1.2V) and 200uV input signal 71dB flat 75dB A-weighted

Cat. K44791 .... **$399**
Assembled and tested $699
packing and postage $10

THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands ...

SPECIAL, ONLY $209 SAVE $30

Cat. K44590 .... 1 unit: **$239**
.... 2 units: **$429**
packing and postage $10

SERIES 4000 SPEAKERS

8 Speakers .... only **$549**
8 Speakers with Crossovers **$795**
Speaker Cabinet Kit (complete) $395
(Please specify cabinet to suit 7" or 8" mid range woofer)
Crossover Kits **$295**
Complete kit of parts (speakers crossovers, screws, innerband boxes) **$1,095**
Assembled, tested and ready to hook up to your system **$1,295**
(Approximately 4 weeks delivery)

Errors and Ommissions Excepted

VIFA/AEM 3 WAY SPEAKER KIT!

This superb 3 way speaker kit competes with systems that cost 2 - 3 times the cost of these units! (which may even be using VIFA drivers etc.) Never before has it been possible to get such exceptional value in kit speakers! Call in personally and compare for yourself!

The system comprises...
2 x D19 dome tweeters
2 x D75 dome midrange
2 x P25 woofers
2 x pre-built quality crossovers

The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D19 DOME TWEETER SPEAKER SPECIFICATIONS
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20kHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (to 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2ohms
Moving Mass: 0.2 grams
Weight: 0.28kg

D75 DOME MIDRANGE SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 350 - 5,000Hz
Free Air Resonance: 300Hz
Sensitivity (1W at 1m): 91dB
Nominal Power: 80 Watts (to 500Hz, 12dB/oct)
Voice Coil Diameter: 75mm
Voice Coil Resistance: 7.2ohms
Moving Mass (incl. air): 3.6 grams
Weight: 0.65kg

P25 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 25 - 3,000Hz
Free Air Resonance: 25Hz
Operating Power: 5 watts
Sensitivity (1W at 1m): 89dB
Nominal Power: 60 Watts
Music Power: 100 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.7ohms
Moving Mass (incl. air): 44 grams
Thiele/Small Parameters:
Qm: 3.15
Qe: 0.46
Qt: 0.40
Vas: 180.1
Weight: 1.95kg

Complete Kit Cat. K16030 **$1,199**
Speaker Kit Cat. K16031 **$949**
Cabinet Kit Cat. K16032 **$349**

VIFA/AEM 2 WAY SPEAKER KIT!

This exciting new speaker kit, designed by David Tillbrook (a name synonymous with brilliant design and performance) uses VIFA's high perfomance drivers from Denmark. You will save around $800 when you hear what you get from this system when compared to something you buy off the shelf with similar characteristics. Call in personally and compare for yourself!

The system comprises...
2 x P21 Polycone 8" woofers
2 x D25T Ferrofluid cooled dome tweeters with Polymer diaphrams
2 pre-built quality crossovers

The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D25T SPEAKER SPECIFICATIONS
Nominal Impedance: 6 ohms
Frequency Range: 2 - 24kHz
Free Air Resonance: 1500Hz
Operating Power: 3.2 watts
Sensitivity (1W at 1m): 90dB
Nominal Power: 90 Watts
Voice Coil Diameter: 25mm
Air Gap Height: 2mm
Voice Coil Resistance: 4.7ohms
Moving Mass: 0.3 grams
Weight: 0.53kg

P21 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 26 - 4,000Hz
Free Air Resonance: 33Hz
Operating Power: 2.5 watts
Sensitivity (1W at 1m): 92dB
Nominal Power: 60 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.8ohms
Moving Mass: 20 grams
Thiele/Small Parameters: Qm: 2.4
Qe: 0.41
Qt: 0.35
Vas: 80.1
Weight: 1.65kg

Complete Kit Cat. K16020 **$799**
Speaker Kit Cat. K16021 **$649**
Cabinet Kit Cat. K16022 **$209**

NEW!! DIRECT IMPORT!!

MULTI FUNCTION STEREO MIXER EQUALIZER

SPECIFICATIONS
SENSITIVITY:
Phono: 3mV
Mic: 1mV
Line (tape or tuner): 150mV
SIGNAL/NOISE RATIO:
Phono: 55dB
Mic: 60dB
Line: 65dB
FREQUENCY:
Phono: 20Hz-20KHz (RIAA + – 2dB)
Mic: 20Hz-20KHz + – 3dB
Line: 20Hz-20KHz + – 3dB
CHANNEL BALANCE: 0.5dB
T.H.D.: Less than 0.03%
HEADPHONE IMPEDANCE: 4-16 ohms
OUTPUT: 0.775V
EQUALIZER:
Centre frequency: 60Hz, 250Hz, 1KHz, 4KHz, 12KHz
Control Gain: + – 12dB
POWER SOURCE: 110V/60Hz or 220V/50Hz

Cat. A12016 .... Normally $399
SPECIAL, ONLY $349

PHILIPS SPEAKERS

Description	Cat No	Price
AD01610T8	(C12030)	$24.95
AD02160SQ8	(C12040)	$69.95
AD80652W8	(C12042)	$69.95
AD070620M8	(C12045)	$69.95
AD12250W8	(C12050)	$129.00

NEW!!

WALL MOUNTING SPEAKER HOLDERS

Mount your speakers at ear level on your wall!!
Features...
- Holds speakers up to 260mm deep
- Left/Right adjustment
- Up/Down adjustment
- Includes mounting screws
- Nipping-screw pins hold speakers firmly in place
- Installation instructions

Cat. **$89.95**

1" DOME TWEETER SPEAKER

Mylar diaphragm
SPECIFICATIONS:
Sensitivity: 96dB
Frequency Response: 2-20 kHz
Impedance: 8 ohms
Power RMS: 15 watts RMS
Magnet Weight: 5.4oz
Size: 96mm diameter
Cat. C10234 .... **$10.95**

8" WOOFER HIGH POWER SPEAKER

Cloth edge, dark grey cone, rubber mounting seal, cloth dust cap
SPECIFICATIONS:
Sensitivity: 90dB
Frequency Response: 60-4 kHz
Impedance: 8 ohms
Power RMS: 50 watts RMS
Magnet Weight: 20oz
Cat. C10226 .... **$34.95**

2" HORN TWEETER SPEAKER

Mylar diaphragm, aluminium voice coil
SPECIFICATIONS:
Sensitivity: 95dB
Frequency Response: 1.5-20 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 2.5oz
Cat. C10232 .... **$8.95**

8" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 45-16 kHz
Impedance: 8 ohms
Power RMS: 30 watts RMS
Magnet Weight: 13oz
Cat. C10224 .... **$23.95**

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

rie

Rod Irving Electronics
48 A'Beckett St, MELBOURNE
Phone (03) 663 6151
425 High St, NORTHCOTE
Phone (03) 489 8866
Mail Order and Correspondence: P.O. Box 620, CLAYTON 3168
Telex: AA 151938

5" MIDRANGE SPEAKER

Sealed back, foam edge, black cone, silver dust cap
SPECIFICATIONS:
Sensitivity: 98dB
Frequency Response: 500-8 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.4oz
Cat. C10230 .... **$12.95**

6½" TWIN CONE FULL RANGE SPEAKER

Foam edge, black cone, black whizzer cone
SPECIFICATIONS:
Sensitivity: 89dB
Frequency Response: 60-15 kHz
Impedance: 8 ohms
Power RMS: 10 watts RMS
Magnet Weight: 5.3oz
Cat. C10222 .... **$14.95**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES:

$1 – $9.99	$2.00
$10 – $24.99	$3.00
$25 – $49.99	$4.00
$50 – $99.99	$5.00
$100 – $199	$7.50
$200 – $499	$10.00
$500 plus	$12.50

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

All sales tax exempt orders and wholesale inquiries to: RITRONICS WHOLESALE, 56 Renver Rd, Clayton. Ph. (03) 543 2166 (3 lines)

Errors and omissions excepted

*Apple and IBM are registered trade names

MasterCard VISA

• PHONE YOUR ORDER — ALTRONICS TOLL FREE 008 999 007 •

FOR NEXT DAY JETSERVICE DELIVERY

BANKCARD HOLDERS — PHONE ALTRONICS TOLL FREE 008 999 007

BUILD THESE FANTASTIC KITS

ZENER DIODE TESTER

"Simply plugs into Your Multimeter" By simply plugging this handy little tester into your multimeter, it allows you to read out the actual Zener voltage of any Zener Diode up to 60 volts and will also test LEDS! as well as give you a reading of its forward voltage drop. K 2620

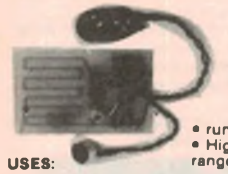
$12.50

DRILL SPEED CONTROLLER

K 6005 **$24.50**

For Brush Motors up to 3 Amps Varies motor speed from a few RPM to full speed while maintaining good torque. Suitable for - Drills and Drill Presses - Circular Saws - Jig Saws - food Mixers - Movie Projectors.

FM RADIO MICROPHONE



This simple FM Microphone kit only requires an ordinary FM Radio for reception
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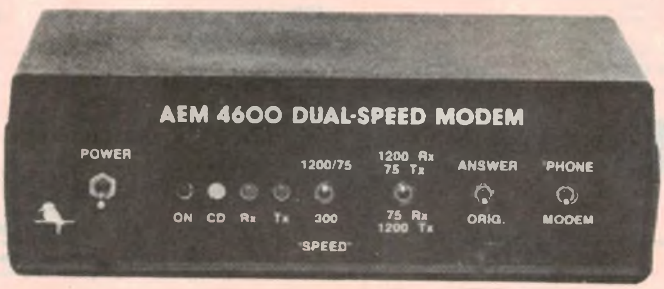

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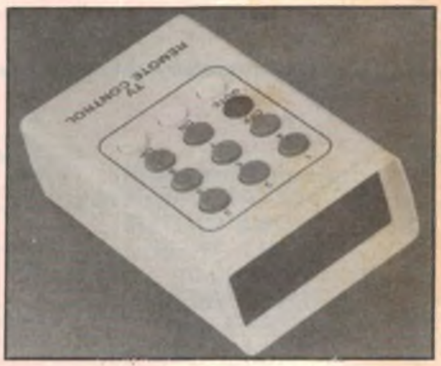
Part 2: receiver construction plus installation

Eight-channel IR remote control

Introduced last month, our Multifunction IR Remote control unit can control up to eight channels and has optional facilities for Power On/Off, Mute and Up/Dn volume. Following on from the description of the transmitter construction, we now continue with construction of the receivers.

by JOHN CLARKE

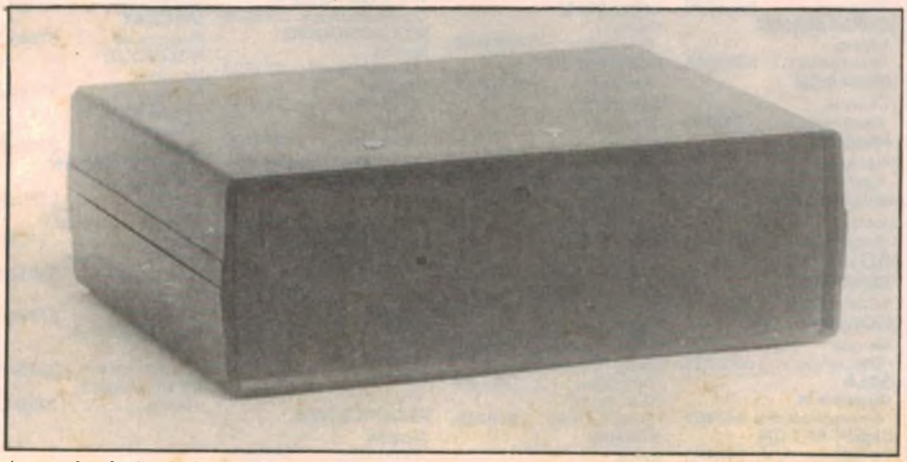


The hand-held transmitter.

There are two receivers which can be built for the infrared remote control. The first uses the full circuit and is suitable when power On/Off, Muting and Up/Dn volume control are required as well as the 8-channel selections. A simpler version of the receiver utilises only a portion of the circuit to provide for the 8-channel selections only with either momentary or latched relay contacts.

The choice of latched or momentary contacts is dependent upon the application. For adding remote control across switches of existing equipment, the choice of latched or momentary contacts is determined by the type of switches within the equipment. For example, most CD, VCR and cassette players use momentary switches whereas most TV sets have latching switches for channel selection.

Most of the circuitry for the receiver is housed on a PCB coded 87rc5 and measuring 173 x 146mm. A separate PCB coded 87pa5 and measuring 46 x 46mm houses the amplifier for the IR receiver diode. This is contained within a tinplate shielded box to reduce the possibility of false triggering from outside interference.



A standard plastic instrument case accommodates the receiver circuitry.

The 87rc5 PCB is designed to fit within a plastic instrument case measuring 200 x 160 x 70mm, with the IR amplifier 87pa5 PCB secured to the inside lid of the case. Alternatively, the entire receiver can be housed within the equipment to be controlled; eg, within a TV set.

Fully optioned version

Fig.1 shows the overlay for the fully optioned remote control receiver PCB. It provides for the full number of functions including power On/Off, Mute and Up/Down volume, as well as the eight channels.

Linking options on the PCB allow for either momentary or latched relay outputs for the eight channels. If only latched outputs are required, then IC5 and the associated 22kΩ resistor, 50kΩ trimpot and 0.027μF capacitor can be deleted from the PCB.

Further simplification can be made if the DC current output from IC3 can be used to directly control volume. Many TV sets utilise DC volume control and readers wishing to install the remote control in a TV should turn to the TV installation section of this article before proceeding with construction.

If there is any doubt about how the volume control operates, the LDR circuit should be used for control of the volume.

Using DC volume control removes the need for the LDR and associated parts. These include LED3, LED4, Q6, Q5, and the 39kΩ, 4.7kΩ, and 2 x 470Ω resistors. Also, the muting relay and D19 may not be necessary for many DC volume controls since the volume may be attenuated to a very low level using the DC volume control.

Of course, the full complement of relays does not have to be used. If you don't require eight channels, simply reduce the number of relays accordingly. For each relay not used, you can also delete the associated driver transistor and the diode across the coil.

Eight-channel version

Fig.2 shows the overlay diagram for the 8-channel version of the receiver. As with the more elaborate version, this has the option of either momentary or latched outputs. You should use the ML926 for IC5 when momentary contacts are required and the ML928 for IC5 when latched contacts are required.

We built this version using four relays with the latching ML928. Note that the relay order changes when the ML928 is used compared to the ML926. The ML926 relay numbering is as shown on

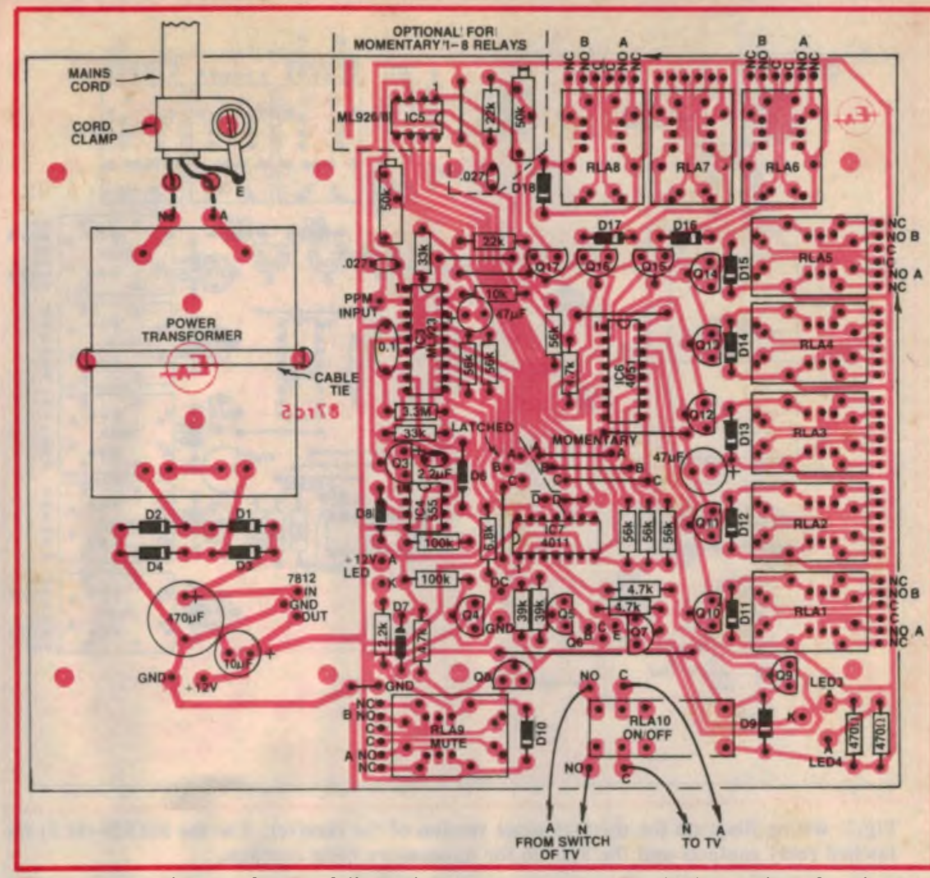
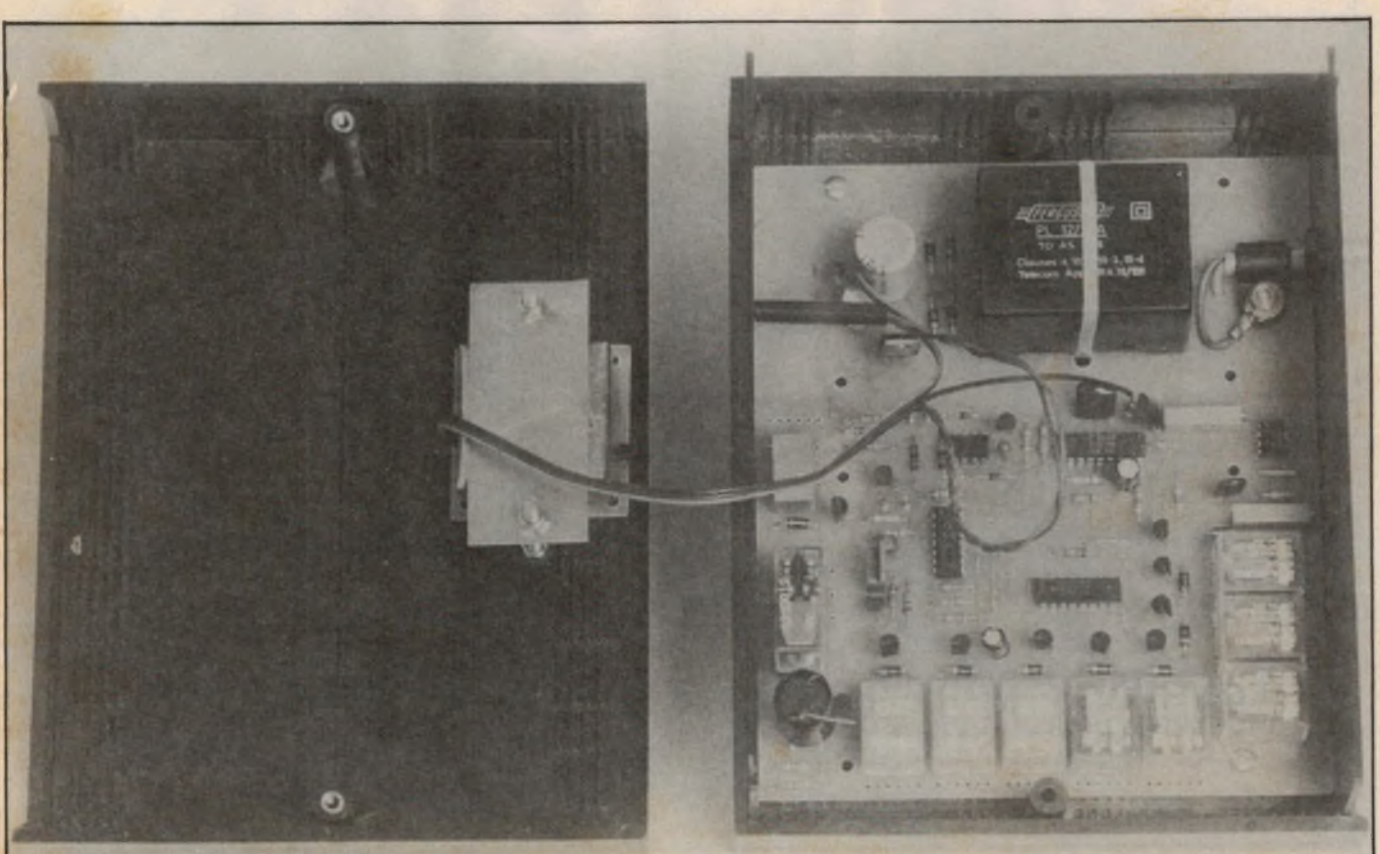


Fig.1: wiring diagram for the fully optioned version. Note the linking options for either momentary or latched relay contacts.



View inside the fully optioned version. The input amplifier fits into a metal shield and is mounted on the lid of the case.

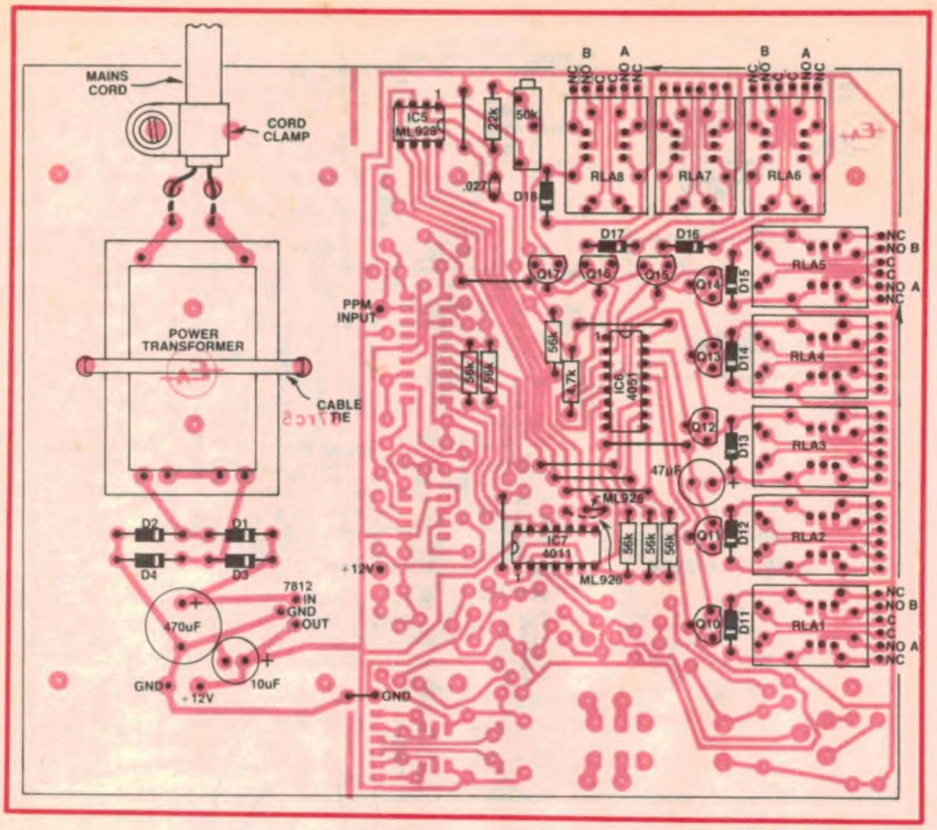


Fig.2: wiring diagram for the 8-channel version of the receiver. Use the ML928 (IC5) for latched relay contacts and the ML926 for momentary relay contacts.

the overlay diagram while numbering when using the ML928 is 6, 5, 7, 8, 2, 1, 3, 4.

Relays

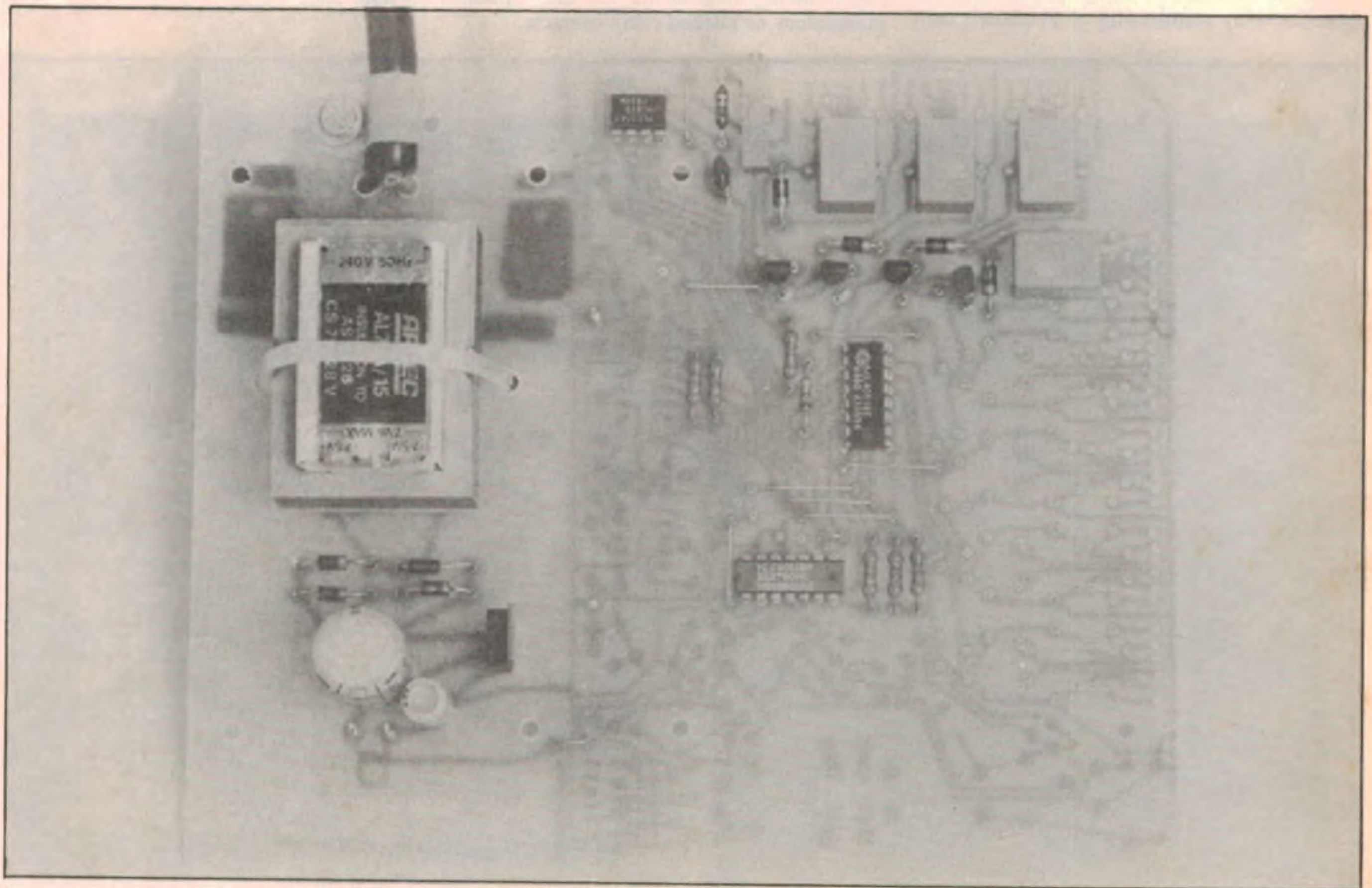
The PCB is designed to accept two different relay types for the 1 to 8 channel selections and for the Mute relay. These are the DPDT Original OUB12V (available from Hi-Com Unitronics, 7 President Lane, Caringbah, NSW 2229), and the Kamling KL2P DPDT relay (available from Altronics and Jaycar, Cat. S-4061).

PCB construction

The 87rc5 PCB can be used as a single PCB incorporating the power supply or, alternatively, the PCB can be separated by cutting between the power supply and receiver/decoder sections. The separated PCBs can then be wired together by joining their +12V terminals and by joining their ground terminals.

Construction of the PCB can begin by installing the links. Note that the A, B, C and D or D-bar links near IC7 are dependent on the type of IC used for IC5 and whether the A, B and C outputs of IC5 or IC3 are decoded by IC6.

Fig.1 shows the required linking for latched or momentary connections on



This unit has relays installed on four outputs only and uses the ML928 for latched contacts. Note relay locations (see text).

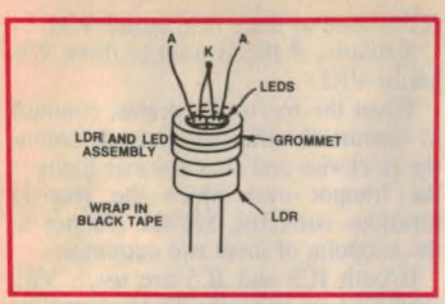


Fig.3: the LDR and LED assembly.

the full-featured version, while Fig.2 shows the link required when either the ML926 or ML928 is used.

We used PC stakes to terminate external connections on the PCB, the only exceptions being the relay outputs and mains wiring points.

The next step is to install the resistors, diodes and ICs. Be careful with the orientation of the ICs and diodes — these must be oriented as shown on the overlay. Note that diodes D6, D7 and D8 are 1N914 or 1N4148 small signal diodes whereas the remaining diodes are all 1N4002 types.

The transistors, 3-terminal regulator and capacitors can all now be installed. Make sure that the electrolytic capacitors and transistors are oriented as shown on the overlay diagram.

The relays can also be installed and soldered in position at this stage. Remember that the sequence of the 1 to 8 channel relays when the ML928 is used is 6, 5, 7, 8, 2, 1, 3, 4. This means that if fewer than 8 relays are used, you should follow this sequence for relay installation.

Construction of the LDR and LED assembly is shown in Fig.3. The two 3mm diameter LEDs are held within the rubber grommet and the assembly is wrapped in insulation tape to exclude any external light. The cathode (K) leads of the two LEDs are soldered together, while the anode leads are soldered to two PC stakes situated in the lower right hand corner of the PCB.

As shown in the photographs, the transformer should be secured using a cable tie. This passes around the transformer and through two holes in the PCB. This precaution provides additional safety as the transformer would otherwise only be supported by its mounting pins.

The mains cord is secured to the PCB using a cable clamp and the wires pass through holes in the PCB and solder to the mains input of the transformer on the underside of the PCB.

It is important to insulate the underside of the PCB where the mains wiring enters the transformer using a piece of stiff insulating material bolted to the underside of the PCB. This will prevent any accidental contact with the mains. Several mounting holes are provided for this purpose.

Amplifier board

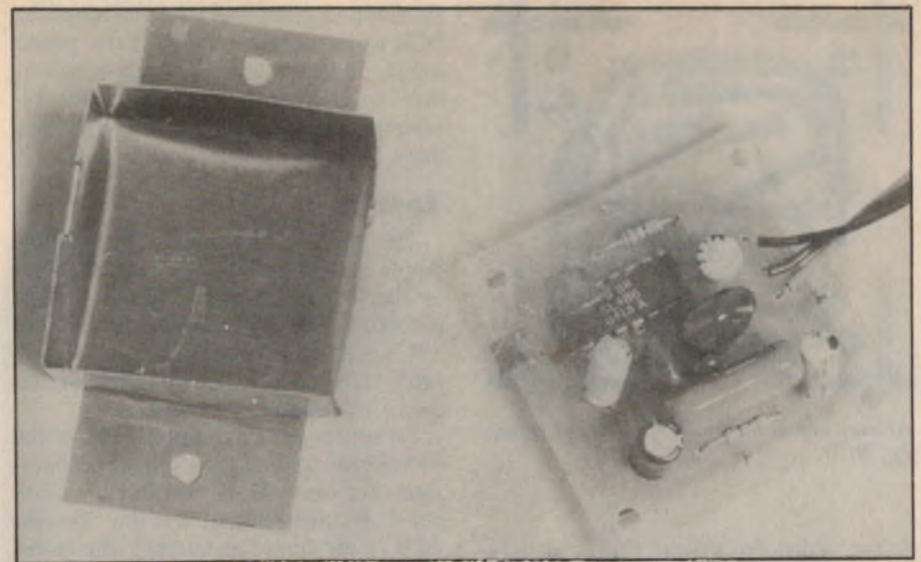
Work can now begin on the 87pa5 amplifier PCB (Fig.4). Install IC2 and the two resistors first, making sure that IC2 is oriented correctly. The nine capacitors can then be installed, with the electrolytics oriented as shown on the diagram.

PC stakes can be used to terminate the +12V, ground, PPM and IR diode connections. They should also be installed at the three perimeter locations on the PCB earth track to facilitate soldering the tin plate shields into position. Do not solder the IR diode in position yet.

Fig.5 shows the dimensions of the tinplate shield for the amplifier 87pa5 PCB. Cut and fold this shield as shown and check that the base and top pieces fit correctly over the three PC stakes on the board. Adjust the sides as necessary but do not solder the shield to the PC stakes until after testing.

You will also have to mark and drill exit holes in the top shield side panels for the ground, +12V, PPM and IR diode connections.

Once construction of the shield has been completed, temporarily solder the



Above: the metal shield is soldered to three PC stakes on the amplifier PCB (right).

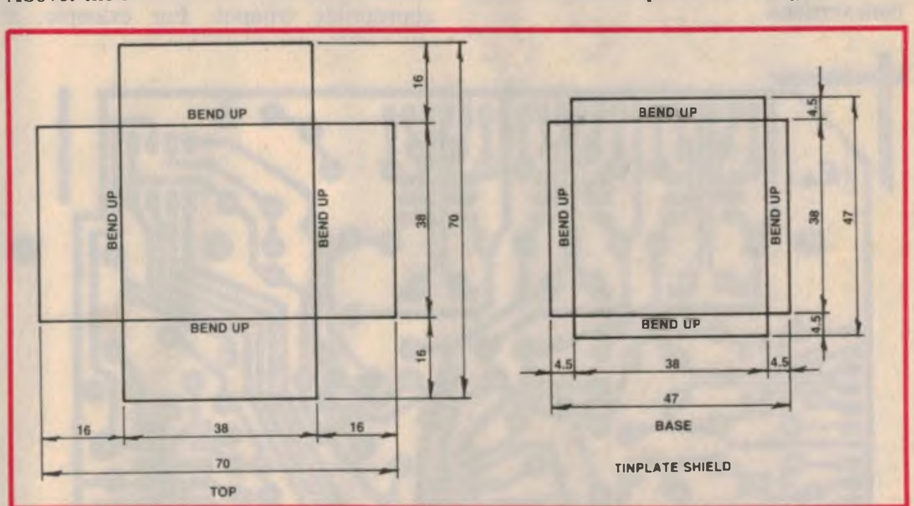


Fig.5: how to make the metal shield. The section at left goes over the top of the amplifier PCB while the section at right is fitted to the copper side.

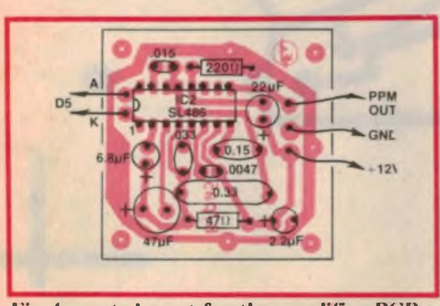
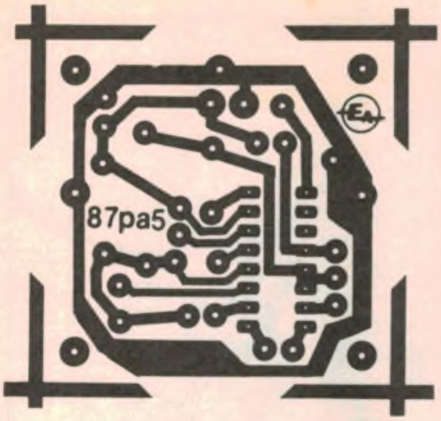


Fig.4: parts layout for the amplifier PCB.



Above: actual size artwork for the amplifier PCB.

Below: actual size artwork for the main receiver PCB. The same artwork is used for both versions.

IR diode in place and wire the amplifier PCB to the receiver PCB. If the power supply is separated from the receiver, then wire the power supply to the receiver at the Ground and +12V connections.

Testing

The unit is now ready for testing. Apply power and use your multimeter to check that the power supply voltage is correct. The 50kΩ trimpots (VR1 and VR2) associated with IC3 and IC5 will probably need adjustment before the receiver will operate correctly.

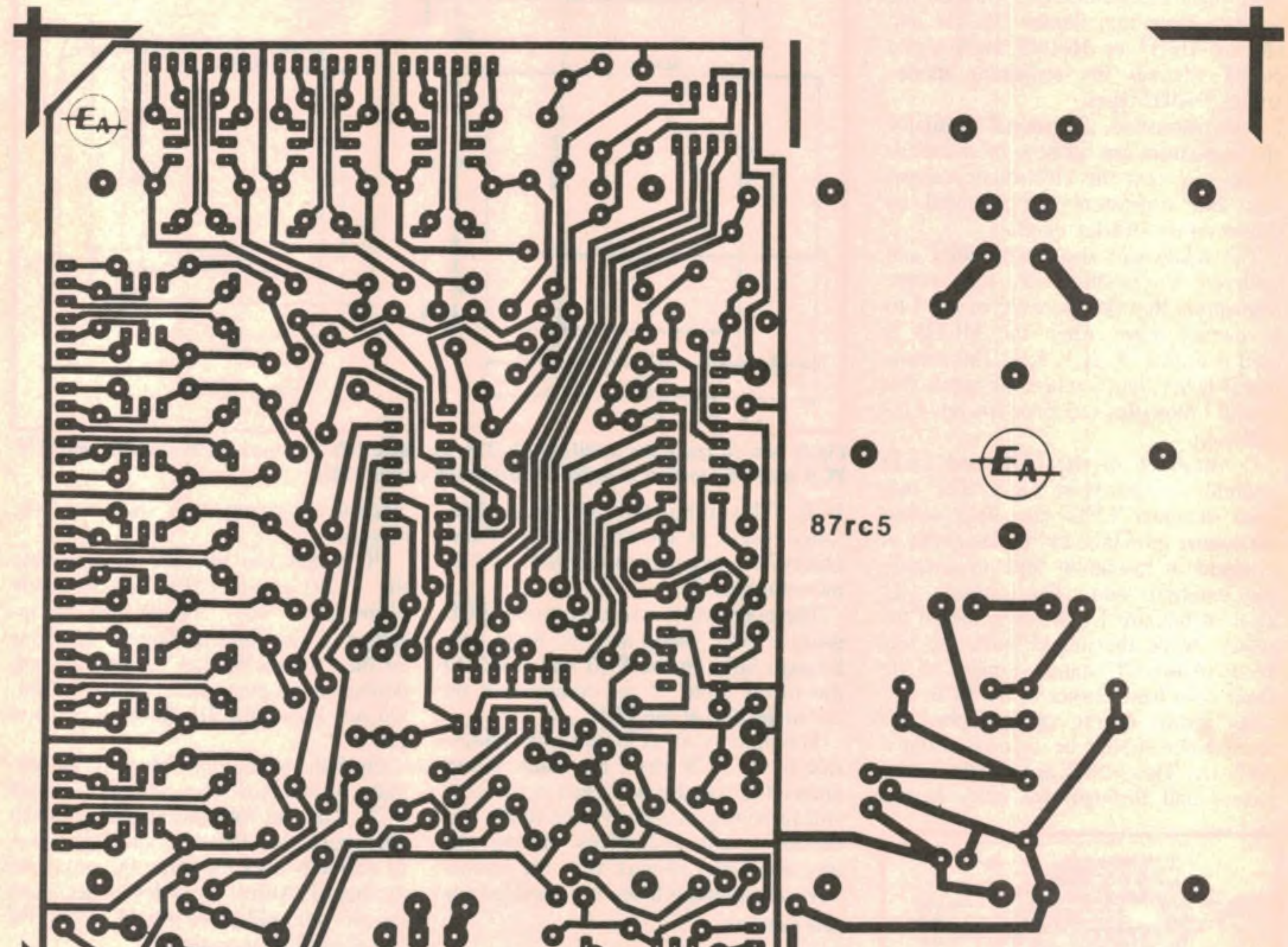
To set the 50kΩ trimpots, one of the transmitter pushbuttons should be operated. For example, if the relay for channel 1 is incorporated on the receiver PCB, then press the number one transmitter pushbutton while adjusting the appropriate trimpot. For example, if IC5 is used to drive IC6, adjust VR1.

Similarly, if IC3 is used to drive IC6, adjust VR2.

When the receiver operates, continue to operate the transmitter to determine the clockwise and anticlockwise limits of the trimpot over which the receiver functions correctly. Set the trimpot to the midpoint of these two extremes.

If both IC3 and IC5 are used, VR2 should be set using the Mute output for testing. You can either monitor the pin 8 output using a meter or, if the mute relay is installed, listen for its operation. The Mute operates in a flipflop fashion so that, on the first pressing of the transmitter switch, the relay switches on and pin 8 goes high. On the second pressing, the relay turns off and pin 8 goes low.

As before, find the limits of the trimpot over which the receiver operates



correctly and set the trimpot to mid setting.

The remaining functions can now be tested. The 1-8 channel relays should switch on when they are selected by the transmitter and be off otherwise.

To check operation of the volume control, connect a multimeter set to measure ohms across the LDR. Now press the up and down volume buttons and observe the change in resistance of the LDR. It should change from about 470Ω on Mute to over 1MΩ at the maximum volume setting.

If the LDR section of the circuit is not used, the current output from IC3 can be checked by measuring the voltage across the 39kΩ resistor at the collector of Q4. The voltage here should range from 0V when muted to about 9.5V at maximum volume setting. At initial power up, this voltage should be about 8.6V.

The Mute relay should switch on and off alternately with each pressing of the Mute control. It should also switch on briefly each time a channel selection is made and be on while the Dn volume is at its minimum setting. Muting should also occur on power off (ie, when the power relay switches off).

Power relay RLA9 should switch on again after selection of one of the eight channels.

Installation

Installation of the 1-8 channel only remote control into an item of equipment is straightforward. Simply connect the relay contacts for each channel across existing switches in the equipment.

A circuit diagram for the equipment will enable you to check the connections required for the switch contacts. In some cases, the switches may be double pole types or even use the changeover facility of the switch. This can be duplicated with the DPDT relay contacts

Note that the relays are not mains rated and cannot be used to directly control mains voltages. You can, however, use them to drive separate mains rated relays.

Where possible, you can install the receiver PCB in the equipment to be controlled. Alternatively, the PCB can be installed in a plastic instrument case measuring 200 x 160 x 70mm (W x H x D).

The accompanying photographs show the full complement circuit board secured to the base of the case using self tapping screws. The IR amplifier PCB is enclosed in the metal shield and mounted towards the front of the lid using suitable brackets.

A hole in the front panel exposes the IR diode which is connected to the amplifier PCB using short leads. Drill a hole in the rear panel for the mains cord and grommet and for the relay contact wires. We opted to include the muting LED on the front panel for the full function version.

TV installation

Connection to a TV set is a little more complex. As well as making connections to the channel pushbutton switches, you also have to wire in the

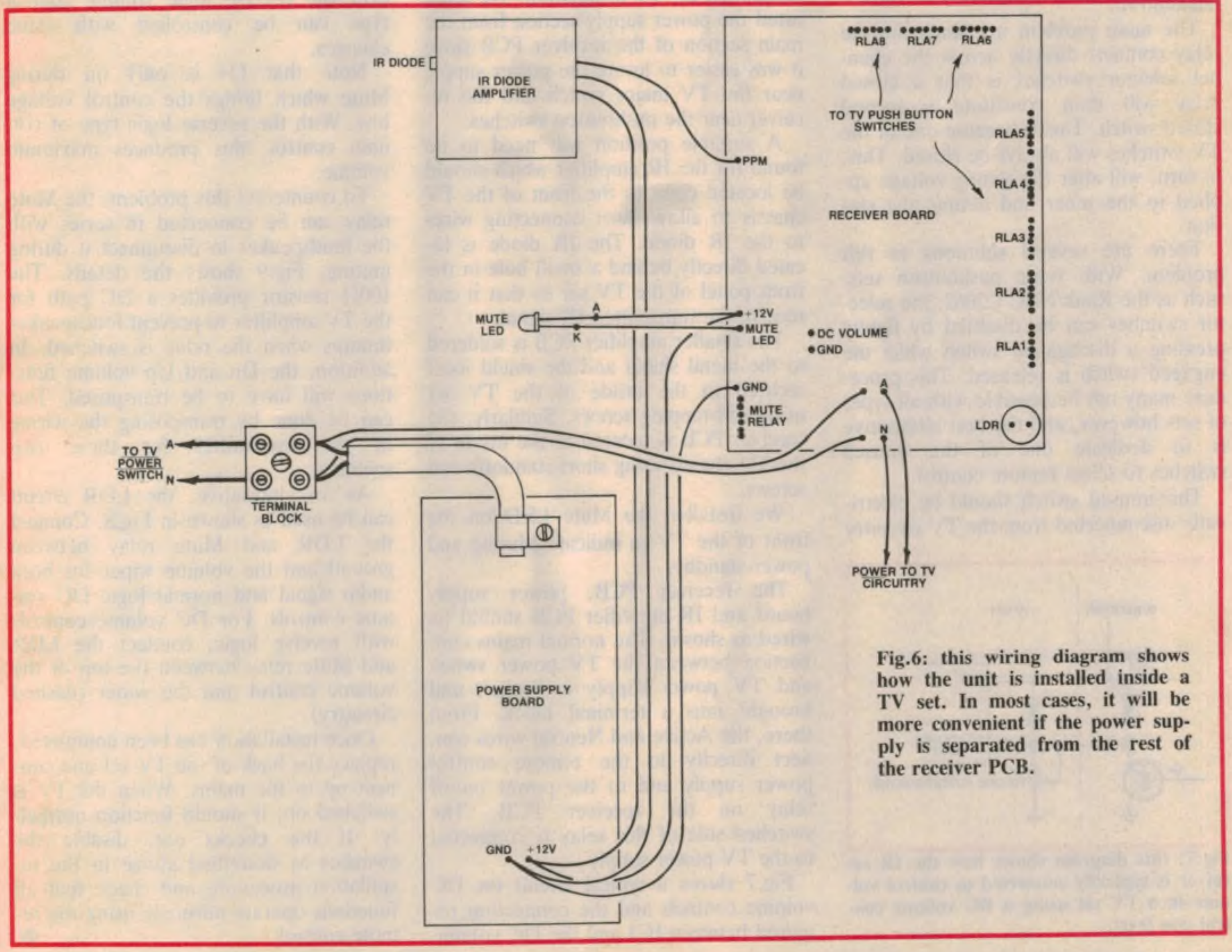


Fig.6: this wiring diagram shows how the unit is installed inside a TV set. In most cases, it will be more convenient if the power supply is separated from the rest of the receiver PCB.

muting, volume and power on/off connections.

Note that the unit can only be connected to pushbutton TV sets. Those with a rotary turret are unsuitable for remote control modification since the switch constitutes part of the tuner.

Adding remote control does not affect normal operation of the TV set. When the set is first switched on via the TV power switch, the power relay is energised, the volume is set to 66% of the normal volume and the 8-channel relays are off. This allows the TV pushbuttons to operate as normal.

Before commencing installation, make sure that you unplug the TV set from the power point. This is to prevent accidental contact with the mains.

Refer to your TV set's schematic diagram for the connections necessary to the pushbutton switches. Many TV sets have eight or more pushbuttons, although it is not necessary to provide remote control for all of these. Some TV sets may also require connection to an indicating LED located beside each pushbutton.

The main problem in connecting the relay contacts directly across the channel selector switches is that a closed relay will then constitute a second closed switch. This is because one of the TV switches will always be closed. This, in turn, will alter the tuning voltage applied to the tuner and detune the station.

There are several solutions to this problem. With some pushbutton sets, such as the Rank/NEC C2062, the selector switches can be disabled by lightly pressing a disengaged switch while the engaged switch is released. This procedure many not be possible with all types of sets however, and the best alternative is to dedicate one of the unused switches to select remote control.

This unused switch should be electrically disconnected from the TV circuitry

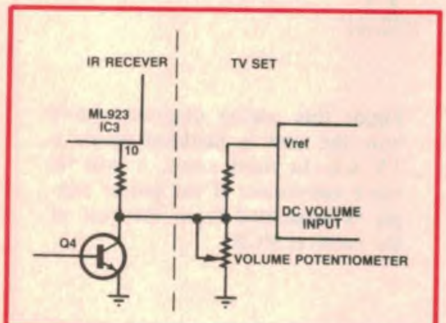


Fig.7: this diagram shows how the IR receiver is typically connected to control volume in a TV set using a DC volume control (see text).

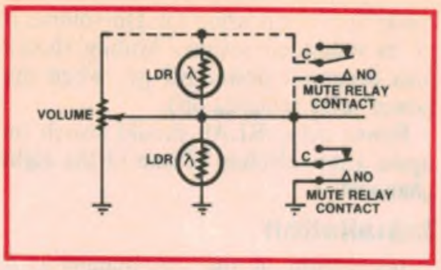


Fig.8: alternative circuit for controlling volume. The dotted circuitry is for reverse logic DC controls.

by cutting the PCB tracks to it, or by disconnecting any wire leads. After that, it's simply a matter of pressing this switch (to disable the others) whenever you wish to use the remote control.

The remaining switches can then still be used for normal operation but note that it will necessary to reset the remote control circuit by turning the TV set off and on again.

Once the switching arrangement has been sorted out, the remote control receiver is ready to be installed within the TV set. Fig.6 shows the general arrangement for TV installation. We separated the power supply section from the main section of the receiver PCB since it was easier to locate the power supply near the TV mains switch and the receiver near the pushbutton switches.

A suitable position will need to be found for the IR amplifier which should be located close to the front of the TV chassis to allow short connecting wires to the IR diode. The IR diode is located directly behind a small hole in the front panel of the TV set so that it can receive the transmitted IR signal.

The smaller amplifier PCB is soldered to the metal shield and the shield itself secured to the inside of the TV set using self-tapping screws. Similarly, the receiver PCB is secured to the inside of the TV chassis using short standoffs and screws.

We installed the Mute LED on the front of the TV to indicate Muting and power standby.

The receiver PCB, power supply board and IR amplifier PCB should be wired as shown. The normal mains connection between the TV power switch and TV power supply is broken and brought into a terminal block. From there, the Active and Neutral wires connect directly to the remote control power supply and to the power on/off relay on the receiver PCB. The switched side of this relay is connected to the TV power supply.

Fig.7 shows a typical circuit for DC volume controls and the connection required between IC3 and the DC volume

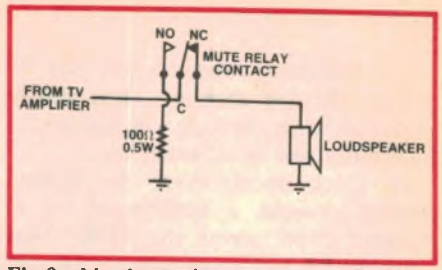


Fig.9: this alternative muting circuit should be used when Fig.7 is used with reverse logic DC controls.

control within the TV set. The Vref input is usually about 6V and the DC input is varied using the volume potentiometer. The current source from pin 10 of IC3 forces current through the volume potentiometer so that the voltage at the DC input can be varied remotely.

Some DC controls operate such that low voltage gives high volume and high voltage, low volume (reverse logic). Others operate with low volume on low voltage and high volume on high voltage (normal logic). The output circuit of IC3 is intended for the later case, however the reverse logic volume control type can be controlled with some changes.

Note that Q4 is only on during Mute which brings the control voltage low. With the reverse logic type of volume control, this produces maximum volume.

To counteract this problem, the Mute relay can be connected in series with the loudspeaker to disconnect it during muting. Fig.9 shows the details. The 100Ω resistor provides a DC path for the TV amplifier to prevent loudspeaker thumps when the relay is switched. In addition, the Dn and Up volume functions will have to be transposed. This can be done by transposing the wiring in the transmitter for these two switches.

As an alternative, the LDR circuit can be used as shown in Fig.8. Connect the LDR and Mute relay between ground and the volume wiper for both audio signal and normal logic DC volume controls. For DC volume controls with reverse logic, connect the LDR and Mute relay between the top of the volume control and the wiper (dashed circuitry).

Once installation has been completed, replace the back of the TV set and connect up to the mains. When the TV is switched on, it should function normally. If this checks out, disable the switches as described above in the installation procedure and check that all functions operate normally using the remote control.

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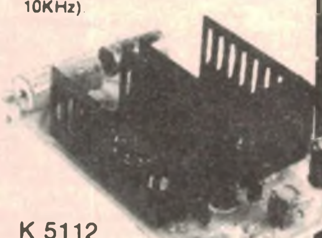

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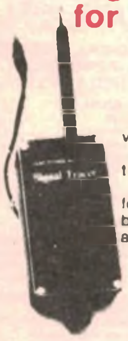

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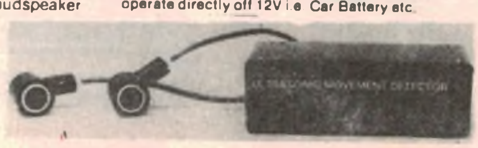

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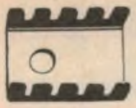

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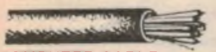

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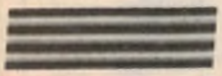

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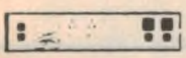

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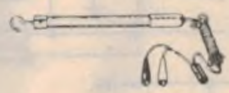

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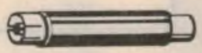

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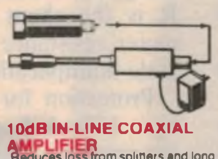

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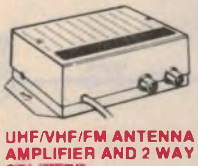

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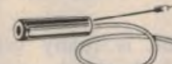

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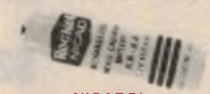

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Circuit & Design Ideas

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

Memory expansion for the Vic-20

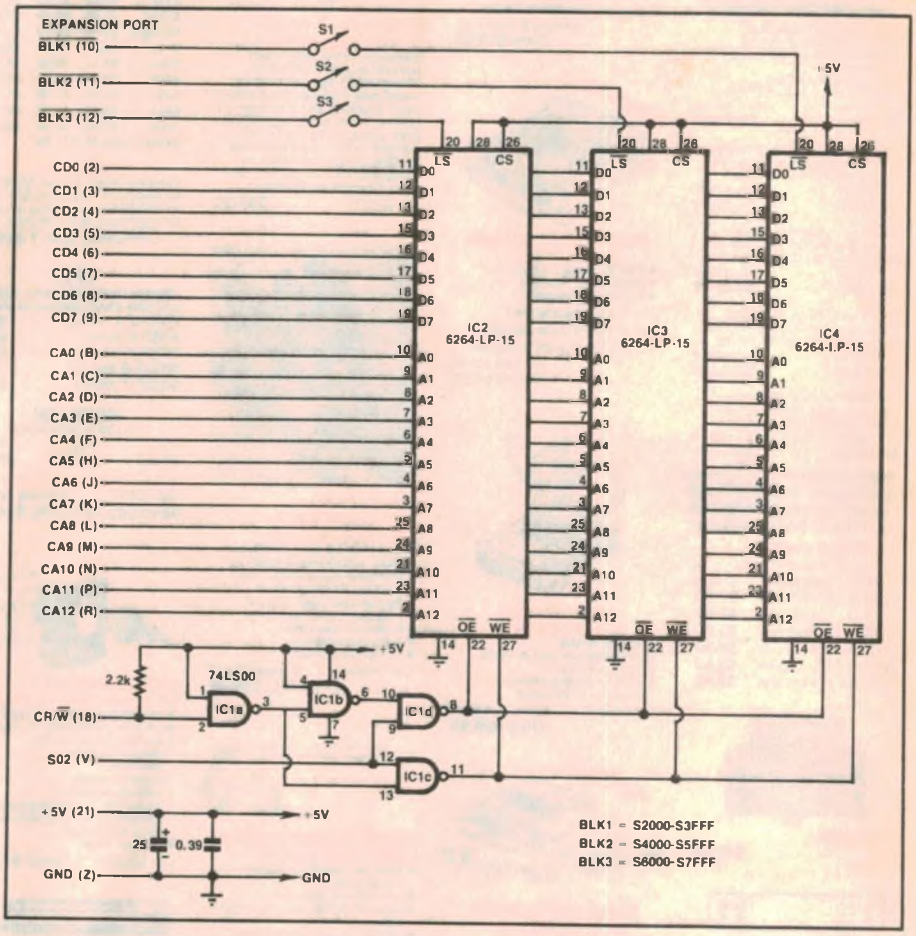
Here's how to add another 24K of RAM to your Vic-20 computer. The circuit can be easily fitted inside the existing case so that there is no need for an edge connector.

The circuit operation is really very simple with BLK-bar 1, 2 and 3 selecting banks of 8K bytes and the 74LS00 preventing data bus contention. The 6264's used in the prototype were low power 150ns types, but any of the slower versions could also be used.

Switches S1, S2 and S3 are used to disable the 8K banks to avoid address bus contention if an expander board is used. The RAMS retain their memory content when switched out of circuit, so that data can be stored there without being lost.

M. Spinaze,
Buderim, Qld.

$25



Benchtop DC ammeter

A separate ammeter is very useful, particularly when it is necessary to observe both current and voltage simultaneously. This DC ammeter provides 12 ranges of measurement from 50μA to 10A.

The circuit is based on a 50μA full scale deflection meter with shunting to provide measurement for currents which are greater than 50μA. The shunting diverts current so that only a maximum of 50μA passes through the meter.

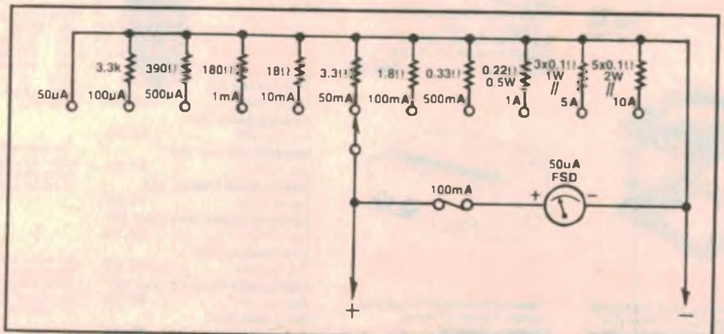
A 12-position single pole switch rated at 10A selects the various shunt resistors. An alternative arrangement to avoid a high switch rating is to use separate socket terminals for each shunt and to connect to the appropriate shunt using a flying lead and plug.

The shunt resistance is calculated using the formula R = Rm/(N-1), where R is the shunt resistance, Rm is the meter resistance (3500Ω) and N is the scale multiplication factor.

Protection for the meter is provided by a 100mA fuse and the measurement accuracy is within 10%.

A. Fong,
Carlingford, NSW.

$10



Low current circuit breaker

This low current circuit breaker can be installed in a multimeter. It connects in series with the standard meter protection fuse but is designed to trip out before the fuse blows. This prevents the time consuming process of replacing the fuse since the circuit is easily resettable with the press of a switch.

The circuit uses a current sensor which is based on a miniature reed switch around which is wound 50 turns of 0.4mm enamelled copper wire. When the current through this coil reaches a particular value, the reed switch closes to fire SCR1 via the 3.3kΩ gate resistor.

When SCR1 is switched on, RLA1 is turned on and this opens the relay contact in series with the fuse. The relay is

General purpose counter

This circuit includes x10 and x100 overranging on a four digit counter. The first four digits are displayed in seven segment format while the remaining most significant digits are each displayed as a series of ten LEDs.

IC1 is a 74C926 4-digit counter, latch, decoder and display driver which drives the FND500 displays in a multiplexed fashion. For every clock pulse at pin 12, the counter increments by one and this is displayed on the four digit display.

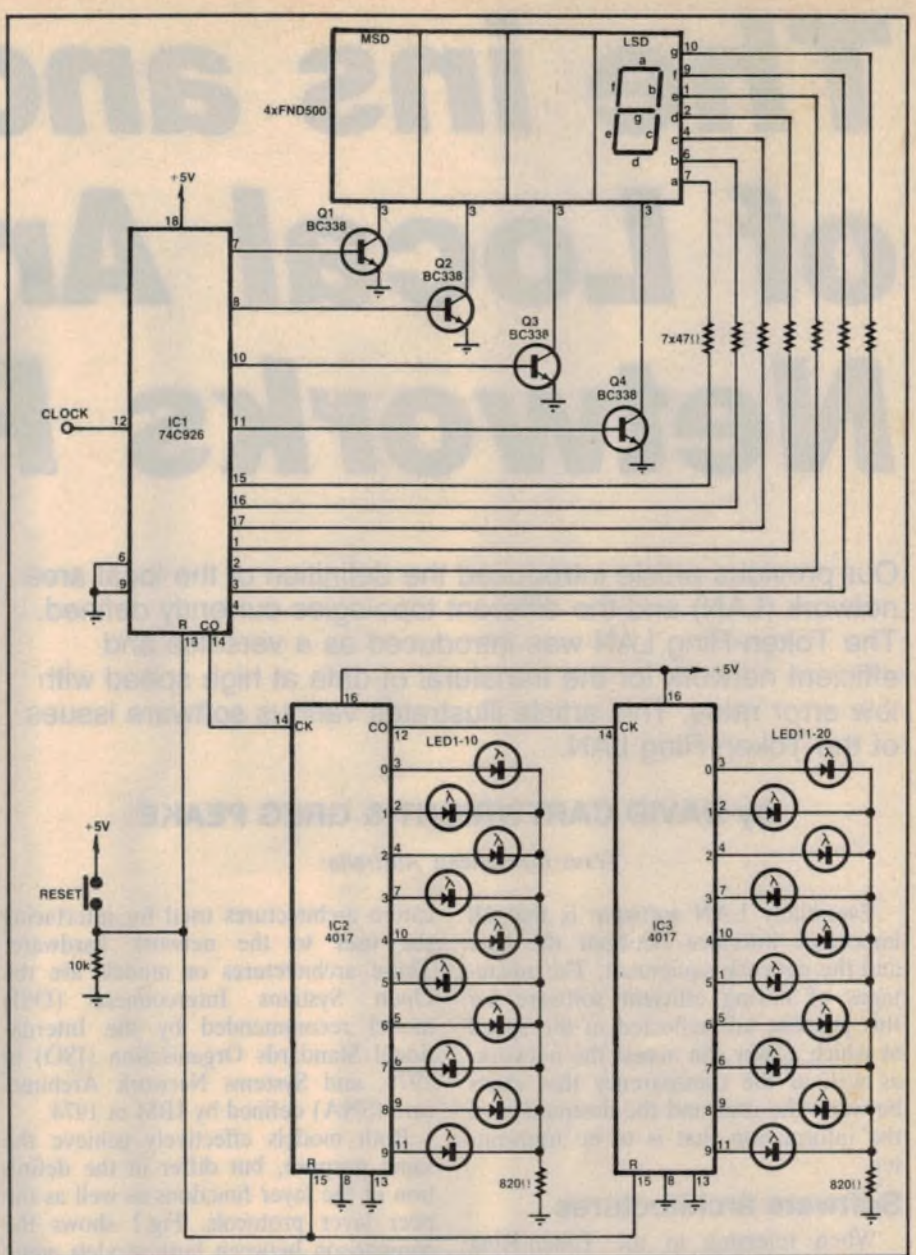
The four digits show counts of up to 9999 until an overflow output at the CO of IC1 clocks the IC2, a 4017 decade counter. This displays the second LED (number "1") to indicate the x 10 overrange of the count. Each time the IC1's count exceeds 9999, IC2 is clocked and the LED display of IC2 increments to the next LED in the sequence.

When IC2 overflows after the final "9" LED is lit, its CO clocks counter IC3. This drives another LED display to indicate the x100 overrange.

Thus, the seven segment displays driven by IC1 show the units, tens, hundreds and thousands, while the LEDs driven by IC2 show the ten thousands and the LEDs driven by IC3 the one hundred thousands.

The Reset pushbutton clears all the counters to zero. The counter must be powered from a 5V supply, since the 74C926 has a maximum supply voltage of 6V.

A Fong,
Carlingford, NSW. $15



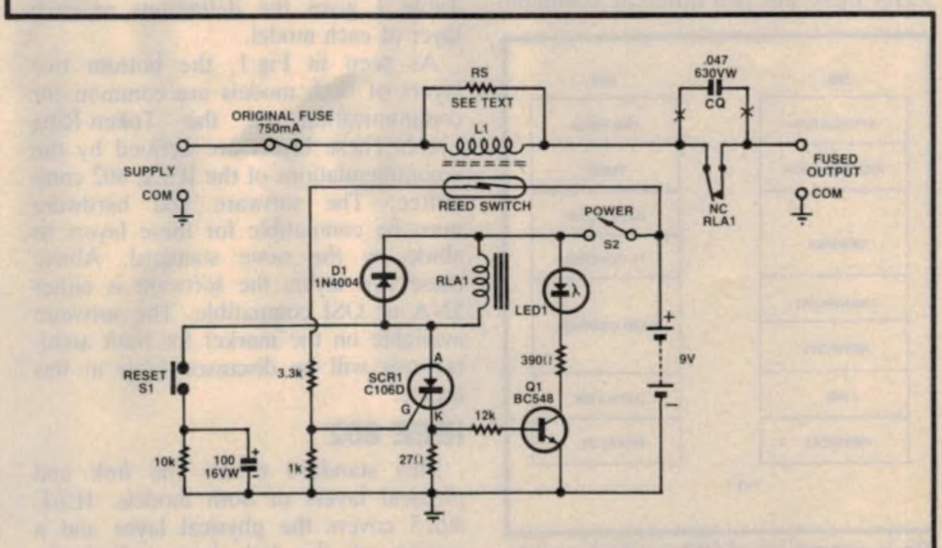
a 5V 56Ω type which is supplied with 5V via the 9V supply due to the voltage drop across the 27Ω resistor in series with the SCR. This voltage is also used to turn on transistor Q1 which in turn powers LED1 to indicate that the circuit has tripped.

To reset the circuit, SW1 momentarily removes the voltage across SCR1 due to the shorting action of the parallel 100uF capacitor. This opens SCR1. LED1 goes off and the relay turns off and closes the relay contact.

The value of RS should be adjusted to set the tripping current of the circuit breaker. Normally, the value for RS will be close to 0.1Ω. CQ should be deleted when used for AC.

Power is derived from the internal 9V battery of the multimeter.

P Boyle,
Edithvale, Vic. **$20**



The ins and outs of Local Area Networks Pt.2

Our previous article introduced the definition of the local area network (LAN) and the different topologies currently defined. The Token-Ring LAN was introduced as a versatile and efficient network for the transferal of data at high speed with low error rates. This article illustrates various software issues of the Token-Ring LAN.

by DAVID CARTWRIGHT & GREG PEAKE

Texas Instruments Australia

Essentially LAN software is that all important interface between the user and the network equipment. The advantages of having efficient software for this purpose are reflected in the speed at which a user can access the network, as well as the transparency that exists between the user and the destination of the information that is to be transmitted.

Software architectures

When referring to the Token-Ring LAN there are two different communication architectures used for interfacing the user to the network hardware. These architectures or models are the Open Systems Interconnect (OSI) model recommended by the International Standards Organisation (ISO) in 1978, and Systems Network Architecture (SNA) defined by IBM in 1974.

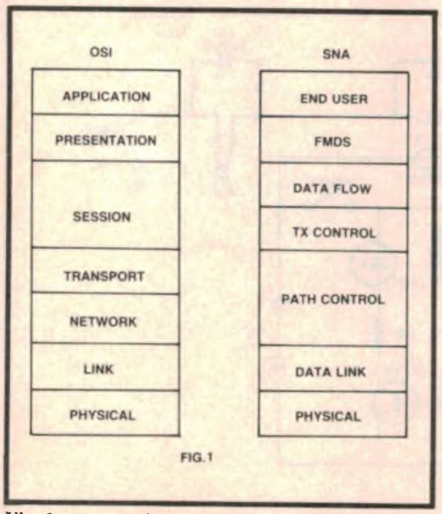


Fig.1: comparison of OSI and SNA models.

Both models effectively achieve the same purpose, but differ in the definition of the layer functions as well as the peer layer protocols. Fig.1 shows the comparison between both models while Table 1 gives the definitions of each layer of each model.

As seen in Fig.1, the bottom two layers of both models are common for communication on the Token-Ring LAN. These layers are defined by the recommendations of the IEEE 802 committee. The software and hardware must be compatible for these layers to abide by the same standard. Above these two layers the software is either SNA or OSI compatible. The software available on the market for both architectures will be discussed later in this article.

IEEE 802

This standard covers the link and physical layers of both models. IEEE 802.5 covers the physical layer and a section of the link layer called the Medium Access Control (MAC). The physical layer defines the topology and access method of the Token-Ring LAN. The MAC, implemented in software, is the controller associated with access to the Ring. It works closely with the hardware of the network adapter.

As seen in Fig.2, the MAC software is a separate entity to the actual data flow that occurs in the model. It provides services such as network management, by being able to communicate to other adapters without any user intervention. It also responds to error conditions on the ring in order to provide proper ring operation. This software is supplied with the network adapter card in either EPROM or in the ROM of a microcontroller; ie. the TMS38020.

IEEE 802.2 defines the other section of the link layer called the Link Level Control (LLC). As seen from Fig.2, this software is concerned with the actual transfer of data to and from the ring. The function of the LLC, in conjunction with the physical layer, is to provide an error free pipeline in which the data from higher layers is transported from one link layer to another.

Currently there are two types of LLC that have been defined. Type 1 LLC packages the user data in a frame format and sends it onto the network. However it does not record whether the frame arrived at its destination, and expects no acknowledgments from the destination. This type of LLC relies on the error control of the higher layers.

Type 2 LLC uses the same method of sending the data, however it expects an acknowledgment from the destination for every frame sent. This is achieved by sending associated control words with the frames. Using this type of LLC, delivery is guaranteed at the link layer level.

The software for LLC is contained on the network adapter, either in EPROM or downloaded into RAM. This alleviates the host from the extra processing required to implement LLC functions, and allows more time for application processing. Also it provides the software manufacturers who implement OSI or SNA architectures with a common interface to the network adapter.

The OSI model

The software supporting layers 3 to 7 of the OSI model must be able to provide the functions of each layer as well as the peer to peer protocols. The layer functions are set out in Table 1. The peer to peer protocols are necessary for communication between the respective layers of the source and destination. Each layer acts as a separate entity in the model, providing its particular service as well as providing an error free link to its peer layer at the destination.

Fig.3 shows the associated peer to peer protocols used between layers. An example of the use of the protocols best defines the operation of peer to peer communication.

If a user wants to communicate to another user on the network, a request is made to the application program for a connection. Associated with that request are parameters such as the destination address or name and the class of service required. The application program in turn makes a request to the presentation layer for connection, the presentation layer requesting the session layer and so on down through the layers.

The parameters given originally will mean something to at least one of the layers as the original request passes through the model. The link layer is the final layer to be requested. At this stage the previous requests are packaged into a frame and sent across the network to the destination. As the original request is passed down through the layers, each layer adds its own header which contains its own request to its peer layer. These frames associated with each layer are known as Protocols Data Units (PDUs).

Once the request frame reaches the destination, each header is stripped off at the appropriate layer. The layers read their header, the request from the originating DTE now being an indication that a connection needs to be set up. This would appear to the destination user at the application layer as an indication that the originating user wants to communicate. The answer would either be a "yes" or "no".

OSI		SNA
Application	Defines protocols for application programs.	End user
Presentation	Data formatting for application layer.	FMDS
Session	Establishes, terminates and maintains connection between end users.	DFC TX Control
Transport	Defines type of control used between nodes on network.	Path control
Network	Controls routing between network nodes.	Path control
Link	Defines protocols for error-free pipeline between two nodes.	Data link
Physical	Physical interfaces involved in connection to network.	Physical

Terms: FMDS — Function Management Data Services DFC — Data Flow Control TX Control — Transmission Control

Table 1: comparison of the layer functions for OSI and SNA.

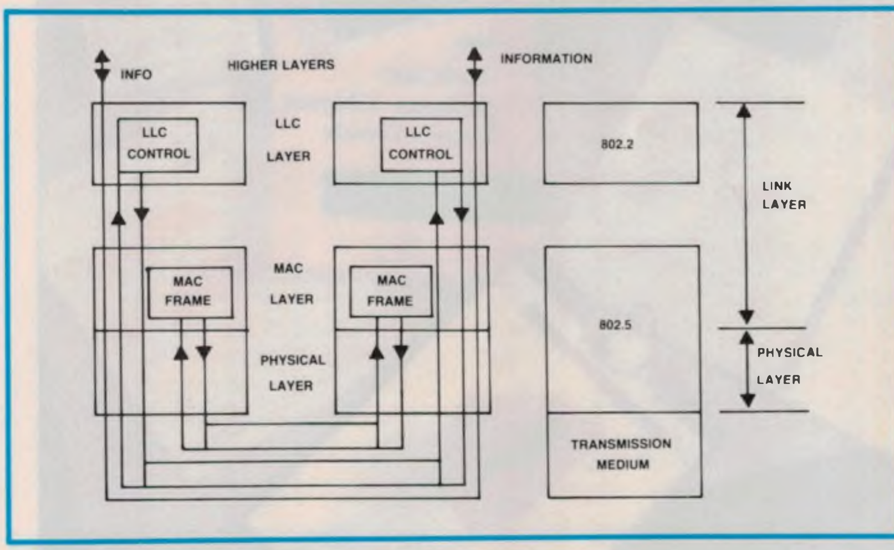


Fig.2: the pipeline layers and the IEEE 802 standard.

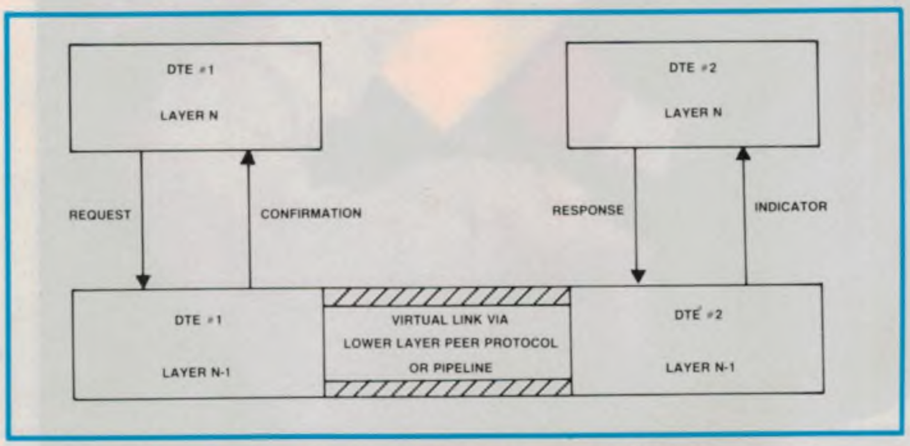
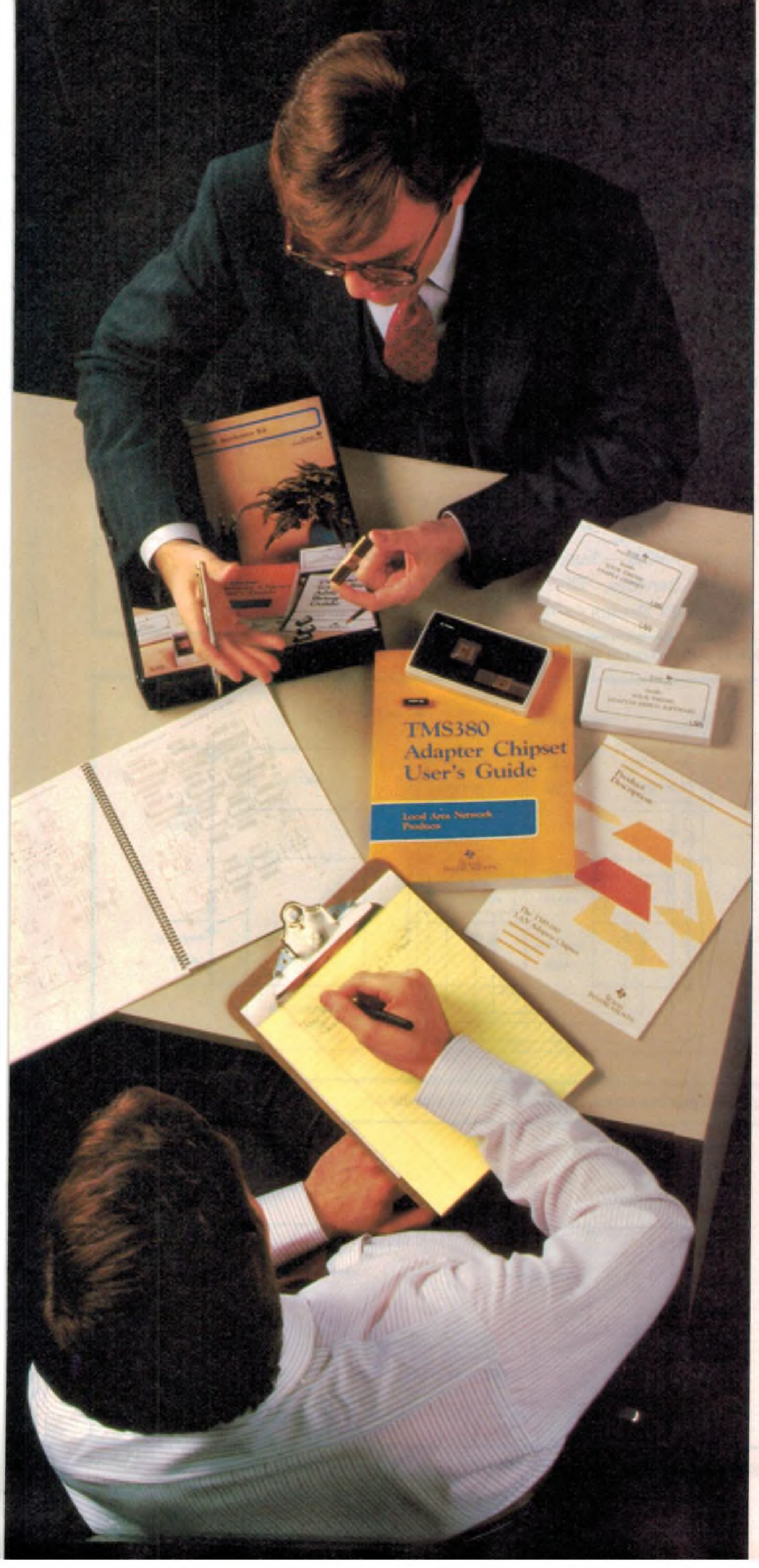


Fig.3: peer to peer protocol between layer N of DTE #1 and DTE #2.



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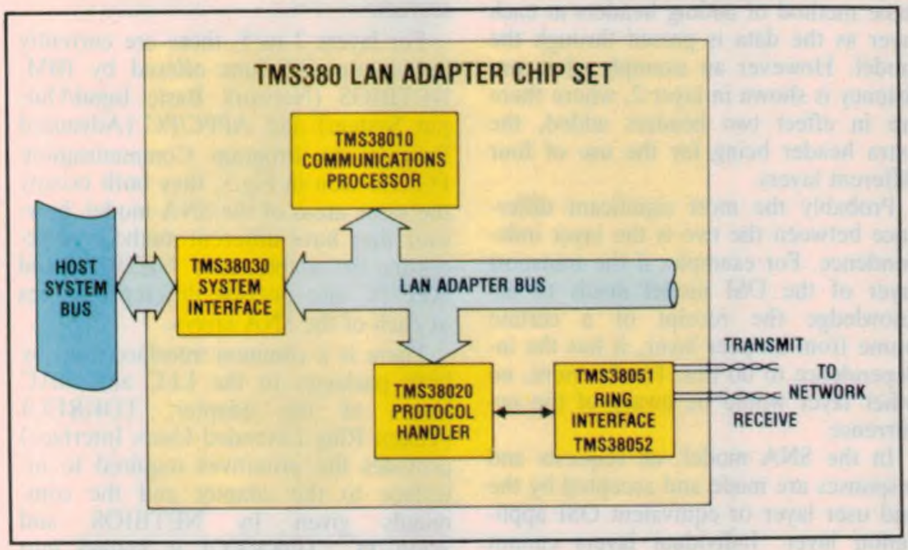
IBM compatibility with token-ring-LAN chip set.



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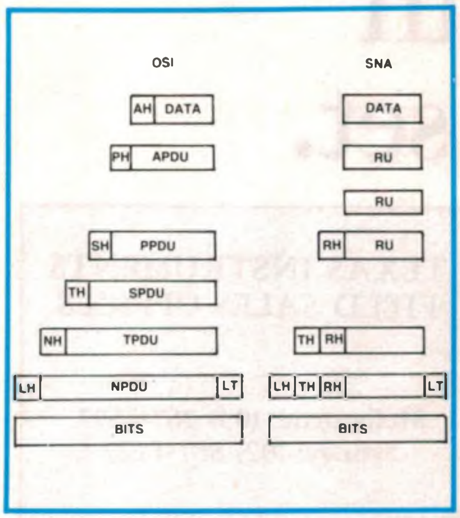

Fig.4: comparison of data transfer within models.

If communication is agreed upon, a response is sent from the destination user to the originator. Each layer of the destination must send a response to its peer layer for a connection to be made.

The responses from the destination appear as confirmations to all of the originator layers. The originating user would receive a message "connection confirmed" at their application layer.

The connection is now set up and data transfer can take place, each layer communicating data and connection status with its peer. If the destination did not want to communicate, a request would be sent to the originator to disconnect; this reply coming from either one of the layers or the user.

The SNA model

The SNA model functions similarly to the OSI model, except that the services that each layer (3 to 7) provides differ somewhat (see Fig.4). The manner in which data and control is transferred between layers is not consistent with the OSI model.

Generally the SNA model uses the same method of adding headers at each layer as the data is passed through the model. However an example of inconsistency is shown in layer 2, where there are in effect two headers added, the extra header being for the use of four different layers.

Probably the most significant difference between the two is the layer independence. For example, if the transport layer of the OSI model needs to acknowledge the receipt of a certain frame from its peer layer, it has the independence to do this. Furthermore, no other layer would be aware of the occurrence.

In the SNA model, all requests and responses are made and accepted by the end user layer or equivalent OSI application layer. Individual layers cannot act independently as they do in the OSI model. The end user selects the commands to be implemented by layers 2 to 5 in the SNA model. The results or acknowledgments of each of these layers are reported back to the end user, so that the next course of action for that layer can be implemented. This presents a more controlled environment, but timing issues regarding connection setup may be inferior to OSI.

IBM software

The software created by IBM for its PC networking products implements layers 2 to 5 of the SNA model. Application or end user layer software comes from both IBM and third party sources, only the layer 2 interface needing to be satisfied for successful SNA implementation. Such software may include data bases, word processors, file and printer servers.

For layers 2 to 5, there are currently two implementations offered by IBM, NETBIOS (Network Basic Input/Output System) and APPC/PC (Advanced Program to Program Communication/PC. As seen in Fig.5, they both occupy the same areas of the SNA model, however they have different methods of accessing the adapter card. NETBIOS and APC/PC also provide different services at each of the SNA layers.

There is a common interface used by both packages to the LLC and MAC layers of the adapter. TOKREUI (Token Ring Extended Users Interface) provides the primitives required to interface to the adapter and the commands given by NETBIOS and APPC/PC. TOKREUI is loaded into the PC initially, with parameters regarding whether the adapter is addressed by its burnt-in address or a software address, and what address of RAM the PC and adapter are going to share. The RAM share is necessary for the PC and adapter to exchange data blocks. TOKREUI, once loaded, stays resident and is accessed by interrupts from the higher layer software.

The NETBIOS emulator, used with DOS 3.2, is suitable for use on the token ring network. It is a session orientated package that implements data flow and presentation services. It interfaces directly to TOKREUI, bypassing layers 4 and 5. So in effect, NETBIOS provides the services of one and half layers. These services include recognising network names and cross-referencing them to network addresses. It also provides the services of the session layer.

The NETBIOS emulator is currently provided on the IBM token ring adapter in EPROM form and accessible via an interrupt from either an application program or the IBM PC LAN program. However, with IBM's latest announcement, NETBIOS will be sold with LLC and TOKREUI as a separate software package. The relevant software can then be downloaded to the adapter RAM in the initialisation stage.

The IBM PC LAN program, once loaded, remains resident and provides the interface to NETBIOS for those application programs that don't support

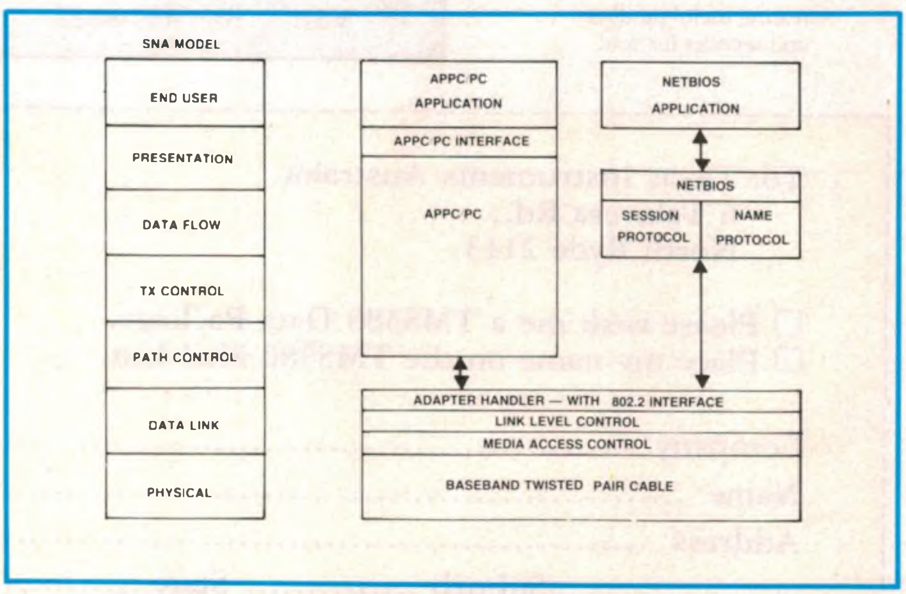

Fig.5: the SNA software options for Token-Ring.

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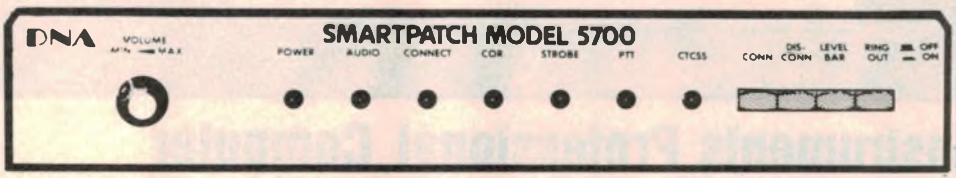

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the interrupt or control format required. The scenario is depicted in Fig.6. PC LAN can be accessed at DOS level via the re-director function.

When PC LAN is loaded there are parameters given, dictating the name and address of a file/printer server accessible by the DTE via the network. For example if a file server needs to be accessed, PC LAN is set up such that whenever a particular drive name is referenced (either at DOS level or by an application program), DOS redirects the reference to PC LAN. PC LAN, in conjunction with the name and address management provided by NETBIOS, then references the appropriate server connected to the network.

DOS was not originally designed to handle servers, and accordingly it tends to be inefficient as regards to speed. Vendors such as 3COM and NOVELL have designed proprietary operating systems which can handle server functions. NOVELL has also developed a NETBIOS emulator for non-IBM equipment, therefore providing access to the token ring network for other equipment manufacturers.

APPC/PC

APPC/PC works as a interrupt entrant, resident program, similar to NETBIOS and TOKREUI. It uses the interface of TOKREUI to access the adapter card. However APPC/PC implements 4 layers of the SNA model, therefore accessing TOKREUI through the path control layer. APPC/PC as the name suggests, was created to implement peer to peer communication between application programs. To facilitiate this, special control words known as verbs are used by the application to control the layers beneath it.

Due to the fact that APPC/PC implements more layers than NETBIOS, the services offered are more extensive. There are five categories that the application program verbs fall under. Control verbs are used to set up and manage the communications link; basic and mapped conversation verbs are used in the data transfer stage by transaction programs; network management verbs are used for network problem determination and recording. Other verbs are used for tracing a particular conversation across the network or converting, for example, ASCII code to EBCDIC.

Although APPC/PC may offer a better class of service, it was not originally designed for the token ring, but rather for an SNA distributed processing environment with intelligent communication between communication controllers.

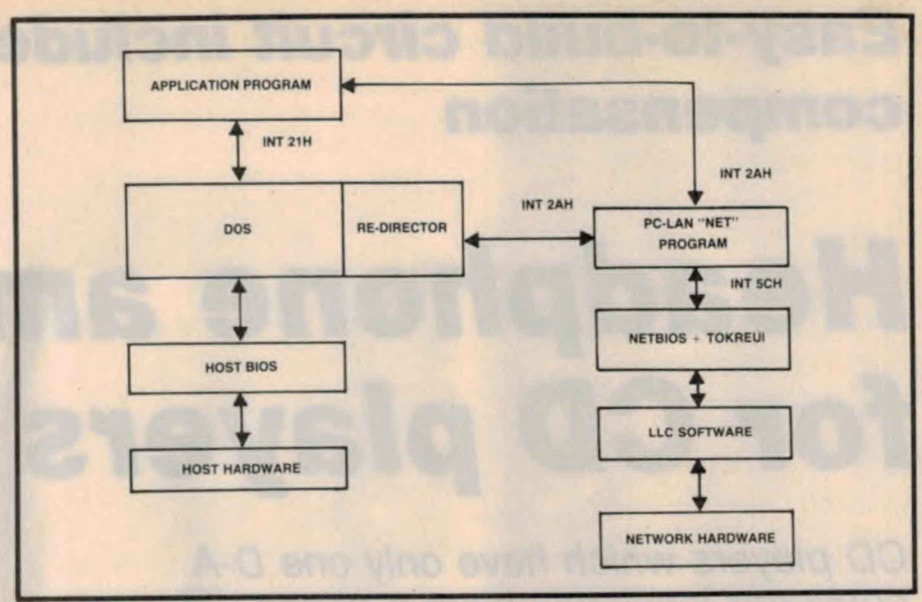


Fig.6: the PC-LAN scenario.

The token ring is in itself a reliable network, and somewhat slowed down by the redundant features offered by APPC/PC. With reference to the token ring LAN, APPC/PC is still in the early stages of development.

Others

Further software packages offered by IBM and others include those for interfacing of the token ring into an SNA distributed processing environment. IBM have software associated with the different servers, such as an asynchronous server program with which modems can be connected into the network. Also a bridging program is available, for interconnecting the Token Ring and PC networks.

For connection of the token ring to host computers, a package called NETVIEW/PC is available which is in effect a complete multitasking operating system. It enables the host to control and record all of the network management functions of the token ring, as it would in a distributed processing environment.

OSI software

As mentioned before, the validity of an architecture to function with the Token Ring is synonymous with the IEEE 802 interface that it provides. Two OSI based protocols, often referred to as OSI software standards, are General Motors' Manufacturing Automation Protocol (MAP) and Boeing's Technical and Office Protocols (TOP).

MAP is designed for the manufacturing process and the token bus topology is defined as its access technology. There are two other versions of MAP which offer improved performance and cost in the manufacturing cell area. These are MINI-MAP and MAP/EPA (MAP Enhanced Performance Architecture). These technologies will allow the use of a Token Ring network as their standard access technology.

TOP is designed for the office environment with the CSMA/CD access technology defined in its bottom layers. Token ring is now under consideration as another access technology under the TOP definition.

Both protocols support different application programs due to the different environments they service. However the protocols used are essentially the same for both. Both have been proven to run on the Token Ring.

Touch Communications has developed OSI MAP/TOP protocol software which runs successfully on the Token Ring network. Touch's software implements layers 3 to 7 of the OSI model, with the ability to link to any of the IEEE 02 access technologies. There is also the ability to communicate between the Token Ring and Ethernet networks using the routing capability inherent in the software.

Conclusion

As the software available for the Token Ring network becomes more versatile and efficient, the wider the applications for such a network will become. The fact that the software is not just IBM based means that the Token Ring can be used in different environments, supporting a variety of applications without tying the user down to one particular vendor in terms of sourcing and support.

Easy-to-build circuit includes group delay compensation

Headphone amplifier for CD players

CD players which have only one D-A converter inevitably have a phase difference between channels. This unit corrects that error and also provides two headphone outputs with adjustable level. It is a high performance circuit which does not degrade the CD signal quality.

by JOHN CLARKE

There are two possible reasons for building this project, depending on your requirements. The first reason could apply to most people who have a CD player. With the inclusion of a headphone amplifier and set of headphones, a compact disc player can become a complete and relatively inexpensive hifi system.

Let's face it. There are many times when it is not possible to listen via loudspeakers and so you are better off listening via headphones than not at all. The problem is, quite a few CD players do not have a headphone socket and if they do, the maximum output level may not be sufficient to drive all headphones to adequate sound levels.

Also, some CD players do not include a volume control for the headphone socket and this is unacceptable for anything more than the shortest of listening periods.

Of course, the chances are that your amplifier has a headphone socket with more than adequate output drive but there is something silly, isn't there, about listening to a pair of headphones via a 50 to 100 watt per channel amplifier. More often than not too, unless the amplifier's performance is exceptional, it will degrade the signal quality from your CD player.

Therefore, we have recognised that there is a need for a high quality headphone amplifier with performance equal to or better than compact disc standards. We also went one better than the typical amplifier by providing two headphone sockets.

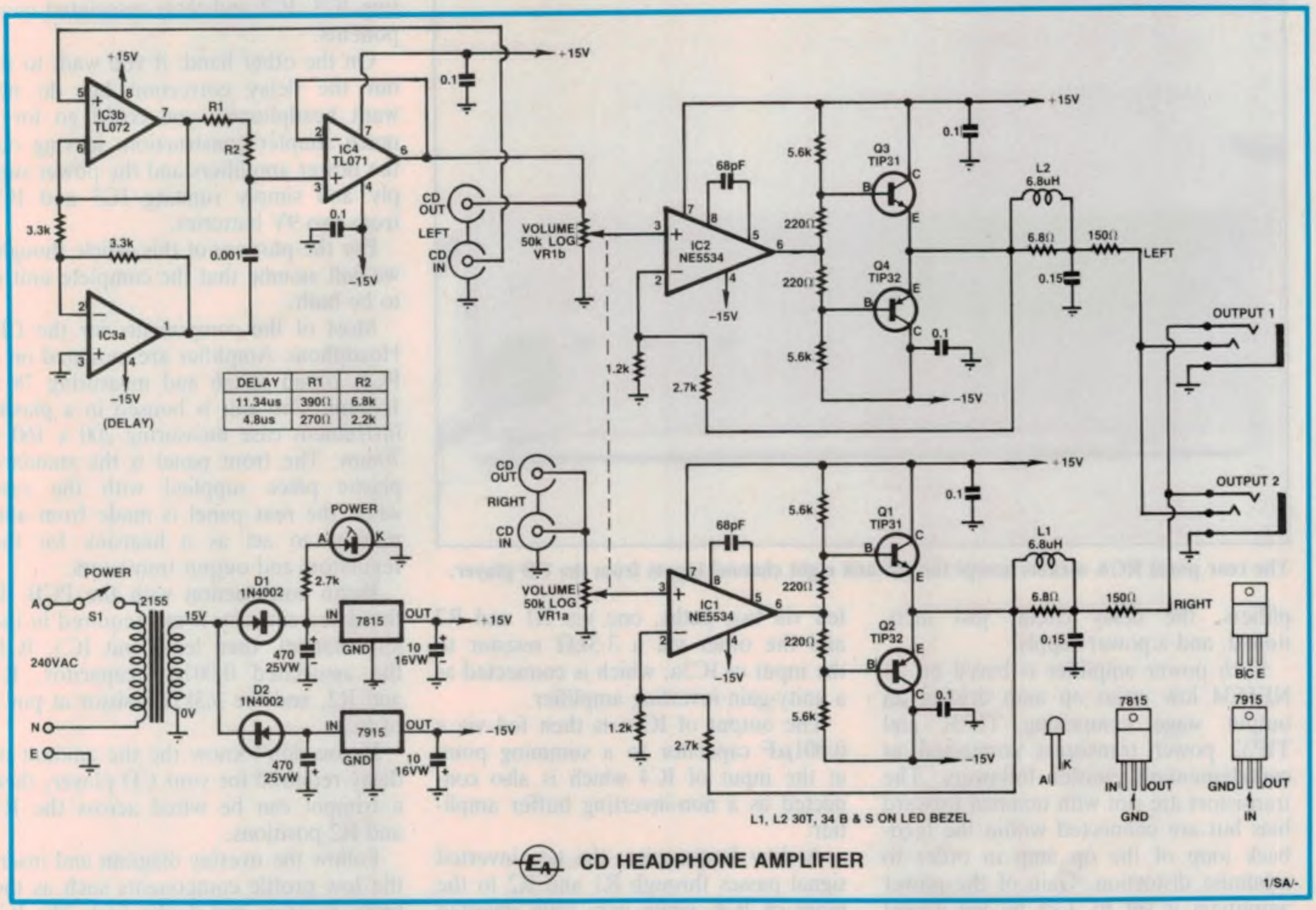
Phase error correction

The second feature of this project which is likely to be of interest to readers is the phase error correction circuit. This compensates for the inevitable phase error that occurs in CD players which use only a single digital-to-analog converter. The majority of CD players from Japan, with a number of notable exceptions, come into this category.

Strictly speaking, it is more correct to refer to group delay rather than phase delay. In a compact disc player, the digital information is read off the disc in serial form and stored in memory. Then the data is fed to the D-A decoder so that the signal for the left channel comes out slightly ahead of that for the right channel.

For some players with a single D-A decoder, the delay is 11.34μs while others have a shorter delay of 4.8μs. This delay applies to right-channel signals of all frequencies and constitutes a phase error which is directly proportional to frequency. For those decks with a delay of 11.34μs, the phase error at 20kHz is about 81 degrees while for those with 4.8μs delay, the phase error is about 35 degrees at 20kHz.

Whether or not this delay or phase error is audible probably depends on



The circuit consists of two low power amplifiers, a delay circuit (IC3 and IC4) and a power supply.

the listening situation. Significantly perhaps, most of the CD players from Europe which are highly regarded amongst audiophiles are Philips-based and have dual D-A decoders (14-bit with 4-times over-sampling) and hence no phase error. Notable CD players from Japan which feature dual D-A converters are Denon and Nakamichi and again, these players are highly regarded amongst audiophiles.

Those who discount the importance of this phase error point out that it amounts to a path difference from the speakers to the ear of less than 4mm. For headphone listening it may be more significant.

Whether or not you believe the phase error to be significant is perhaps unimportant. Those who believe that it is important now have the means to correct it. Those who believe that it is unimportant can build this circuit (or the relevant part thereof) to put their belief to the test.

Unfortunately, the right channel delay is not specified by manufacturers of players with a single D-A converter. Some typical figures for current model CD players are as follows: ADC CD100X, 4.8μs; Audio Technica AT-CD20, 11.34μs; Onkyo DX-200, 4.8μs; Pioneer PD-M6, 11μs; Sharp DX-111, 4.8μs; and Sony CDP-502ES, 4.8μs.

Readers with other CD players will need to determine the delay between channels before completing the headphone amplifier. This will be discussed later in the article after the construction.

Features

Our CD Headphone Amplifier is housed in a plastic instrument case and is powered from the mains. The front panel features include a power on/off switch, volume control and two headphone sockets.

At the rear is a four-way RCA socket panel which provides for the left and right CD inputs and sockets for the right and delayed left outputs. These can be applied to the input sockets of a power amplifier.

Circuitry

The CD Headphone Amplifier comprises two high-quality low-power am-

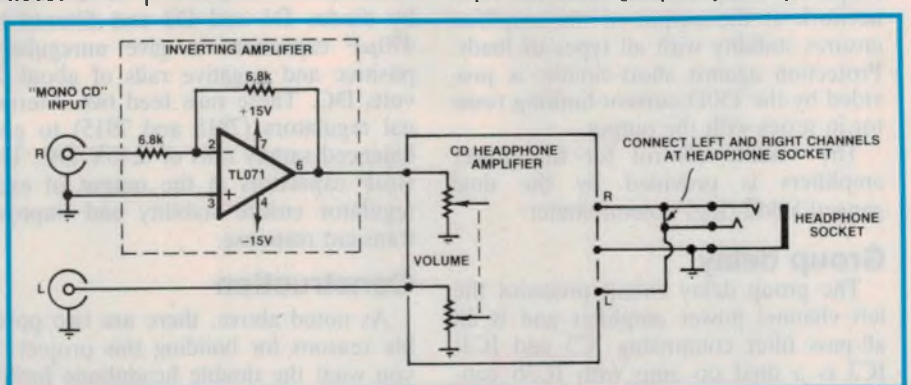
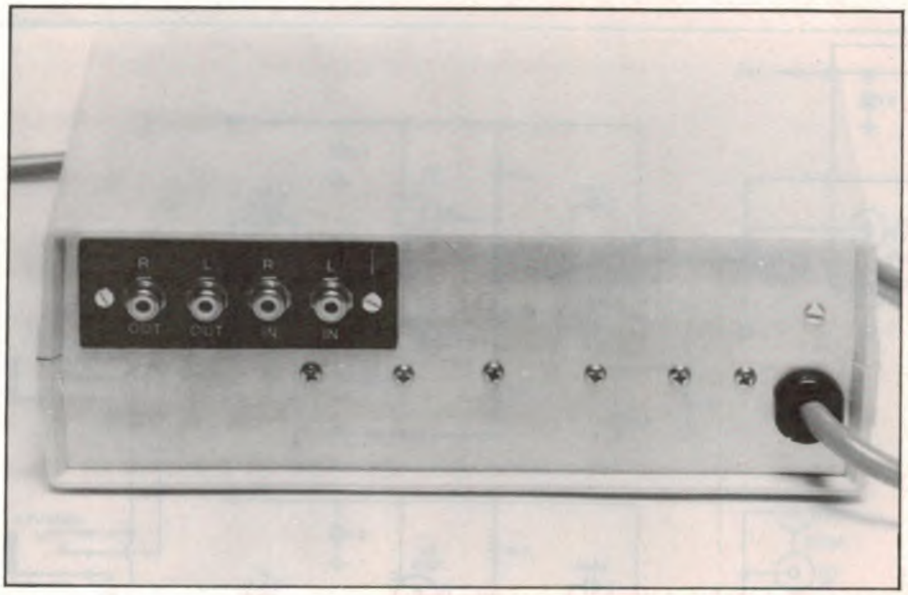


Fig.1: arrangement for adjusting the delay circuit in the headphone amplifier. A 10kΩ trimpot is substituted for R1 and R2 and adjusted for minimum sound output.



The rear panel RCA sockets accept the left and right channel inputs from the CD player.

plifiers, the delay circuit just mentioned, and a power supply.

Each power amplifier is based on an NE5534 low noise op amp driving an output stage comprising TIP31 and TIP32 power transistors connected as complementary emitter followers. The transistors are run with minimal forward bias but are connected within the feedback loop of the op amp in order to minimise distortion. Gain of the power amplifiers is set to 3.25 by the 1.2kΩ resistor at the inverting input and the 2.7kΩ feedback resistor.

The quiescent forward biasing for the driver output is supplied by the two 220Ω biasing resistors between the bases of the two transistors and the 5.6kΩ resistors from the bases to the positive and negative supply rails. The resulting bias is not enough to cause significant current to pass through the output transistors but is enough to effect a major reduction in crossover distortion.

A 68pF capacitor connected to pins 5 and 8 of the NE5534 op amp provides frequency compensation while the RLC network at the output of the amplifier ensures stability with all types of loads. Protection against short-circuits is provided by the 150Ω current-limiting resistor in series with the output.

The volume control for the power amplifiers is provided by the dual ganged 50kΩ (log) potentiometer.

Group delay

The group delay circuit precedes the left channel power amplifier and is an all-pass filter comprising IC3 and IC4. IC3 is a dual op amp with IC3b connected as a unity gain non-inverting buffer. The output signal from IC3b is fed via two paths, one via R1 and R2 and the other via a 3.3kΩ resistor to the input of IC3a, which is connected as a unity-gain inverting amplifier.

The output of IC3a is then fed via a 0.001μF capacitor to a summing point at the input of IC4 which is also connected as a non-inverting buffer amplifier.

At low frequencies, the non-inverted signal passes through R1 and R2 to the input of IC4, while very little inverted signal is transmitted via the 0.001μF capacitor. At higher frequencies, the capacitor allows more inverted signal from IC3a to pass through to the input of IC4. Since this summing point combines the non-inverted signal and the inverted signal, the result is a gradual phase delay which increases with frequency.

For a required delay of 11.34μs, R1 and R2 should be 390Ω and 6.8kΩ respectively. For a delay of 4.8μs, R1 and R2 should be 270Ω and 2.2kΩ respectively.

The power supply uses a 15VAC transformer which is half wave rectified by diodes D1 and D2 and filtered by 470μF capacitors to give unregulated positive and negative rails of about 20 volts DC. These rails feed two 3-terminal regulators (7815 and 7915) to give balanced supply rails of ±15V DC. The 10μF capacitors at the output of each regulator ensure stability and improve transient response.

Construction

As noted above, there are two possible reasons for building this project. If you want the double headphone facility but do not require the delay correction circuitry, it is simply a matter of omitting IC3, IC4 and their associated components.

On the other hand, if you want to try out the delay correction but do not want headphones, you could go for a much simpler construction, leaving out the power amplifiers and the power supply and simply running IC3 and IC4 from two 9V batteries.

For the purpose of this article though, we will assume that the complete unit is to be built.

Most of the components for the CD Headphone Amplifier are mounted on a PCB coded 87ha6 and measuring 78 x 168mm. The unit is housed in a plastic instrument case measuring 200 x 160 x 70mm. The front panel is the standard plastic piece supplied with the case while the rear panel is made from aluminium to act as a heatsink for the regulators and output transistors.

Begin construction with the PCB. If the delay circuitry is not required in the left channel, then leave out IC3, IC4, the associated 0.001μF capacitor, R1 and R2, and the 3.3kΩ resistor at pin 2 of IC3.

If you don't know the the amount of delay required for your CD player, then a trimpot can be wired across the R1 and R2 positions.

Follow the overlay diagram and insert the low profile components such as the links, resistors and diodes first. The ICs can then be inserted. Make sure that ther are correctly oriented before soldering them in place.

We used PC stakes for all external connections to the PCB including the driver transistors and regulators. This facilitates wiring and connection to the transistors and regulators once the PCB is installed in the case.

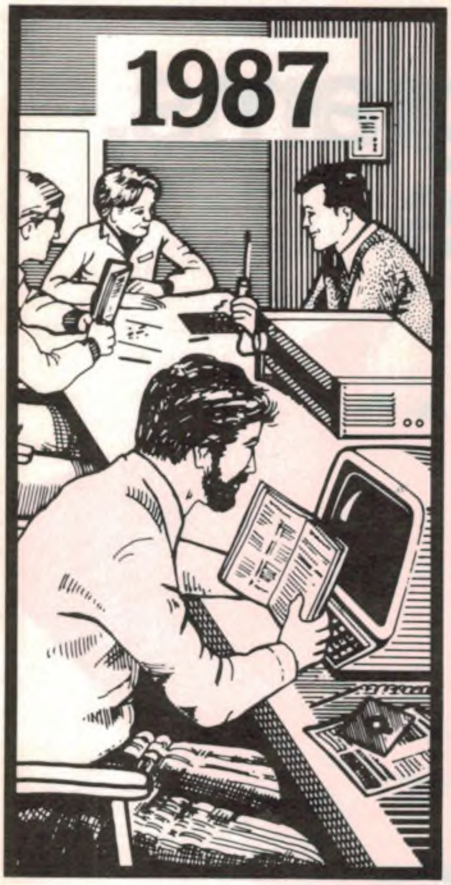
Now the capacitors can be installed. Make sure that the electrolytics are oriented as shown on the overlay diagram.

In the prototype, L1 and L2 were made by winding 30 turns of 34 B&S enamelled copper wire around 5mm LED bezels which act as formers. Strip back the insulation from the ends of the wires to allow the coils to be soldered to the PCB.

The PCB can now be secured to the base of the case using self-tapping screws into the integral spacers. Insert the aluminium rear panel into place and mark the locations for the regulators and transistors directly opposite their respective hole locations in the PCB.

Mark out the holes required to mount the cord clamp grommet, earth lug and 4-way RCA socket panel. Drill all the necessary holes in the rear panel.

The front panel should also be drilled



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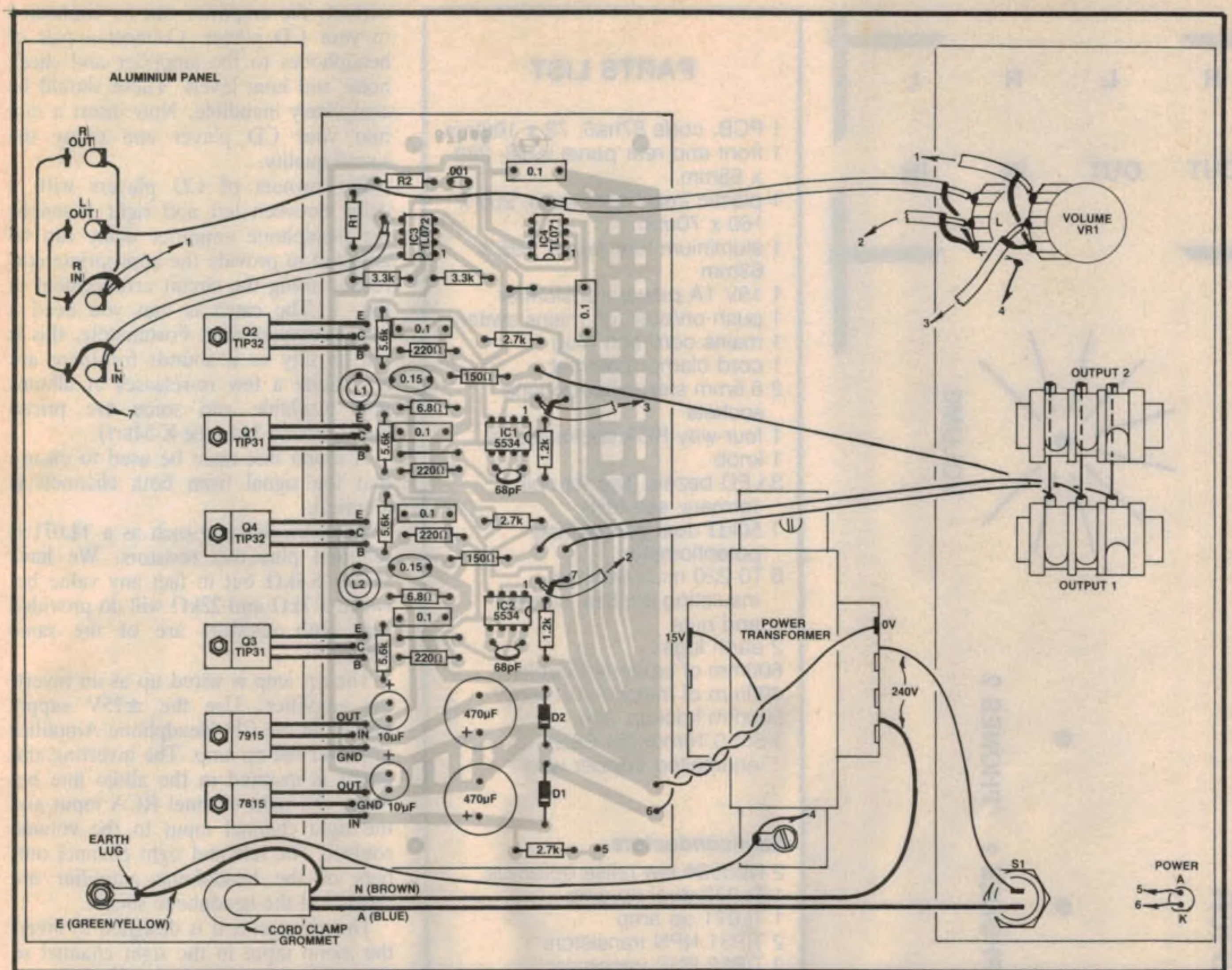


Q1-Q4 and the two 3-terminal regulators must be isolated from the aluminium panel using mica washers and insulating bushes.

at this stage. Use the front panel artwork as a guide for marking out the hole positions for the mains power switch, LED, headphone sockets and volume control.

Mount the RCA socket panel and the power switch, LED, headphone sockets and volume control. The transistors and regulators are mounted using mica washers and insulating bushes to isolate the metal tabs of the devices from the rear panel. Use heatsink compound between the mating surfaces to provide better heat conduction.

Once the devices are mounted, slide the rear panel into the case and solder the device leads to the PC stakes provided for connection to the PCB.

The next step is to mount the transformer on the base of the case using the integral standoffs and self-tapping screws. Remember to insert an earth lug under one of the mounting points of the transformer so that it can be earthed.

Follow the wiring diagram when making all the external connections to the printed circuit board. Clamp the three-core mains cord into the cord clamp grommet and solder the green/yellow earth lead to the earth lug on the rear panel. Continue with the earth wiring from the rear panel earth lug to the transformer earth lug. A wire then runs from this lug and is soldered to the case of the volume potentiometer.

The Active (blue) mains wire connects directly to the power switch, while the Neutral (brown) wire connects directly to one of the 240V lugs on the transformer. The second 240V transformer lug connects to the remaining switch contact.

It is important to insulate all the bare mains connections on the switch and transformer using insulating sleeving. This will avoid any possibility of accidental contact with the mains.

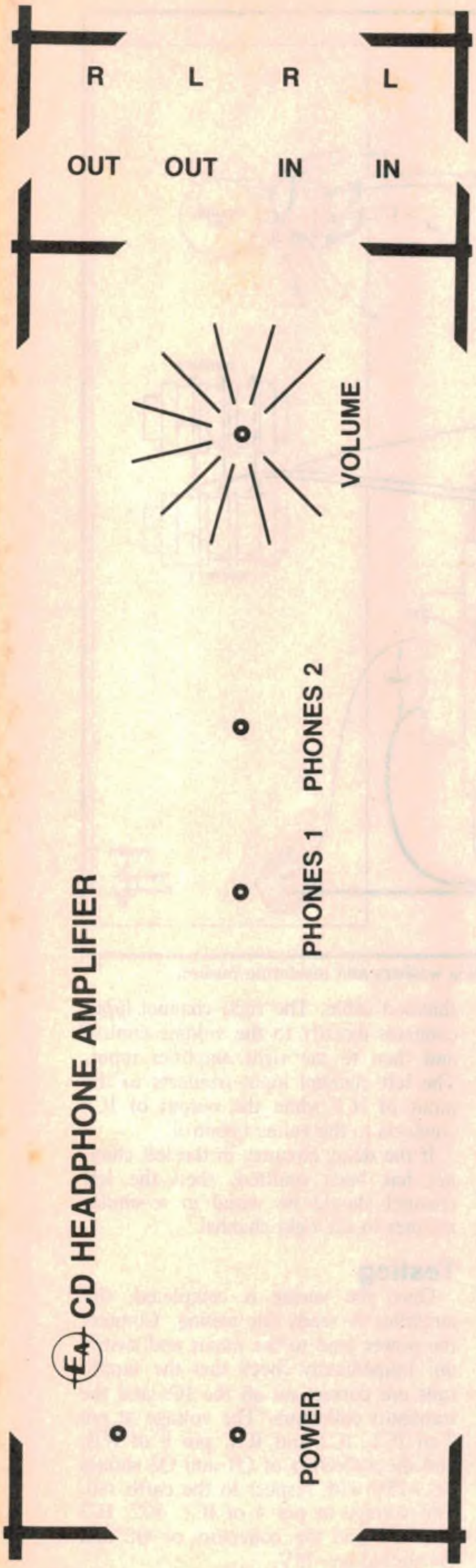
Wiring from the CD inputs to the PCB and volume control is made using shielded cable. The right channel input connects directly to the volume control and then to the right amplifier input. The left channel input connects to the input of IC3 while the output of IC4 connects to the volume control.

If the delay circuitry in the left channel has been omitted, then the left channel should be wired in a similar manner to the right channel.

Testing

Once the wiring is completed, the amplifier is ready for testing. Connect the power lead to the mains and switch on. Immediately check that the supply rails are correct on all the ICs and the transistor collectors. The voltage at pin 7 of IC1, IC2 and IC4, pin 8 of IC3, and the collectors of Q1 and Q3 should be +15V with respect to the earth rail. The voltage at pin 4 of IC1, IC2, IC3 and IC4 and the collectors of Q2 and Q4 should be –15V.

Once the voltages are found to be



PARTS LIST

1 PCB, code 87ha6, 78 x 168mm
1 front and rear panel label, 229 x 65mm
1 plastic instrument case, 200 x 160 x 70mm
1 aluminium rear panel, 195 x 63mm
1 15V 1A power transformer
1 push on/push off mains switch
1 mains cord and plug
1 cord clamp grommet
2 6.5mm stereo headphone sockets
1 four-way RCA socket panel
1 knob
3 LED bezels (two for coil formers; see text)
1 50kΩ dual ganged log potentiometer
6 T0-220 mica washers, insulating bushes, screws and nuts
2 earth lugs
600mm of screened cable
400mm of mains earth wire
800mm hookup wire
1.5m 0.16mm (34 B&S) enamelled copper wire

Semiconductors

2 NE5534 low noise op amps
1 TL072 dual op amp
1 TL071 op amp
2 TIP31 NPN transistors
2 TIP32 PNP transistors
1 7815 3-terminal regulator
1 7915 3-terminal regulator
2 1N4002 1A diodes
1 5mm LED

Capacitors

2 470μF 25VW PC electrolytic
2 10μF 16VW PC electrolytic
2 0.15μF metallised polyester
6 0.1μF metallised polyester
1 0.001μF metallised polyester
2 68pF ceramic

Resistors (0.25W, 5%)

4 x 5.6kΩ, 2 x 3.3kΩ, 2 x 2.7kΩ, 2 x 1.2kΩ, 4 x 220Ω, 2 x 150Ω, 2 x 6.8Ω, R1, R2 (see text)

Miscellaneous

PC stakes, self tapping screws, machine screws and nuts.

Left: this actual size artwork can be used as a drilling template for the front panel.

correct, the amplifier can be connected to your CD player. Connect a pair of headphones to the amplifier and check noise and hum levels. These should be completely inaudible. Now insert a disc into your CD player and enjoy the sound quality.

For owners of CD players with a delay between left and right channels, the headphone amplifier delay can be adjusted to provide the appropriate correction using the circuit arrangement in Fig. 1. The catch is that you need a mono compact disc. Fortunately, this is not as silly as it sounds for there are now quite a few re-releases of albums now available and some are priced down around $14 (see K-Mart).

A mono disc must be used to ensure that the signal from both channels is identical.

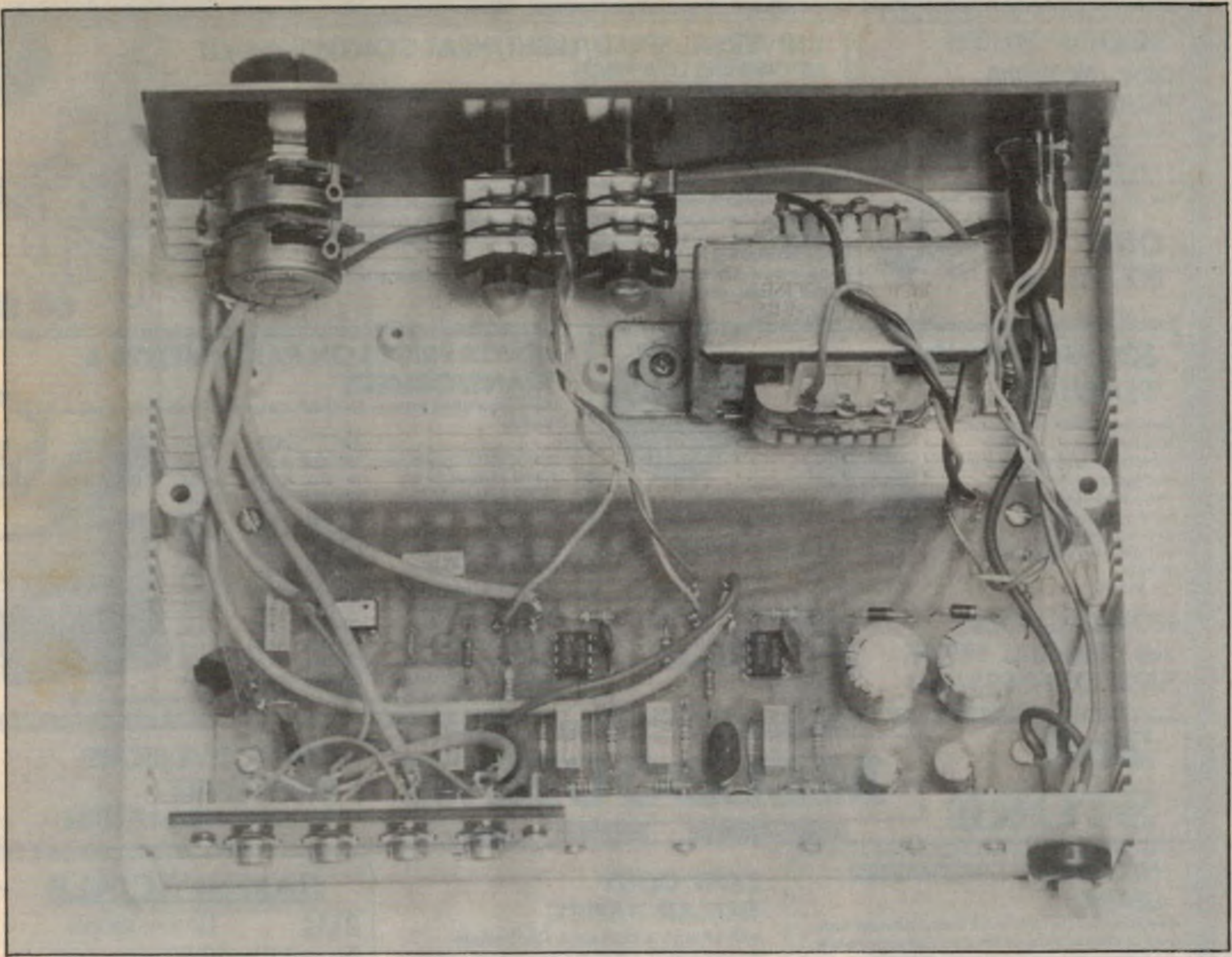
An extra op amp such as a TL071 is required plus two resistors. We have shown 6.8kΩ but in fact any value between 4.7kΩ and 22kΩ will do provided that both resistors are of the same value.

The op amp is wired up as an inverting amplifier. Use the ±15V supply rails from the CD Headphone Amplifier to power the op amp. The inverting amplifier is inserted in the audio line between the right channel RCA input and the right channel input to the volume control. The left and right channel outputs of the headphone amplifier are shorted at the headphone socket.

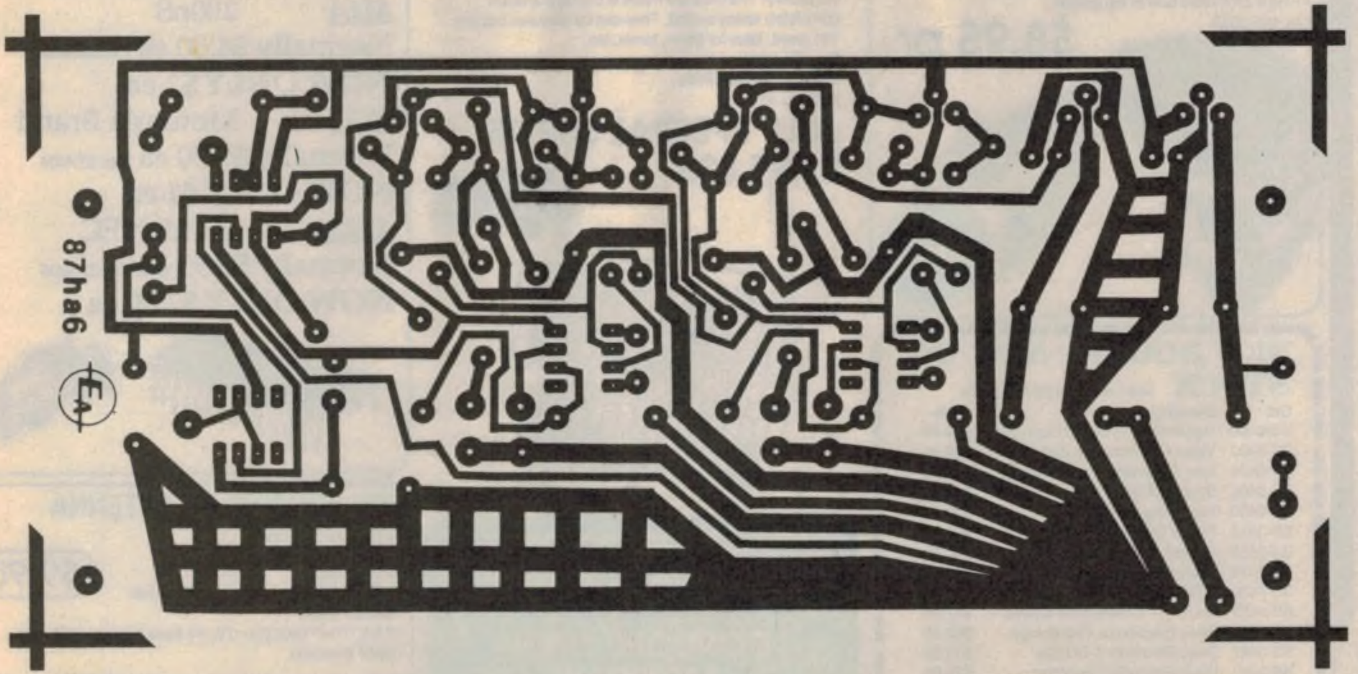
The arrangement is designed to invert the mono input in the right channel so that when the signal is mixed at the headphone socket there should be no signal due to total cancellation. If the signal is delayed in one channel, then cancellation will not be complete and a signal will be audible. In practice, the cancellation is not total, due to slight differences in level between the two channels.

Adjust the value of the R1 and R2 resistors using a trimpot for minimum sound from the headphones. This sets the phase delay within the headphone amplifier to completely compensate for the delay in one channel of the CD player. Once this has been done, measure the resistance value set for the trimpot and replace it with two series resistors which add up to give the same value.

Finally, remove the external inverting amplifier from the right channel input and remove the short between the left and right channels at the headphone socket and place the lid on the case. The headphone amplifier is now complete.



Above: view inside the prototype. Make sure that the mains cord is securely clamped and sleeve the switch contact with plastic tubing to prevent accidental shock.



Here is the full size artwork for the PCB.

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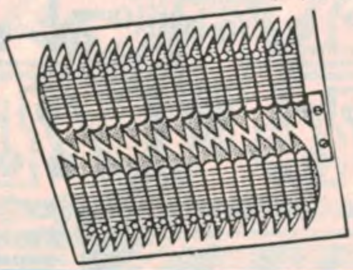

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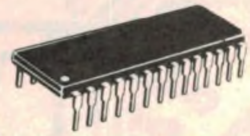

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We have a small quantity of a Univolt Pocket DVM. The unit measures only 56(W) x 108(H) x 10(D)mm. It's auto-ranging, 3.5 digit and complete with a case which fits inside your top pocket.

Functions: DC and AC volts 2, 20, 200, 400.

Resistance 200, 2k, 20k, 200k, 2M

Overload protected and complete with batteries.

Normally $69.95
A few left for only
$50.00 each

DIRT CHEAP!!

Cat. QM-1510

MIXED COMPONENT PACKS - SAVE HEAPS!!

We reserve the right to make changes to these packs if stock shoratges occur

DIRT CHEAP!!

NEW ELECTROLYTIC PACK

- Contains over 80 assorted electrolytics
- Most are normal stock lines
- Types supplied: 1, 2.2, 10, 22, 25, 47, 100, 150, 220, 470, 680, 4700, 10,000uF
- Voltages 6.3, 10, 16, 25, 35, 40, 50, 63, 250V
- At our current prices these caps are worth $85.00
- That's only 12¢ per capacitor

Cat. RE-6260

80 PRIME SPEC ELECTROS FOR $10.00 SAVE 88%

NEW

MIXED CAPACITOR PACK

Don't miss this bargain!

This pack contains approx. 150 assorted capacitors. Not junk values, most are normal stock lines. Here's what you get:

RT Electro	1, 4.7, 25, 100, 220, 470uF most 63V
RB Electro	1, 2.2, 25, 47uF
Greencap	100V - 0.0022, 0.01, 0.22, 1uF
Greencap	630V - 0.022, 0.1uF
Ceramic	4.7, 47, 220, 470pF, 0.022uF
Polystyrene	220, 820, 2200pF
1kV Ceramic	330, 470, 680pF

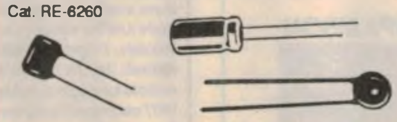
PLUS LOTS MORE

150 PRIME SPEC CAPACITORS FOR $10.00

THAT'S ONLY 6¢ EACH!! SAVE 84%

At our current prices these caps are worth $61.00!!

Cat. RE-6260



POT PACK

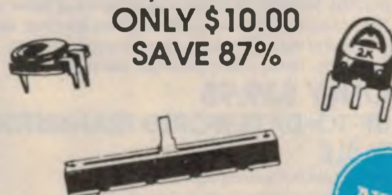
After the huge success of our Plessey pot pack, we present our new one.

This pack includes trimpots of various styles, switchpots and expensive slider pots. There is a minimum of 10 sliders, dual sliders sell for $5.50 each. If you only use two sliders, you will be in front, not to mention the trimpots. Typical values included are: 500, 2k, 5k, 20k, 100k, 250k, and 500k ohm. The pack includes at least 35 items.

We estimate the current retail price of pots in the pack to be over $82.

Cat. RP-3902

35 POTS/TRIMMERS FOR ONLY $10.00 SAVE 87%



NEW

2nd STORE MELBOURNE

OLD ACTIVE STORE SPRINGVALE TELEPHONE 547 1022

ULTRASONIC PEST INSECT REPELLER

(full details 1987 Jaycar Catalogue.)

Cat. YS-5510

SAVE $30.05

ONLY $24.95 Less than 1/2 price

SENSATIONAL BUY OF 1987!!!

Jaycar is proud to announce that we have made a SCOOP PURCHASE of genuine VIATEL terminals WITH 14" COLOUR MONITOR at an unbelievable price!!

We can pass ENORMOUS SAVINGS on to you as a result! RGB MONITOR. Such is the quality of this system the monitor has RGB input. RGB signals from a suitable computer can be connected to the monitor so that it can double as a high res COLOUR computer monitor! With a composite RGB adaptor you can use virtually any computer!

VIATEL ADAPTOR. The adaptor is professionally made by Philips & INCLUDES an inbuilt modem to Viatel standard (1200/75). It features:

- Detachable remote keypad
- Keylock ON/OFF switch
- Centronics type printer port
- Telecom approved (C82/39/489)
- Tape record port
- Full keyboard port
- Instructions

WANT TO KNOW MORE?
Ring (02) 747 2022
and ask for "Mr Viatel"
for full details

ONLY $399 SAVE A FURTHER $100

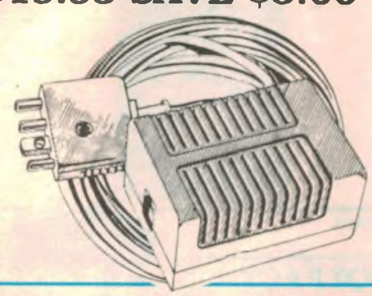
We must emphasise that these units are from 3-5 years old but are in a very clean and good condition

TELEPHONE EXTENSION BELL

This compact unit is supplied with 10 metres of cord fitted with a standard Telecom plug. Simply plug into a wall outlet and it will ring at the same time as your telephone. A LED is fitted as well which will flash. (Note: if you only have one telephone outlet a double adaptor will be required (Cat. YT-6020 - $7.50)
Cat. YT-6030

DIRT CHEAP!!

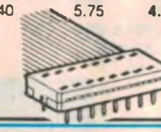
WAS $24.95
JULY ONLY
$19.95 SAVE $5.00



LOWER PRICES ON DIL INSULATION DISPLACEMENT CONNECTORS

DIRT CHEAP!!

Cat	Pins	Was	Now	10 up
PI-6549	14	2.75	**1.95**	1.75
PI-6550	16	2.95	**2.25**	2.00
PI-6555	24	4.50	**3.95**	3.70
PI-6558	40	5.75	**4.95**	4.60



TRANSISTOR BARGAIN

2N5415 PNP, 200V, 1A, metal TO-5 case.

Cat. ZT-2365

Normally 50¢ ea
JULY SPECIAL
10 for $1.00
50 for $3.50
100 for $6.00

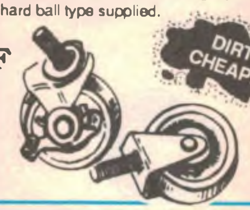
TURN YOUR SURPLUS STOCK INTO CASH!! Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.
CALL GARY JOHNSTON OR BRUCE ROUTLEY NOW ON (02) 747 2022

CASTORS

Four castors to suit large speaker boxes or anything for that matter. Drill a 1/4" hole and self tap into wood. Please note that the illustration shows a castor slightly different to the Shephard ball type supplied.
Cat. HP-0835

50% OFF
ONLY
$5.00
for 4

DIRT CHEAP!!



CONCORD OPEN SATURDAY 9am - 12 noon

2nd STORE MELBOURNE

OLD ACTIVE STORE
SPRINGVALE
TELEPHONE 547 1022

IC SUBSTITUTION MANUAL

This book is as good as they come. Lists all of the current ICs from 108 of the western worlds manufacturers. National Semiconductor lists 19 pages, (4 cols/page) of their products. Motorola 19 pages, RCA 9 pages and Texas 18 pages.
Many obscure (to Australia) manufacturers are listed. And that's only half the book! The other half of the book lists the generic number of the IC.
358 pages, 190(w) x 262(h)mm. Cat. BM-4552

ONLY $39.95

UP-TO-DATE WORLD TRANSISTOR COMPARISON TABLE

784+ pages of transistor equivalents in strict alpha-numeric order. Each device is briefly described by its prime maker, material, polarity, case type and lead configuration, function and whether a complimentary version exists.
Equivalent parts listed.
790 pages, 110(w) x 145(h)mm. Cat. BM-4550

ONLY
$29.95

PASSIVE INFRA RED DETECTOR

with Pulse Count Triggering

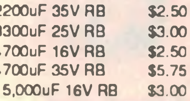
The absolute latest technology is used in this PIR. It employs a pusle count triggering circuit which virtually eliminates false alarms. The circuit first senses an alarm (pulse 1) and then goes into an alarm standby mode for 30 seconds. If during this period a second alarm event occurs (pulse 2) the unit goes into alarm mode and the standby period is extended a further 30 seconds. If there is no alarm pulse during this 30 seconds the unit returns to normal condition. Also suitable for single shot triggering. See the Jaycar 1987 catalogue for full technical specifications.
Cat. LA-5019

ONLY $139

HI QUALITY ELECTROLYTICS

Jaycar has made a scoop purchase of extremely high quality electrolytic capacitors made in JAPAN by National. The capacitors are RB type with lugs that will solder into a 1.5mm hole. These are about half the price you would expect to pay.

Cat	Value	1-9	10 up
RE-6241	2200uF 35V RB	$2.50	$2.00
RE-6242	3300uF 25V RB	$3.00	$2.50
RE-6243	4700uF 16V RB	$2.50	$2.00
RE-6244	4700uF 35V RB	$5.75	$5.00
RE-6249	15,000uF 16V RB	$3.00	$2.50



SCOOP BUY

NEW

BETTER RADIO/TV RECEPTION

This book describes a simplified approach to improving one's radio or TV reception by gaining an understanding of the principles. Technical concepts have been presented in plain language. Whilst most readers on this subject have confined themselves to short wave reception, this book covers all broadcasting bands, including TV. This book aims to plug the gap between the textbooks and the leaflet that came with your TV or radio. This is the FIRST such book published in Australia according to Radio Australia.

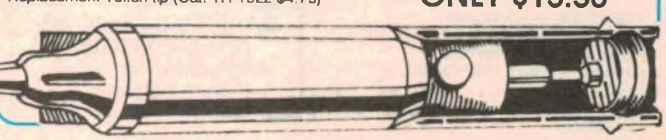
Contents:
Chapter 1 - Radio/TV reception - an overview
Chapter 2 - The broadcasting bands
Chapter 3 - Receivers
Chapter 4 - Antennas
Chapter 5 - Advanced topics
Chapter 6 - The broadcasters
Chapter 7 - The hobby of radio DXing
Cat. BA-1150

$19.95

DESOLDERING TOOL

As reveiwed by Electronics Australia. This unit has many excellent features. Clear body to see when it's full, incredibly strong suction power. Made from high density polycarbonate plastic, one hand, easy to use operation and an automatic tip cleaner action. There's even a hole in it to hang on a hook. Supplied with Teflon tip.
Cat. TH-1820
Replacement Teflon tip (Cat. TH-1822 $4.75)

ONLY $15.50

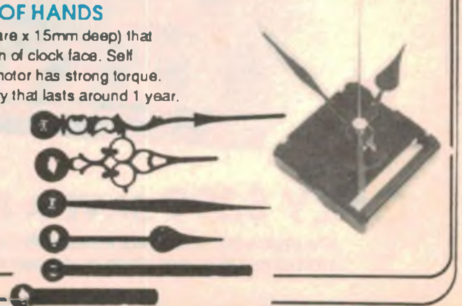


QUARTZ CRYSTAL CLOCK MOVEMENT

SUPPLIED WITH 3 SETS OF HANDS

Very compact unit (56mm square x 15mm deep) that can be used in your own design of clock face. Self starting one second stepping motor has strong torque.
Powered by 1 x 1.5V AA battery that lasts around 1 year.
Accuracy is ±15 secs/month.
Cat. XC-0100

ONLY
$12.95



Includes sweep second hand

MASSIVE SCOOP PURCHASE

SAVE OVER 50%

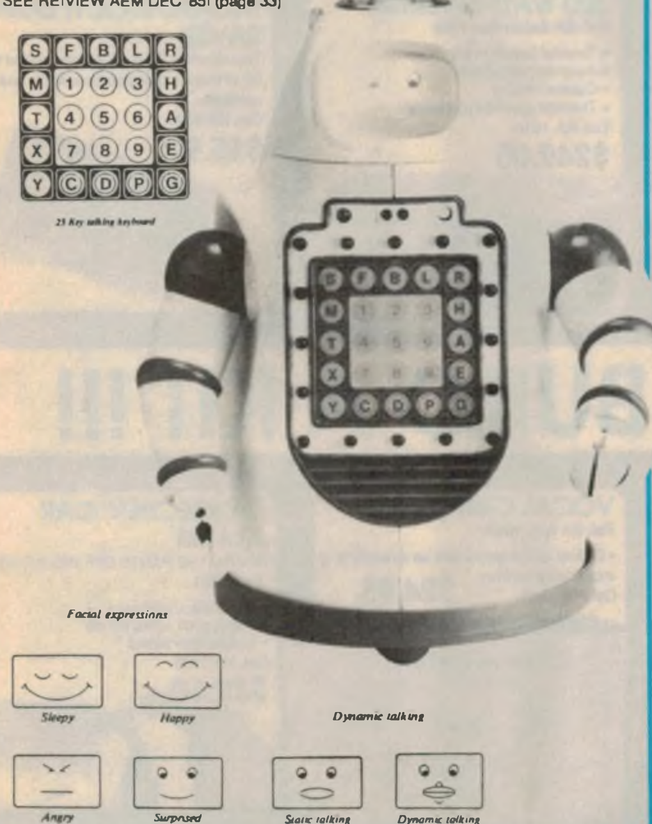
The most sensational personal robot we have EVER SEEN!!

- NOT ONLY does this robot TALK to you, it has an LCD 'face' with lips that move in synchronisation! How would you like a robot to have these features?
- Up to 206 words of speech
- Tactile bumper sensors
- Infra red sensor - sees in the dark!
- MOBILITY. Forward AND backwards in 2 speeds! Right and left turning AS WELL AS curved right and left turning!
- 25 key TALKING keypad with 16 blinking lights
- Individual security code. Supplied with individual plastic ID card!
- LCD face. 4, yes FOUR expressions, happy, surprised, angry and sleepy, and remember the lips move too!!
- Other blinking LEDs on head and chest which work with the voice
- TWO mechanical arms with grippers - up, down, open, close
- 8 bit microprocessor
- 4k RAM for operations
- 16k speech processor, 2 x 128k ROM chips for vocabulary!
- Full alphanumeric programming keypad
- Comprehensive programming and troubleshooting manual

Well! See what we mean? We trust that you are as convinced as we are!!
Once again (boring isn't it), we have made a SCOOP PURCHASE from an importer. The LANDED COST plus sales tax is well above the price that we offer these goods to you. The original recommended price of the goods was $199. You can have an "ELAMI Jr" running around your lounge room for only $99!!
Once again (boring!) we only have a limited number of Elami Jr's - ACT NOW!
Cat. XR-1030
(Requires 4 x "AA" & 4 x "C" batts - not included). SIZE 300(H)x 175(D) x 235(W)mm

ONLY $99.00

SEE REIVIEW AEM DEC '85! (page 33)



"SPY-IN-THE-SKY" SENSOR

Jaycar is proud to announce that we stock a Pyroelectric Infra-Red Sensor Element. This is the 'eye' of a passive infra-red detector.
The Murata IRA.F001-P is tiny! It measures 10mm high, 9mm wide and only 6.2mm deep. The element is a ceramic-ferroelectric (modified Lead Zirconate Titonate) which is very stable with VERY high sensitivity and wide spectral response - (1-20um)!
The IRA.F001-P comes complete with full technical data including performance graphs, information on the operating principle and two typical application circuits!
Typical Applications:

- Burglar Alarms
- Proximity Detectors
- Automatic door/shutter switch
- Toys, robotics
- Accident prevention/machine guard
- Electronic appliances
- Automatic lighting (in toilet?)

Jaycar (once again!) has purchased this item at a stunning low price so (once again!) we pass the savings on to you!
Cat. ZR-9500
The IRA.F001.P comes complete with all data mentioned above for:

NEW

ONLY $19.95

8 CHANNEL AUDIO MIXER KIT JAYCAR 8002

A balanced input/output 8 channel mixer with features found in units costing well over $2000!
MAIN FEATURES: * Blanced (600 ohm) mic inputs/line inputs * Input attenuators * Cannon connectors included in the price * Bass, treble and mid equalisation on each input * "Effects" i.e. echo, etc capability * Foldback on all 8 inputs * Stereo pan on all 8 inputs * 60mm slide faders used throughout * 19" rack mount capability (or console mount) * Professional black front panel with format borders and multicoloured knobs to assist function identification * Designed for quick and easy service * VU metering * Only high quality components used * 5534A OP amps used for low noise and very low distortion.
Cat. KJ-6504

$595

As illustrated $714.00

PIONEER 12" WOOFER

White cone and chrome surround with superb specifications make this driver a winner. Only 1/3rd the price of European equivalents. 65 watts rms, frequency response 25 - 2.5kHz, resonance frequency 25Hz, SPL 97dB/0.5 metre.
Cat. CW-2121

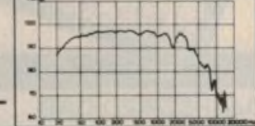
SAVE $10.00
ONLY $39.50

DIRT CHEAP!!

PIONEER 355 10" WOOFER

10" woofer with excellent tone. Ferrofluid 50 watts rms, frequency range 25 - 2.5kHz, resonant frequency 25Hz, SPL 96dB/0.5 metre.
Cat. CW-2117

SAVE $8.00
ONLY $29.50



SEND $1.00 FOR THE 1987 JAYCAR CATALOGUE WITH 116 PACKED PAGES OF GOODIES

ILLUMINATED ROCKER SWITCH

- Very classy
- Great for amps
- SPDT, 8A, 240V
- Illuminated actuator
- As used in P/Master 60/60
- Size 21 x 15mm
- Panel cutout 13 x 19.5mm

Cat. SK-0985

DIRT CHEAP!!

Catalogue Price $7.50 ea

JULY SPECIAL $3.95 ea 10 up $3.25 ea

MAGGY LAMP

DESK MOUNTED LAMP/MAGNIFIER
Cat. SL-2700

ONLY $185

FAX FOR ORDERS (02) 744 1767

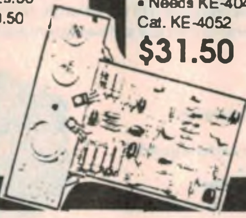
ETI 480/50 WATT AMP MODULE

Same circuit as 480/100 but with less output transistors.

Cat. KE-4050 **$26.50**

Power Supply Cat. KE-4048 $29.50

Transformer Cat. MF-1095 $29.50



ETI 480/100 WATT AMP MODULE

- 100W Module
- Includes PCB, all components, heatsink bracket
- Needs KE-4048 power supply

Cat. KE-4052

$31.50

SUBWOOFER ETONE 10"

As used in the Electronics Australia subwoofer system.

Size	10" (250mm)
Cast Frame	QT=0.39, VAS = 631
Power Handling	100 watts rms
Free Air Res.	32Hz±1Hz
Voice Coil Dia.	2"
Magnet	3 kg (6.6lb)

Cat. CW-2119

$119.50

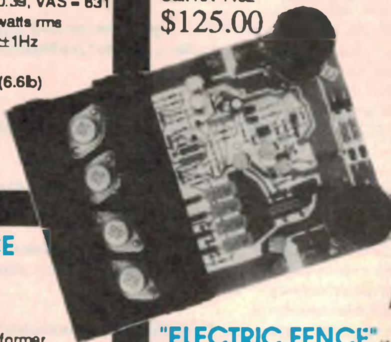
SUBWOOFER AMP

Ref: EA July 1982

- Mosfets used • 100W RMS • Includes PCB, parts, heatsink • Use subwoofer shown

Cat. KA-1452

$125.00



DUAL TRACKING POWER SUPPLY

Ref: EA February 1987

- Incorporates current limiter
- Floating ground
- Switchable from V to A
- Output ±1.3V to ±22V @ 2A - 5V @ 1A
- ABS instrument case
- Foldback current protection
- Adjustable voltage to 10mV
- Fully protected
- LED indicator for regulator dropout

Cat. KA-1682

$129.95

JAYCAR No. 1 FOR KITS

ELECTRIC FENCE CONTROLLER

Ref: EA December 1985

- Needs no auto coill
- Uses special output transformer
- Less current drain and higher performance

Cat. KA-1660

$49.95

"ELECTRIC FENCE"

Ref: Sept 1982

- Mains or battery
- Inexpensive & versatile
- Auto ignition coil required

Cat. KA-1109

$21.50

MUSICOLOR IV

Ref: EA August 1981

- 4 channel musicolor • 4 different chaser patterns • Auto and manual reverse chase • Sound-triggered chase
- Inbuilt electret mic • Safe, opto-isolated circuitry.

Cat. KA-1010

$119.50

40 WATT 12/230V INVERTER

Ref: EA August 1985

- Run 240V appliances from your car
- Also use as battery charger

Cat. KA-1598

$99.95

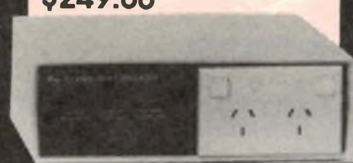
300 WATT INVERTER

Ref: EA September 1985

- Toroidal transformer]
- Automatic regulation
- Current limiting
- Thermal overload protection

Cat. KA-1610

$249.00



INCANDESCENT LAMP SAVER

This kit when fitted will greatly extend the life of those expensive downlights and spotlights.

Cat. KA-1670

$15.99

DON'T JUST SIT THERE ON THESE COLD NIGHTS - BUILD A KIT !!!

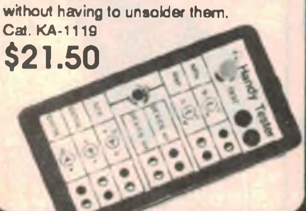
IN-CIRCUIT TRANSISTOR TESTER

Ref: EA September 1983

- Tests transistors, SCR's and Diodes without having to unsolder them.

Cat. KA-1119

$21.50



"SONICS" MAGAZINE & ETI DIRECT INJECT" OR DI BOX

Ref: "Sonics"/ETI Sept 1985

- Transforms an unbalanced signal to a balanced one.

Cat. KE-4708

$42.50

VOCAL CANCELLER

Ref: EA April 1982

- Cancel out singers voice on a record & substitute your own

Cat. KA-1430 **$24.95**

"SCREECHER" CAR ALARM

SCARE THE PANTS OFF WOULD-BE THIEVES!

- Fits under dashboard
- Alarm goes off inside car
- Unbearable sound

Cat. KA-1675

$32.50

DASHBOARD CAR ALARM LAMP FLASHER

- Clayton's alarm
- Includes 2 stickers

Cat. KA-1630

$12.95

ETI 1527 ECONOMY HOME BURGLAR ALARM

Ref: ETI May 1986

This clever design by Robert Irwin features 4 sectors (2 with entry delay two without) ability to use NO and NC reed switches on the one circuit, a comprehensive LED status display. All electronics fit on the one board. The Jaycar kit includes all PCB components and an attractive Scotchcal front panel.

Cat. KE-4698 **$29.95**

ETI TEMPERATURE PROBE FOR MULTIMETERS

Ref: ETI June 1983

- Extends the function of your multimeter to measure temperature from -55 to + 150C

Cat. KE-4033

$27.95

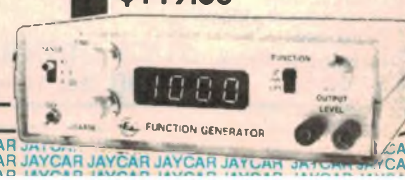
FUNCTION GENERATOR with Digital Readout

Ref: EA April 1982

- Produces sine, triangle, square waves from 20Hz to over 160kHz

Cat. KA-1428

$119.50



The Serviceman

Red in the face over a bad blue

One of the traps in day-to-day servicing is the tendency to make a snap diagnosis; the temptation to assume a specific fault on the basis of symptoms which, superficially, are similar to those previously associated with that fault. It's really something of a gamble and, if one guesses right, it can pay off handsomely in time saved. But one needs to be careful; a wrong guess can cause a very red face.

Something like this could have happened to me recently when I encountered a couple of video recorders with very similar symptoms and which I could have easily construed as having the same fault. In the event, neither fault was particularly profound, although one set of symptoms were particularly important and worth noting.

The first unit was a National model NV-450 which had been sold a few months earlier by a local retailer for whom I do warranty and other service work. It had come back from the customer with the complaint that it would neither play nor record. Having satisfied himself that there was no obvious mechanical fault — the tape loaded and functioned in all modes — he called me in to have a look at it.

A quick check in the shop confirmed the complaint and this was where I played my first hunch. For no reason that I can really explain I sensed that there was very little wrong with the main section of the recorder, but only in the modulator/splitter amplifier section — or the "RF Converter" as the maker calls it. I expressed this thought to my colleague and suggested that we could test this very easily.

All we needed was a TV set with monitoring facilities (ie, video and audio in terminals) and the necesary connecting leads, and we could check the video and sound signals directly. A couple of such sets were available on the showroom floor and it took only a few minutes to set everything up. And my hunch was right; the recorder played perfectly in this mode.

On this basis I felt the point was proved. Such a fault would prevent the video and sound from being converted to RF in the playing mode and, because the splitter amplifier which handles the signal from the antenna to the recorder's tuner is part of the same unit, it would most likely prevent any signals reaching the recorder.

So I prepared to order a new RF converter. There was little point in trying to troubleshoot and repair it; they are quite compact units, employing surface mounting construction and, since the machine was under warranty, it would be quicker and cheaper all round to simply fit a new unit. However, I first took the precaution of checking the voltage supply to it, just in case it was a more subtle fault. When this aspect was cleared I ordered the new one.

The new converter duly arrived, was fitted, and cured the fault, thus vindicating my original hunch. It went back to the customer and that was the last we heard of it.

It was not long after this that a customer brought in another video recorder which he described as having the same fault — failure to either play or record. It was also a National but an older model, the NV-370, and almost out of its three-year warranty.

Remembering the NV-450 I naturally wondered whether this machine could have the same fault. And while I didn't really expect to encounter such a coincidence, I felt it was worthwhile making a similar test. The only snag was that I had no TV set with monitor terminals — something I fully intend to rectify at the earliest opportunity. The next best thing was the CRO; all I had to do was connect it to the video out terminal, play a colour bar tape and check what came out.

Once again it seemed that my hunch was going to pay off because the CRO produced a perfect staircase pattern. On that basis, I could easily have been tempted to blame the RF converter and order a new one. Fortunately, I decided to make a couple of backup checks before taking the plunge. One was to check the supply rails to the converter — as I had done with the NV-450 — and the other was almost an afterthought.

Having checked the video on one beam of the CRO it occurred to me that I might as well feed the audio output to the other beam. It was a quite casual thought and I never imagined that the CRO would produce anything other than the 1000Hz sine wave which was on the tape. Imagine my surprise, therefore, when it displayed a very crude square wave at something closer to, but not exactly at, 500Hz.

Suddenly the picture looked very different indeed. What weird kind of fault could be producing such an audio output, long before the signal reached the RF converter. I didn't waste too much time dwelling on those questions but put my other backup check into operation — the supply rails to the converter.

There are two such rails; one marked "+B" and the "BS". After some circuit tracing I established that the "+B" rail was a 12V regulated supply and "BS" was a 12V unregulated supply. More importantly, the 12V regulated rail was nothing of the sort; it was down to 5.8V and I had no doubt it was no longer regulated. (N.B. There are two versions of RF converter used in the NV-370; type ENC87704, and type VSQO332. The latter type was fitted to this machine).

This 12V regulated rail supplies several sections of the recorder and any one of them could have developed a fault which was pulling the voltage

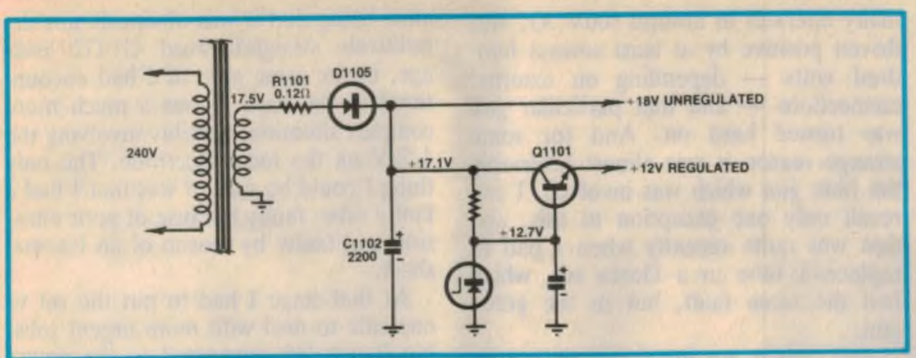


Fig.1: relevant portion of the NV-370 supply showing how the 12V regulated supply rail is generated, along with an 18V unregulated supply.

down. On the other hand, with the exception of the audio "funny", the rest of the machine appeared to be working normally. I decided that the best course was to go back to the power supply and clear that first.

This proved to be the right decision because it quickly became clear that the power supply itself was at fault. The 12V regulated supply is derived from a 17.5V winding on the power transformer, rectified by a single diode D1105, and smoothed by a 2200μF electrolytic capacitor, C1102. This produces about 17V DC which is regulated via transistor Q1101 with a 12.7V zener in its base circuit and which delivers 12.2V at its emitter. It's all very conventional and straightforward.

Well, the 17.5V AC from the transformer was spot on, but the DC on the other side of the diode, where there should have been 17V, was barely 12V. And, incidently, there is a supply rail in its own right, designated as 18V unregulated. Clearly, with only 12V on the collector of Q1101, it would be impossible for the regulator circuit to work.

Based on previous experience I first checked R1101, a 0.12Ω fusible resistor between the transformer winding and the diode. These can give trouble, although it is usually a complete failure. However, I have heard rumours of high resistance faults. I drew a blank.

The diode was checked next but also proved to be intact. Which didn't leave much, except the 2200μF electrolytic. And in fact, that was it. A new one restored all the voltages to normal, the audio out terminal delivered the correct 1000Hz sine wave, and the record and replay functions came good.

And that, from a practical point of view, was more or less it. As I said at the beginning, it wasn't any great technical achievement and rated a mention mainly because of the similarity of symptoms to a previous case and the possibility that I could have been misled by them.

An explanation

And then there was the audio "funny" which first alerted me. That was a real puzzler and I don't pretend that I can do more than guess at the cause. But, for what it is worth, here's my theory. In broad terms I feel fairly confident that the signal I observed was a form of oscillation — probably somewhat akin to motorboating — which was occurring somewhere in the system.

But whereabouts in the system and why? The most likely place would seem to be the amplifier chain following the sound head and which ultimately feeds audio to both the RF converter and the audio out terminal. If this had become violently unstable it could easily produce a crude square wave such as I had observed, and at a frequency dictated by a whole range of factors and component values.

As to the why, I suspect that it was the loss of regulation on the supply rail. The audio amplifier is fed from that same supply rail, via a second regulator stage delivering a slightly lower voltage. This second regulator stage — which could not possibly have functioned at only 5.8V — suggests that this audio stage needed a particularly well regulated supply; something far better than could be provided by a conventional decoupling network.

In these circumstances, loss of regulation would be akin to failure of a decoupling network or even a main filter capacitor. After all, a regulator stage is really a glorified filter capacitor — at least in this respect — or, if you prefer, a filter capacitor is a rather crude voltage regulator.

Whichever way you look at it, a poorly regulated supply rail can provide a very effective feedback path between the output and input stages of an amplifier, and this is what I imagine happened in this case. It can be only a theory, of course, because the practicalities of servicing make it impossible to follow up every such puzzle we encounter on the bench.

But if I ever strike another one like it . . .

A blue K9

My next story is on quite a different theme. It concerns a Philips K9 63cm colour set; a set belonging to one of my regular customers and which I had serviced on a number of occasions over most of its life. In this respect it had not needed any more service than typical for this model and, in fact, it was still a very clean, well preserved set.

But on this occasion the lady of the house rang with a tale of woe concerning it. It appeared that picture quality had deteriorated markedly over the last few months and was now virtually unwatchable. In greater detail, she described the picture as being very weak and predominantly blue in colour. She went on to suggest that perhaps the tube was worn out and that, if this was so, she would like my opinion as to whether it was worth fitting a new tube.

While her description of the symptoms struck a chord in my memory, I didn't feel like committing myself at that stage. I simply suggested that her husband bring it into the shop and that I look it over and give an opinion. And in answer to my query, she confirmed that they had another set, so there was no great hurry. In fact, they were planning a couple of months holiday shortly, so I could really take my time.

And so the set was duly delivered and while the owner was there I plugged it in and gave it a quick check. Sure enough, it performed exactly as described; a very weak picture behind a strong blue overcast. My immediate reaction was that it was most likely a tube fault or, more likely, two faults. One was simply that the tube had reached the end of its life and the other was that there was some form of internal short causing the blue overcast.

I was basing this latter diagnosis on previous experience involving a number of tubes with a similar symptom. This problem first appeared about ten years ago in what was apparently a batch of Canadian RCA 63cm tubes which had been fitted to National sets at that time, although they were probably fitted to other sets as well. I remember attending a lecture by National service personnel who described a range of typical faults, including this one.

It took the form of an internal short between G1 and G2 and, since G2 normally operates at around 600V, G1 was driven positive by at least several hundred volts — depending on external connections — and that particular gun was turned hard on. And for some strange reason it was almost invariably the blue gun which was involved. I can recall only one exception to this, and that was quite recently when I had to replace a tube in a Decca set, which had the same fault, but in the green gun.

And, while not inevitable, it usually happened that the fault was intermittent, often occurring at switch-on and continuing for anything from a few seconds to fifteen minutes or more. Nor did the fault seem to be related to the age of the tube. It first showed up less than twelve months after the National sets appeared on the market and has turned up at odd times ever since.

Voltage checks

With these thoughts in mind, I opened the back of the set and attacked the neck board with a meter. My first check point was G1 of the blue gun, pin 12, and I wasn't altogether surprised to find that it was higher than normal. This explained the excessive blue but left the reason for the excessive voltage still to be determined. Was it a fault in the tube or was it in the blue G1 external circuitry somewhere?

Fortunately, it was a simple matter to lift the blue G1 lead where it joins the neck board at R164, a 2.7kΩ resistor. (This is shown as 1.5kΩ in some manuals). This should have taken G1 down to virtually zero volts but, instead, it shot up to around 200V. Apparently, disconnecting the G1 lead had relieved the spurious voltage source — whatever it was — of significant loading, thus allowing it to rise.

Well at least that cleared the G1 circuitry and tended to reinforce my suspicion that it was probably an internal tube fault, most likely a leakage between G1 and its associated blue G2, pin 13. Acting on this thought I switched off the G2 blue voltage at switch SK7, which is fitted to facilitate equalising the gun cut-off points. This produced an even more surprising result; not only did it have little effect on the spurious G1 voltage, but it also failed to reduce the G2 volts to zero, as it should have done. All it did was drop it substantially from its normal value at around 600V to a couple of hundred volts.

By now I was convinced that it was an internal tube fault, the only difference being that it was obviously not the relatively straightforward G1/G2 leakage, in the same gun, as I had encountered in the past. It was a much more complex situation, possibly involving the 4.5kV on the focus electrode. The only thing I could be sure of was that I had a faulty tube; faulty because of poor emission and faulty by reason of an internal short.

At that stage I had to put the set to one side to deal with more urgent jobs, but it was left connected to the power point and antenna outlet. Sometime later, intending to turn on something else, I mistakenly turned this set on again. After a few seconds a weak picture appeared, in all its blue glory, and I realised my mistake. I was about to turn it off when the phone rang and so the set was left running.

It so happened that it was quite a long call, lasting for some twenty minutes or so, and when I finally put the phone down and turned my attention to the set I was surprised to realise that the blue overcast had vanished. It was still a washy picture, but the blue fault had cleared. I immediately recalled the aforementioned Canadian tubes and the fact that they often came good after various running periods. Was this another example of this kind of fault?

I turned the set off, left it for an hour or so, then tried again. It came up blue again, but not as strong as previously and, in a few minutes, the blue had vanished. I switched it off and left it overnight, turning it on again the next morning. Sure enough, up it came again with a full strength blue overcast, and I let it run while keeping a close watch on it.

And again, it took about twenty minutes to come good and I was able to confirm something I was not quite sure of until now; the fact that the blue decreased gradually, rather than suddenly as in all the cases I had seen until now. These two factors — the repeatable nature of the fault and its gradual demise — were two clues which, in hindsight, I should have given more attention. But the truth was that, while I noted them, and they intrigued me, I had no way of assessing their significance.

New picture tube

In any case, it was clear that the set needed a new tube if it was not to be written off. I rang the owner and explained the situation and, in answer to his inevitable question as to whether the set was worth the cost — it was going to make a mess of $300 — I said yes, I did

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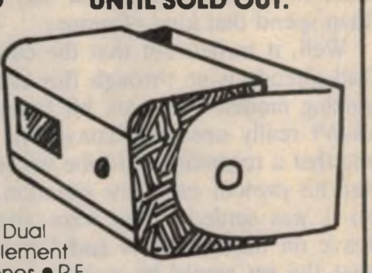

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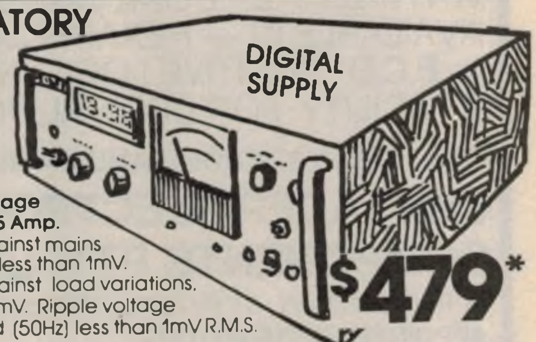

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Output Voltage
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Stability against mains variations, less than 1mV.
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think it was worth it. The set was in good condition otherwise, most of the preliminary faults to which it might be prone had been found and fixed, and there should be several years life in it yet.

Finally, I suggested he consider the alternative. To buy a similar size new set these days is likely to set him back the best part of $1000, even without all the frills. In fact, a lot of customers have been baulking at these recent price hikes and opting for a reconditioned tube in an otherwise good set, rather than spend that kind of money.

Well, it turned out that the customer had already gone through this exercise, pricing models that took his fancy, and didn't really need any convincing from me that a reconditioned tube would best suit his present cash flow situation. And so it was settled. They were about to leave on their holidays and I promised that the set would be waiting for them when they returned.

I removed the old tube, despatched it to the reconditioning firm with the appropriate order, and put the set to one side until the new tube arrived. This it did in due course and I waited for an appropriate slack period before attacking the job.

Fitting a new tube to a K9 is not the kind of job one tackles as a form of light entertainment. It's a major job and everything is a pretty tight fit. It might have been fine for those who did it all day and every day on the production line, but for blokes like yours truly, who do it once every pancake day, it's a real chore.

But it was duly done and I switched the set on and sat back to enjoy the fruits of my labour. Granted, there was convergence and gray scaling yet to be done, but I was anxious to see a nice bright picture in place of the weak effort of the previous tube. Nor was I disappointed, it had the makings of a first class picture — except for one thing. The blue overcast was still there, just as strong, or even stronger, than ever.

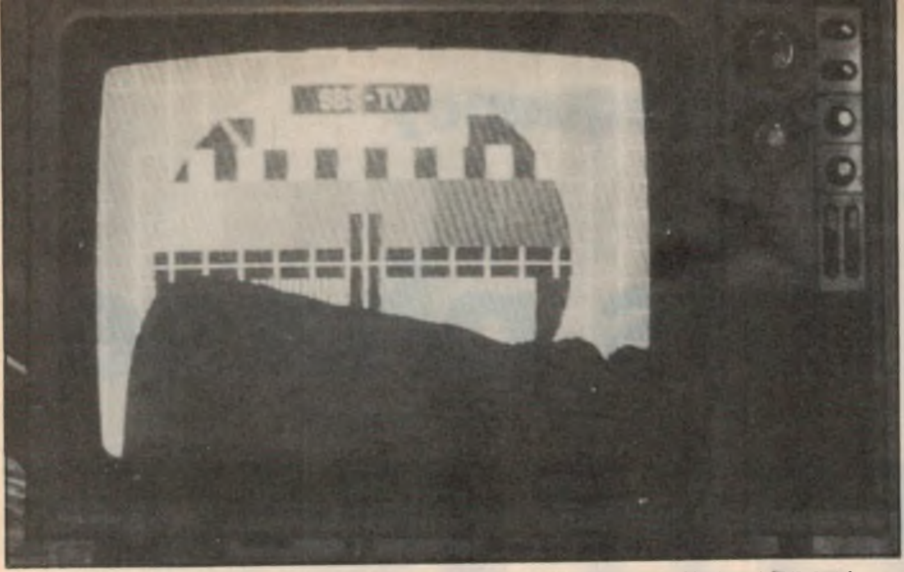
A state of shock

I'm afraid I went into a state of shock in the next few minutes. The only consolation I could find was the fact that I had not condemned the tube on the basis of the blue problem alone. And for that I thanked my lucky stars because, if I had, my face would have been as red as the screen was blue.

When I regained my composure somewhat I realised that what really mattered now was to find the real cause of the fault. I let the set run as I had before and sure enough, after about half an hour, the blue had vanished and I took the opportunity to do a rough convergence routine and confirm that all was well in this regard. And it was — even without a final touch up, I had a first class picture.

I turned the set off, left it for the rest of the day, and tackled it again the next morning. It came up brilliant blue as before and I decided that now was the time to strike. I switched it off and pulled the neck board of the tube, unplugged it and unsoldered the remaining leads. Then I connected the high range ohmmeter between pins 12 and 13 and realised immediately that I was on the right track; the leakage between these two points was less than one megohm which, in a circuit of this kind, with the voltages involved, was quite serious.

I also measured from pin 12 to pins 4 and 5, the G2 connections for the red and green guns respectively. There was



This photograph shows the classic "Ayres Rock effect" as seen on a National TC-2002.

leakage here also, slightly higher than the first measurement, but quite significant nevertheless. So that was it; the whole board was leaking like the proverbial sieve and pin 12 appeared to be the major victim.

I refitted the neck board, let the set run for half an hour or so until the blue had cleared, then removed the board and repeated the measurements. And that clinched it because there was now no sign of leakage whatsoever, even using my most sensitive meter. While I was still not sure of the precise reason for the leakage, or the mechanism of its cure when let run, it was clear that this was the fault. In short, I needed a new neck board.

I wasn't sure as to the ready availability of a new board, or what it would cost, but I did recall that there were a couple of junked K9 chassis tucked away somewhere in the storeroom. Sure enough, a little searching unearthed them and two apparently good neck boards. I picked the better looking one, gave it a resistance check, which it passed, then fitted it to the set.

It performed perfectly and I finished off the convergence adjustment, went through the grey scale routine, and finished up with an absolutely first class picture. And, since the owners were still on holidays I had plenty of opportunity to give the set a real test over the next few weeks. I put it through regular switch-on cycles, and I let it stand for several days of rain and high humidity. It came through all these with flying colours — if you get my meaning.

And when the owners finally took delivery they were delighted with the result, probably realising for the first time just how poor the original performance had been, even before the blue problem arose. So all ended happily.

A nasty fright

But I'd had a nasty fright. Once again I had allowed myself to be trapped by relating the symptoms to previous experience and jumping to the conclusion that it had to be the fault.

It's all too easy to con oneself.

And, as a final thought, just where did that spurious voltage originate? I had first blamed the blue gun G2, then the G2s in the other guns, and even the 4.5kV focus electrode. In hindsight I am inclined to settle for the latter, the only difference being, of course, that it was not happening in the tube, but on the neck board. And, while the path between pin 9 (focus) and pin 12 had been deliberately lengthened by the design of the socket and board, the kind of leakage I found, at that voltage, could easily account for the fault.

Strangely enough, when I considered this possibility as I began to prepare these notes, I went back to the faulty board and repeated the leakage measurements, only to find that the problem had vanished completely. Don't ask me why, but I'm convinced that I could put that board back into a set and it would work perfectly, at least for a while.

As to why the board behaved as it did; well, your guess is as good as mine. The important thing is to be aware of the possibility and to realise that it need not produce exactly the same symptoms. In fact, the likely leakage combinations are quite numerous.

The Ayres Rock effect

And to finish off here is another comment concerning the "Ayres Rock effect" on the National TC-2003 as described in the September 1986 notes, but also mentioned in the August "TETIA Fault of the Month" and December 1986. It is from Mr D.D. of Warwick, W.A., and he writes as follows:

I had the same fault in a National TC-2002 (48cm) and I am enclosing a photo of the screen. I am only an amateur and fix TV sets and video recorders for friends and friends of friends &c.

I was lucky with this fault; it became worse as the set warmed up. By applying the hairdryer/freezer method I soon found the cause to be the non-polarised electrolytic, C857 (0.47μF, 50V). Replacing this with two 1μF electrolytics, back to back, cured the fault.

I hope this letter may be of some help.

Many thanks, D.D., particularly for the photograph which I will ask the editor to reproduce. One picture is worth a thousand words and this may make it easier for other readers to recognise the fault. It is not clear from your letter, D.D., whether you saw the follow-up article on this fault in the December notes. If not, I'm sure you'll find it interesting.

And that's about it for this month.

TETIA Fault of the Month

JVC 735OAU
Symptom: No sound or picture. White screen with traces of hum bars. HT rail up to 130V with no control available from R10 (B+ adjust).
Cure: One or both of series regulator transistors (2SC1106) short circuited. A BU108 makes a suitable replacement in this position.

National TC86
Symptom: Rapid flutter in picture, rather like vertical jitter but hold control has no effect. Sound is OK, but soft clattering noise comes from the power transformer.
Cure: Replace C808 on power supply board. This 1μF 160V electro goes low and reduces drive to the regulator SCR.

Sharp 8C220, 8C223 Etc.
Symptom: Screen goes white, with no sign of picture. Retrace lines are sometimes visible. R1127 (47Ω 1W) fails repeatedly.
Cure: C716, a 47μF 250V electro, open circuit. This cap takes yoke current to ground and when it goes open the current is forced through C1108, via R1127. In the fault condition, this resistor has some 40-50V AC across it but only half a volt DC!

For really accurate frequency comparision ...

Build this phase difference meter

This simple phase difference meter is designed to indicate phase changes between two frequencies over a period of time. It's also easy to build and uses readily available parts.

by IAN POGSON

There are many ways of comparing two frequencies, either those which are on the same nominal frequency or those that are harmonically related. Perhaps one of the better known procedures is that employed by the piano tuner. The instrument he uses for the purpose is his ears and he tunes by the "beat" method.

The "beat" method is also often used in the field of electronics. The two signal frequencies to be compared are mixed together (eg, in a radio receiver) to produce an audible difference frequency, or beat frequency. When the user wants the two frequencies to be exactly the same value, then usually one of them is adjusted so that they are brought into "zero beat" with each other.

However, this method is not accurate enough for many applications and so other methods must be adopted. A worthwhile step forward is to use a dual trace CRO. The two frequencies to be compared are fed into the two CRO channels.

If there is a difference between the two frequencies, then this will show up by one display moving with respect to the other. Again, one is adjusted until they appear to be stationary with respect to each other.

Even so, this is still not good enough in some situations and more sophisticated methods must be adopted. This is where our Phase Difference Meter can be put to good use. Although a relatively simple device, it can give high orders of accuracy provided it is used with care.

Inside the Phase Difference meter are two separate divider channels whose outputs are compared in a phase comparator. The phase comparator, in turn, drives a meter movement.

In practice, a reference frequency is fed to one channel while the frequency to be adjusted is fed to the other channel. By observing the meter movement, or by hooking up a chart recorder to the output, changes in phase between the two channels over a period of time can be easily observed.

Note that the Phase Difference Meter cannot be used to directly measure the absolute phase difference between the reference and signal frequencies. This is because of differences in signal propagation time through the two channels. Instead, the Phase Difference Meter is used to indicate changes in phase over a period of time.

In fact, it may be useful to think of the unit as a phase drift meter or a phase comparison meter.

Finally, it should be stressed that if absolute accuracy is required, as opposed to simply adjusting two frequencies to the same value, then a known accurate frequency reference must be available. One such source is Omega and this may be tapped using the Omega Derived Frequency Standard de-

The Phase Difference Meter circuit is housed in a standard instrument case.

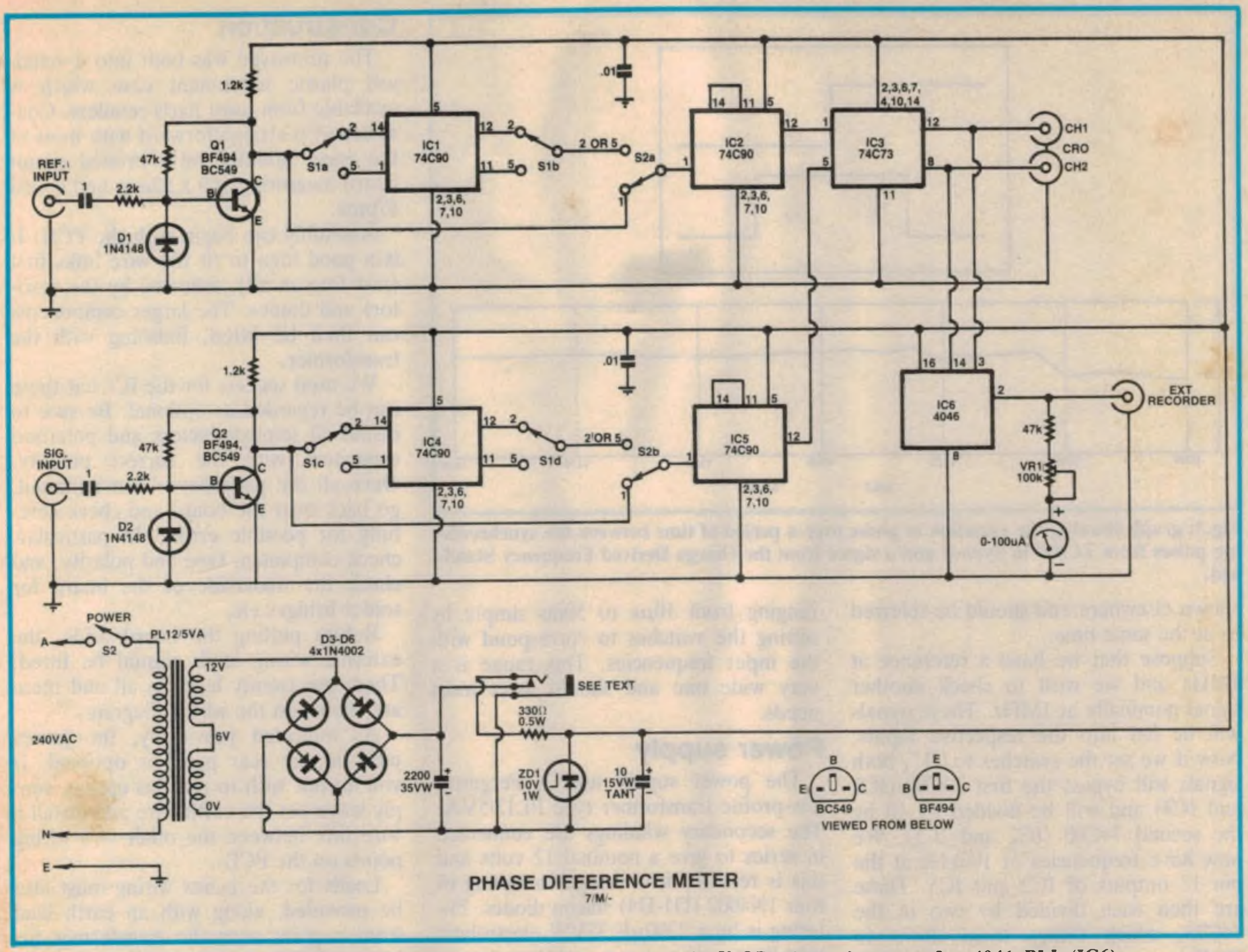


Fig.1: the circuit has two identical input channels which are fed into the X-OR phase detector of a 4046 PLL (IC6).

scribed in *Electronics Australia* for April and May 1987.

Circuit details

Let's now have a look at the circuit. Basically, it consists of two identical channels, the outputs of each being fed into the X-OR (exclusive OR) phase detector of a 4046 phase lock loop (IC6). A built-in power supply is also included.

To differentiate between channel 1 and channel 2, we have labelled them "Ref Input" and "Signal Input", respectively. It is intended that the frequency fed into the "Ref Input" will be the standard against which the frequency fed into the "Sig Input" will be compared.

Because the two channels are identical, we'll only consider the circuit associated with the Ref Input.

The input stage is based on common emitter amplifier Q1. We used a type BF494 although a number of other types may also be used. The signal at the input socket is fed to Q1 via a 1μF blocking capacitor and a 2.2kΩ current limiting resistor. A 1N4148 diode is connected across the base-emitter junction to protect the transistor against excessive reverse voltage. A 1.2kΩ resistor serves as the collector load while the 47kΩ resistor provides bias.

The input is capable of accepting a signal of between 300mV and 12V peak-to-peak. This signal may be an equal or unequal duty cycle square wave, or a sine wave. Q1 provides sufficient drive for the following digital stage circuitry.

The output of Q1 is fed to the wiper of switch S1a. When the switch is in position "2", IC1 is connected to divide by 2 and this signal is made available at pin 12. In position "5", IC1 is connected to divide by 5 and this signal appears at the pin 11 output.

S1b selects between the two divided outputs while S2a selects either the divided output from the wiper of S1b or an undivided output directly from the wiper of S1a. Thus, S1 and S2 can be set to provide division by 1, 2 or 5 as appropriate.

Following S2a, the signal is fed into pin 1 of a second 74C90 (IC2), connected to divide by 10. The divided output from pin 12 goes to the pin 1 clock input of a 74C73 dual J-K flipflop (IC3), where the signal is divided by 2. Similarly, the signal from the second channel is fed into pin 5 of the 74C73, and is also divided by 2.

The two outputs from pins 12 and 8 of the 74C73 go to the pin 3 and pin 14 inputs of the phase detector in the 4046 (IC6). The resultant output from pin 2 drives a 0-100μA meter which shows the time difference. Provision is also made at this point for driving a chart recorder, should one be available.

Switching

Let us return to the switching and explain the reasons for the arrangement. Perhaps a couple of examples may make the functions clearer. A table showing the switching functions is

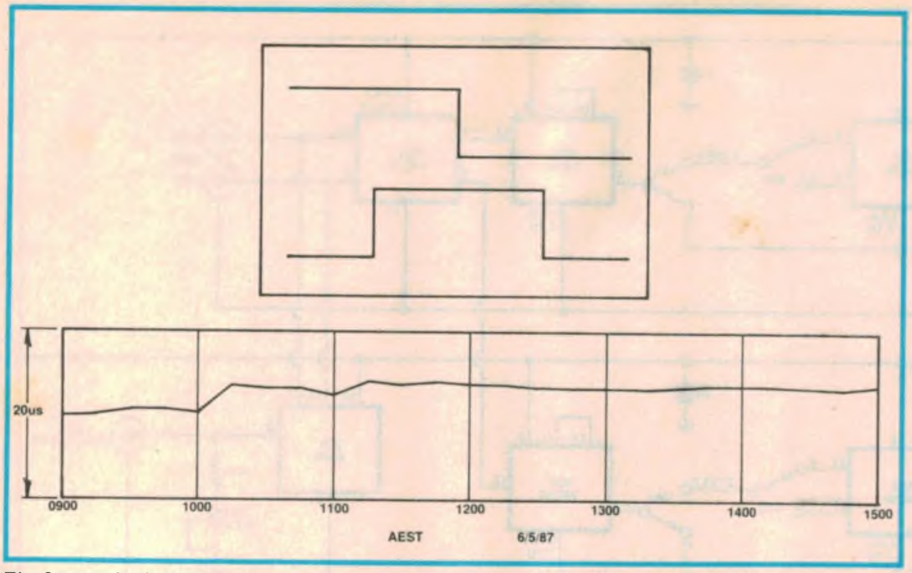


Fig.3: graph showing the variation in phase over a period of time between the synchronising pulses from TCN-9 in Sydney and a signal from the Omega Derived Frequency Standard.

shown elsewhere and should be referred to at the same time.

Suppose that we have a reference at 1MHz and we wish to check another signal nominally at 1MHz. These signals will be fed into the respective inputs. Now if we set the switches to "1", both signals will bypass the first 74C90 (IC1 and IC4) and will be divided by 10 by the second 74C90 (IC2 and IC5). We now have frequencies of 100kHz at the pin 12 outputs of IC2 and IC5. These are then each divided by two in the 74C73, which brings them down to 50kHz.

There are two important points here. First, the two signals are square waves of equal duty cycles, which is essential for our purpose. Second, we only need half a cycle to make our comparison. Half a cycle at 50kHz is equal to a period of 10μs and so the meter scale covers a range of 10μs. Check this result against the table.

If we now move the switches to "2" and refer to the table, we find that the meter scale covers a range of 20μs. Further, by moving the switches to "5" and referring to the table, we have a meter scale equal to 50μs.

Now have another look at the table, this time on the line below, where we have figures for input frequencies of 100kHz. This time, we have multiplied all the above periods and the meter full scale value by a factor of 10. This gives us meter scales of 100μs, 200μs and 500μs. Further study of the table shows that we have decades up to a maximum of 50ms (milliseconds).

Thus, we can set up our Phase Difference Meter for full scale meter readings ranging from 10μs to 50ms simply by setting the switches to correspond with the input frequencies. This range is a very wide one and should meet most needs.

Power supply

The power supply uses a Ferguson low-profile transformer type PL12/5VA. The secondary windings are connected in series to give a nominal 12 volts and this is rectified in a bridge consisting of four 1N4002 (D1-D4) silicon diodes. Filtering is by a 2200μF 35VW electrolytic capacitor.

A closed circuit jack is included in series with the supply, immediately after the filter capacitor. This was included for the writer's benefit and is obviously an optional extra.

Voltage regulation is achieved using a 10V 1W zener diode, in series with a 330Ω 0.5W resistor. A 10μF 15V tantalum bypass capacitor is connected across the output of the supply.

Construction

The prototype was built into a standard plastic instrument case which is available from most parts retailers. Construction is straightforward with most of the parts mounted on a printed circuit board measuring 169 x 93mm and coded 87pm8.

Assembly can begin with the PCB. It is a good idea to fit the wire links first (just four in all), followed by the resistors and diodes. The larger components can then be fitted, finishing with the transformer.

We used sockets for the ICs but these can be regarded as optional. Be sure to install all semiconductors and polarised capacitors with the correct polarity. Once all the parts have been mounted, go back over the board and check carefully for possible errors. In particular, check component type and polarity, and check the underside of the board for solder bridges etc.

Before putting the board aside, the external wiring leads should be fitted. There are twenty leads in all and these are shown on the wiring diagram.

As indicated previously, the power jack on the rear panel is optional. If you do not wish to use this option, simply leave out the earth wire and install a wire link between the other two wiring points on the PCB.

Leads for the mains wiring must also be provided, along with an earth lead from a point near the transformer for later connection to an earth lug on the rear panel. All these leads should be of 240V AC rating.

The PCB can now be screwed to the appropriate four mounting pillars. In order to avoid soldered joints under the board from fouling other pillars, 3mm-long spacers can be installed between each mounting pillar and the PCB. Washers or suitable oversize nuts could be pressed into service for this job.

INPUTS REF & SIG	SWITCH POSITIONS 1	2	5
	FULL SCALE		
1MHz	10us	20us	50us
100kHz	100us	200us	500us
10kHz	1000us	2000us	5000us
1kHz	10ms	20ms	50ms

This artwork shows the full-scale meter reading for various switch settings.

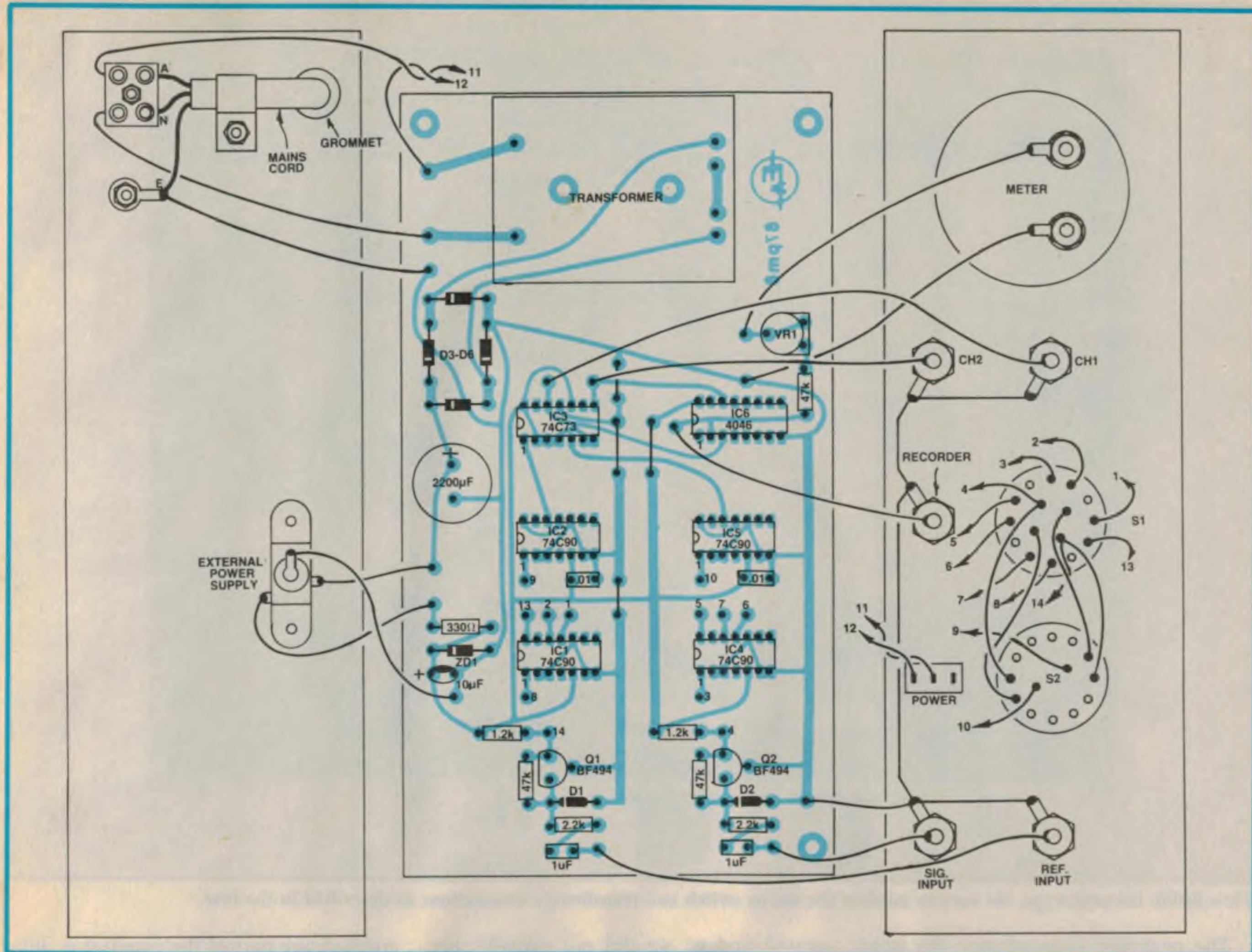
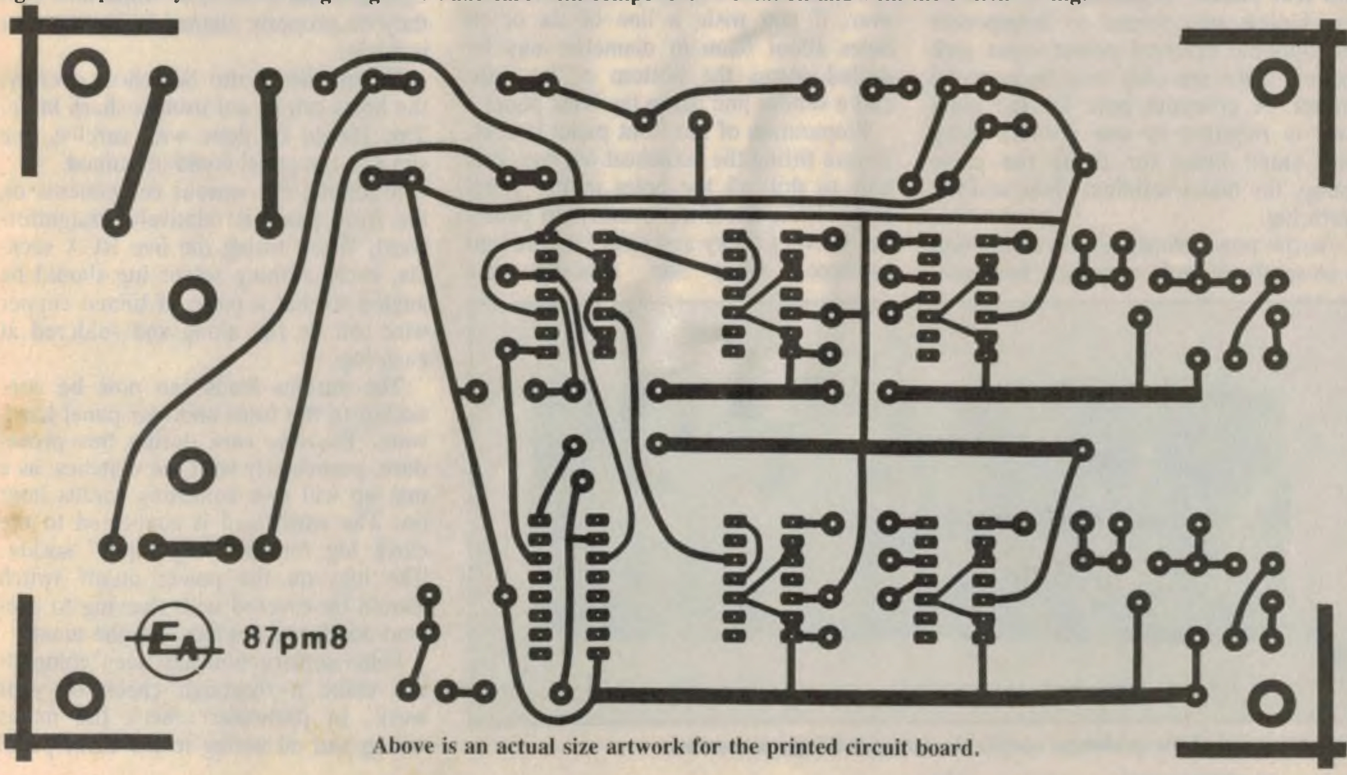
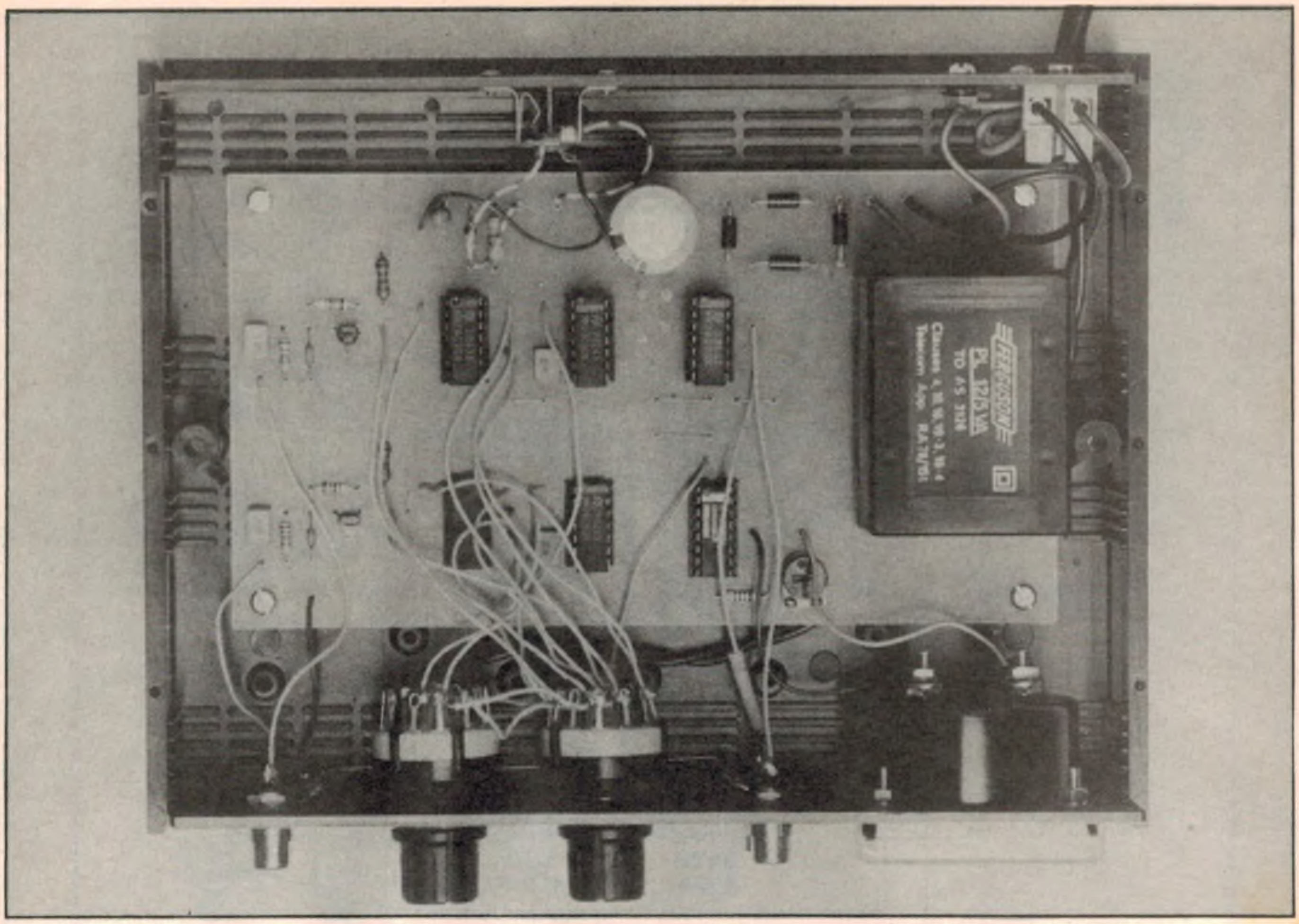


Fig.2: the parts layout and wiring diagram. Take care with component orientation and with the switch wiring.



Above is an actual size artwork for the printed circuit board.



View inside the prototype. Be sure to insulate the mains switch and transformer connections as described in the text.

The next step is to prepare the front and rear panels, beginning with the latter. Unless you intend to incorporate the optional external power input jack socket, there are only four holes to be drilled. A grommet hole for the main cord is required in one corner, along with small holes for fixing the cable clamp, the mains terminal block and the earth lug.

As the power consumption of the unit is so small, there is very little heat generated and so we did not provide any ventilation holes in the prototype. However, if you wish, a line of six or so holes about 6mm in diameter may be drilled across the bottom of the case and a similar line along the back panel.

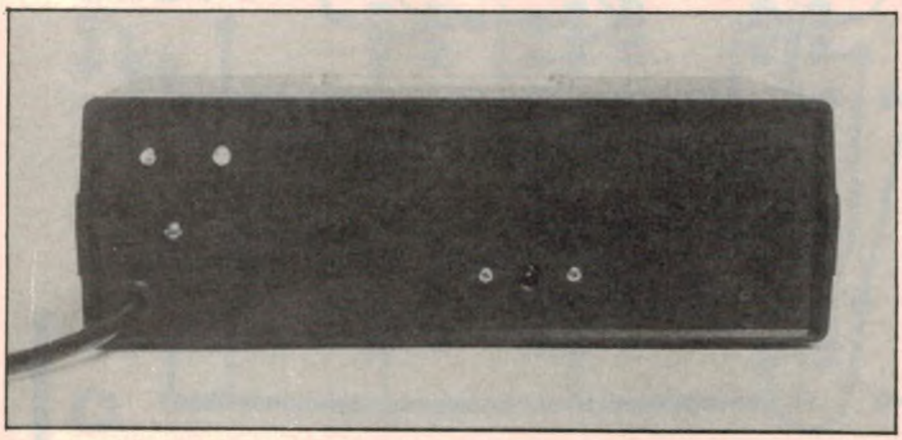
Preparation of the front panel is next. Before fitting the Scotchcal overlay, it is best to drill all the holes in the panel first. Fitting Scotchcal overlays to panels can be very tricky and calls for care and patience. Once the adhesive has grabbed any part of the panel, it is difficult to remove so it is important that they be properly aligned before contact is made.

Having fitted the Scotchcal overlay, the holes can be cut using a sharp knife. This should be done with care as one slip and the panel could be ruined.

Mounting the various components on the front panel is relatively straightforward. When fitting the five RCA sockets, each earthing solder lug should be angled so that a piece of tinned copper wire can be run along and soldered at each lug.

The various leads can now be connected to the front and rear panel hardware. Exercise care during this procedure, particularly with the switches, as a mix up will give confusing results later on. The earth lead is connected to the earth lug for the "Sig Input" socket. The lugs on the power on/off switch should be covered with sleeving to prevent accidental contact with the mains.

Once construction has been completed, make a thorough check of your work. In particular, check the mains wiring and all wiring to the front panel



The rear panel of the prototype carries the optional DC power socket.

hardware. You are now ready for the smoke test.

Setting up

The setting up procedure could hardly be simpler. First, set VR1 to the centre of its rotation, then switch on and check the meter reading. It will either read zero or read somewhere near full scale. If it reads zero, switch off and on repeatedly until you get a full-scale reading. When this happens, adjust VR1 for exactly full scale on the meter.

That's it! The instrument is now ready for use.

We'll conclude with a few pointers on how best make use of the Phase Difference Meter. First, we'll assume that you have a reference frequency at say 1MHz. This could, for example, be obtained from the Omega Derived Frequency Standard. We'll also assume that you wish to compare it with another 1MHz signal.

The procedure is as follows: set S2 to "1", then feed the reference 1MHz signal into the "Ref Input" and the frequency to be checked into the "Sig Input". The two signals will now be available at the "CRO Ch1" and the "CRO Ch2" sockets and these should be coupled to a suitable CRO. Set the CRO timebase to 2μs per division and the triggering to "CH1", corresponding to the reference signal.

This done, you should have a full cycle for the 1MHz reference as shown at the very top of Fig.3. You should also have a full cycle for the signal to be checked, but the phase relationship is likely to be anything but that shown on the diagram. With the phase relationship as shown, the meter should be at about mid-scale but will otherwise read accordingly.

If the two signals are in agreement, then there will be no movement of the bottom display. If the signal is running fast with respect to the reference, then it will be moving to the left on the screen, and vice versa. The rate of movement is a direct function of the difference between the two signals.

This last statement highlights the need for a CRO to establish which way the measured frequency is going. The meter on the instrument does not give this information but, once established, the CRO may be dispensed with, provided the readings do not overrun the meter scale. It is also obvious that readings could be taken directly from the CRO calibrations.

The foregoing illustration, while chosen for its simplicity, is only for measurements calling for the very highest stability situations. To avoid meter scale overrun and for easier initial measurments, less sensitive ranges should be chosen. In fact, if the stability and rate of the signal to be measured is unknown, it would be a good idea to select the highest range (50ms) to start with and work up from there. The procedure is similar to making unknown voltage measurements with a multimeter by selecting the highest range first.

Once the test setup is established, a graph may be drawn, after a series of meter readings have been taken. To illustrate this, I took meter readings every fifteen minutes, between 9.00am and 3.00pm one day and drew up the graph shown herewith. In this case I used the signal from the Omega Derived Frequency Standard, and compared it with the synchronising pulses from TV station TCN Channel 9 in Sydney. The variation between these two signals amounted to only 4μs over the period covered by the graph.

As mentioned earlier, provision has been made for driving a suitable chart recorder. If you are fortunate enough to have one of these units, then a recording can be made over long periods with all the advantages and benefits this system has to offer.

PARTS LIST

1 PCB, code 87pm8, 169 x 93mm
1 plastic instrument case, 200 x 160 x 70mm
1 Scotchcal label, 194 x 63mm
1 0-100μA meter, 50 x 50mm
1 Ferguson PL12/5VA PC-mounting transformer
1 mains cord and plug
1 cord clamp
1 rubber grommet
1 2-way mains terminal block
1 earth lug
5 RCA panel-mounting sockets
1 SPDT mains toggle switch
1 4-pole 2-position rotary switch
1 2-pole 2-position rotary switch
2 knobs (19mm)
5 14-pin IC sockets
1 16-pin IC socket
1 2.5mm DC power socket (optional, see text)

Semiconductors

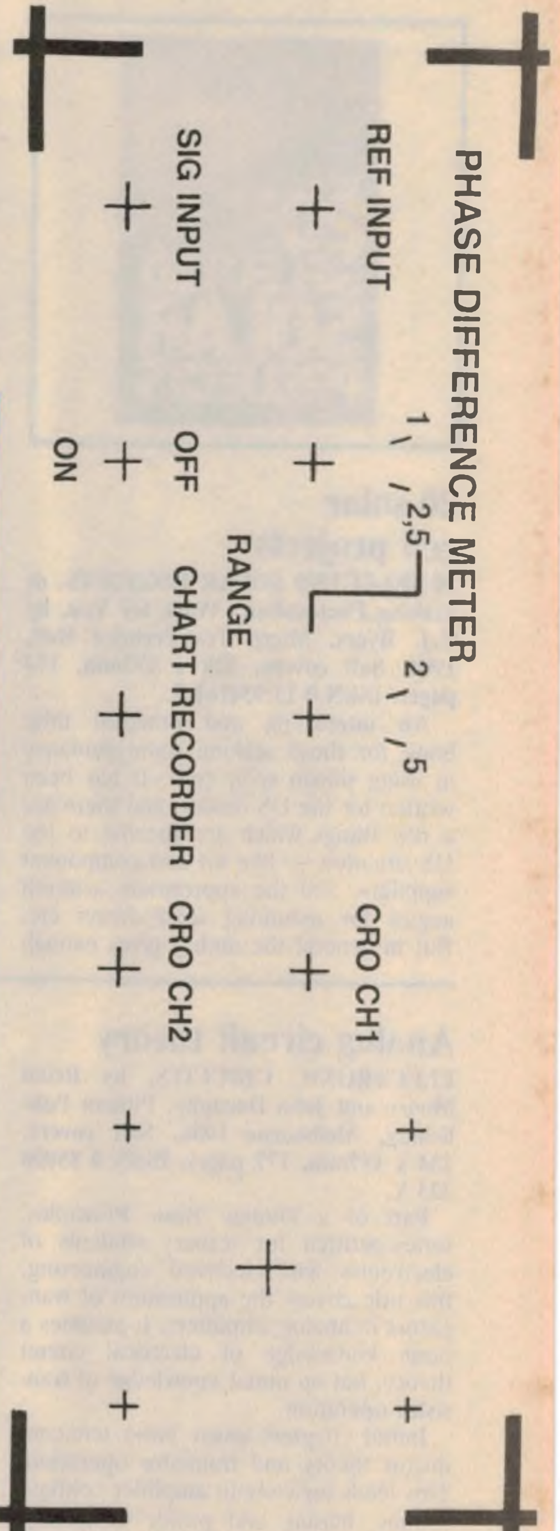
4 74C90 decade counters
1 74C73 dual J-K flipflop
1 4046 phase lock loop
2 BF494, BC549 transistors
2 1N4148, 1N914 diodes
4 1N4002 diodes
1 10V 1W zener diode

Capacitors

1 2200μF 35VW PC electrolytic
1 10μF 15VW tantalum
2 1μF metallised polyester
2 .01μF metallised polyester

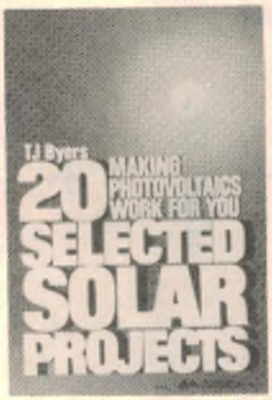
Resistors (5%, 0.25W)

3 x 47kΩ, 2 x 2.2kΩ, 2 x 1.2kΩ, 1 x 330Ω 0.5W, 1 x 100kΩ miniature trimpot



Above: the front panel artwork.

Books & Literature



20 solar cell projects

20 SELECTED SOLAR PROJECTS, or Making Photovoltaics Work for You, by T.J. Byers. Micro Text/Prentice Hall, 1984. Soft covers, 229 x 153mm, 174 pages. ISBN 0 13 934761 5.

An interesting and practical little book for those seeking some guidance in using silicon solar cells. It has been written for the US reader, and there are a few things which are specific to the US situation — like kit and component suppliers, and the appropriate azimuth angles for mounting solar arrays etc. But in general the author gives enough general theory and other data to allow the fairly astute Australian reader to adapt these for our conditions.

As the title suggests there are 20 projects, ranging from a fairly simple solar cell tester to more elaborate things like a solar powered electric fence and a solar powered robot. Some projects may seem a little fatuous, like a garden water fountain or solar powered garden lights, but again they're likely to be a good source of ideas if nothing else.

Basically the author has provided quite a lot of sound, down to earth information on using solar cells, if that's what you're after. There's even a short but highly readable explanation of basic cell operation.

The review copy came direct from the publisher. (J.R.)

Beyond UNIX basics

ADVANCED UNIX — A PROGRAMMER'S GUIDE, by Stephen Prata. The Waite Group/Howard Sams, Indianapolis 1985. Soft covers, 249 x 188mm, 484 pages. ISBN 0 672 22403 8. Recommended retail price $62.00.

Another impressive programming text from the highly respected Waite Group, led by author and editor Mitchell Waite. This time it's a work on advanced programming techniques in UNIX, the Bell Labs developed operating system-cum-language that is gradually becoming the standard for serious mini and micro computers.

Essentially it begins where the introductory UNIX primers (like Waite, Martin and Prata's *UNIX Primer Plus*, or Mark Sobell's *Practical Guide to the UNIX System)* finish off.

It takes you into the more arcane world of kernels and shells, writing your own shell scripts, using UNIX tools and making system calls to the library of C language utilities. It also covers interfacing with applications programs written in C, most relevant because UNIX is itself written in this language and interfacing can therefore be most efficient and elegant.

As usual with Waite Group publications, the text is a model of clarity and presentation. If you need to delve further into UNIX, it would make an excellent choice.

The review copy came from Jaycar Electronics. (J.R.)

Science commonsense

OUTPOURINGS, by Robyn Williams. Penguin Books, Melbourne, 1987. Soft covers, 199 x 127mm, 190 pages. ISBN 0 14 009292 7. Recommended retail price $9.95.

If you're a regular listener to ABC Radio's "The Science Show", Robyn Williams won't need any introductions. Personally I try not to miss his show, which is always very stimulating. But I confess to not realising that he is also a writer.

My wife gave me this new book of his for my birthday, and I've been very impressed with just how good a writer he is. In fact I only wish I was as good a broadcaster as Robyn W. is at his second vocation!

Enough eulogising, though. In this book he takes up a number of pretty controversial topics in scientific/technological circles, including what seems to have gone wrong with science and hi-tech run rampant, the rebirth of anti-intellectualism (did it ever die?), the narrow mindedness of many researchers and academics, and so on.

All very personal, perhaps, but written in lucid, clear and highly accessible prose. If you find yourself in agreement with most of his theses — as I do — you'll find it a delight. Even if you don't, I'm sure you'll find it very stimulating and thought provoking.

I'm not sure where Laraine bought my copy, but I suspect it was from the ABC shop. No doubt you could pick it up from any of the larger booksellers.

Analog circuit theory

ELECTRONIC CIRCUITS, by Brian Moore and John Donaghy. Pitman Publishing, Melbourne 1986. Soft covers, 234 x 157mm, 177 pages. ISBN 0 85896 323 X.

Part of a Pitman 'Basic Principles' series written for tertiary students of electronics and electrical engineering, this title covers the application of transistors in analog amplifiers. It assumes a basic knowledge of electrical circuit theory, but no initial knowledge of transistor operation.

Initial chapters cover basic semiconductor theory and transistor operation. This leads logically to amplifier configurations, biasing and power dissipation considerations. Later chapters then deal with feedback, load lines, output swing and distortion, and finally differential and operational amplifiers.

I confess I found it a bit terse — there's not a great deal of explanatory text, and heavy reliance on maths. The general impression given is that it is meant to be used as a text complementing a course of lectures, not a complete treatment in itself.

Still, if your maths is reasonably strong and you want a book to deepen and tighten up your knowledge of transistor amplifier circuits (perhaps for doing a bit of design work), this would make a good choice. It's pretty well up to date, and gives plenty of worked examples to illustrate circuit analysis.

The review copy came direct from the publisher. (J.R.)

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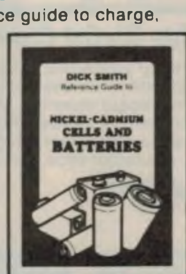

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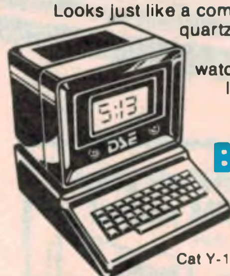

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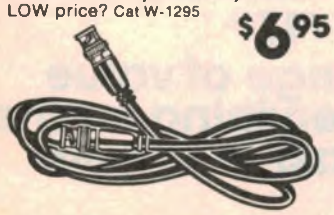

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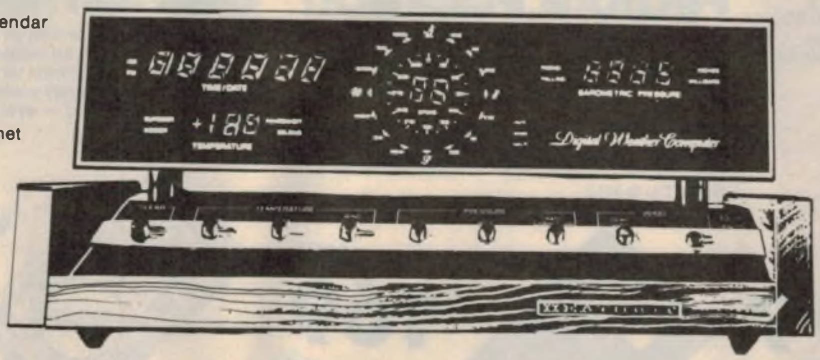

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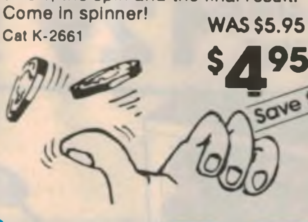

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Teletext — without a VCR

Teletext Tuner

A great idea that can save you heaps! The Teletext Tuner can be built into your Teletext Decoder (Cat K-6315) so you don't need to own a VCR. So now anyone can have all the advantages of teletext — and it needn't cost the earth. It's easy to build and even easier to install. Cat K-6319

WAS $149.50

$99.95

Save $50!

DICK SMITH ELECTRONICS PTY LTD

MULTIMETERS

Put DSE To The Test and Save!

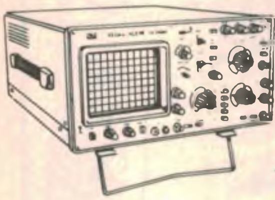
Affordable Dual Trace CRO

Here's a budget priced CRO that won't make a Gallah of you! It's a fully professional quality CRO offering outstanding performance for the price. Schools, colleges, hobbyists or technicians will find it an invaluable work tool.

Features:

- 20MHz bandwidth (-3dB)
- Use in single or dual trace mode
- Complete with 2 probe sets
- Inbuilt component checker — capacitors, inductors, transistors, diodes, zeners, etc.

Cat Q-1260



ONLY $879

GREAT VALUE!

Feature Packed!!

Just the thing for the serious minded hobbyists or technician! A versatile 3.5 digit Multimeter with all the standard capabilities PLUS temperature reading. Ideal for checking the thermal stability of amplifiers and heatsinks, etc. Covers an outstanding -20 to 1370° Celsius and will measure in both C & F. Has audible continuity checker plus capacitance and conductance measurement... and more! Cat Q-1512

Complete with temp. probe and leads!!

ONLY $169

BARGAIN PRICE!

DMM with Frequency!!

The Digital Multimeter with all the standards PLUS frequency reading to an incredible 200kHz! Service people will find this a must for audio and general service work. One handy piece of test equipment which does everything — even reads to 20A AC/DC!! Cat Q-1505

BARGAIN PRICE!

$159

One for the Bench

The great all round bench model! 4.5 Digit Multimeter with 10 times the accuracy of a 3.5 digit meter. With dual slope integration measurement — it's virtually immune to noise. Of course, it features continuity, diode testing, etc. Battery operated (they'll last up to 2 years) so you can still take it out in the field. Comes with tilting bail/handle and test leads and complete instructions including recalibration procedure! Cat Q-1550

ONLY $199

Push-Button Selection

It's so easy to use! Push-button range selection makes this LCD Multimeter a joy to use. With large 13mm LCD display and inbuilt bench stand. It's a quality unit at a great price! Features diode checking, 16 ranges, high input impedance, 10A DC range and overload protection. Cat Q-1444

$49

Best of Both Worlds

The DSE Bargraph Multimeter has all the ease of an analogue meter PLUS the speed and accuracy of digital meters! Ideal for the professional or hobbyist. With diode test, audible continuity tester, maximum display value freeze and more! Look at the features: • Data hold • Sample Rate; 10 sec • 5M ohms imput impedance • Complete with probes • And much more! Cat Q-1777

JUST $149.95

Windspeed Meter

$30 Off!

Fits in the palm of your hand and measures true windspeed — quickly and accurately! Imagine the applications; boating, scientific, aviation, sporting, etc. Knots miles per hour or metres/second... it measures the lot! With 3 digit LED display and sapphire jewel bearings for minimum resistance and long life. Cat Q-1405

Was $159 ONLY $129

SAVE $30!!

MM with 5 range Cap. Checker

It's the Digital Multimeter with it all! All the usual features including 10A AC/DC PLUS 5 ranges of capacitance checking two ranges of conductance AND a diode check. And it's accurate (<0.25% on DCV). Good enough for design and inexpensive enough for the hobbyist! Cat Q-1460

FANTASTIC!!

$99

E-Z Cable Checker

Every roadie, every band in the world needs one of these. Even the amateur sound recordist, club or church PA operator — anyone involved in audio cables will fnd the E-Z Check invaluable. Simply plug your cable in — Cannon, 6.5mm mono or stereo, RCA or BNC — and a series of LEDs tell you if it is okay. Imagine the time savings when searching for that elusive cable fault. Works equally well with patch cables having different connectors on each end. Requires only single 9V battery (not included). Rugged, heavy-weight steel case will handle the knocks. Cat Q-1532

WAS $79.95 NOW $59.95

SAVE $20!!

ONLY $9.95

Cable Voltage Tester

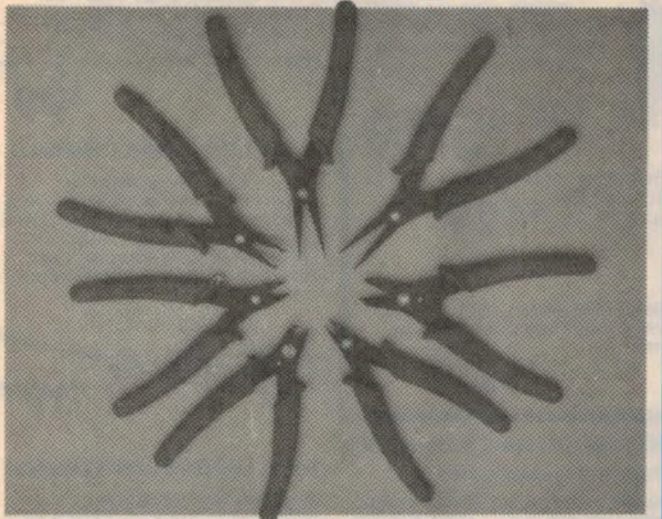
Ideal for automotive use. This piercing type lead tester gives you an LED readout to indicate if the lead is alive. Can save heaps of time! Cat Q-2000

4000 Counts Multimeter

Now the multimeter which has it all! Digital and bargraph display, resistance, audible continuity checks, diode test, 10A AC/DC range, memory, auto power down, 40M ohm resistance range... the list goes on! Full scale display of 4000 counts provides high accuracy and resolution. If your work depends on the best — then you won't get better value! Cat Q-1666

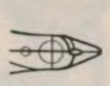
Amazing! $249.95

Quality tools save time and money — Piergiacomi now at DSE!



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.

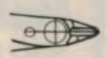
Cutting Nipper with back-angled cut



Designed especially for pcb soldering work. Blade opening 7mm, handles up to 1.3mm copper wire. Cat T-3261

$16.95

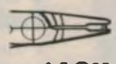
Cutting Nipper with standard cut



Ultra-precision cutter with standard angled blades allowing completely flush cutting. Cat T-3262

$16.95

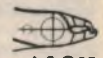
Inclined Frontal Cut Nippers



Very easy to handle, allowing leads to be cut 1.5mm from plane — perfect for soldering or to clear soldered joint. Cat T-3263

$19.95

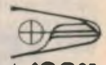
Inclined Cutter and Bender



Not only cuts the pigtail, but bends it away from pcb so the component won't fall out. Fantastic! Cat T-3264

$18.95

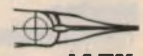
Shears



For larger cutting jobs — like mini scissors but with the extra strength needed to get through metal, plastics, etc. Cat T-3265

$22.95

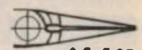
Needle Nose Pliers



Tweezer-like ends for reaching into almost inaccessible places — and flat blades so delicate components won't be damaged. Cat T-3266

$17.95

Flat Nose Serrated Pliers



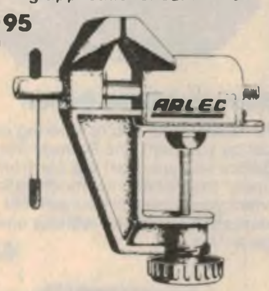
Fine (2.5mm) ends with serrations along blade mean extra grip when you really need it. Cat T-3267

$16.95

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

$12.95



Allen Key Set

Here's an ideal set for the workshop. 7 gunmetal finish Allen keys in a plastic wallet. Sizes 1.4mm, 1.5mm, 2mm, 2.4mm, 2.5mm, 3mm, 4mm. They are ideal for most European and Japanese equipment that have Allen screws. Cat T-5080

$3.95

Deluxe Pin Vice

It's a small hand tool that looks a lot like a jeweller's screwdriver — without a blade. Stored away inside the body are two double-ended locking collets that can be used to hold anything from 3mm diam. down to virtually nothing. That could be small drills (fantastic for drilling PCB's!), screwdriver blades (now you don't have to throw broken blades out!) awl points, scribers, reamers, needles and pins, etc etc. Cat T-5115

$15.95

Retractable Blade

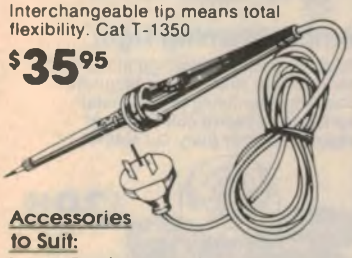
Avoid that dangerous habit of carrying around a screwdriver in your pocket! Famous Germain "Boker" quality 'driver has retractable blade for safety PLUS inbuilt mains voltage neon tester (100 to 500V). Screwdriver blade length 25mm, 3mm width. Handle (inlcuding pocket clip) 115mm x 15mm diam. Cat T-4007

WAS $6.55 **NOW $5.95**

Varitemp Iron

Variable temperature — the right heat for every application! And the temperature adjustment is right there on the handle: that's convenient! Interchangeable tip means total flexibility. Cat T-1350

$35.95



Accessories to Suit:

- Spare Tip (medium) Cat T-1351 $4.35
- Spare Tip (large) Cat T-1352 $4.35
- Spare Tip (conical) Cat T-1353 $3.95

Multi-purpose Stand

Holds boards or components firmly in rubber faced vice. Angle of vice may be varied widely in three dimensions for greater accessibility to board. Convenient soldering iron holder also adjustable. Adjustable spool holder for solder & desoldering wick. Ideal for the hobbyist or professional. Leaves both hands free. Cat T-5700

$39.95

Butane Soldering Iron

Totally portable, 'all-in-one' soldering iron that fits easily in a shirt pocket. Uses refillable 'butane' — the type used in ordinary cigarette lighters provides an amazing 60 minutes continuous use at a full 60 watts. Adjustable temperature control provides an equivalent to 10 to 60 watts. Detachable cap features a built-in ignition system which uses replacement flints. Cat T-1370

$59.95

Just the size of a marker pen — ideal for on-the-spot repairs.

S/S Transistor Nipper

Ideal for pcb work. Very sharp precision cut with long life cutting edge. 95mm body with spring return. 9mm cutting blades. Cat T-3205

$16.95

DICK SMITH ELECTRONICS PTY LTD

Quality, reliable tools from DSE — Where the Price is Always Right!

Scope Cordless Solder Gun

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

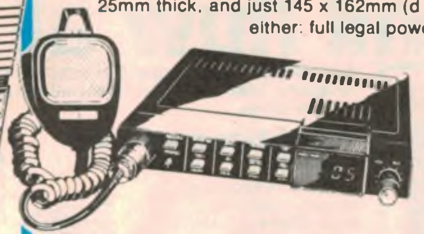
$119

UHF Hand-Held

Go-anywhere action on UHF CB: that's the Sundowner Hand-Held. All 40 channels fitted with very healthy 1.5W output (switchable to 0.15W to save battery). It's supplied complete with 10.8V NiCad battery (recharger also inc) and whip antenna — so you don't need anything else to start talking! Cat D-1807

ONLY $599

Royce Slimline



It's the most advanced UHF CB set available. And yet it's also one of the smallest — an amazing 25mm thick, and just 145 x 162mm (d x w)! Nothing has been left out, either: full legal power output, all forty channels, full scanning facilities, instant highway/emergency channel access, repeater access, optional selcall and tone squelch... everything the avid UHF CBer could possibly want! Cat D-1810

VALUE! $599

Selcall Option

5 tone Selcall (selective calling) pcb which means squelch will only open when it receives the correct tones. Great for clubs etc. Cat D-1808

$129

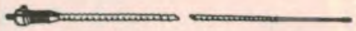
Make it portable!

What a brilliant idea! The Royce Portable Carry Case lets you take (and use) your CB anywhere. Has battery rack, antenna and shoulder strap for complete portable operation! Cat D-1812

$189.95

183cm Whip, Super Heavy Duty

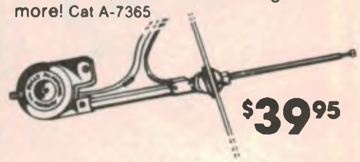
Just right for 4WD's vans etc — or anyone really serious about CB! Heavy duty unbreakable mounting base unit and massive spring, complete with PL-259 coax lead. Requires 13mm mounting hole — in something real solid! Cat D-4078



$99

Fully Automatic Antenna

The ultimate in ease! Antenna automatically goes up when you turn on your radio. Features 5 section anti corrosion stainless steel mast, FM/MW/LW reception, easy two wire connection, 300mm underhang and more! Cat A-7365



$39.95

5W 6 Channel Marine Transceiver

At this low price anyone on the water can have the security of a quality transceiver! With maximum legal power and fitted with 27MHz marine frequencies, it's ideal for the small boat owner and weekend fisherman. Cat D-1126

Features:
- **27.880MHz crystals**
- **On/Off/Volume, channel select, PTT, squelch switches**
- **External power jack**
- **Huge 5 watt power**
- **Signal/battery meter**
- **High/Low power switch**
- **High/Low mic. gain**

$149

3-way Antenna Switch

If you have more than one antenna or use more than one rig then this switch will save you swapping by hand. Handles 150 watts at 30MHz: ideal for base or mobile use. Cat D-5206

$16.95

VHF/UHF Universal Antenna Kit: Whip, coax and base

- Quality stainless steel 520mm whip, complete with cutting chart, suitable for mid VHF band (about 120MHz) up
- Deluxe gutter gripper mount.
- 5/16", 26TPI coaxially fed antenna base (intended for UHF work — even better at VHF!)
- 2 metres UHF quality RG58C/U coaxial cable
- PL-259 UHF converter (as used on most tranceivers)

Cat D-4025

BEST VALUE! $32.95

Your own Radiator Checker

You know how hard it is to remember to check the water level in your car's radiator! Now the DSE Fluid Level Monitor does it for you. Easy to fit it could save you a fortune on repairs. Cat A-8535

$19.95

Dual Beam Timing Light

With our fantastic Dual Beam Timing Light your car will be purring like a kitten. Save time and money and do it youself. Cat A-7470

FANTASTIC!! $59.95

SHARP

Car sound at its best!!!

The Sharp RG-F887G Car Stereo is, without doubt, one of the most sophisticated systems around. With 3 band tuner, 7 band graphic equaliser, LED display, 5 memory station program, auto reverse, blank tape pass, 50 watt power output, built in security alarm... There just isn't the room to list all the fantastic features! Cat A-9020

True Car Hi-Fi! $599

3-Way Closed Speaker System

The CP-FA30 closed, rear mount system produces great dynamics. Uses the square-type flat diaphragm woofers for improved bass response. Couple this with 60W input power and you'll never want to get out of the car. Cat A-9060

- **60W per channel maximum input power**
- **Square, flat diaphragm woofer with honeycomb core**
- **100cm squared mid-range**
- **3.5cm tweeter**

$299

Remote Starter Switch

Fantastic when you're working on the car by yourself! The Remote Starter Switch lets you start the car from under the bonnet. It's much safer when you control it yourself. No workshop should be without one! Cat A-7465

$9.95

Amber Warning Light

Revolving emergency signal light for car, truck or marine use. Magnetic base for easy fixing to any metal surface. 3.6 metre coil cord and cigarette lighter plug. Cat A-8510

$39.50

10 Function Engine Analyser

Optimise engine performance and maximise fuel economy! The 10 Function Analyser is a professional quality test device for reliable and accurate automotive use. **Checks:** **• Idle speed and carburettor adjustment • Adjusts ignition contact points • Tests battery condition and electrical systems • Tests generators/alternators • Tests high tension leads and coil • Provides simple method for troubleshooting. Comes with comprehensive instructions and all connecting leads, etc. Cat A-7480**

$69.95

Auto Inspection Lamp

A compact 12 volt DC lamp which is ideal for the car, truck, camper, etc. High intensity lens provides concentrated beam which is ideal for emergency repairs. Comes complete with built-in hook, cigarette lighter adaptor and 6 metres of lead. Ct A-8506

$5.50

DICK SMITH ELECTRONICS PTY LTD

Get more for your dollar!!! With peripherals from DSE.

MASTERING SOFTWARE... The Easy Way!

Now with **Listen & Learn** you can master those complex computer software programs in your own time, at your own pace! You'll save money on training programs AND you can use **Listen & Learn** over and over again. Each pack comes with four audio cassette tapes PLUS the easy to follow, colour coded instruction manual. Look at these current titles!! Lotus 1-2-3, Multimate, dBaseIII+, Wordstar, Displaywrite3, MS-DOS... with many more on the way! Cat X-9800 to X-9810

From $99

Monitor Bases

Budget Swivel Base

Nylon slide assembly and non-skid feet for positive action. Allows full 360° rotation and 25° vertical adjustment. Suits all monitors (or even your home telly!) from 22cm to 35cm screen size. Cat X-1190

$24.95

Deluxe Swivel Base

Similar to above, offering same degree of rotation and angle, but this one has knurled knob on front for locking and freeing monitor. If you want to turn then monitor frequently (eg for others to see screen) this is the one to choose, as the montior does not have to be removed to adjust angle. Cat X-1191 **$34.95**

Dataphone 1200 Modem

Dataphone enables you to enjoy all the benefits and advantages of data transference without the high cost. Now information transmission and reception is as easy as using the telephone. X-3300

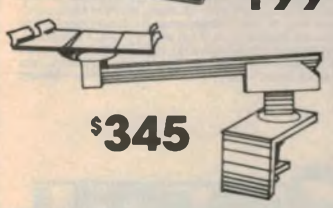
$349

Dataphone 300 Modem

The economy modem that will keep you in touch! Dataphone 300 is a 300 Baud, full duplex modem that comes complete with push-button phone for greater convenience.

$199

Gas-Lift Monitor Arm



Ergonomically designed gas-lift arm allows you to place monitor **exactly** where you want it — with no effort. Even push it up and out of the way... anywhere. And more than that, the monitor connection cables are hidden away neatly inside the arm. One of the best designed arms we've seen (apart from Racquel, Bo...) Cat X-1192

$345

Budget DSE Diskettes

Why pay more? Top quality computer media at a realistic price, made exclusively for Dick Smith Electronics by one of the world's leading disk manufacturers. They're so good we use them ourselves! (13cm) standard size.

Single sided: Box 10 disks Cat X-3500 **$27.50**

Double sided: Box 10 disks Cat X-3501 **$29.50**

Add-on Boards

Graphics Card

Industry-standard graphics adaptor cards for the type of graphics to suit your application/software. Most computer systems include one or other of these boards. If your application requires a different type of graphics card, or if you want to upgrade, the card supplied with your Multitech can be substituted for another type (with price adjustment if necessary). These cards simply plug into a vacant slot. All include the appropriate connection socket.

CGA Card

(Colour Graphics Adaptor) Essential for many of the games programs you'll play. (You're not going to use your computer for games? Who's kidding whom!!!) Cat X-8140 **$199**

MGA Card

(Mono Graphics Adaptor) Hercules-compatible card for software requiring MGA standard. Also includes a second parallel printer port. Cat X-8141 **$249**

EGA Card

(Enhanced Graphics Adaptor) Switch selectable to simulate MGA, CGA or EGA format. The most versatile "all rounder" board you can get — and essential for most of today's highly graphics oriented software (eg desktop publishing) Cat X-8142 **$699**

RS232 Breakout Box

Ideal for modems, other serial applications where connections need changing. DB25 male to DB25 female, pin 1 permanently wired, all others open with wire links supplied. Cat X-3568 **$27.50**

Permanent RS232 Jumper Box

Similar to above, but connections made internally and soldered for permanent applications. All 25 pins open. Wire links supplied ready for soldering. Cat X-3569 **$17.50**

Female/Female Gender Bender

Adapts male serial cables without resoldering or reconnecting. Simply plug in — twin female DB25 sockets with all 25 pins wired pin to pin. Cat X-3566 **$15.95**

Male/Male Gender Bender

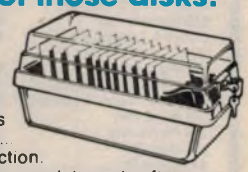
As above, but twin male plugs permanently wired. Cat X-3565 **$15.95**

Famous Xidex Diskettes

One of the world's leading disk manufacturers! If you want the best, you want Xidex. All soft sectored type. 5¼" (13cm) format.

Single sided, double density (40 track): Single disk Cat X-3510	$4.50
Single sided, double density (40 track): Box 10 disks Cat X-3512	$44.95
Double sided, double density (40 track): Box 10 disks Cat X-3514	$49.95
For "AT" machines with high (1.2Mb) capacity drives: Double sided, high energy (80 track): Box 10 disks Cat X-3516	$79
For laptops and other machines using 3½" (9cm) format disks: Double sided, double density: Box 10 disks Cat X-3503	$85

Protect those disks!



Your disks need help... and protection. Look after your data and software properly by storing your disks away in a disk box. Everything from 30 to 100 disks can be stored with this range.

5¼" (13cm)format

30 disk hinged box Cat X-3528	$15.95
50 disk hinged box Cat X-3531	$22.50
100 disk hinged box Cat X-3534	$29.95
3½" (9cm)format 40 disk hinged box Cat X-3533	$28.95

Serial Data Cable

2 metre serial cable with male DB25 plug one end, female DB25 socket the other. All 25 pins wired 1-1, etc. For serial printers, modems, computer/computer connection, and other data applications. Also ideal as extension lead for parallel printer cable (gives over 4m). Cat X-3564 **$39**

Parallel Printer Cable

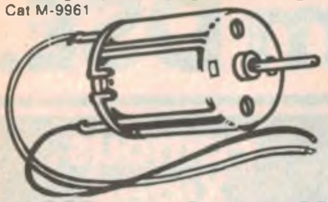
Standard "Centronics" type printer cable with 36 pin Centronics plug (as used on 99% parallel printers) one end, 25 pin D socket the other. 1.7m long Cat X-8614 **$34.95**

DICK SMITH ELECTRONICS PTY LTD

Don't forget the DSE Computer Hotline! For product information and advice ring (02)888 2002.

2 FOR THE PRICE OF ONE!!

Hey, this is fantastic value! Quality, reliable Mabuchi Electric Motors at half their normal price. Rated at 3 volts these are great for projects, experiments, model building or just playing around. Right now, you get two for the price of one!
Cat M-9961



TWO FOR $2.75

POWER SUPPLY 16V AC 900mA

The biggest problem with most projects is fitting in the transformer! This one obviates the problem — keep the supply components inside, but the plug-pack hangs on the power point! With a very healthy 16V at 900mA, it's perfect for 12 volt DC supplies. Energy authority approved.
Cat M-9567

SAVE $5!

WAS $14.95 NOW $9.95

TRANSFORMERS

Save heaps on our quality transformers! Hundreds of applications for projects, power supplies, linear amplifiers, etc. Our low prices are always hard to beat — but now they're even better!

5-15V Variable 2A Power Supply

The perfect work bench companion! Continuously variable output from 5 to 15V DC at 2A continuous, 4A peak. Ideal for the hobbyist, handyman and technician. Fully metered, showing either voltage or output current (switchable). Low ripple: <20mV at 2A (or <200mV at 4A). Cat M-9549

JUST $99

3-6-9-12V DC @ 1 amp

Invaluable around the home or workshop. It will give a maximum of 1 amp at 3, 6, 9 and 12 volts DC. Simply plugs into 240V AC power socket — DC connections via screw terminals on front of unit. Ideal for use with alarm systems, intercoms, etc.
Cat M-9530

$29.95

3-6-9V DC @ 200mA

This great value Power supply has the three most used voltages for battery powered equipment. 3, 6 & 9V @ 200mA
Cat M-9525

$17.50

POWER SUPPLY SAVERS!

Hurry, take advantage of our amazing power supply $$$ savers now! Battery eliminators from DSE save you money.

Primary: 240V. Secondary voltage: 18V. Secondary current: 2.2A. Terminations: Flying Leads. Cat M-1990

WAS $15.75 NOW $12.95

Primary: 240V. Secondary voltage: 40V @ 10mA, 19V @ 200mA, 11.2V @ 450mA. Terminations: Flying Leads. Cat M-1200

WAS $10.45 NOW $9.95

Primary: 240V, 50Hz. Secondary voltage: 6.3, 7.5, 8.5, 9.5, 12 & 15V. Secondary current: 1 amp. Terminations: Flying Leads. Cat M-2155

JUST $7.95

STORE LOCATIONS

NSW		
Swift & Young Sts.	**Albury**	**(060)21 8399**
T55 Terrace Level	**Bankstown Sq**	**(02)707 4888**
Shop 1, 65-75 Main St	**Blacktown**	**(02)671 7722**
613 Princess Hwy	**Blakehurst**	**(02)546 7744**
Oxford & Adelaide Sts	**Bondi Junction**	**(02)387 1444**
Shop 2, 1B Cross St, Warringah Mall	**Brookvale**	**(02)93 0441**
Campbelltown Mall Queen St	**Campbelltown**	**(046)27 2199**
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147 Hume Hwy	**Chullora**	**(02)642 8922**
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315 Mann St	**Gosford**	**(043)25 0235**
4 Florence St	**Hornsby**	**(02)477 6633**
Elizabeth Dr & Bathurst St	**Liverpool**	**(02)600 9888**
450 High Street	**Maitland**	**(049)33 7866**
621-627 The Kingsway	**Miranda**	**(02)525 2722**
173 Maitland Rd, Tighes Hill	**Newcastle**	**(049)61 1896**
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George & Smith Sts	**Parramatta**	**(02)689 2188**
The Gateway High & Henry Sts	**Penrith**	**(047)32 3400**
818 George St	**Railway Square**	**(02)211 3777**
125 York St	**Sydney City**	**(02)267 9111**
Treloar's Bldg, Brisbane St	**Tamworth**	**(067)66 1711**
263 Keira St	**Wollongong**	**(042)28 3800**
ACT		
96 Gladstone St	**Fyshwick**	**(062)80 4944**
VIC		
Creswick Rd & Webster St	**Ballarat**	**(053)31 5433**
145 McCrae St	**Bendigo**	**(054)43 0388**
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Bridge Rd & The Boulevarde	**Richmond**	**(03)428 1614**
Shop 2, 141 Maroondah Hwy	**Ringwood**	**(03)879 5338**
Springvale & Dandenong Rds	**Springvale**	**(03)547 0522**
QLD		
157-159 Elizabeth St	**Brisbane City**	**(07)229 9377**
166 Logan Rd	**Buranda**	**(07)391 6233**
Gympie & Hamilton Rds	**Chermside**	**(07)359 6255**
Queen Elizabeth Dr & Bernard St	**Rockhampton**	**(079)27 9644**
2nd Level Western Entrance Redbank Shopping Plaza	**Redbank**	**(07)288 5599**
Gold Coast Hwy & Welch St	**Southport**	**(075)32 9863**
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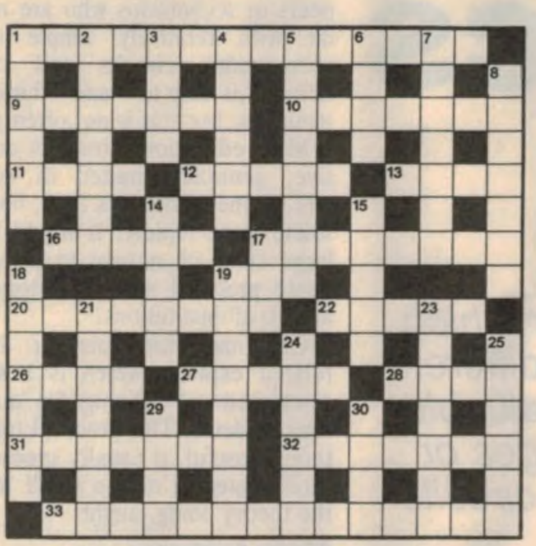
JULY CROSSWORD

ACROSS

1. Good optical clarity of graphics, etc. (4,10)
9. Having excess bass response. (7)
10. Radio enthusiast. (7)
11. Brand of amateur radio equipment. (4)
12. Unit of charge/voltage ratio.(5)
13. Diodes which visibly conduct. (4)
16. Uses keyboard. (5)
17. Period for a program. (8)
19. Display with twisted nematic fluid. (1,1,1)
20. RF waves were once called — waves. (8)
22. Telephone compartment. (5)
26. Magnetic recording medium. (4)
27. Famous contemporary of Faraday. (5)
28. Warning signal. (4)
31. Exuding liquid from cell, etc. (7)
32. System of linked electronic devices. (7)
33. Said of certain satellites.(14)



DOWN

1. This describes a computer with both analog and digital function. (6)
2. Earth science. (7)
3. Hydrometeor detectable by radar. (4)
4. Electromagnetic impulse. (6)
5. Variety of battery. (4-4)
6. Timber veneer often used for speaker enclosures. (4)
7. Minimum configuration for a battery. (3,4)
8. Activates a timer switch. (7)
14. Hold. (5)
15. Electrostatic copier. (5)
17. NSW station on channel 9. (1,1,1)
18. Reusable space vehicle. (7)
19. Star Wars weapon. (5,3)
21. Fit new component, etc.(7)
23. Low frequency modulation of amplified sound. (7)
24. Part of 32 across. (6)
25. Sharp transient pulses. (6)
29. Reduces light intensity. (4)
30. First name of Hahn, discoverer of fission. (4)

SOLUTION FOR JUNE

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

July 1932

New line of rotary converters: The Gilco Radio Converter, a quiet-running efficient rotary transformer, designed for connection to 32 volt, 110 volt and 240 volt DC farm lighting systems, places the man on the land in the sphere of first quality all-electric reception and enables even the largest all-electric receiver to be used where city power is not available.

New telephone system: The British Post Office is about to adopt a new system of telephone, which offers the possibility of holding 640 conversations on the same wire. One of the British Post Office chief engineers has announced that the first tests will be carried over between London and Birmingham and then between Birmingham, Manchester and Newcastle. Up to this day it has not been possible to hold more than twelve conversations on the same wire.

RADIO, TELEVISION and HOBBIES

July 1962

Light beam bounced off the Moon: A light beam powerful enough to reach the Moon and return may sound like a tall order, but this was recently achieved at the Massachusetts Institute of Technology.

This latest achievement was made possible by the recently developed optical maser — a means of generating light with among other things, an extremely narrow angle of radiation. It is so effective in this regard that even after travelling to the Moon it would cover only a relatively small area.

Underwater motor: An underwater motor available in America requires no pressure-tight case, since the water is allowed to circulate freely around the rotor and stator.

The motor operates entirely by induction, eliminating brushes, slip rings or centrifugal switches which would be short-circuited by the water. Free circulation of the water around the rotor keeps the motor cool.

The encapsulated coil are said to withstand pressures up to 2000lb per square inch. Motors are available up to 100 hp.

Teach yourself about electronic circuits

Build this electronics trainer

Here we present an electronics trainer which could be used to patch up countless different electronic circuits. It should prove a valuable student training aid for technical colleges or for teaching yourself about electronic circuits at home.

by BRANCO JUSTIC

This article describes a relatively self-contained "electronics trainer" which should appeal to educational institutions and electronic circuit designers alike. It includes many desirable features but, at the same time, the cost has been kept to a minumum. In fact, the cost is comparable to that of a single good quality textbook!

Unlike a textbook, however, it should be useful for a much longer period of time. For people involved with the occasional development of circuitry, this unit should prove a valuable aid, even after their academic courses and training are finished.

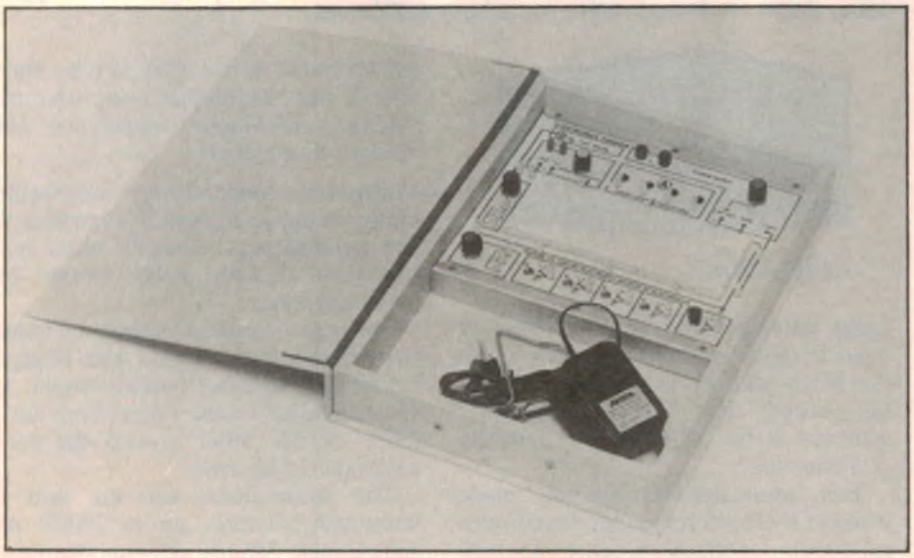
Practical training

Few people would argue that a person who has achieved a good grounding in electronics has had a balanced background in both the theoretical and practical aspects.

Usually it is the practical component that leaves something to be desired. For example, how many times do we read about supposedly fully qualified engineers or technicians who are not familiar with relatively simple electronic components, circuits and configurations? It is easy to blame educational institutions, but this is not often justified.

Most educational trainers are expensive, generally limited in application and, in the electronics field, become obsolete quite rapidly. It would take very large sums of money to provide adequate practical and laboratory training aids to all institutions.

One may also consider the work-related expense which is a significant component of training for many part-time students. This practical training, although useful, is usually specialised and thus relates to only a small fraction of the theory being taught.



The new electronics trainer fits neatly into a standard file box.

Main features

This new trainer provides a simple, low-cost means of patching up various analog and digital circuits. As can be seen from the accompanying photographs, it is based on a readily available prototype breadboard. Various circuits are also included in the trainer and they can be connected to the circuit under test.

Available circuits on the trainer are:

(1). A +1.2V to +12V regulated power supply which is capable of delivering load currents of up to 300mA (with specified AC-AC plugpack transformer).

(2). A fixed –12V regulated power supply which is capable of delivering up to 300mA (with specified AC-AC plugpack transformer).

(3). A variable frequency oscillator which delivers square wave and triangular output voltages.

(4). A fixed 12V 50Hz sine wave generator (mains).

(5). A debounced switch.

(6). Four logic level indicators.

(7). Four logic level switches.

(8). Two potentiometers.

Power supply

The various circuits included are very simple. Fig.1 shows the details.

The power supply section uses two half wave rectifier stages to derive the positive and negative supply rails. These are followed by 1000μF filter capacitors and two 3-terminal regulator ICs, one fixed and the other variable.

In greater detail, the 12V AC input from the plugpack transformer is applied via current limiting resistor R1 to recitifier diodes D1 (positive supply) and D2 (negative supply). C1 and C5 are the main filter capacitors. IC1 is an LM317T adjustable regulator which, with the components shown, gives an output voltage range from 1.2V to approximately 12V.

The output voltage is varied by means of VR1 which is wired between the ADJ terminal and Ground. Note that the 1kΩ resistor on the output of the regulator can be varied slightly to give a maximum output voltage of exactly 12V. IC2 (7912) provides the fixed –12V output.

The oscillator

The oscillator section of the circuit employs a single 74C14 Schmitt trigger inverter (IC3a). The output frequency is determined by R3, VR2 and C8. As shown, it can be adjusted from approximately 250Hz to 1.4kHz but these values can easily be reduced by adding extra capacitance ('C') in parallel with C8.

Two extra terminals in the oscillator section allow for this feature.

Note that the oscillator produces both square and triangular waveforms — the square waves at pin 10 and the triangular waves at pin 11. Emitter follower stage Q1 has been added to reduce the loading that would normally occur at the gate of the inverter when the triangular waveform output is being used.

Debounced switch

A monostable multivibrator consisting of transistors Q2 and Q3 makes up the debounced switch circuitry. When momentary contact switch S5 is pressed, a positive going output pulse of 0.5s duration appears at the collector of Q3. Here's how it works:

With the pushbutton released, R7 supplies sufficient base current via D3 to saturate transistor Q3. This means that a low output voltage (approximately 0.2V) is normally present at the collector output of Q3 and this is applied via R9 to the base of Q1. Thus, Q1 is turned off and its collector voltage is high.

Note that, in this state, C9 charges via R6 to almost the full supply voltage.

When S5 momentarily closes, current

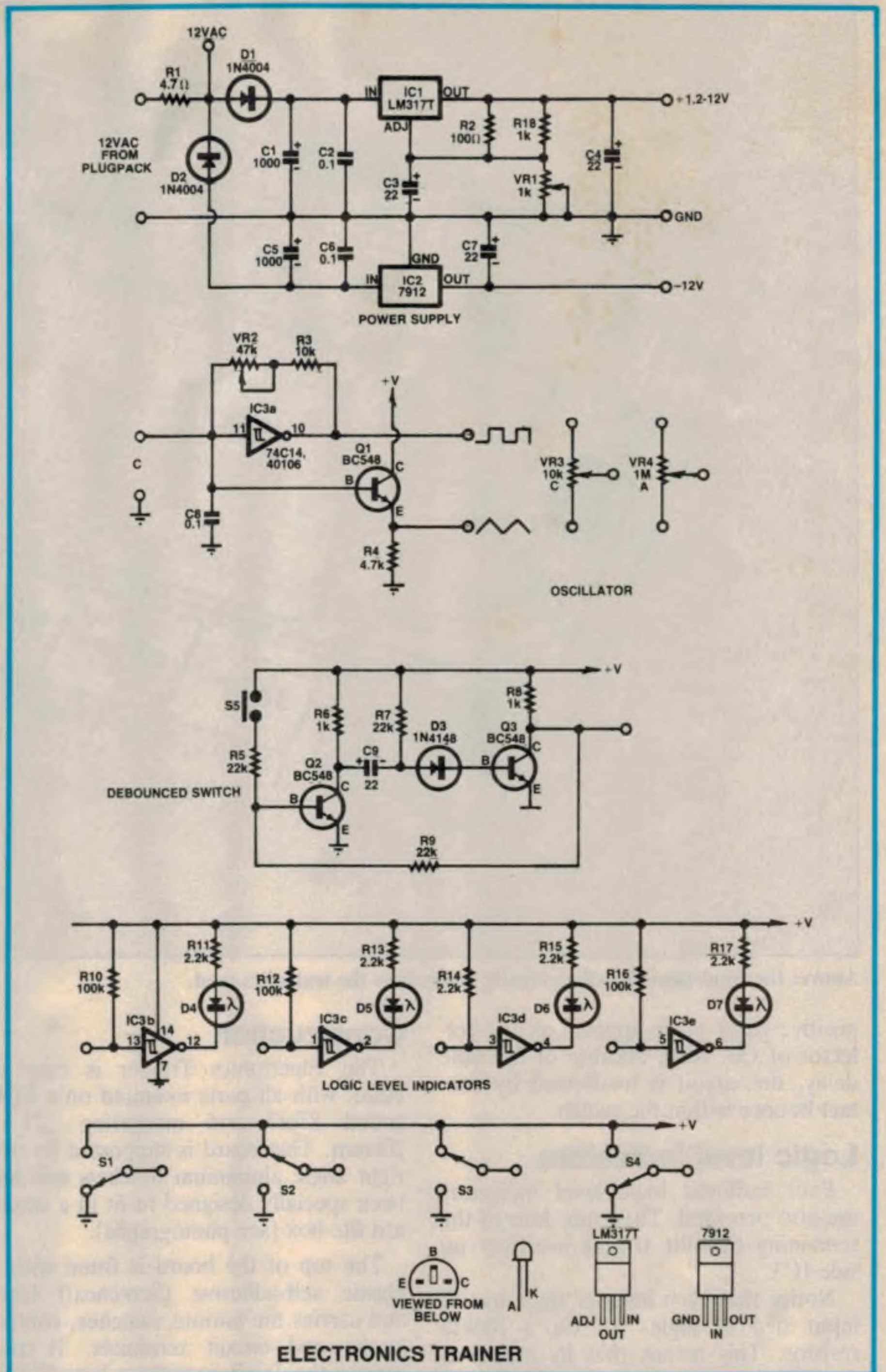


Fig.1: five different circuits make up the trainer: a power supply, an audio oscillator, a debounced switch, a logic level indicator circuit, and logic level switches.

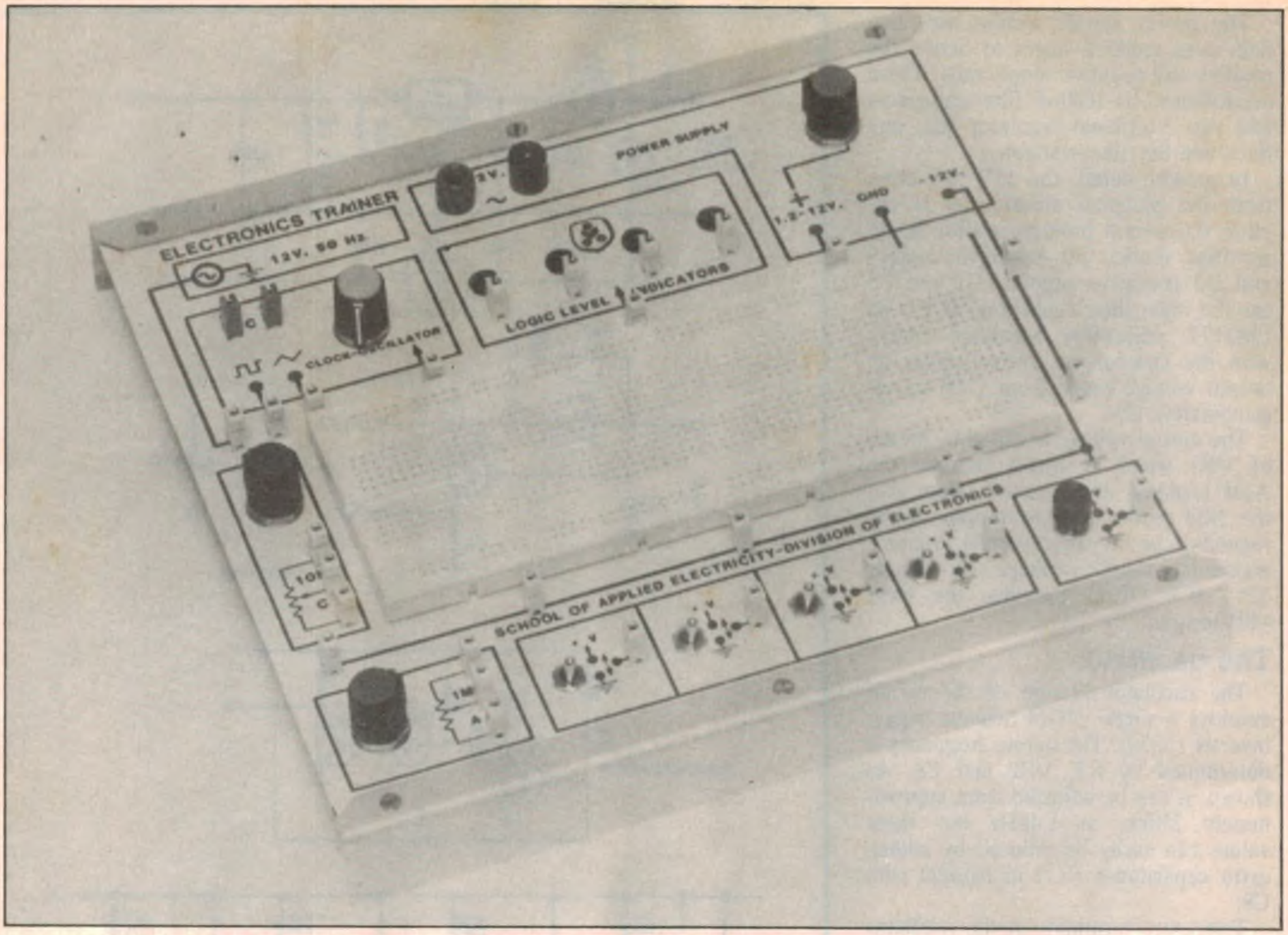
flows via R5 to the base of Q2. Q2 thus turns on and pulls the anode of D3 negative via C9. This, in turn, switches Q3 off and its collector voltage rises to near full supply voltage. At the same time, positive feedback resistor R9 ensures that Q2 remains on, even if the pushbutton is released.

The circuit now remains in this state for approximately 0.5 seconds until C9 has discharged sufficiently via R7 to provide forward bias for Q3. When this happens, Q3 turns on again, its collector goes low, and Q2 turns off due to feedback via R9.

Finally, C9 charges quickly via R6 to reset the circuit, ready for the next switch action.

Note that diode D3 is included as a precaution against reverse breakdown of the base-emitter junction of Q3. This breakdown voltage is normally of the order of 5V.

Thus, each time S5 is pressed, a 0.5s



Above: the front panel labelling clearly shows how the trainer is used.

positive-going pulse appears on the collector of Q3. And, because of the time delay, the circuit is unaffected by contact bounce within the switch.

Logic level indicators

Four buffered logic level indicators are also provided. These use four of the remaining Schmitt trigger inverters inside IC3.

Notice that each inverter stage has its input tied to logic "1" via a 100kΩ resistor. This means that its output is normally low and the corresponding output LED is normally lit. If, however, a logic "0" is applied to an input, the output of that stage switches high and the LED extinguishes.

Switches and pots

Four level switches and the two uncommitted potentiometers are also provided on the trainer. Switches S1-S4 are all single-pole double throw types and are wired to select either logic "1" or logic "0". VR3 is a 10kΩ logarithmic potentiometer, while VR4 is a 1MΩ linear pot.

Construction

The Electronics Trainer is easy to build, with all parts mounted on a PCB coded 87et7 and measuring 221 x 206mm. This board is supported by two right angle aluminium brackets and has been specially designed to fit in a standard file box (see photographs).

The top of the board is fitted with a plastic self-adhesive (Scotchcal) label and carries the various switches, control knobs and circuit terminals. It also carries the large prototype breadboard and this is centrally mounted on the board, again using a self-adhesive backing. Note that a plastic Scotchcal panel must be used to avoid shorting the various front panel terminals — do not use aluminium

Begin construction by carefully affixing the adhesive label to the PCB. The trick is to first use several small pieces of adhesive tape to hold the label in position. This done, peel and cut off the backing paper from a large corner section of the overlay, then carefully stick down this corner section, taking care to avoid air bubbles.

The remainder of the backing paper can now be slowly peeled away from the fastened corner and the label progressively stuck to the PCB. Avoid air bubbles and creases. When the job is completed, cut out all the necessary holes using a sharp knife.

The potentiometer shafts can now be cut to length to suit the knobs supplied. You should also now mark out and drill the required holes in the mounting brackets. This done, the mounting brackets, potentiometers, knobs, switches and terminal connectors can all be installed on the PCB.

The next step is to install and solder the electronic circuit components. As can be seen from the photographs, most of the components are surface mounted on the copper side of the PCB. Surface mounting is really very simple if one follows three basic instructions:

(1). Shape the component leads and cut them to the required length.

(2). Tin the component leads and the location on the PCB that will accommodate the component.

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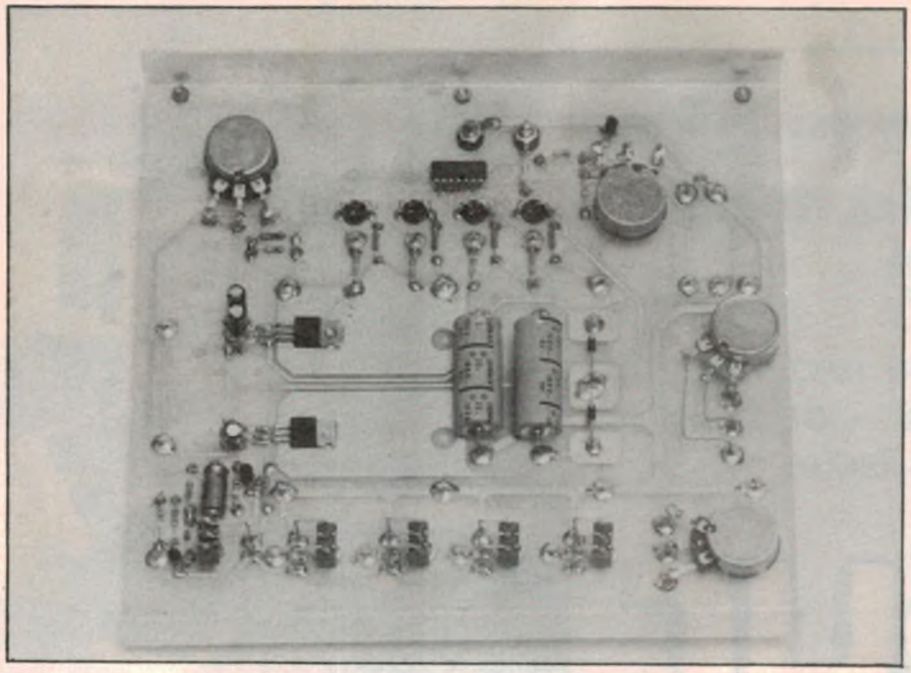


Virtually all the parts are installed on the copper side of the PCB. Note that the regulator tabs must be attached to the two large copper pads.

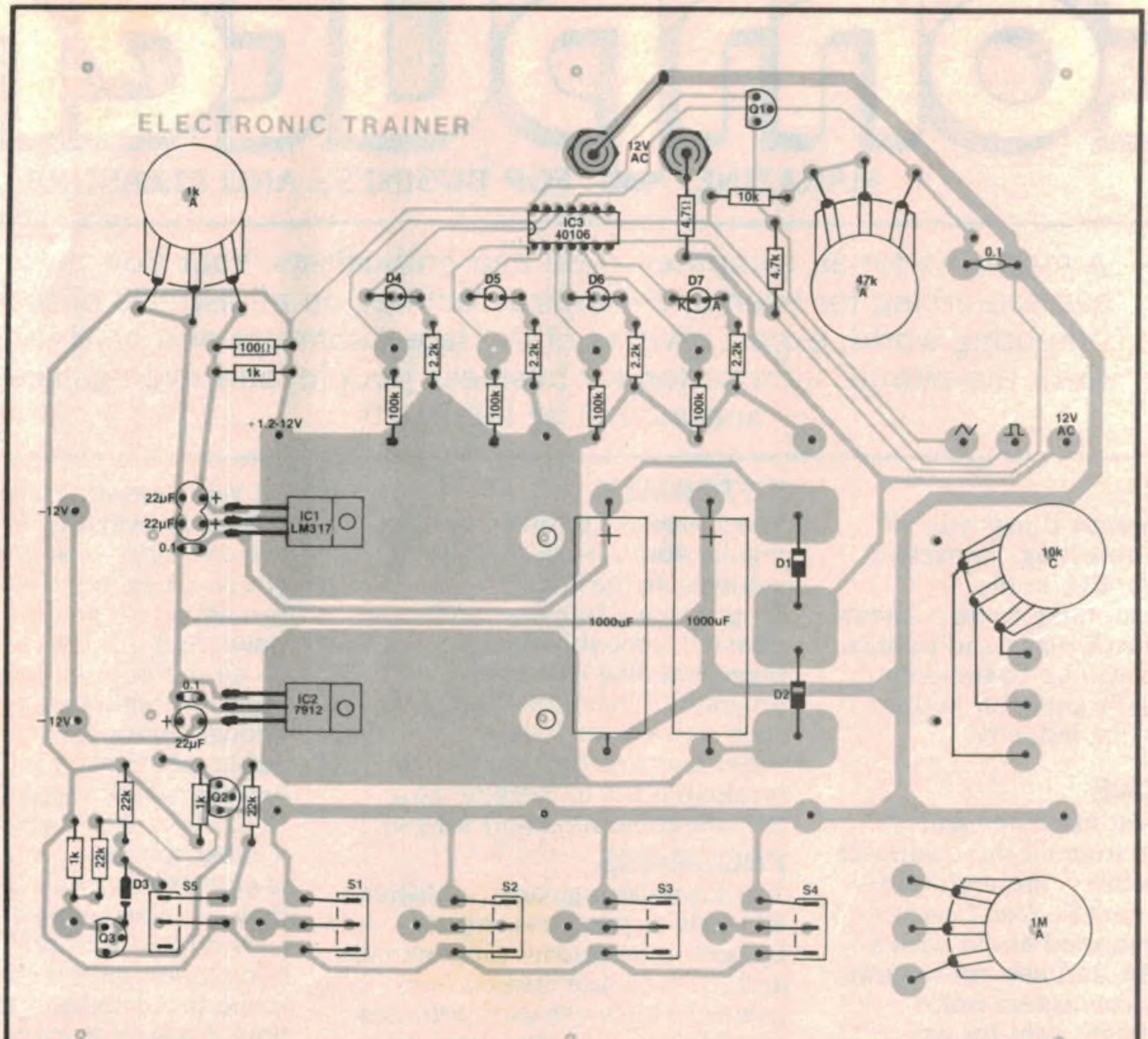
(3). Position the component on it's correct location and solder the leads.

The above procedure should be quite straightforward, but take care with the orientation of the IC, LEDs, transistors, diodes and electrolytic capacitors. The metal tabs of the 3-terminal regulators were soldered to their respective copper lands in the prototype, but a better method would be to bolt them into position using countersunk 6BA screws and nuts.

Note that the screws must be countersunk so that they will not later foul the prototype breadboard when this is installed.

The 29 terminal connectors are installed on the top (label side) of the PCB, as are the four banana sockets. The four LEDs are installed from the copper side of the PCB and secured using mounting bezels. Tinned copper wire is used to wire the switch and pot. terminals to their respective pads on the PCB.

Construction can now be completed



by installing the prototype breadboard. As mentioned previously, this comes with a self-adhesive backing and it's simply a matter of peeling away the backing paper and carefully affixing the breadboard to the PCB.

Testing

To test the unit, connect up a 12V AC plugpack to the supply terminals and switch on. The LEDs in the logic level indicator section should all light.

You can now use your multimeter to check that the power supply is working correctly. Check that the positive rail can be varied between +1.2V and +12V and that the negative rail is at –12V. The logic level indicator circuits can be checked by pulling each input low in turn (ie, connect the input to ground). The relevant LED should go out in each case.

The clock-oscillator circuit is best checked out using a CRO. Check for the presence of square and triangular waveforms at the appropriate terminals and check that the oscillator frequency can be varied using the associated pot.

If you don't have a CRO, try connecting your multimeter to each of the clock outputs in turn. You should get a reading of approximately half supply rail in either case. Alternatively, connect the clock outputs to two of the logic level indicator circuits. The two associated LEDs should dim noticeably and you should be able to vary their brightness using the oscillator frequency control.

Operation of the debounced switch circuit can be checked by connecting your multimeter to the associated terminal connector. The terminal voltage should go high for (ie, switch to the positive supply rail) for about 0.5s each time the button is pressed.

You can also check the debounced switch circuit by connecting its output terminal to one of the logic level indicators. The indicator LED should go out but should light for 0.5s each time the switch is operated.

Acknowledgements

This Electronics Trainer was developed in conjunction with Department of Technical and Further Education (TAFE), School of Applied Electricity, Division of Electronics, Sydney Technical College. It is intended for use in the Electronics Trade Course, with possible extension to the Electronics Engineering Course.

The idea is that each student will make his/her own trainer during practical classes early in the course. The trainer will then be used by many laboratory/practical classes during the remainder of the course.

The author would like to acknowledge the assistance of the staff of the Division of Electronics at Sydney Technical College in developing this project, including Mr K. Harris (Senior Head Teacher), Mr R. Finneran (Head Teacher), and Mr G. Barnes (assistance with PCB artwork and assembly of the prototype).

PARTS LIST

1 PCB, code 87et7, 221 x 206mm
1 front panel artwork, 221 x 206
2 mounting brackets, 221 x 25 x 12mm
1 12V AC plugpack transformer
1 momentary contact pushbutton switch
4 SPST miniature toggle switches
2 banana sockets
4 knobs to suit
29 terminal connectors
1 prototype breadboard, 178 x 67 x 8mm

Semiconductors

2 1N4004 silicon diodes
3 BC548 NPN transistors
1 LM317T adjustable 3-terminal regulator
1 7912 –12V 3-terminal regulator
1 74C14, 40106 hex Schmitt inverter
4 red LEDs

Capacitors

2 1000μF 25VW electrolytic
3 22μF 25VW electrolytic
3 0.1μF ceramic (monolithic)

Resistors (0.25W, 5%)

4 x 100kΩ, 2 x 22kΩ, 1 x 10kΩ, 1 x 4.7kΩ, 4 x 2.2kΩ, 3 x 1kΩ, 1 x 100Ω, 1 x 4.7Ω

Potentiometers

1 1MΩ linear
1 47kΩ linear
1 10kΩ logarithmic
1 1kΩ linear

Where to buy the parts: a kit of parts for this project is available from Oatley Electronics, 5 Lansdowne Pde (PO Box 89), Oatley, NSW 2223. Telephone (02) 579 4985. The price had not been finalised at the time of writing but should be around $90 (includes all parts and the plugpack transformer, but not the box file).

Note: outside TAFE, copyright of the PCB and front panel artworks for this project is owned by Oatley Electronics.

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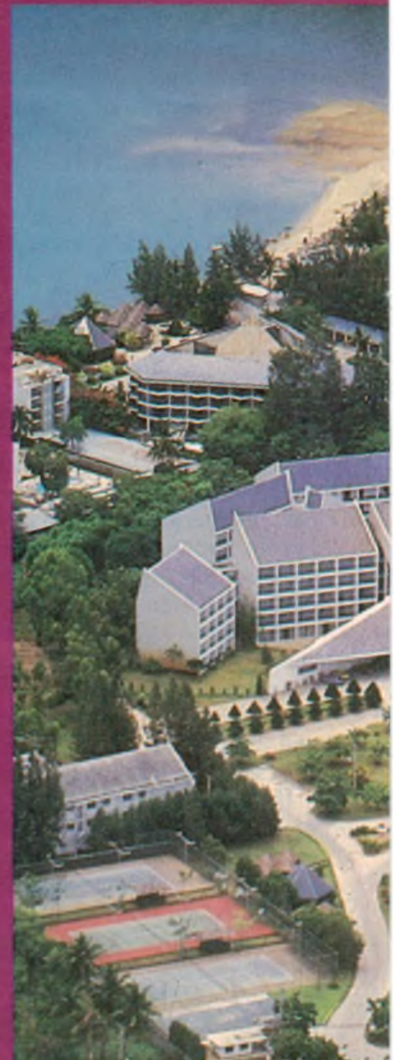
Siam Bayshore Resort Hotel, Pattaya

Siam Bayshore Resort Hotel is on the farthest tip of South Pattaya's beachfront, close to Pattaya village. Tennis lessons are available, as well as many watersports. With three restaurants, two bars and a nightclub, the Siam Bayshore Resort Hotel has all the charm and hospitality you could wish for.

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A quiet revolution has been gathering pace over the last few years as more and more miniature electronic components find their way into electronic equipment. These new devices are called surface mounted components, or SMCs for short, and have spawned new production and servicing technologies.
This article covers the gamut of surface mount technology, including PCB assembly methods, board design, soldering techniques, and components.

Surface mount devices — the revolution continues

by TERRY AYSCOUGH

Evolution of surface mounting

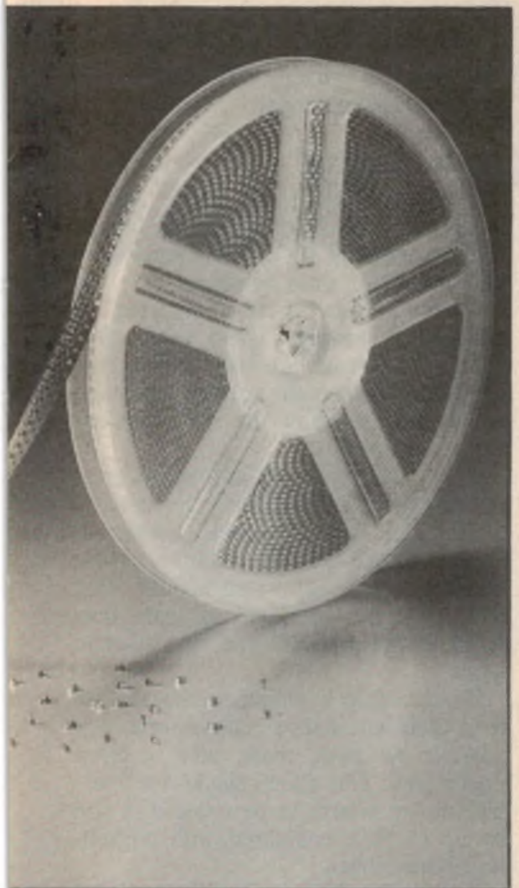
In the earliest days of radio, most components had screw terminals and were connected together using separate lengths of wire. The high cost and inconvenience of this system quickly became apparent and it was not long before small components such as resistors and capacitors had their connecting wires built in. As printed circuit board (PCB) technology developed, connecting leads provided a handy means of holding components in position on one side of the board, whilst providing electrical connections to the print tracks on the other. Now, after half a century of reduction in size, components are starting to change radically.

The development of thin and thick film hybrid circuits in the early 1970s created a demand for new types of components. Hybrid circuits are like miniature high-density PCBs, but often use ceramic substrates. It's not practical to drill multiple holes for connecting leads to pass through ceramic, so small components, such as resistors, capacitors, diodes and transistors were mounted on the same side as the print paths and soldered directly to them.

The first components to be 'surface mounted' in this way had ordinary wire ends, but it was not long before specially designed surface mount devices (SMDs, alternatively known as surface mount components, SMCs), became available. With SMDs, lead out wires were replaced by short tags, or metallised pads, which could lay flat on the print tracks before being soldered into place. Without the need to terminate and anchor connecting leads within the encapsulation, components could be drastically reduced in size.

The term 'chip' component was first adopted to describe very small leadless resistors and capacitors, but is now used to cover the whole range of smaller SMDs. In recent years more and more chip devices have become available and today, most component and semiconductor manufacturers offer most of their ranges in either conventional wire leadout or surface-mount configurations.

A PCB can use surface mount technology in a variety of ways. The print



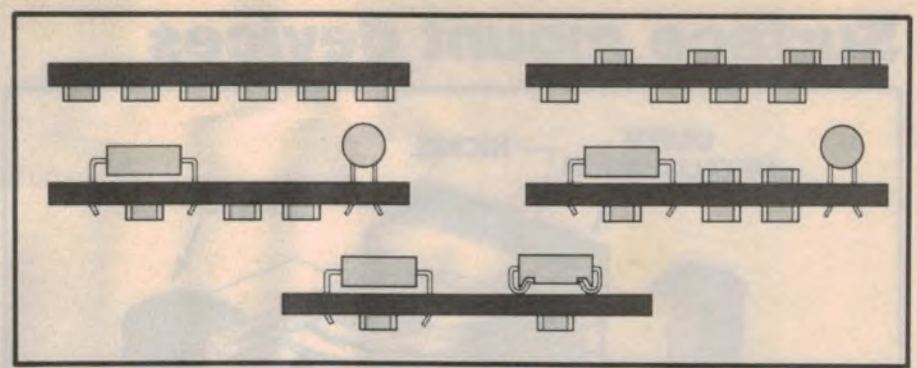


Fig.3: Surface mount devices can be used alone or mixed with other components and be mounted on or below PC boards. (Diagram by courtesy of Siemens.)

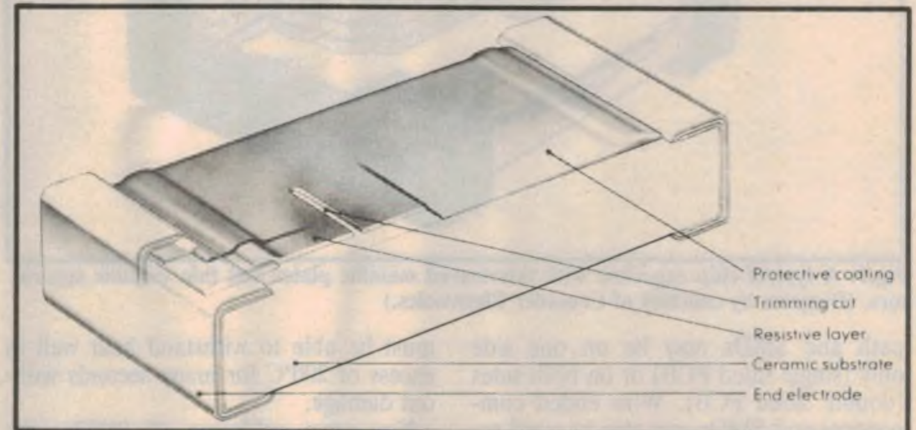


Fig.5: A typical chip resistor. Note the laser trimming cut which sets the resistance value precisely. (Diagram by courtesy of Philips.)

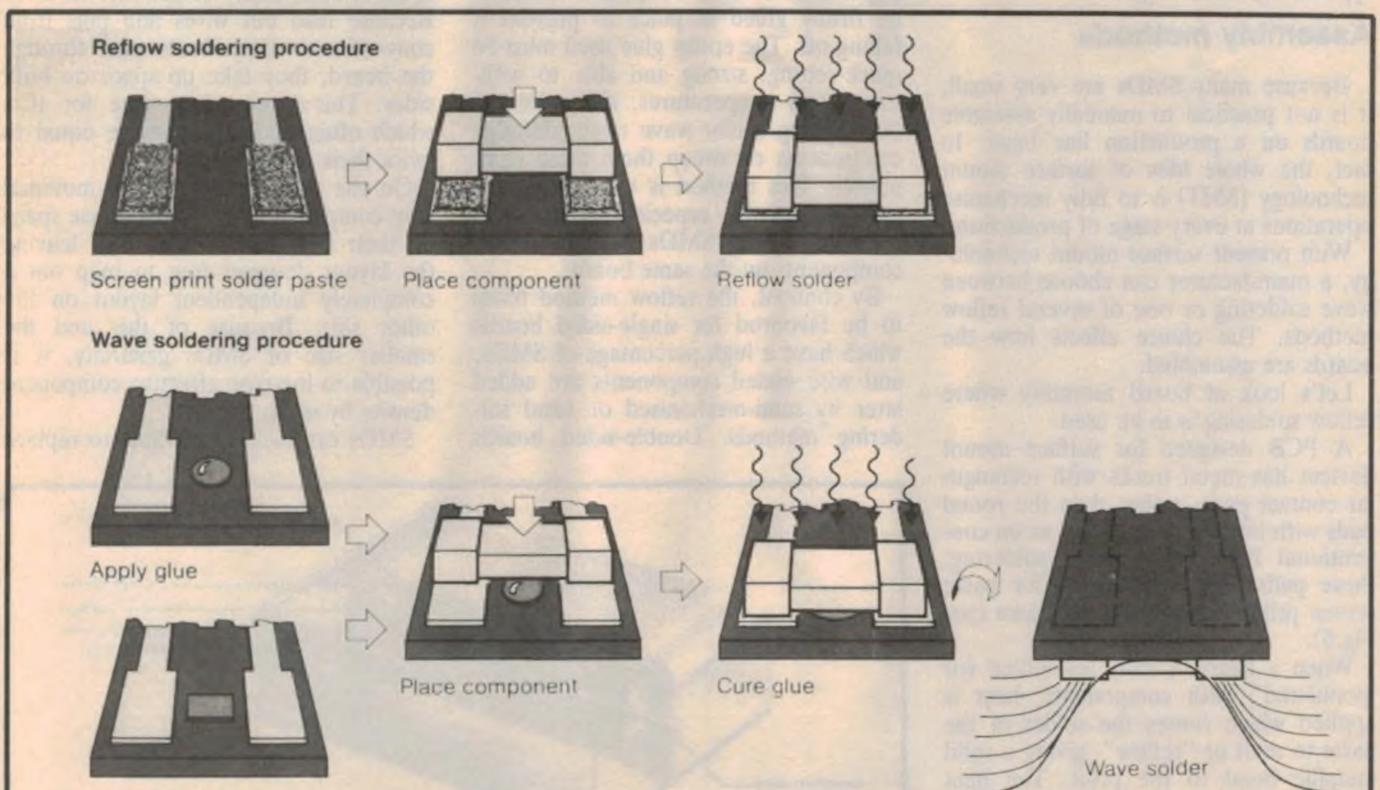


Fig.4: Wave soldering and reflow soldering require different assembly procedures. Wave soldering is commonly used for components below the board. Reflow soldering is used for components above the board. (Diagram by courtesy of Siemens.)

Surface mount devices

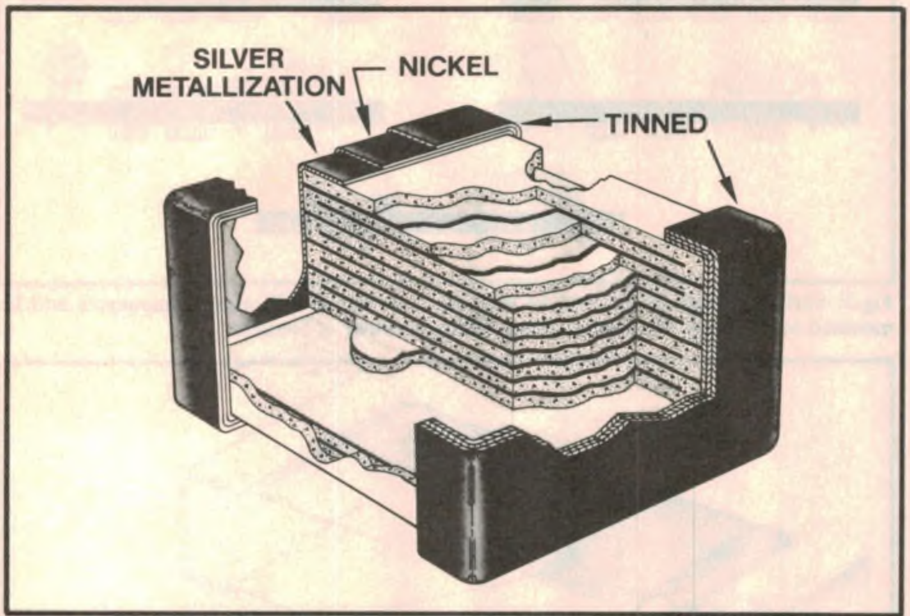


Fig.6: A typical chip capacitor with interleaved metallic plates and thin ceramic separators. (Diagram by courtesy of Crusader Electronics.)

path and SMDs may be on one side only (single sided PCB) or on both sides (double sided PCB). Wire ended components and SMDs can also be used together, giving 'mixed' boards of various types as shown in Fig.3.

Assembly methods

Because many SMDs are very small, it is not practical to manually assemble boards on a production line basis. In fact, the whole idea of surface mount technology (SMT) is to fully mechanise operations at every stage of production.

With present surface mount technology, a manufacturer can choose between wave soldering or one of several reflow methods. The choice affects how the boards are assembled.

Let's look at board assembly where reflow soldering is to be used.

A PCB designed for surface mount devices has metal tracks with rectangular contact pads, rather than the round pads with holes in the middle as on conventional PCBs. For reflow soldering, these pads have a sticky solder paste screen printed onto them as shown (see Fig.6).

When a board is fully assembled (or 'populated') with components, heat is applied which causes the solder in the paste to melt or "reflow", giving a solid metallic bond to the print. The heat may be supplied by gas flames, radiant infrared sources (including lasers) or hot vapour as described in the separate panel. In all cases, the components must be able to withstand heat well in excess of 200°C for many seconds without damage.

For wave soldering of SMDs, the board must be turned over after being populated, so each component needs to be firmly glued in place to prevent it falling off. The epoxy glue used must be quick-setting, strong and able to withstand high temperatures, otherwise the fast flowing solder wave might dislodge components or sweep them away completely. This method is very commonly used at present, especially where it is necessary to mix SMDs and wire ended components on the same board.

By contrast, the reflow method tends to be favoured for single-sided boards which have a high percentage of SMDs, and wire ended components are added later by semi-mechanised or hand soldering methods. Double-sided boards can use reflow soldering for surface mount components on top and wave soldering for mixed wire ended and SMDs on the underside.

Board Design

The introduction of surface mount technology will have major effects on some sections of the electronic industry and only minor ones on others.

Circuit design is not expected to change very much. There are a few components, such as large electrolytic capacitors and high wattage resistors, which will probably be designed out whenever possible.

But board layout and production engineering will be dramatically changed by SMT. The factory trouble-shooter or service technician will continue to use familiar tools and instruments with SMT, but he will need to learn new tricks on the practical side, as explained later.

Because chip components are smaller than their wire-ended counterparts, it is possible to pack more into a given board area. This allows single-sided surface mount boards to be reduced in size by up to 50% compared with conventional assemblies.

If a double-sided or multilayer board is used, SMT really comes into its own. Because lead out wires and pins from conventional components pass through the board, they take up space on both sides. This is especially true for ICs, which often take board space equal to twice their own area.

On the other hand, surface-mounted chip components and ICs only use space on their own side of the PCB, leaving the layout designer free to map out a completely independent layout on the other side. Because of this and the smaller size of SMDs generally, it is possible to increase effective component density by up to 300%.

SMDs can make it possible to replace

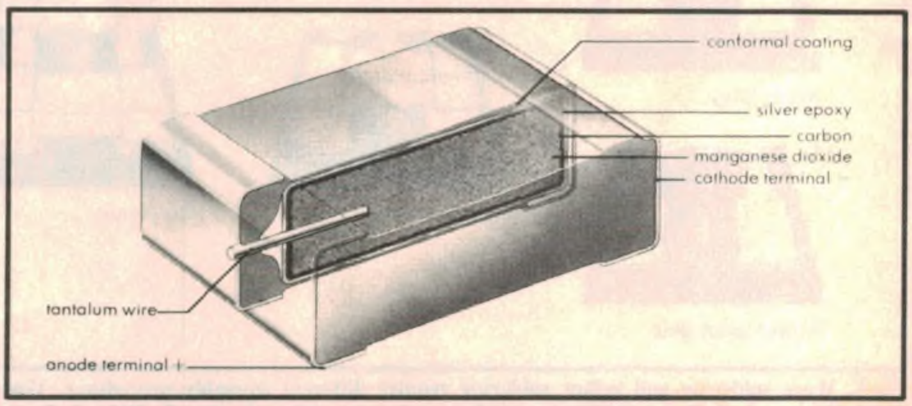


Fig.7: Surface-mounted tantalum capacitor, as made by Philips.

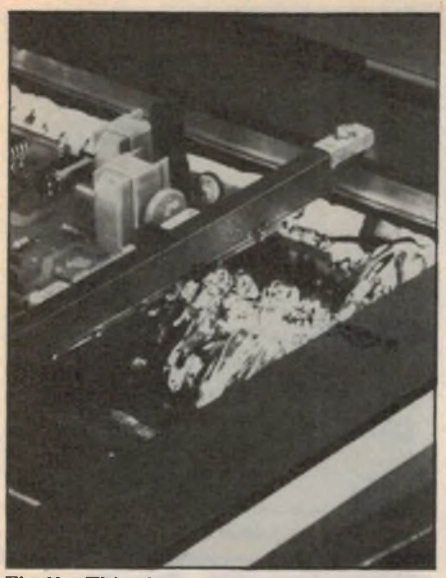


Fig.1b: This shows the turbulent soldering action of a dual wave soldering machine. (Photo by courtesy of Alfatron Pty Ltd.)

two or three separate boards with a single assembly. This can cut costs by eliminating connectors and wiring, simplify testing and improve reliability.

There are some limits, though, on just how closely components can be packed together. If a circuit is dissipating a lot of power, a small component version will get a lot hotter than one which is spread out and has good air flow.

Board design and layout can also be affected by the soldering system used. With the solder wave method, space must be provided for the blob of epoxy under each component. Printed tracks normally run under most larger components and their presence or absence will vary the amount of glue required to fill the gap.

As mentioned in the panel on wave soldering, the spacing and shape of components can also prevent the solder in the wave from flowing freely. If solder flow is obstructed, it can result in dry joints.

The small size of many SMDs and the closeness of connections on the latest ICs and chip carriers (well below 0.5mm) presents a particular challenge to PCB manufacturers. Improved masking and etching techniques will be needed to provide the fine, accurately positioned print paths and connecting pads required.

Wave Soldering

The standard soldering method, used for through-hole mounted components on conventional PCBs, is to pass the board slowly over the top of a single molten solder wave. As the board surface is flat, with only component leads sticking out, the solder can flow smoothly, giving good joints in all areas.

Because SMDs are packed closely together and protrude below the board surface, they tend to cause eddies in the solder wave. This prevents proper flow to adjacent joints, causing solder skips.

This problem is overcome by using a wave with a mushroom shaped cross section as shown. As the board moves across the wave, every part of it experiences solder flow from at least two different directions and all nooks and crannies are penetrated.

Dual wave soldering systems are often used. The first broad, turbulent wave is necessary to ensure good wetting of the contacts, but it can leave excessive amounts of solder behind, causing bridging of closely spaced leads on ICs, etc. The second, narrower wave has a gentle laminar flow, to remove excess solder and thereby avoid short circuits (see Fig.1).

There is a problem with gas, too. Wave soldering creates flux gases, but with conventional boards these can escape up the insertion holes of component tags. With surface mounting, bubbles or pockets of gas can form under components, preventing the proper flow of solder and thereby causing poor joints. Tilting the board as shown, in Fig.1, allows gases to escape more easily.

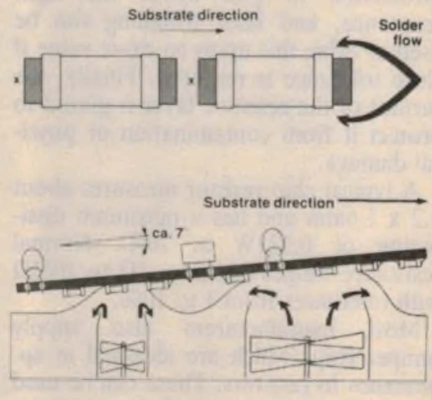


Fig.1a: SMD components close together tend to stop the flow of solder to individual connections. Tilting the board helps vent any gases produced during soldering. (Diagram by courtesy of Philips.)

Test points

Traditional PCB construction methods using wire ended components provide plenty of points for connecting probes or clipping on test leads. This does not occur with surface mounts so special test pads have to be included in the printed track layout.

Computer-aided design

Computer aided design (CAD) is often used to lay out large PCBs. Software programs originally written for designing boards using only conventional components will need lots of changes to take advantage of surface mount technology.

Component categories

As we have seen, SMDs are subjected to high levels of radiant or absorbed heat during reflow soldering processes or are completely immersed in molten metal if wave soldering is used. Imagine the effect of this on ordinary components and it's obvious that SMDs require very special survival characteristics.

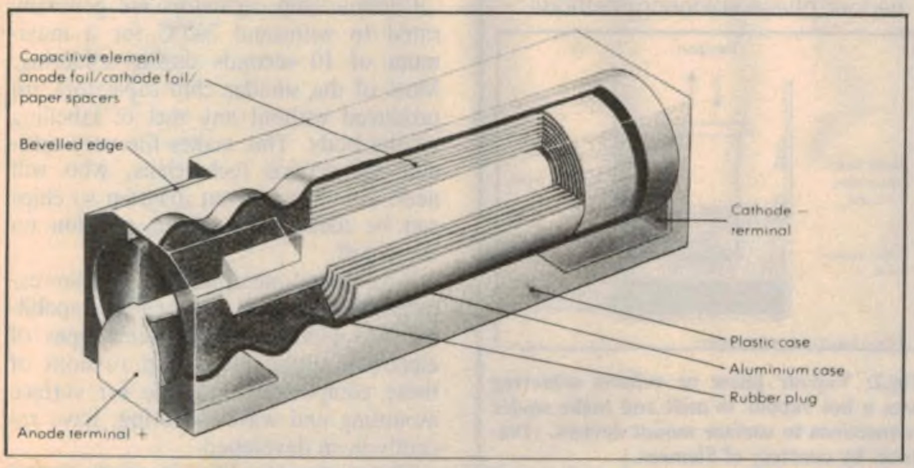


Fig.8: Surface-mounted aluminium wet electrolytic capacitor, as made by Philips.

Surface mount devices

Surface mount versions of almost all low power component types are now available, but resistors, capacitors, and discrete semiconductors make up about 80% of all SMDs used.

Resistors

Chip resistors are usually based on a tiny bar of high grade ceramic (aluminium oxide) material. Flat metal electrodes are fitted at either end for soldering to the PCB track. One side of the bar is coated with a resistive paste, formulated to give about the right resistance, and laser trimming can be used to bring this up to an exact value if close tolerance is required. Finally, the surface of the resistive layer is glazed to protect it from contamination or physical damage.

A typical chip resistor measures about 3.2 x 1.6mm and has a maximum dissipation of 0.125W at 70°C. Normal resistance ranges are from 1Ω to 10MΩ with tolerances from 1 to 10%.

Most manufacturers also supply jumper chips which are identical in appearance to resistors. These can be used in a similar way to wire links on a conventional PCB, but are more easily handled by automatic assembly equipment. For newcomers to SMD technology, it can be a surprise to find zero ohm resistors included in the parts list.

An alternative to the rectangular chip construction for resistors described above is the "metal electrode face" bonding (MELF) or mini-MELF format. These devices are cylindrical and resemble miniature cartridge fuses. They are generally a little larger than rectangular chip resistors and some have rated dissipation up to 0.25W at 70°C.

There is no agreed system for labelling surface mount resistors and some manufacturers simply leave the chip blank. Many Japanese suppliers use a three number system where the first two digits give resistance value and the last digit indicates the number of noughts. For example, 103 would indicate 10 followed by three noughts for a resistance of 10kΩ; 224 would indicate 22 and four noughts for 220kΩ. Some MELF resistors use the familiar colour band system found on wire ended types.

Most surface mount resistors are very rugged and can withstand heating to 250°C for up to one minute during soldering without damage.

Vapour Phase Soldering

Vapour phase soldering was initially developed in the USA about 15 years ago. It uses a sticky solder paste, with a consistency similar to Vegemite, which is screen printed on to the PCB connecting pads. This serves to hold the components in place during assembly and soldering.

A tray containing a special viscous liquid, which boils at 210 to 220°C, is heated to provide a saturated vapour cloud as shown. The PCB is placed in the cloud and hot vapour condenses on to it. Latent heat flows into the metal contacts on both components and board, causing the solder paste to melt or reflow. Bonding occurs over the full area between contact surfaces and there is no excessive solder to cause bridging problems.

The hot vapour penetrates even the most inaccessible gaps between densely packed components, ensuring uniform results regardless of board layout (see Fig.2).

The hot vapour cloud or zone is confined within a small area by using cooling pipes to form a 'lid' of colder, heavier vapour on top and at the sides. This prevents the expensive primary liquid from boiling away too rapidly while condensed liquid is returned to the heated tray for re-use.

Because the boiling point of a liquid can be closely defined, there is little danger of overheating SM components or boards with vapour phase soldering methods.

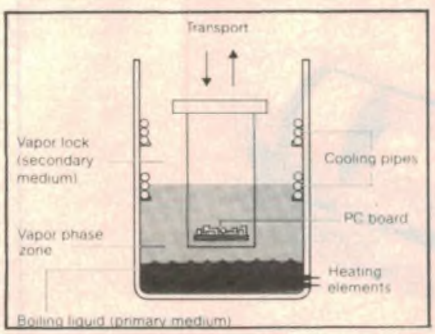


Fig.2: Vapour phase or reflows soldering uses a hot vapour to melt and make solder connections to surface mount devices. (Diagram by courtesy of Siemens.)

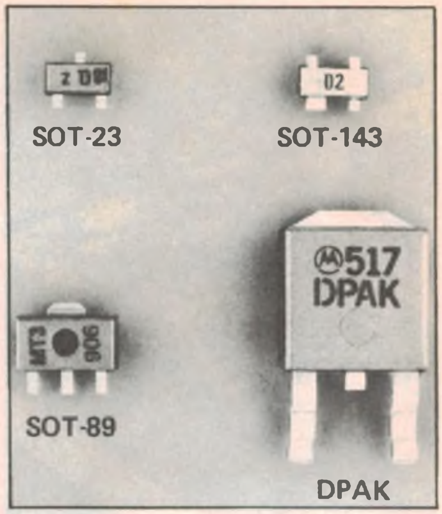


Fig.9: Surface mount transistors are available in several encapsulations, some of which are shown above. (Photo by courtesy of Motorola Semiconductor products.)

Capacitors

Like their wire ended cousins, surface mount capacitors come in a variety of types, to meet differing requirements.

The most popular chip capacitor at the moment is the ceramic multilayer type. A sandwich construction with interleaved metallic plates separated by very thin ceramic slices is used. These are stacked up, layer upon layer, until the required capacity is obtained. Each end of the capacitor is metallized to connect alternate plates together and a metal end cap is usually fitted to provide a good solderable connection to the PCB print.

Multilayer ceramic chips offer a very wide range of capacity extending from 1pF to 1.5μF. Typical working voltages are 63 or 100V but 200V units are available. Different formulations can be used for the ceramic dielectric, giving various capacity/temperature drift characteristics to suit particular applications.

Ceramic chip capacitors are generally rated to withstand 260°C for a maximum of 10 seconds during soldering. Most of the smaller chip capacitors are produced without any sort of labelling on the body. This makes life very difficult for service technicians, who will need a detailed layout diagram so chips can be identified by their position on the board.

Wire ended metallized plastic film capacitors, with their self-healing capability, are widely used in many types of electronic equipment. Chip versions of these components, suitable for surface mounting and wave soldering, have recently been developed.

Thin polyester film is used as the

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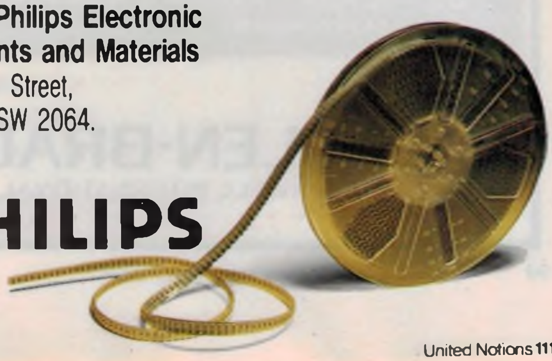

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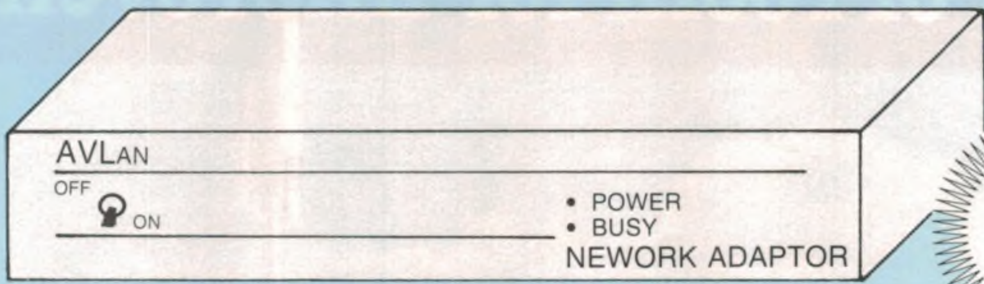

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Surface mount devices

dielectric, but this can easily be damaged by excessive heat. The capacitor is constructed by first tightly rolling the metallised dielectric films together to form a compact core. This is then buffered from thermal shock during PCB soldering by a special moulded plastic case and lead out connections designed to minimise heat conduction. These techniques enable the capacitors to withstand 260°C for up to five seconds without problems.

Extremely stable polyester capacitors in the range 0.01 to 0.68μF and rated at about 50V working are currently available. As the moulded cases are generally larger than the bodies of ceramic chip capacitors, it is usual for the capacity and working voltage to be printed on them.

For applications requiring higher values of capacity, various types of polarised capacitors are available.

Surface mounted tantalums have been around for some time and are widely used. Capacities range from 0.1 to 100μF and working voltages from 4 to 50V. The smallest surface mount tantalums are about 2.5mm long and the largest about 7.5mm.

The capacitor body is coated with a heat resistant encapsulation to protect it from soldering temperatures. Typical tantalums are rated to withstand 260°C for 10 seconds or 300°C for 5 seconds. The small size and coatings used make it difficult to print any information on the component body, but polarity can sometimes be determined by identifying the small irregularity caused by the end of the tantalum rod, which provides the anode or positive connection.

Wet electrolytic capacitors for surface mounting are produced with values ranging from 0.1 to 22μF and working voltages from 6.3 to 63V. They are constructed by rolling etched aluminium foil electrodes and electrolyte impregnated paper separators together and mounting them inside a miniature aluminium case. A moulded plastic outer case provides insulation and protection from soldering heat.

Wet electrolytics are usually bigger than corresponding tantalum types and have overall lengths from about 8 to 12mm. Their larger size and the smooth surface provided by the plastic case make it possible for details of the capacity and voltage to be printed on them. The case sometimes also has a notch or bevelled edge to indicate the positive terminal.

Discrete semiconductors

Surface-mounted transistors and diodes, originally intended for use in miniature hybrid assemblies, have been available for some years. The first such standard plastic package to be introduced was the three terminal SOT-23 in the late 1960s. This was followed by the slightly larger SOT-89 in the mid 1970s and the four terminal SOT-143 in the early 1980s. SOT stands for 'small outline transistor' but the packages are used for all types of diodes and other semiconductors as well. A recent addition is the hermetically sealed SOD-80 two-terminal glass package, specifically intended for diodes of various types.

Transistors and single or double diodes of just about every type, except for power devices, are available in SOT-23 packaging. Because of their more recent introduction, SOT-89 and SOT-143 types are a little less common. Devices in SOT-23 and SOT-143 format can dissipate 200/350 mW and SOT-89 500/1000 mW. Motorola have recently announced a new DPAK range of surface mount power transistors. These are much larger than the standard SOT devices described above, but can dissipate 20W at 25°C (see Fig.9).

Readers may also come across several other commonly used package designations. These are TO-236 which equates to SOT-23, TO-243 which equates to SOT-89 and SOT-37 and SOT-103 which are used for RF transistors.

Red, yellow and green light emitting diodes are available in SOT-23 packaging. As there are three connections available, it is also possible to mount red and green LED chips in the same package and electrically select whichever is required. Alternatively, two chips of the same colour can be used together to double the light intensity.

As LEDs in this packaging measure a tiny 1.3 x 3mm and are only 1mm high, they can be grouped together on a PCB as elements in larger displays of numbers of characters, used as contact indicators under touch pads or mounted on PCBs to give visual indication of circuit status or fault conditions.

Soldering survival temperatures for transistors and diodes are typically 280°C for 10 seconds.

Because of their very small size, discrete semiconductors often have a two or three digit code stamped on them, rather than the full type number.

Integrated circuits

Small outline IC packages were originally introduced for use in subminiature applications, such as electronic watches, etc. They usually incorporate the same silicon chips as conventional ICs, but the encapsulation, together with pin size and spacing, has been 'squeezed' down to make the final device very much smaller. A smaller package will not radiate heat as effectively as a larger one and maximum permitted dissipation is typically reduced by up to one third compared to the same chip in a standard package.

A long and complicated list of "SO" numbers is used to cater for the various IC package sizes, numbers and spacing of pins, and we will not attempt to

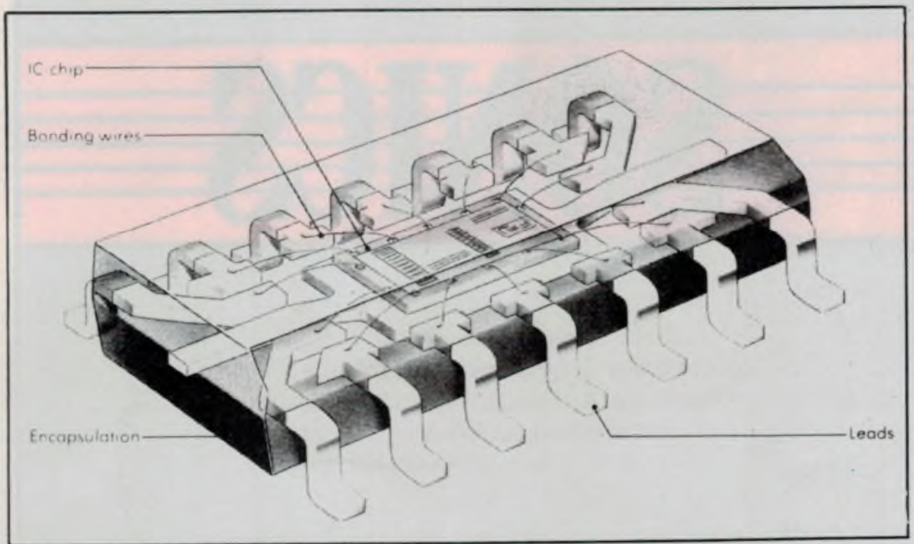

Fig.10: Surface mount ICs have smaller packages and much closer lead spacings. (Photo by courtesy of Philips.)

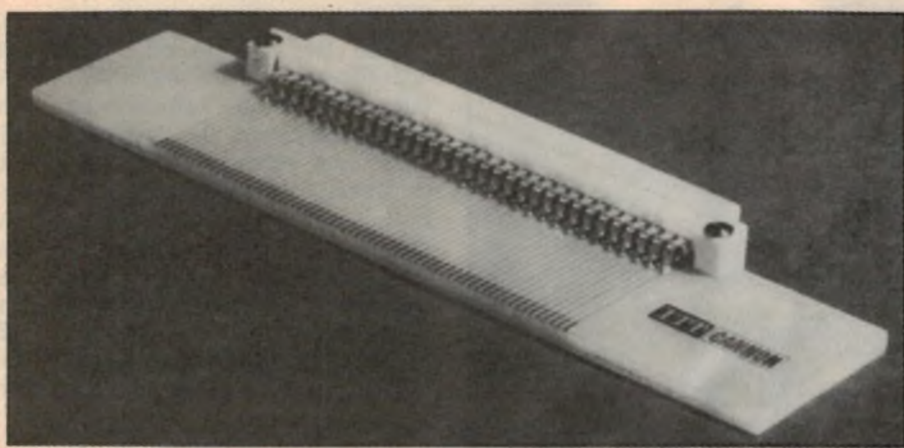

Fig.11: Board edge connectors are available in SM varieties too, as this photo from STC-Cannon shows.

rationalise them here.

Several different pin shapes and arrangements will be encountered on surface mount ICs. One of the most common is the outward facing L-shape. This makes the IC look rather bow legged and extends the board surface area required well beyond the encapsulation size.

An alternative is to bend the pins back under the encapsulation to form an inward facing J-shape. This method saves space and also permits some flexing of leads to take up movement caused by thermal stresses during manufacture. One of its disadvantages is that soldered joints are out of sight below the IC and thus difficult to inspect.

Surface mount ICs often have a pin-spacing between centres of either 1.27 or 0.762mm. The smaller pitch calls for special PCB design and assembly methods. Reflow soldering techniques are preferred, because wave soldering can easily leave short circuits across closely spaced pins or associated print paths.

When ICs have more than about 40 connections, it is common practice to use square packages with leads emerging from all four sides. Chip carriers and special IC packaging for VLSI devices can now provide up to 400 connections to a surface mount PCB if required.

ICs are some of the more thermally sensitive components used in surface mounted assemblies. Many types can only take the 220/230°C temperatures required for good solder flow for about four or five seconds. Because of this and the bridging problems mentioned earlier, reflow soldering methods are preferred to wave systems for sensitive ICs. In some cases, device manufactur-

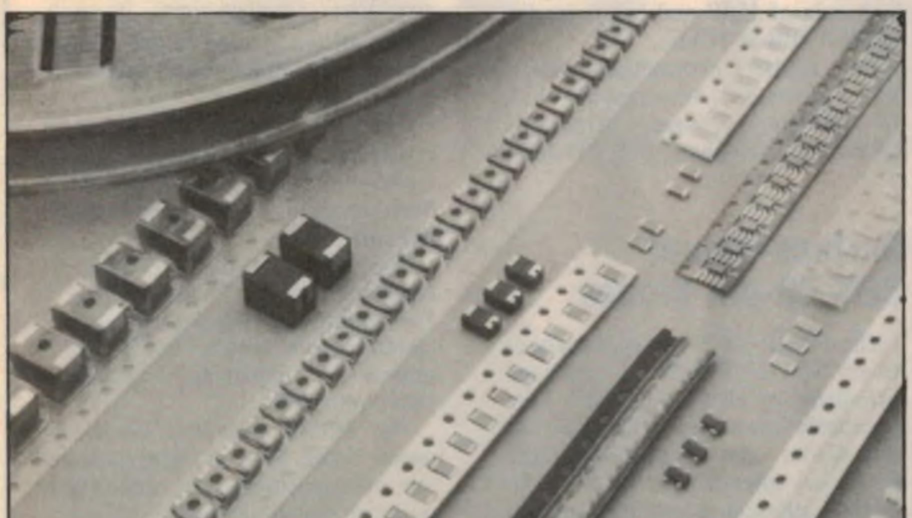

Fig.12: SMDs can be supplied in a wide variety of paper or blister tapes, as this photo from Siemens shows.

New technology centre for SMD

Philips has made a further major commitment to surface-mount technology with the recent opening of the new SMD Technology Centre in Eindhoven, The Netherlands. Initially, 18 people will be working in the Centre, all of whom have come from other research departments within Philips.

Philips was one of the first major Western electronics manufacturers to move into surface-mount technology and is a recognised world leader in this area. The Elcoma (Electronics Components and Materials) Division of Philips manufactures both surface mounted devices (SMDs) and the placement machines that are an essential part of the assembly process. At the same time Philips has been concentrating on other important aspects of SMD technology, reserch and technology.

The new centre in Eindhoven will focus on all aspects of SMD technology. It is organised into three interactive groups — Applications, Technology Development, and Verification.

The primary concern of the Applications Group will be to provide expert counselling for present and prospective customers in practical circuit design, PCB design, component choice, production processes and testing. This Group has been in existence for some time, but has previously only advised groups within Philips.

The Technolgy Development Group will focus on developing new technologies, as well as expanding existing technology. This group will work closely with other manufacturers, testing machines and techniques that will be of value both to Philips and to other companies. Philips hopes that such cooperation will lead to significant standardisation of components and machines.

The Verification Group will be concerned with the applicability of surface mounted components. Ideas and theories from the Technology Development Group will be put into practice by this group which will also be involved in small-scale pilot production.

For further information contact Philips Elcoma, 11 Waltham Street, Artarmon, NSW. Telephone: (02) 439 3322.

Surface mount devices

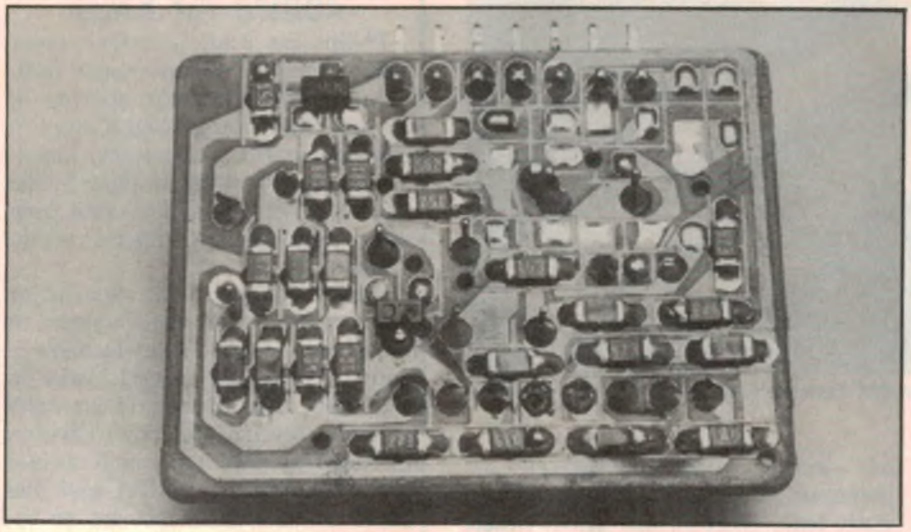

Fig.13: This small board, reproduced more than twice full size, is from a UHF transceiver marketed by Standard Communications Pty Ltd. It uses a mixture of conventional and surface mount devices.

ers recommend individual soldering of ICs using semi mechanical systems. These apply heat in short pulses directly to the joint areas between pin and board and avoid unnecessarily raising the package or silicon chip temperature.

Type number labelling on surface mount ICs is usually done in the same way as for through board devices.

Other components

An interesting selection of other component types, suitable for surface mounting, is now starting to appear. These include ferrite-cored inductors up to 100mH, filters and resonators, presettable (trimmer) resistors and capacitors, NTC and PTC thermistors and board edge connectors (see Fig.11).

Until recently, passive components and discrete semiconductors have been out of the limelight, with most attention being focussed on the development of bigger and better ICs. Surface mount technology is changing this and a great deal of work is now underway to adapt and upgrade existing component designs or develop new types which will be cheaper, smaller and more rugged than their predecessors. This should all lead to some interesting new components becoming available over the next few years.

Board production

In the preceding sections, we have taken a look at surface mount assembly/soldering methods, board design and the special components used. Now let's discuss how surface mount PCB assemblies are actually fabricated using the latest computer controlled production machinery.

Because of their small size and close pin spacings, it is essential that SMDs are positioned on the board with considerable accuracy. This requirement rules out the use of hand assembly methods for any sort of volume production and makes the use of precision 'pick and place' machinery essential. Once the

Surface-mount SOT-23 transistors

Hewlett-Packard has introduced the HSMX-3131 and the HSMX-3635 surface-mount SOT-23 package transistors for use in non-hermetic, automated-assembly applications.

Primary applications are in consumer electronics, communications equipment and instrumentation where the SOT-23 package size and ease of automated assembly are important.

Both the HSMX-3131 and the HSMX-3635 are low-priced, NPN bipolar transistors in the plastic SOT-23 package. They provide wide dynamic-range performance for a variety of VHF and UHF applications.

The transistors are available in tape-and-reel packaging for automated assembly as well as in bulk packaging. Both are available in standard or low profile to allow thorough board cleaning or epoxy bonding by the customer.

The HSMX-3131 is a general-purpose transistor with a high gain of 17dB at 1GHz. The noise figure is typically 1.8dB at 1GHz.

The HSMX-3635 is a low-noise, high-gain transistor, with a typical high gain of 15dB and low-noise figure of 1.4dB at 1GHz.

For further information contact VSI Electronics (Australia) Pty Ltd, 16 Dickson Avenue, Artarmon, NSW 2064. Telephone (02) 439 4655.

Surface-mount SOT-23 pin diodes

The HSMP-38XX series of surface-mount SOT-23 PIN diodes has been introduced by Hewlett-Packard. Like previously introduced SOT-23 Schottky diodes and transistors, these diodes are intended for use in high-volume, automated-assembly applications.

Typical PIN diode circuits include attenuators, switches, phase shifters, limiters, duplexers, levelling circuits, pulse modulators and amplitude modulators.

Designed to be the electrical equivalent of the industry-standard HP glass PIN diode (5082-3080, 5082-3081 and 5082-3077), the three classes of parts come in two convenient single-configurations each, with six new part numbers.

The HSMP-3800/-3801 has an RF resistance of 40Ω (when biased at 1mA) and is ideally used in applications requiring a 50Ω transmission-line impedance.

The HSMPO-3810/-3811 has an RF resistance of 75Ω (when biased at 1mA) and is suitable for use in applications which require a 75Ω transmission-line impedance (eg. television equipment).

The HSMP-3830/-3831 diodes are useful when low on resistance and low off capacitance are necessary to optimize switch designs.

For further information contact VSI Electronics (Australia) Pty Ltd, 16 Dickson Avenue, Artarmon, NSW 2064. Telephone (02) 439 4655.

decision to use fully mechanised assembly has been made, the next step is to ensure that all components arrive in the factory packed in a way which is convenient for feeding the pick and place machinery without unnecessary handling.

Surface mount components are delivered to manufacturers packed in a variety of ways. The simplest form is bulk packaging, where devices are supplied without individual protection in boxes or bags. This method can only be used where there is no risk of bent pins or other damage and most MELF and mini MELF components are OK in this regard. Before assembly, the components are tipped into a hopper and from there go via an automatic sorter which assembles them into neat rows. In the case of polarised devices, such as diodes, it also makes sure they are the correct way round.

Devices such as ICs are supplied in various types of magazines which automatically feed the pick-and-place machine. These magazines may be in the form of long plastic sticks, with the ICs lined up end to end inside, special stack packages where removal of the bottom device causes all the others to drop down one place, or flat 'waffle' tray packs where the pick up system goes to a different compartment each time, until the tray is emptied.

By far the most popular packaging system is for components to be sealed into suitably sized pockets in a paper or plastic tape which is then wound, like movie film, on to a reel. Tape widths of 8, 12, 16 and 24mm are currently used to take different sizes of components. Sprocket holes in the tape allow components to be fed to the pick up system at the required rate (see Fig.12).

Each of the component pockets looks like a small bump or blister and so this form of packaging is known as blister tape. Examples of various width tapes, housing different size components, are shown. A typical 18cm (7-inch) reel of 8mm blister tape can carry between 3000 and 10,000 chip resistors or capacitors.

Pick and place machines vary enormously in size and capacity. A really big system might place 32 different devices simultaneously and have a capacity of 155,000 components per hour. At the other end of the scale is a range of smaller machines which handle devices one or two at a time and have a capacity between 3600 and 10,000 components per hour. The largest systems can handle several hundred different component feeds and the smallest ones about 30.

As mentioned earlier, the exact assembly process will vary according to the soldering method to be used. If components need to be glued into place for wave soldering, the pick and place machine will usually be depositing carefully controlled blobs of quick-setting epoxy with one application head, whilst simultaneously placing components on a previously prepared board with another.

If reflow soldering is to be used, the solder paste will already have been screen printed on to the boards and a placement machine with two heads can 'populate' both boards with components at the same time. Alternatively, a single head machine can be used.

An interesting bonus is obtained with the reflow soldering method. Surface tension in the molten solder and fluxes causes the connection areas of small components to 'swim' into exact position over their PCB pads. This provides a handy correction for any small discrepancies between the placement program and the PCB print pattern.

Each head on the pick and place machine contains a suction tube which initially lifts the required component from the blister tape or other feed system. Four tiny jaws then close against the sides of the component to give the exact orientation required. On some larger machines, components can even be automatically tested by contacts on the jaws. When the SMD has been correctly positioned on the PCB, an ejection pin holds it down while the suction grip is released.

All pick and place machines are controlled by built in computers which utilise software on floppy disk or tape. This makes it fairly easy to change the assembly sequence if a variety of different board types are being produced.

The precision of both the software and hardware is such that less than 20 placement errors per one million operations are normally expected.

At present, there is a lot of argument going on about the best method to use for fabricating both pure surface mount and mixed board assemblies. It may be several years before a clearly defined 'best way' of doing things becomes clear.

Electronics Australia reviews:

Hewlett-Packard 54201D digitising oscilloscope

The Hewlett-Packard HP 54201A and HP 54201D are general purpose dual-channel digitising oscilloscopes with storage bandwidths of 50MHz. They are useful for capturing and analysing single shot and repetitive waveforms from digital and analog circuits. Here we evaluate the HP 54201D.

At first impression it is clear that the HP 54201D is not a traditional oscilloscope with digital storage facilities. It is a highly complex piece of equipment with a vast array of features and applications. For example, it has auto scaling plus save/recall memory, up to 27 channels of state triggering, the facility to print, remote operation via a bus to the IEEE Standard 488-1978, and programmability.

At 426 x 190 x 447mm (W x H x D), the unit is slightly larger than most oscilloscopes. Mass is 12.7kg. The front panel contains the screen at the left, and this measures 133 high x 185mm wide. To the right is an array of push-button controls, together with the left and right channel and triggering inputs.

The rear panel carries the mains power input socket, HP-IB (Hewlett-Packard Interface Bus) socket, a programmable BNC TTL output and, finally, the inputs for the 27 parallel bits of the state trigger.

Main features

The HP 54201D is a dual trace storage oscilloscope with a bandwidth of 50MHz using real time sampling, and 300MHz with repetitive sampling. It has a fully digitised display with 6-bit resolution, although the effective resolution can be extended to about 7 bits by using data filtering and averaging. The 6-bit resolution provides 64 levels of digitisation.

Measurements are automatically made for frequency, period, positive pulse width, negative pulse width, rise time, fall time, duty cycle and delay between the first edge on one graph and the first edge on a second graph. Voltage measurements are also automatic and include voltage amplitude, maximum voltage, minimum voltage and RMS voltage. Depending on the display format, any of these readings can be displayed on the screen .

The HP 54201D is fully programmable so that instrument settings and operating modes may be programmed via the HP-1B. The bus can also be used to send data to a graphics printer or plotter for hard copies of the display.

Apart from automatic measurements of time and voltage the oscilloscope can perform addition and subtraction of the two channels. Cursors on the display can be moved around the display to select voltage and time measurements between the cursors.

Four waveform memories are available to store the displayed waveform. These memories remain even with the power switched off and are recalled using the label assigned to each memory.

The front-panel keyboard has 39 keys, 37 of which serve two or more functions in conjunction with the Shift key. As can be expected, this enables selection of many functions .

To define the display, six menu keys are used to alter the system, display, status, channel, trigger and timebase. Deeper levels for the system, status, display and trigger menus are in the form of submenus.

System

The system menu has control over automatic calibration, self testing and configuring peripherals.

The system peripherals submenu is used to configure the oscilloscope to communicate with other instruments or controllers. In addition, the rear panel BNC socket can be configured to provide an output at the end of data aquisition, for true state sequence, master clock, triggering or as a probe compensation output.

For system calibration, the oscilloscope trace can be set up for automatic gain, for vertical offset, hysteresis of triggering, and delay for both channel 1 and channel 2. It is also self testing such that the HP 54201D goes through routines to verify that more than 90% of the oscilloscope circuitry is functioning correctly.

Status

The status menu presents information on the present state of the instrument. This information includes the instrument settings submenu for channel, time and trigger status and the measurement and memory status submenus.

Measurement status in the standard format sets the graphs to 10%, 50% and 90% thresholds. The delay and pulse widths are measured from the middle threshold at 50%. These thresholds may be changed and specified in percentages, voltages or preset TTL or ECL levels.

Display

The display menu provides for selection of the display arrangement. This is done using six display submenus. Three select the graph arrangement as follows: graticule type (whether frame or grid), the number of graphs (1 to 4); and the reference lines and how they are defined.

With its 300MHz bandwidth and 200 megasample/second digitising rate, the 54201D digitising oscillosope is useful for designers of digital and analog systems and for solving transient fault conditions.

The final three display menus select the trace type. The display trace can be selected to be accumulative whereby the display shows the present trace along with previous traces. A data filter selection extends the resolution to 7 bits. Finally, the display can either show the sample dots or these can be connected by straight lines on the display.

Trigger

The HP 54201A includes analog triggering only while the HP 54201D includes both analog and state triggering. Analog triggering allows the usual channel 1, channel 2 or external triggering with plus or minus slope. The trigger level can be adjusted, set to centre, or set to automatic.

In addition, the trigger can be delayed until after a number of trigger events from 0 to 59999.

The triggering state inputs comprise three HP 10271A ten channel probes called pods, and these accept up to 27 channels and three clock inputs. Each pod can be programmed for a different threshold level. For example, pod 1 could be for TTL levels and pod 2 for ECL.

The state mode assignment can be set to normal, where up to 27 channels can be used as a trigger; qualified, where triggering occurs relative to the clock input; missing bit, where triggering occurs on a missing bit; and extra bit (glitch), where triggering occurs on an extra bit in the data stream.

Other assignments in the state triggering menu include multiplexing, threshold, labelling and polarity.

The state trigger sequence menu includes sequence terms,restart terms, number base and resource terms. The sequence terms are four user-defined terms called the resource terms (a, b, c and d) which describe the sequence of triggering inputs. Each of the resource terms can have a number base which is hexadecimal, binary, octal or decimal format.

To restart triggering, from one to four recourse terms may be used as ORed trigger inputs.

Channel

This menu provides selection of input channel parameters. These are range, offset, auto scale, store mode, probe and coupling.

The full scale voltage range is selectable from 40mV up to 16V with two digit resolution. Alternatively, the auto scale feature can be used to rescale the graph to suit the range of the input signal. An offset can be selected which shifts the signal vertically on the graph. This is a DC voltage that is subtracted from the input signal.

The store mode can be either normal, average or envelope. The normal mode displays the signal directly after each digital sample, while the average mode displays the average voltage of the input for 4, 16, 64 or 256 trace samples. The envelope mode shows both the minimum and maximum voltage for each trace.

A probe attenuation factor can be entered for each channel so that the HP 54201D can correct the scale factors, according to the attenuation ratio of the probe. Similarly, the input coupling for channel 1 or channel 2 may be selected for 1MΩ AC or DC or 50Ω DC.

Time

This menu allows the user to define the timebase and parameters related to the timebase. These are mode, range, delay, auto scale and reference.

The mode sets auto, triggered or single shot timebase triggering modes, while delay sets the time before or after a trigger event.

The range sets the full scale from the left to the right side of the graph.

Delay allows observation by a specified amount before or after triggering. The selection to observe the trace before triggering is made possible by the storage facility of the oscilloscope.

Auto scale selects the scale to suit the displayed portion of the waveform.

Finally, the reference places the trigger event either at the left of the graph, the centre or right side of the graph.

Using the HP 54201D

The HP 54201D has a variety of uses on the designer's bench and in production test areas. Its high speed, storage facilities, and programmability make it extremely useful for product evaluation and automatic testing. The test results can be hard copied onto a printer for permanent record.

On the design bench, the unit is extremely useful because of its state triggering, automatic waveform measurements and storage facilities. It can be used to catch glitches, observe random signal variations and observe signals that are buried in noise.

The ability to observe a waveform just before and just after triggering is a valuable feature for debugging digital circuits. Again, the state triggering brings the HP 54210D into the logic analyser class but with the added facility to display analog waveforms.

Note that the display of analog signals is not as detailed as that available from a traditional analog oscilloscope. This is due to the quantisation of the signal after digitisation.

Supplied with the HP 54201D is an operating and programming manual. We found the manual excellent for quick familiarisation with the operating controls so that we could manage to display a signal. The manual is broken into two halves with the first half discussing the front panel controls and the second half detailing the programming facilities.

Also supplied with the oscilloscope are two sets of Hewlett-Packard 10017A miniature probes plus three HP 10271A 10-bit state data probes.

The 54201D is priced at $19,012 + 16% sales tax. The 54201A is similar to the 54201D but deletes the state triggering facilities. It is priced at $11,368 + 16% sales tax.

For further information contact your nearest Hewlett-Packard Australia office, or Hewlett-Packard Australia Ltd, 17-23 Talavera Rd, North Ryde, NSW 2113. Telephone (02) 888 4444.

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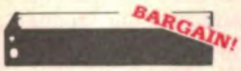

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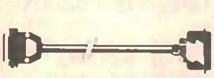

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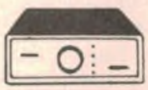

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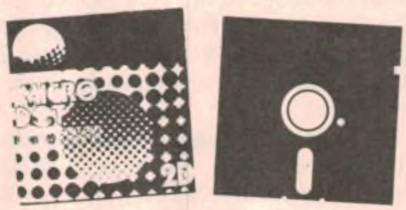

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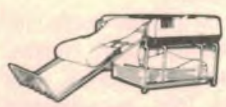

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Introduction to hifi, Pt.15.

FM radio tuners — 3

Modern designs, digital tuning, specifications

Current model FM tuners differ little in terms of basic signal processing from those discussed in the preceding chapter. However, the changeover from manual to pushbutton tuning has added a whole new dimension to the design and a fresh challenge for those who like to keep up with the way in which circuits operate.

by NEVILLE WILLIAMS

The most accessable example of contemporary design practice for EA readers is undoubtedly the Playmaster AM/FM Stereo Tuner described for home construction in the issues December 1985 to March 1986, with supplementary material in July 1986. Those with access to these issues will be able to study the articles and diagrams in as much detail as they choose.

For the present purpose, Fig. 1 shows just the FM section of the particular tuner, extracted from the comprehensive block schematic diagram in the December 1985 issue. The signal processing modules, depicted vertically down the left-hand side, are essentially a logical up-date of those discussed in the previous article in connection with the relatively basic Heathkit AJ-1214 tuner.

Referring to Fig. 1, the input circuit provides for a 75Ω coaxial feed or 300Ω via an external balun.

Internally, the signal passes to a double-tuned bandpass filter feeding a dual-gate Mosfet as the RF amplifier, with AGC voltage applied to the second gate. The upgraded circuitry provides effective AGC but, more importantly, offers greater protection against so-called "third order intermodulation" — when signals from other powerful local stations interact in the front end of the receiver to create spurious intermodulation products affecting the wanted station.

In the IF channel, a single NS (National Semiconductor) LM1865 IC substitutes for the two Motorola MC1357P ICs specified for the Heathkit, providing adequate IF gain, plus limiting improved quadrature detection, AGC, signal strength meter drive, and a station detect signal, which is used when the tuner is operating in the "seek mode". (Fed to the "Stop" input of the microprocessor, as indicated, it interrupts the seek function and releases the mute, allowing each newly found station to be heard).

Stereo decoding is performed by another special-purpose IC, the NS LM1870, which adds a "blend" function to its other (now) routine duties. Blend combats background noise by progressively merging the L and R components into mono, if the strength of the incoming signal falls below a certain adjustable minimum. The "Forced Mono" input shown provides for manual stereo/mono switching at the discretion of the user.

50μs de-emphasis components (not shown) are connected directly to specified pins on the IC. In the actual output circuit, supersonic filtering is configured somewhat differently from that in the Heathkit, involving a low-pass filter in each channel and a notch filter centred on 19kHz. The purpose of the latter is to prevent the pilot tone from penetrating any associated tape recorder and interacting with the bias frequency and/or high-order audio harmonics to produce audible resultants.

Output switching is effected electronically rather than by mechanical contacts.

Electronic tuning

These refinements notwithstanding, by far the most radical design departure, now virtually standard in modern up-market tuners, is the use of so-called "crystal locked" or "quartz synthesiser" electronic pushbutton tuning and readout, in place of the traditional gang capacitor and tuning dial. But while it makes a dramatic difference to the external controls and the internal "works", it is essentially an add-on facility, that does not greatly affect the basic signal processing circuitry.

To be sure, the familiar tuning capacitor and dial are missing, but there are signal input, RF and oscillator coils, as before, along with parallel "trimmer" capacitors for circuit alignment. In place of the mechanical gang sections are an equivalent number of matched varicap diodes (sometimes called varactors), the capacitance of which is electrically controlled by a common DC voltage. Varying this voltage, by whatever means, tunes the front end of the receiver just as surely as rotating the drive spindle of a tuning gang.

(By way of interest, a simple AM radio described in EA for January 1987 uses varicaps with the applied voltage tuned manually using a 10kΩ potentiometer).

In the case of the Playmaster Stereo AM/FM Tuner, tuning is executed by an NEC "dedicated" microprocessor — a computer-style IC designed expressly for the purpose. How it operates is discussed in the original articles but the basic concept can be summarised to advantage, in association with the remaining modules in Fig. 1.

In the Playmaster design, as in other modern pushbutton tuners, the microprocessor is connected to an AM/FM switch on the front panel, along with an adjacent row of pushbuttons (numbered 1-6) by which the operator can nominate or "input" the station he/she wants to listen to (Fig.2). The microprocessor acknowledges the instruction by displaying the mode and frequency in the appropriate readout windows.

At the same time, with the help of an external buffer amplifier (Fig.1), it proceeds to readjust the voltage applied to the varicaps and thereby change the front-end tuning to match the display. In round figures, the amplifier boosts the 0-5V control voltage ("error output") available from the microprocessor to around 0-28V DC, needed to control the varicaps.

To sense the frequency to which the tuner is set at any given time, the microprocessor monitors the frequency of the local oscillator, allowing for the fact that it is required to operate 10.7MHz above the centre of the input signal passband. As indicated in the diagram, the monitoring process involves the use of a "dual modulus" (or dual mode) prescaler IC — in this case, one that can divide the oscillator frequency by either 16 or 17, to bring it into a range which the microprocessor can cope with more easily.

The microprocessor has its own inbuilt "programmable" (or internally adjustable) divider, which can further divide the oscillator frequency (after prescaling by a suitable factor so that it can be compared directly with a 25kHz-based reference frequency, stepped down from a precision 4.5kHz quartz crystal.

To facilitate the comparison, the microprocessor has, as part of its rather comprehensive programming, what is known in computer jargon as a "look-up table". Given the frequency channel of the wanted station, the microprocessor is able automatically to set the prescaler and its own programmable divider to implement the appropriate frequency comparison — a different combination for each individual FM channel.

Any discrepancy between the two frequencies being compared generates an error output voltage which, when amplified and applied to the varicaps, has the effect of changing the front-end tuning

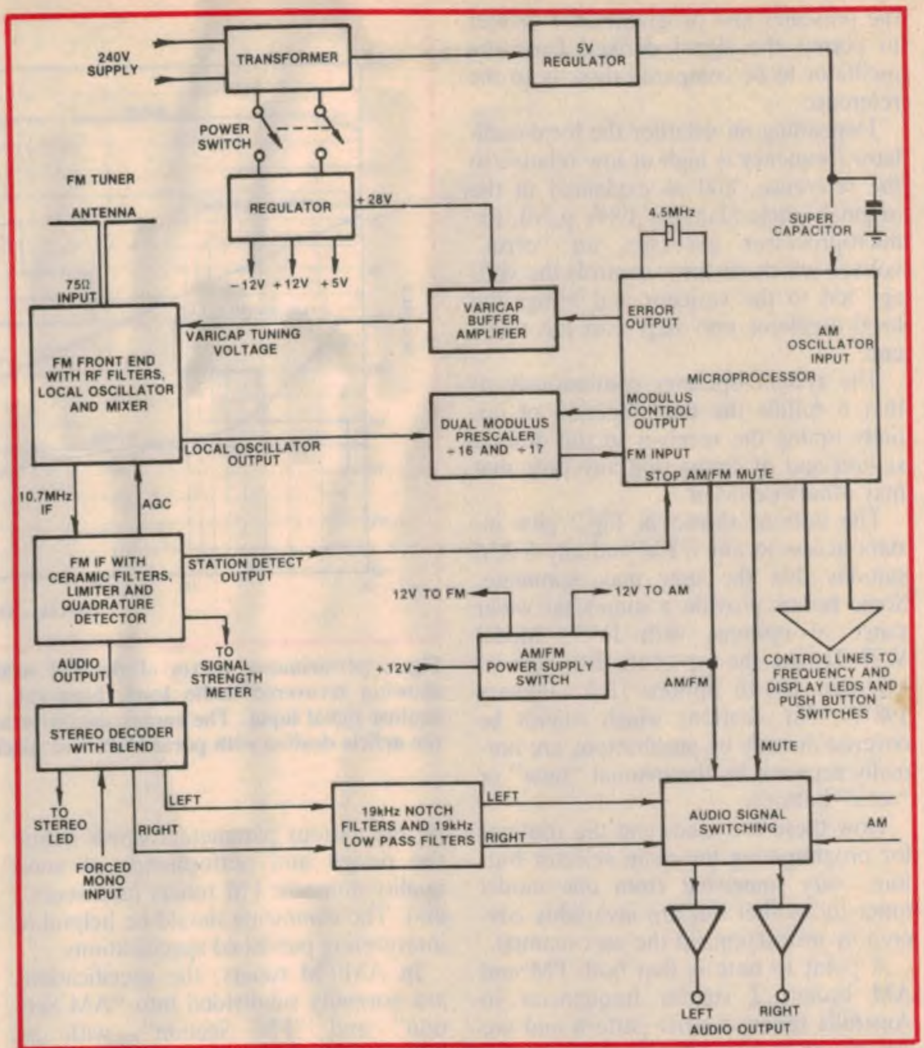

Fig.1: the FM section of the Playmaster AM/FM stereo tuner represented in block schematic form. It is typical of modern design practice, using advanced ICs and crystal-locked pushbutton tuning.

to close the gap, ultimately locking the variable oscillator to the reference crystal.

Fortunately, this all happens in much less time than it takes to tell — almost instantaneously, in fact, as far as the user is concerned. There is just the slightest pause, rendered all the more fuss-free because the microprocessor mutes the audio output briefly whenever it is performing a tuning function.

The pushbutton era

In operation, the microprocessor constantly scans the AM/FM switch and the pushbuttons which would normally have been pre-programmed by the user so that each represents a particular frequency or station. Thanks to the 47,000μF supply voltage "super capacitor" shown, the pre-programming does not disappear when the tuner is switched off, being retained in the computer chip's memory bank, even after months of disuse.

Pushing button 6, for example, may effectively be an instruction to tune, say, 2SER (Sydney) on 107.5MHz. That would mean a local oscillator frequency of 118.2MHz and particular settings for

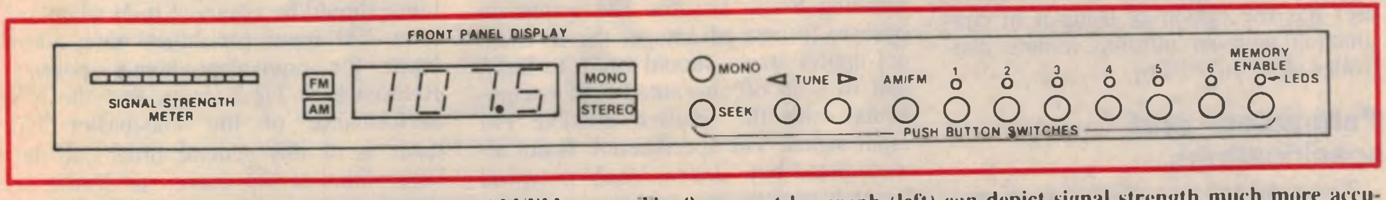

Fig.2: the front panel layout of the Playmaster AM/FM tuner. The 9-segment bargraph (left) can depict signal strength much more accurately than is usually the case.

the prescaler and programmable divider to permit the signal derived from the oscillator to be compared directly to the reference.

Depending on whether the local oscillator frequency is high or low relative to the reference, and as explained in the original article (January 1986, p.36), the microprocessor generates an "error" voltage which, in turn, controls the voltage fed to the varicaps and brings the local oscillator into step with the reference.

The system operates continuously so that it fulfills the dual function of initially tuning the receiver to the desired station and of countering any drift that may otherwise occur.

The buttons shown in Fig.2 give instant access to any 6 FM and any 6 AM stations that the user may nominate. Some tuners provide a somewhat wider range of options, with JVC's model W77CD near the top of the list, with no less that 16+16 options (EA, January 1987, p.36). Stations which cannot be covered directly by pushbuttons are normally accessed by the manual "tune" or "seek" buttons.

How these are used, and the routines for programming the main selector buttons, vary somewhat from one model tuner to another but are invariably covered by instructions in the user manual.

A point to note is that both FM and AM broadcast station frequencies in Australia follow a strict pattern and are capable of being represented by a four-figure readout: either three or four figures in the case of AM (531 to 1692kHz); either two or three figures plus one decimal place in the case of FM (88.1 to 107.9MHz).

Some commercial tuners provide a potential five-figure readout and provision to increment FM channels by 25kHz. Whatever value these facilities may have in some other countries, they are redundant as far as Australia is concerned.

More important in practice is the readability of the figures from a distance, as determined by their size and brightness. It is handy to be able to verify at a glance the station to which one is listening. It is even more so when, as with the Playmaster tuner, the user has the option of using it in conjunction with an infrared remote controller (EA, July 1986).

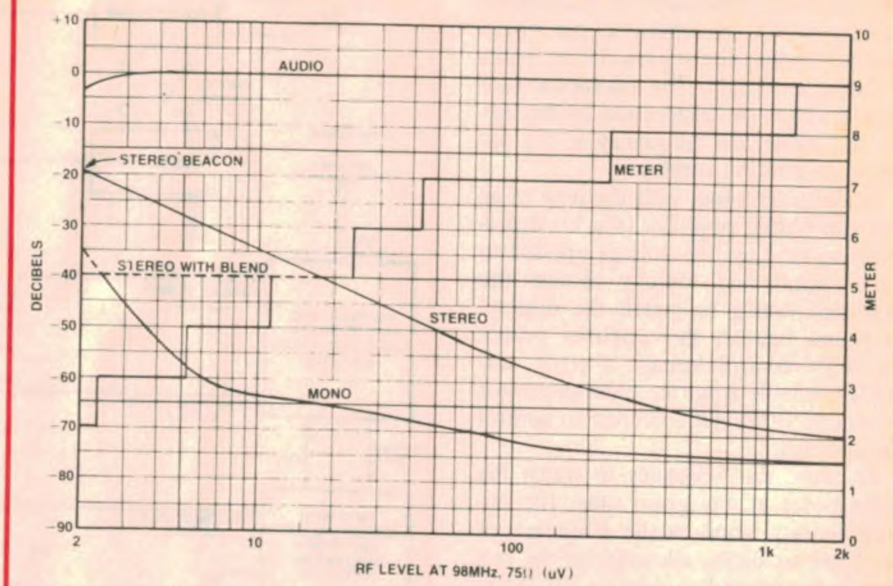

Fig.3: performance curves of the FM section of the Playmaster AM/FM stereo tuner showing recovered audio level, bargraph reading, stereo S/N and mono S/N plotted against signal input. The curves should be studied in association with the latter section of the article dealing with parameters and specifications.

Parameters and specifications

To round off this discussion, it may be helpful to list and comment briefly on the various parameters which define the design and performance of good quality domestic FM tuners (and receivers). The comments should be helpful in interpreting published specifications.

In AM/FM tuners, the specifications are normally subdivided into "AM Section" and "FM Section", with an "Audio Section" as well in the case of AM/FM receivers. Performance figures in each mode may differ considerably and should not be confused. The observations below relate specifically to the performance of the "FM Section" as a signal source.

Specification Range: where a range of figures is quoted in what follows, the preferred specification is denoted by an asterisk.

Frequency Band Coverage should extend from marginally below 88MHz to marginally above 108MHz, with the ability to lock to channels starting at 88.1MHz and spaced every 0.2MHz to 107.9MHz. Beware of obsolete or "other-country" models which may not cover the required frequency range.

Limiting Point: For the FM system to operate to best advantage, the IF channel limiter stages should begin to limit, and to strip off unwanted AM components, with the smallest possible FM input signal. The specification is not always listed but *2.0 to 3.0μV is typical for high performance tuners.

Fig. 3 indicates that, in the case of the Playmaster tuner, limiting is effective at about 3μV, with the recovered audio output completely flat for input levels above that figure.

Usable Sensitivity: often referred to as "IHF sensitivity" (Institute of High Fidelity), this specification indicates the ability of a tuner to resolve very weak ("fringe area") signals — an ability that depends both on the overall gain of the tuner and the amount of inherent noise it produces when operating under high gain conditions.

Usable sensitivity is expressed as the smallest fully tone-modulated FM signal from which the tuner can recover the audio component at a level 30dB above the total extraneous noise and distortion. (Some manufacturers use a reference of 26dB). The test assumes mono mode and (preferably) the use of an audio filter to isolate the fundamental modulating tone for measurement purposes.

In round terms and notwithstanding the above variations, the usable sensitivity rating for a typical modern FM tuner should be around 1.0μV when fed to a 75Ω input (or 2.0μV to a 300Ω input for equivalent signal power). Reference to Fig.3 shows that the S/N performance of the Playmaster FM tuner is of this general order: at the lower limit of the curve, as drawn, it shows a signal/noise ratio in mono mode of 35dB with an input of 2μV to 75Ω.

The IHF or usable sensitivity is informative as a laboratory measurement and of practical significance for an in-car FM tuner which, on occasions, may be called upon to intercept signals under highly adverse reception conditions. It is less relevant for domestic hifi installations where the expectation is for stereo reception (wherever possible) with a much lower level of background noise. Read on:

Quieting Sensitivity is a supplementary rating which seeks to express the ability of a tuner to suppress noise on weak signals sufficient to offer reasonably good listening. It is represented by the minimum input signal which will ensure that the recovered audio signal with full modulation is 50dB (some use a reference of 46dB) above the tuner's noise content.

Distortion is not included in this test, which can therefore be performed on a simple modulation on/off basis, without the need for a sharply tuned audio filter.

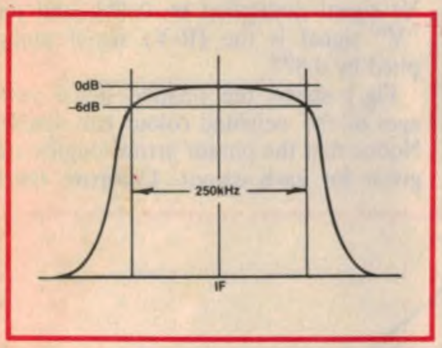

Fig.4: a good compromise selectivity curve for a stereo FM tuner: 250kHz wide between –6dB points and steep sides.

Typical good quality tuners exhibit quieting sensitivity figures in the range *3.0 to 5.0μV in mono mode, the figure in the case of the Playmaster FM tuner being 3.6μV. For stereo mode, the required input for 46/50dB quieting can be up to 10 times the mono figure, falling typically in the range *20 to 45μV into 75Ω (about 35μV for the Playmaster tuner).

(In most modern tuners, the circuitry switches automatically to mono mode or blend when the signal level falls close to or below the 46dB stereo quieting region. It was at exactly this figure in the Sony ST-JX220A tuner reviewed in the March 1986 issue).

Ultimate Quieting: sometimes referred to as the Ultimate S/N Ratio; this is the figure obtainable using a large input signal (typical of a strong signal area) and a low frequency filter to minimise power supply noise. A figure of 1000-2000μV is commonly used for the measurement and, for a typical good quality tuner, should yield a S/N ratio of 68 to *73dB in stereo mode, and from 74 to *78dB when switched manually to mono. If measured without a filter, the hum contribution from a well designed power supply should affect the above figures only marginally.

Signal/Noise Ratio: this is an ambiguous term, unless qualified in respect to signal input level and mono/stereo mode, and whether or not it includes power supply noise. In brochures from responsible sources, it would probably signify S/N ratio under good listening conditions, therefore ultimate quieting, as above — but treat with caution.

Bandwidth and Selectivity are areas of contention and compromise for which published specifications are frequently vague. A wide bandwidth is desirable to minimise envelope distortion (therefore THD) but can lead to problems with inter-channel interference. Fig.4 is a "textbook" selectivity curve for a stereo tuner suggesting, as a good compromise, a bandwidth of 250kHz between 6dB-down points. Beyond that, the sides should be as steep as practicable.

The most common specifications in this area are as follows:

Alternate Channel Selectivity: the original thinking was that, at the very worst, FM stations in any one area would occupy alternate channels, normally 400kHz apart. Selectivity was determined and rated on this basis, with figures (if quoted at all) ranging from about 65 to *90dB.

Adjacent Channel Selectivity covers the more demanding situation of how a tuner could cope with a transmission in an adjacent channel just 200kHz away. Again, the figures are not always quoted but those that are range from 40 to *75dB, as measured on channel 98. In opting for the higher figure, make sure that it is not being obtained at the expense of unacceptable THD.

Spurious Signal Rejection is a collective term covering the leakage of superhet "image" signals, local oscillator harmonics, IF components &c, into the signal path. These effects are sometimes listed separately, at other times collectively, as above. The figures for quality tuners range from around 70dB to as high as *90dB, where the matter has presumably received special attention.

Capture Ratio refers to an effect, evident in FM reception, whereby a tuner faced with two FM signals of differing strength tends to lock on to and demodulate the stronger one and substantially reject the weaker — usually by about 30dB. It is a fortuitous effect, not only in the presence of co-channel interference but when multipath reflections of the wanted transmission might otherwise cause problems.

A capture ratio of 1.5dB for a 30dB margin in signal level is good; 1.0dB or less is even better.

Signal Strength Meter: potentially useful for observing the signal level from individual stations and the effect of antenna adjustments, &c. Most conventional analog meters offer good reading accuracy. Bargraph displays are decorative but those with only three or four segments are singularly uninformative. A 9-segment display, as in the Playmaster tuner, can be related sensibly to signal strength, as indicated in Fig. 3.

Audio Frequency Response is limited by the system at the top end to well below 19kHz. A typical specification for a modern hifi tuner would be 20Hz-15kHz within +0.5dB and –1dB — this on the assumption that 50μs de-emphasis is applied to the received signal. Some older tuners, especially if intended for the American market, may apply 70μs de-emphasis, resulting in an overall 6-7dB loss at 15kHz.

Total Harmonic Distortion (THD): A figure of 1% was considered good at the end of the valve era. Solid state technology saw it come down to about 0.5% but some current model specifications are under 0.2% for stereo mode and under 0.1% for mono. In principle, the lower, the better; in practical situations, a measured figure of around 0.3% in stereo mode is entirely acceptable.

L/R Stereo Separation: 40dB or more at 1kHz (or low and middle frequencies); 35dB or more at 10kHz (upper treble).

L/R Channel Balance: typically ±1dB (250-6300Hz).

Sub-carrier Suppression involves as much attenuation as possible, both of the 19kHz pilot tone and artefacts of the 38kHz sampling frequency. It is likely to be particularly important where the user (illegally or otherwise) plans to record FM broadcasts on tape. A rejection figure of 50dB is desirable but some tuners offer 60dB or more, which is obviously to be preferred.

SCA Transmission (short for Subsidiary Communications Authority): refers to a background music service which some American FM stations transmit on an entirely separate subcarrier centred on 67kHz. The system is not used in Australia so that references to it in American source literature can be ignored.

Part 6: the colour decoder — 2

Understanding colour television

Last month, we discussed the operation of a typical PAL colour decoder. Before continuing our study of the decoder, we'll look again at the "U" and "V" signals and their relationship to each other.

by DAVID BOTTO

Fig.1 is the horseshoe-shaped chromaticity diagram (see also Fig.6, January 1987). In this case, the diagram has been turned around so as to bring the "red" light wavelengths slightly to the left of the top of the diagram. The "blue" wavelengths are now at the right and the "green" wavelengths at the lower left. The "axis" lines show the positions of the "V" and the "U" signals.

This diagram will help us to understand how the relative values of the "U" and the "V" signals produce various colours.

Remember that the *hue* of a colour is determined by the relative signal voltages of the "U" and "V" signals, and the *saturation* of a colour depends on the amplitude of the two signal voltages (see part 3, February 1987).

Fig.2 shows the vector diagram for blue. The solid line of the phasor arrow represents a lightly saturated blue. Medium saturation is indicated by the arrow on the line of dashes, and a heavily saturated blue by the arrow at the top of the dotted line. The angle (and thus the hue) between the "U" and the "V" arrows remains the same, but as the saturation increases so does the phasor voltage.

Because the "V" signal in the PAL system is switched 180 degrees every other line of colour picture information, the signals for the next line are shown above the +"U" axis. On the third line (for the same hue) the signal is again below the +"U" axis.

Fig.3 shows the "cotton reel" waveform of the chroma signal before it passes through the PAL delay line and the adder/subtractor circuitry of the decoder.

The colour represented by each section is marked on the diagram together with the proportional signal voltages. We need to know how this waveform is developed if we are to properly understand the colour signals. You'll remember that the colour signals are "weighted" to prevent overloading the TV transmitter. So the "U" signal is the (B-Y) signal multiplied by 0.493, and the "V" signal is the (R-Y) signal multiplied by 0.877.

Fig.1 shows the relative signal voltages of the weighted colour bar signals. Notice that the phasor arrow lengths are given for each colour. Compare these

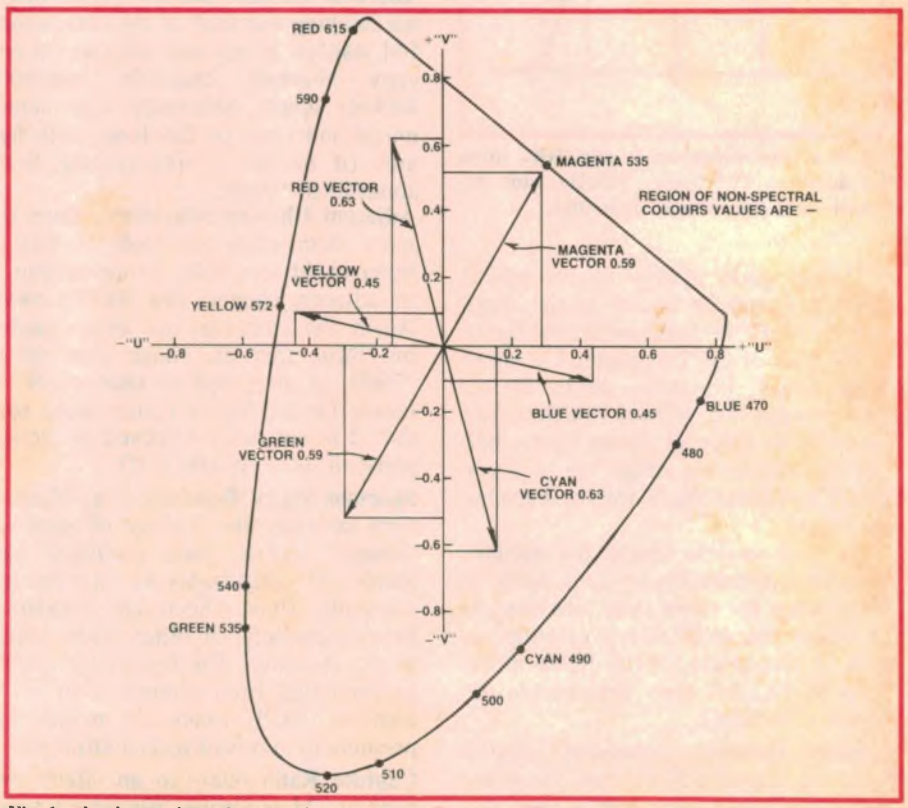

Fig.1: the horseshoe-shaped chromaticity diagram. The figures outside the perimeter are in nanometres. The hue of a colour is determined by the relative values of the "U" and "V" signals.

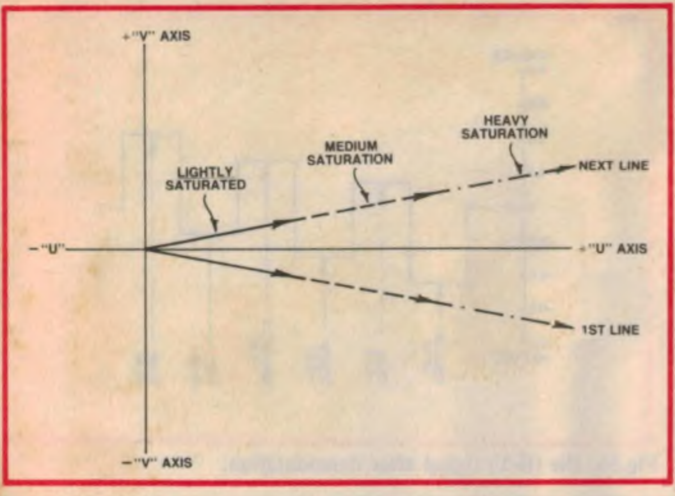

Fig.2: the solid line represents lightly saturated blue, the arrow at the end of the dashes indicates medium saturation, and the dash-dot line indicates heavily saturated blue.

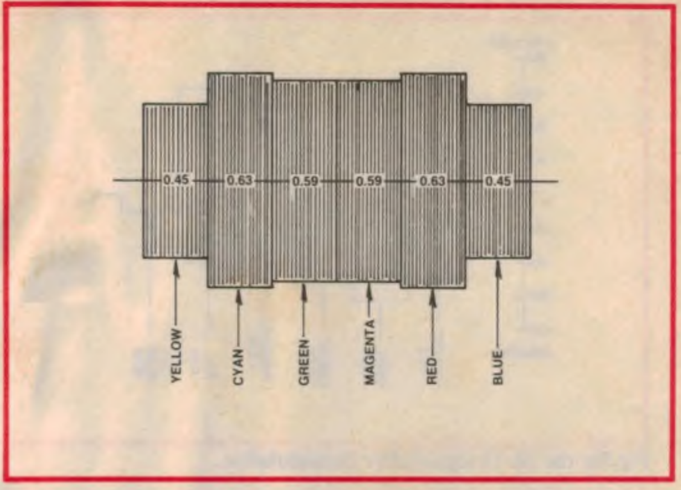

Fig.3: the "cotton reel" waveform of the chroma signal before it passes through the PAL delay line and the adder/subtractor circuitry of the decoder. Compare this diagram with Fig.1.

values with those shown in Fig.3 and you will see how the "cotton reel" waveform is formed.

The "U" and "V" weighted signal values for the colour bars are as follows:

Yellow: "V" = 0.1, "U" = –0.44
Cyan: "V" = 0.62, "U" = 0.15
Green: "V" = –0.52, "U" = –0.29
Magenta: "V" = 0.52, "U" = 0.29
Red: "V" = 0.62, "U" = –0.15
Blue: "V" = –0.10, "U" = 0.44

Figs.4(a) and 4(b) show the two colour signal waveforms after the "V" and "U" signals have been separated by the PAL delay line and the adder/subtractor circuitry.

The output from this circuitry consists of +2V or –2V to form the separated "V" signal, and +2U and –2U to produce the separated "U" signal. So in theory we should obtain signal outputs of twice the amplitude voltage of the input signal.

However, this does not occur in practice because of losses in the PAL delay line. But the proportional values of the colour bar signals remain constant provided we always consider peak white as equal to "1". Compare the values shown in Figs.4(a) and 4(b) with the "V" and "U" values above.

In Fig.5(a), the (R-Y) waveform is shown as it appears at the output of the "V" synchronous demodulator. If you look at the positive and negative values of the "V" signals you will see how this waveform is formed.

Fig.5(b) is the (B-Y) waveform at the output of the "U" demodulator. This waveform is produced by using the positive and negative values of the "U" signal for each colour bar. Follow the values through carefully, comparing Fig.4(a) with Fig.5(a) and Fig.5(a) with Fig.5(b).

We now have the (R-Y) and (B-Y) signals but need to recover the (G-Y) signal. But before discussing how this is done we will first follow the luminance signal from the TV receiver video detector through to the picture tube cathodes.

Fig.6 shows the path of the luminance or "Y" signal. Consider that we have a complete colour bar signal at point "A" (from the video detector). Signals passing through the narrower bandwidth chrominance circuits take longer to reach their destination than do the wider bandwidth luminance signals.

To ensure that the luminance and chrominance signals arrive together at their destination, a delay line is used. This luminance delay line is quite different in construction from the PAL glass delay line. Because of its relatively long delay time and the higher frequencies contained in the "Y" signal, compensation must be included to prevent excessive phase distortion.

One method of construction is to use an insulated tube of Paxolin or plastic material with a strip of copper foil along its length. This is covered with plastic tape or plastic film. Finally, a coil of insulated wire (about 46 SWG) is neatly wound from end to end. You can see the circuit symbol of the luminance delay line in Fig.6. The impedance of the delay line is 1kΩ and the signal delay time is about 0.6ms.

Included in the luminance amplifier circuitry is a 4.43MHz "notch" filter. This filter stops the chrominance information from passing through and causing dots and possible desaturation of colours on the displayed picture. The waveform of the luminance signal at point "Y" is shown in Fig.6.

We know that the luminance signal controls the brightness of the picture and supplies the fine detail. The complete colour picture is then built up by additive colour mixing of the red, blue and green components.

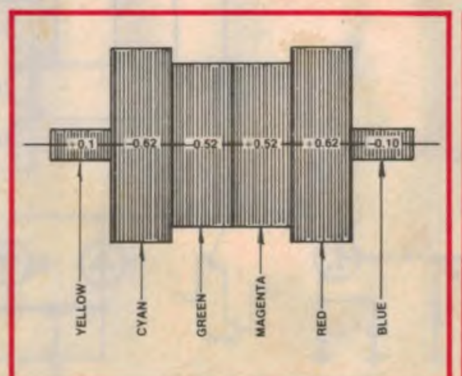

Fig.4a: the "V" signal after separation by the PAL delay line, but before demodulation.

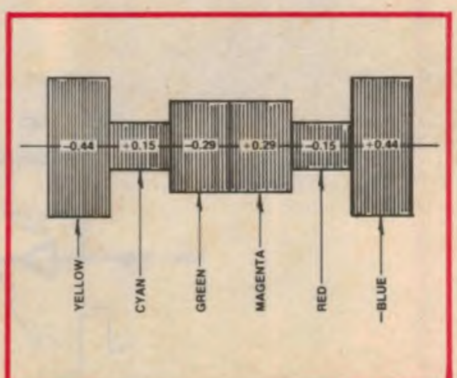

Fig.4b: the "U" signal after separation by the PAL delay line, but before demodulation.

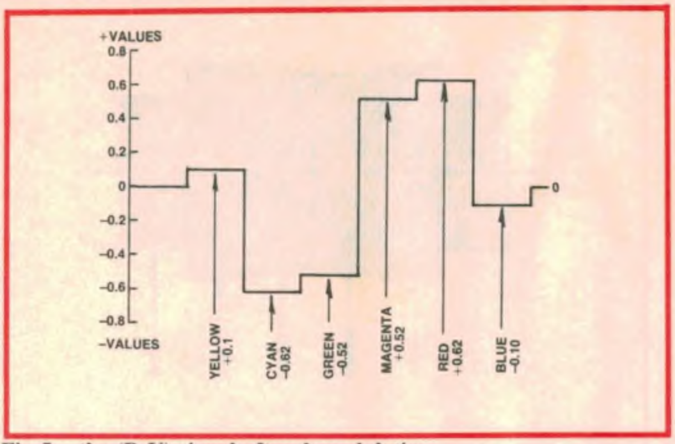

Fig.5a: the (R-Y) signal after demodulation.

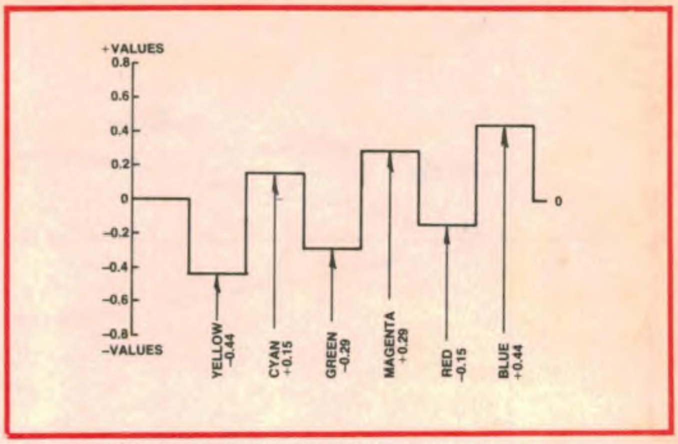

Fig.5b: the (B-Y) signal after demodulation.

Recovering the G-Y signal

The two synchronous colour demodulators produce the (R-Y) and the (B-Y) signals. You'll remember that the luminance or "Y" signal consists of proportions of voltages representing red, blue and green. These proportions are 59% green, 30% red and 11% blue which we showed by the formula:

Y = 0.59G + 0.30R + 0.11B

Remember that the values of R, G, B and Y are each taken as being 1.

So to find the values of (B-Y) all we need to do is to take "Y" from B. So (B-Y) = B — (0.59G + 0.30R + 0.11B). This works out as:

(B-Y) = 0.89B — 0.59G — 0.30R.

In the same way, we can take "Y" away from (R-Y). This gives us R — (0.59G + 0.30R + 0.11B). This becomes:

(R-Y) = 0.70R — 0.59G — 0.11B

Again (G-Y) can be found by taking Y away from G because (G-Y) = G-(0.59G + 0.30R + 0.11B). This becomes:

(G-Y) = 0.41G — 0.30R — 0.11B

51% of (R-Y) works out as 0.36R — 0.30G — 0.06B. 19% of (B-Y) is 0.17B — 0.06R — 0.11G. Add these together and we obtain — 0.41G + 0.30R + 0.11B. This is exactly the same as (G-Y) above, except that the + and — signs are reversed.

In the colour TV receiver, 51% of the (R-Y) signal is combined with 19% of the (B-Y) signal. Then the resulting signal is inverted by passing it through an amplifier. In this way, the (G-Y) signal is recovered.

Fig.7 illustrates how this is done. Note that in the latest colour sets, the matrix circuitry is usually contained within a large scale integrated circuit, together with the remainder of the decoder circuitry.

Transistor Q1 amplifies the (R-Y) signal and Q3 does the same for the (B-Y) signal. Inverted (R-Y) signals from transistor Q1 and inverted (B-Y) from transistor Q3 are applied to two trimpots (VR1 and VR2). These trimpots are adjusted so that the base of transistor Q2 is supplied with a signal consisting of 51% -(R-Y) and 19% -(B-Y). This mixed signal is then passed through uninverted by transistor Q2 which acts as an emitter-follower, producing a (G-Y) signal at point "G".

Colour drive to the tube

In the late 1960s and early 1970s, almost all PAL receivers had colour difference drive circuitry (see Fig.6). In

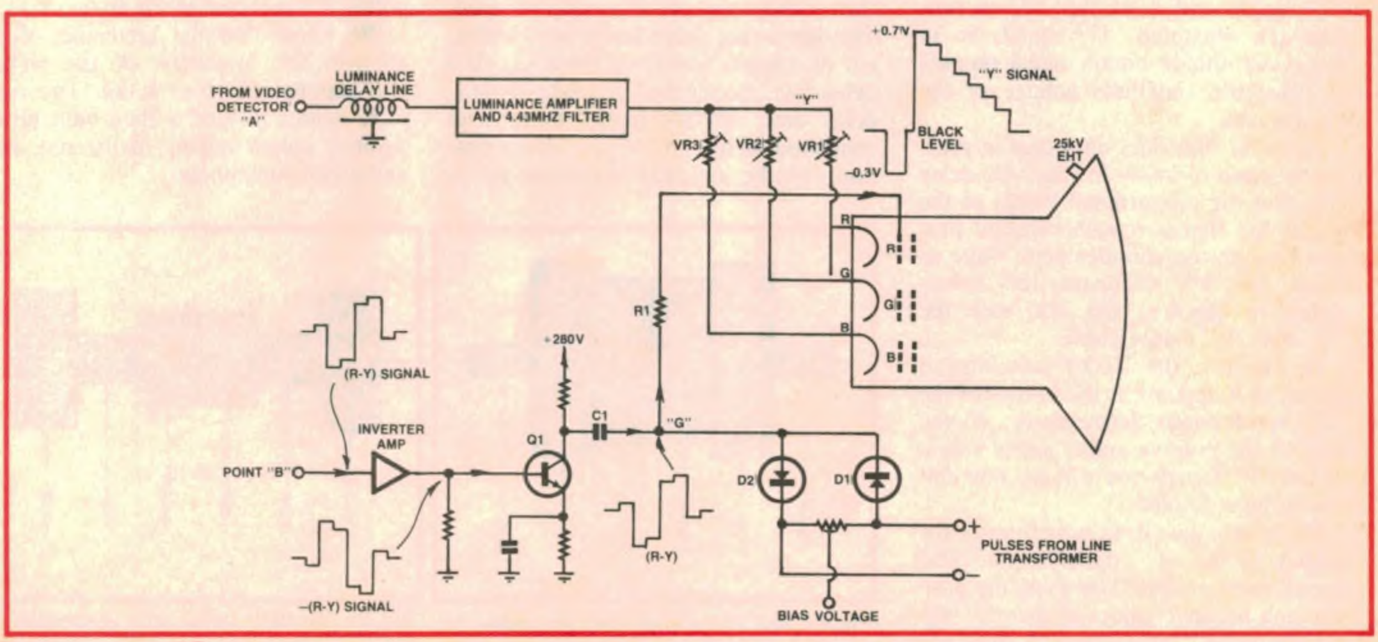

Fig.6: the colour difference output stage. In this circuit, the luminance signal is applied to the tube cathodes while the colour signals are fed to the three control grids.

this type of circuitry the luminance signal is supplied to the tube cathodes, and the three colour signals are fed separately to each of the picture tube's three control grids.

Transistor Q1 in Fig.6 functions as a colour difference amplifier. Waveforms are shown on this diagram for an (R-Y) input with a colour bar input signal. The (G-Y) and (B-Y) amplifiers are identical. The two diodes (D1 and D2) act as a "clamp" and are driven by pulses that come from the receiver line output transformer. D1 and D2 conduct each time the pulses arrive at capacitors C1 and C2.

When this happens the DC voltage at point "G" is practically the same as the bias voltage. The result is that the picture tube grid is held at a DC voltage corresponding to the "black" level of the signal. Look again at the waveforms in Fig.6 and note the black level. Capacitor C1 couples the collector of transistor Q1 to point "G" and thence via resistance R1 to the picture tube grid.

A colour picture tube is more sensitive to changes of cathode voltages than it is to changes of grid voltages. So when the amplified colour signals drive the tube control grids, rather than the cathodes, the signal must be greater by about 30 to 33 percent.

You will see from Fig.6 that the "Y" signal is applied to each of the picture tube cathodes. This means that the "red" electron beam is controlled by the "Y" signal at the cathode, and the (R-Y) signal at the control grid labelled "r". But because –Y plus Y = 0, (R-Y) at the grid and + Y at the cathode add up to R. The result is that the signal at the control grid acts as R only.

In the same way, (G-Y) at grid "g" becomes G, and (B-Y) becomes B at grid "b".

The fine detail of the picture is supplied by the luminance signal as we discussed in previous articles in this series., You'll remember that when a monochrome program is received, — perhaps an old black and white film — the picture depends entirely on the luminance signal. The brightness of each of the three electron beams must be adjusted so that the viewer receives the sensation of a monochrome picture.

In other words the brightness of the picture must vary from black through various shades of grey to peak white.

This setting up of the electron beams is called "Grey Scale Tracking". Fig.6 shows the preset controls VR1, VR2 and VR3 used for this adjustment.

Usually the "red" drive "Y" signal needs to be greater in amplitude than the "green" and "blue" drive signals. This is because the "red" phosphor on the tube face needs the largest electron beam current of the three beams in order to emit the desired amount of red light. Having said this, keep in mind that colour picture tube design and tube face phosphor efficiency are constantly being improved by the manufacturers.

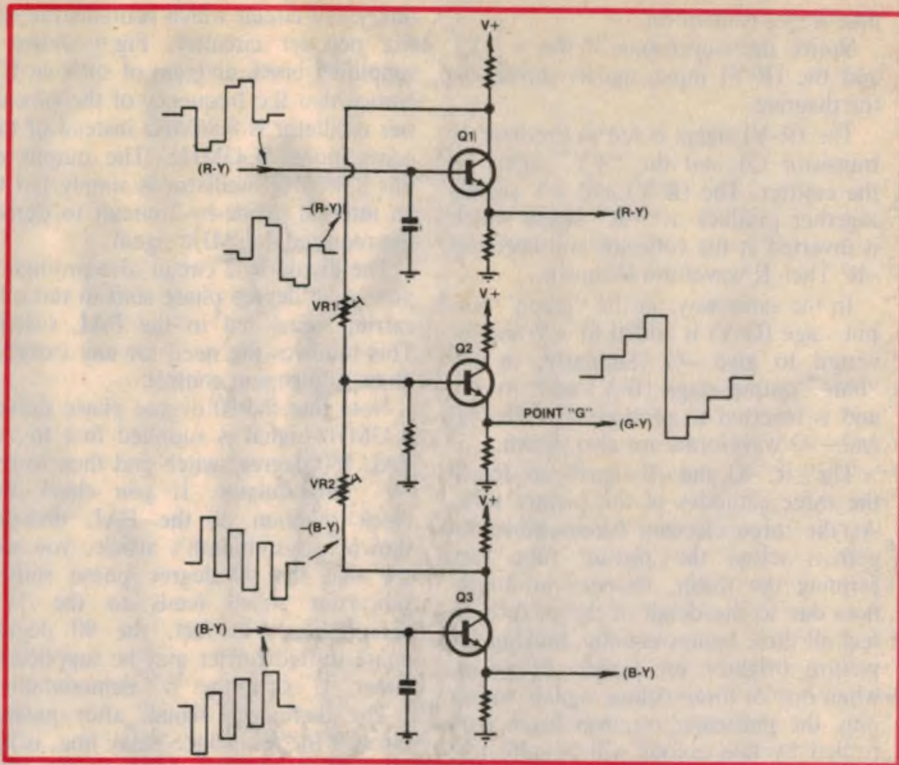

Fig.7: how the G-Y signal is derived. Inverted R-Y signals from Q1 are mixed with inverted B-Y signals in Q3 to give the G-Y signal at Q3's emitter.

When a colour program is received, the brightness signal continues to supply the detail. The colour difference signals at the picture tube grids vary in intensity according to the colour of the transmitted picture so that a wide range of colours are visible in the picture. These are, of course, produced by additive mixing of the three primary colours. Together, the luminance and colour signals make up the complete colour picture.

RGB drive

RGB drive is used in the newest colour TV receivers, with all colour and picture detail information being supplied to the tube cathodes. Typical colour drive output voltages for a late model colour set are 90 volts peak-to-peak at the "red" cathode, and 70 volts peak-to-peak at the "green" and "blue" cathodes.

Fig.8 is a simplified circuit of the "red" output stage of an RGB drive colour TV. The circuitry of the green and

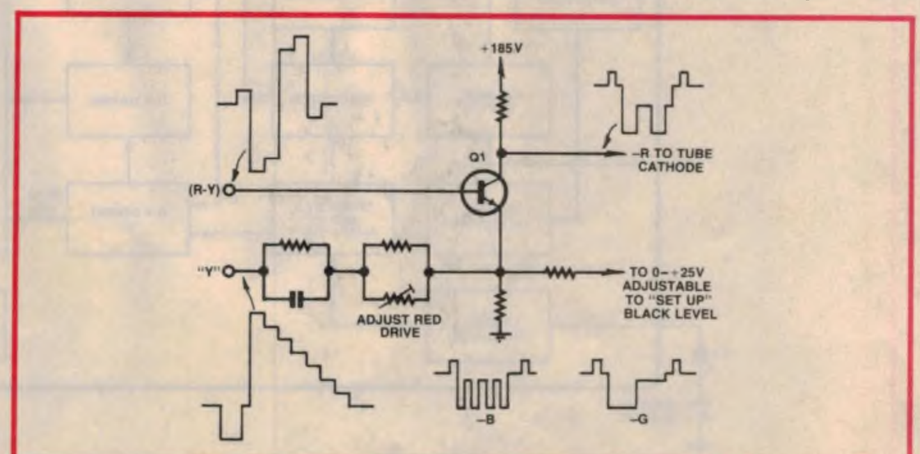

Fig.8: simplified circuit of the "red" output stage of an RGB drive colour TV receiver. The circuitry for the green and blue stages is identical.

blue stages is identical.

Notice the waveforms of the + "Y" and the (R-Y) input signals shown on the diagram.

The (R-Y) signal is fed to the base of transistor Q1 and the "+Y" signal to the emitter. The (R-Y) and +Y signals together produce a "+R" signal which is inverted at the collector and becomes –R. The –R waveform is shown.

In the same way, in the "green" output stage (G-Y) is added to +Y and inverted to give –G. Similarly, in the "blue" output stage (B-Y) adds to +Y and is inverted to produce –B. The –B and —G waveforms are also shown.

The –R, –G and –B signals are fed to the three cathodes of the picture tube. As the three electron beams move together across the picture tube face forming the raster, changes in brightness due to the detail of the picture affect all three beams equally, making the picture brighter or darker. However, when one of three colour signals varies, only the particular electron beam controlled by that colour will be affected. In this way the fine detail of the picture is displayed with the full range of colours added.

The one-chip decoder

A new development in colour TV receivers is the use of a single large scale integrated circuit which contains the entire decoder circuitry. Fig.9 shows a simplified block diagram of such an IC. Notice that the frequency of the subcarrier oscillator is 8.86MHz instead of the conventional 4.43MHz. The output of this 8.86MHz oscillator is simply fed to an internal divide-by-2 circuit to derive the required 4.43MHz signal.

The divide-by-2 circuit also produes a precise 90 degree phase shift in the subcarrier signal fed to the PAL switch. This removes the need for any external phase adjustment control.

Note that the 90 degree phase shifted 4.43MHz signal is supplied first to the PAL 180 degree switch and then to the "V" demodulator. If you check the block diagram of the PAL decoder shown in last month's article, you will see that the 90 degree phase shifted subcarrier signal feeds to the "U" demodulator. In fact, the 90 degree phase shifted carrier may be supplied to either "U" or to the "V" demodulator.

The luminance signal, after passing through the luminance delay line, is applied to point "L" which is the "Y" input pin connection to the IC. It then passes through the internal "Y" amplifier and feeds into the RGB matrix circuit. The chrominance signal is supplied to point "C" and into the gated chrominance amplifier. The output of this amplifier is fed to external PAL/chroma delay circuitry.

The resulting separated "U" and "V" signals then re-enter the decoder IC and are supplied to the (R-Y) "V" and (B-Y) "U" demodulators. Proportions of the (R-Y) and (B-Y) demodulated outputs supply the (G-Y) matrix circuitry. The (R-Y), (G-Y) and (B-Y) signals are then fed into the RGB matrix.

The output from the RGB matrix consists of "R", "G" and "B" signals which are then further amplified. Black level "clamping" (not shown) is applied to the signals within the IC. The colour signals are then amplified by external transistors to drive the three cathodes of the colour picture tube.

An external electronic switch allows the IC to operate on either the PAL or NSTC colour system.

You'll appreciate that our diagram (Fig.9) shows only the main features of this single IC decoder. Quite a lot of other circuitry is also contained within the IC. The important thing is that you understand the basic operating principles.

Next month, we'll begin considering the complete PAL colour television receiver. In particular, we'll consider the the tuner and IF stages, plus the power supplies, EHT generation and the other sections of the colour TV set.

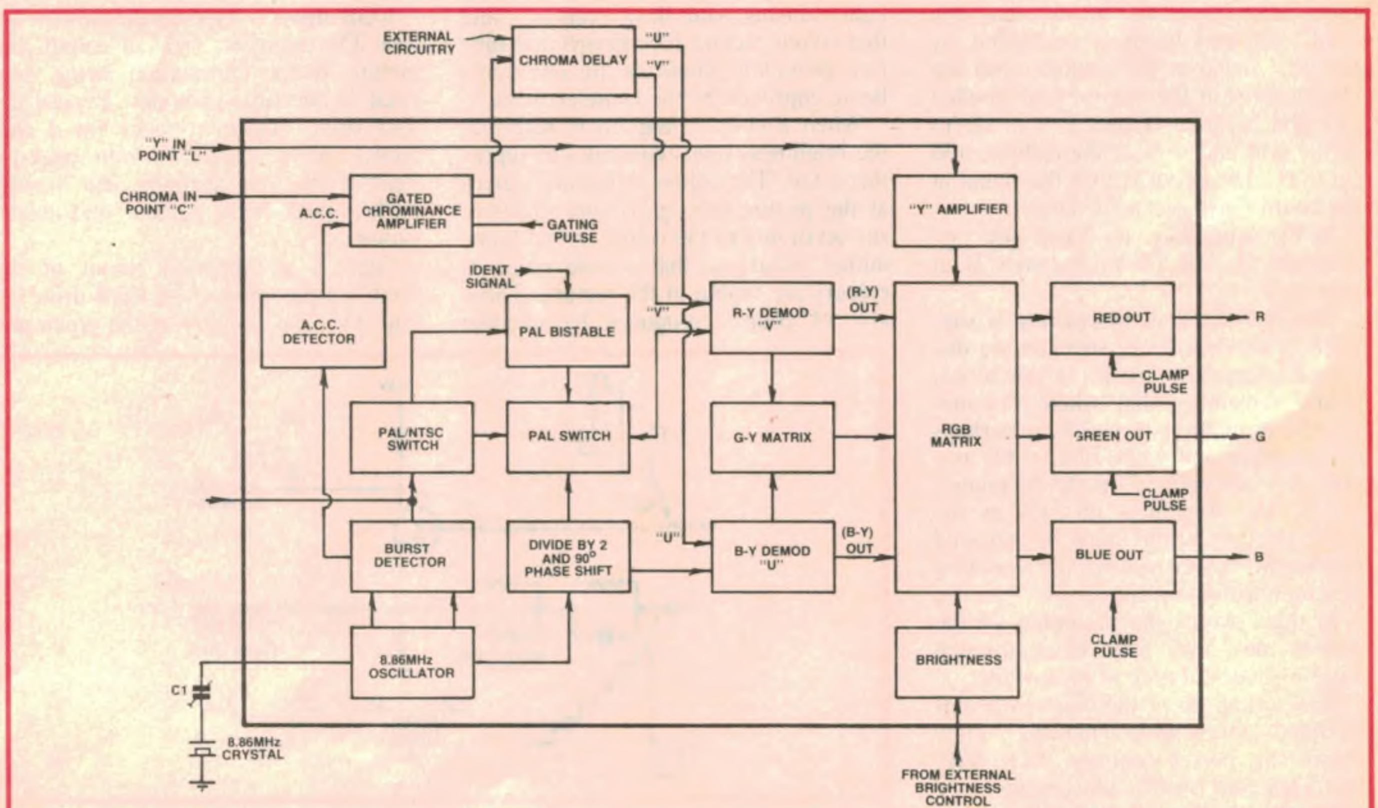

Fig.9: simplified block diagram of the TDA 3562A single-chip colour decoder IC.

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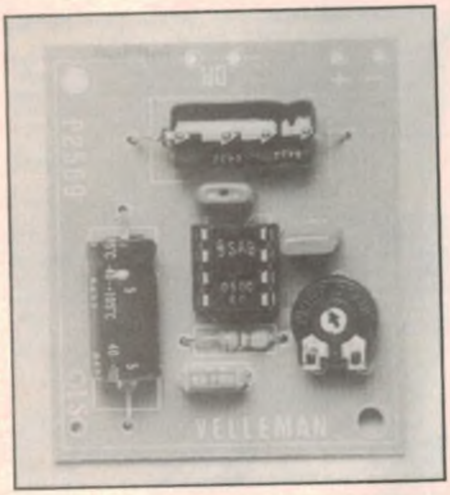
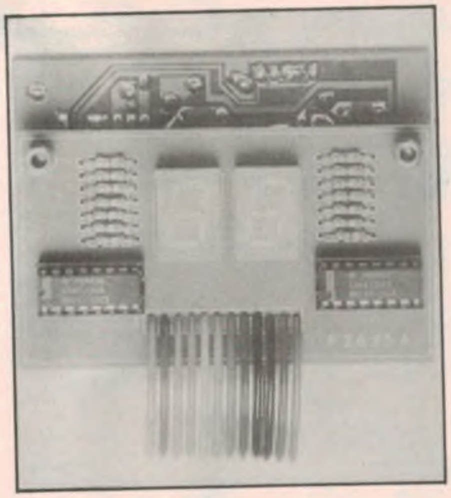
New Products...

Product reviews, releases & services





New range of pre-packaged kits

The Velleman range of electronic kits from Belgium is now available in Australia. Included in the range are audio, automotive, lighting, and power control projects, power supplies, infrared remote controls, alarms, timers and meters.

All the kits are built onto fibreglass printed circuit boards which feature solder masking and a screen printed parts overlay. They are supplied neatly packed in plastic cases and include full instructions and all the parts necessary to assemble the PCB. Depending on the kit, the purchaser supplies any ancilliary components (case, power supply, loudspeaker, etc).

We received a sample 3-Tone Chime kit (No. K2569) and a Digital RPM Meter kit (No. K2625) for evaluation. Both kits included all parts, and good quality components and PCBs were supplied.

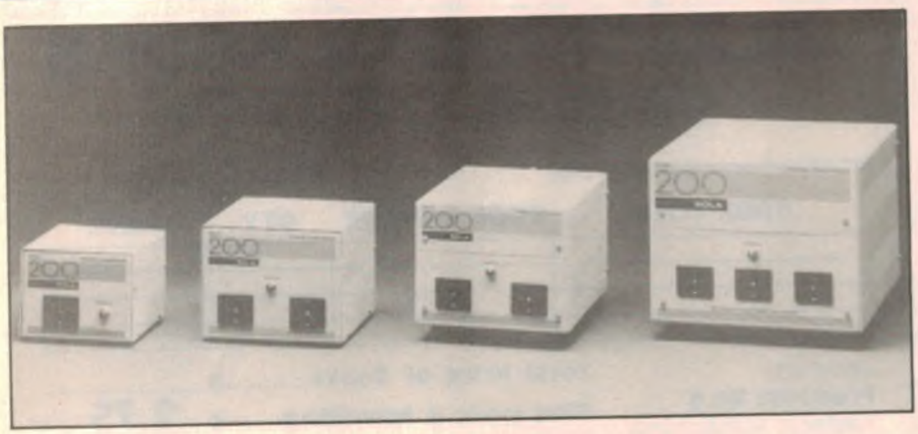
The Door Chime kit is based on a Siemens door chime IC plus four capacitors, a resistor and trimpot. It requires a power supply of between 7 and 12V DC plus an 8-ohm loudspeaker.

The Digital Tacho has a 2-digit readout and provides readings up to 9,900rpm with 100rpm resolution. It is suitable for use with 2 or 4-stroke petrol engines with up to six cylinders and features an intensity contol for the display brightness.

The tacho is built on two circuit boards, one for the display and the other for the counter circuitry. These are connected together using a pre-stripped wiring loom. A front panel with an integral red filter for the display is supplied.

We assembled both kits as shown in the photograph, and both worked as expected without trouble.

The Velleman kit range is available from FHS Electronics, 59 Barry Parade, Fortitude Valley, Qld 4006. Phone (07) 832 3700. Trade enquiries should be directed to Fred Hoe and Sons, 246 Evans Road, Salisbury, Qld 4107. Phone (07) 277 4311.



Power conditioners

Sola Basic Australia has announced an extension to its popular Series 200 Power Conditioner Line.

Previously available only in ratings up to 2.5kVA, units are now offered to 18kVA. The new units are up to 30% lighter in weight than Sola's traditional equipment, and some models may be configured for single or three-phase application. All are on castors for easy positioning and plug/socket options are offered on the lower power units.

For further information contact Sola Basic Australia Ltd, 13 Healey Road, Dandenong, Vic 3175. Telephone: (03) 791 1033.

Octal transceiver from Fairchild

Newly released from Fairchild is the F552 octal transceiver which contains two 8-bit registers for temporary storage of data flowing in either direction.

Each register has its own clock pulse and clock enable input as well as a flag flipflop that is set automatically as the register is loaded. The flag output will be reset when the output enable returns to high after reading the output port.

Each register also has a separate output enable control for its 3-state buffer. The separate Clocks, Flags and Enables provide considerable flexibility as I/O ports for demand-response data transfer. When data is transferred from the A-port to the B-port, a parity bit is generated.

For further information contact Fairchild Australia Pty Ltd, 366 Whitehorse Road, Nunawading, Vic. 3131. Telephone (03) 877 5444.

Tandy's 1000EX personal computer

Tandy has announced the release of the 1000EX — an IBM PC compatible computer for the home, education and small businesses. The new computer incorporates Deskmate software.

The Deskmate software has a variety of applications such as *Test,* which is an editing system which includes cut-copy-paste functions, search and replace and underlining and boldface. Another feature of the software is *Worksheet* which produces a spreadsheet with 99 rows and 99 columns of numeric, text or calculated cells. Within Deskmate are four functions: *Calculator*, *Notepad*, *Calendar*, and *Phone Directory*.

A separate application, *Filer* is an aid for the office or home for any filing requirement. The *Paint* application is a graphics editor that includes functions for drawing basic shapes (solid or outline), lines, fonts and pattern files.

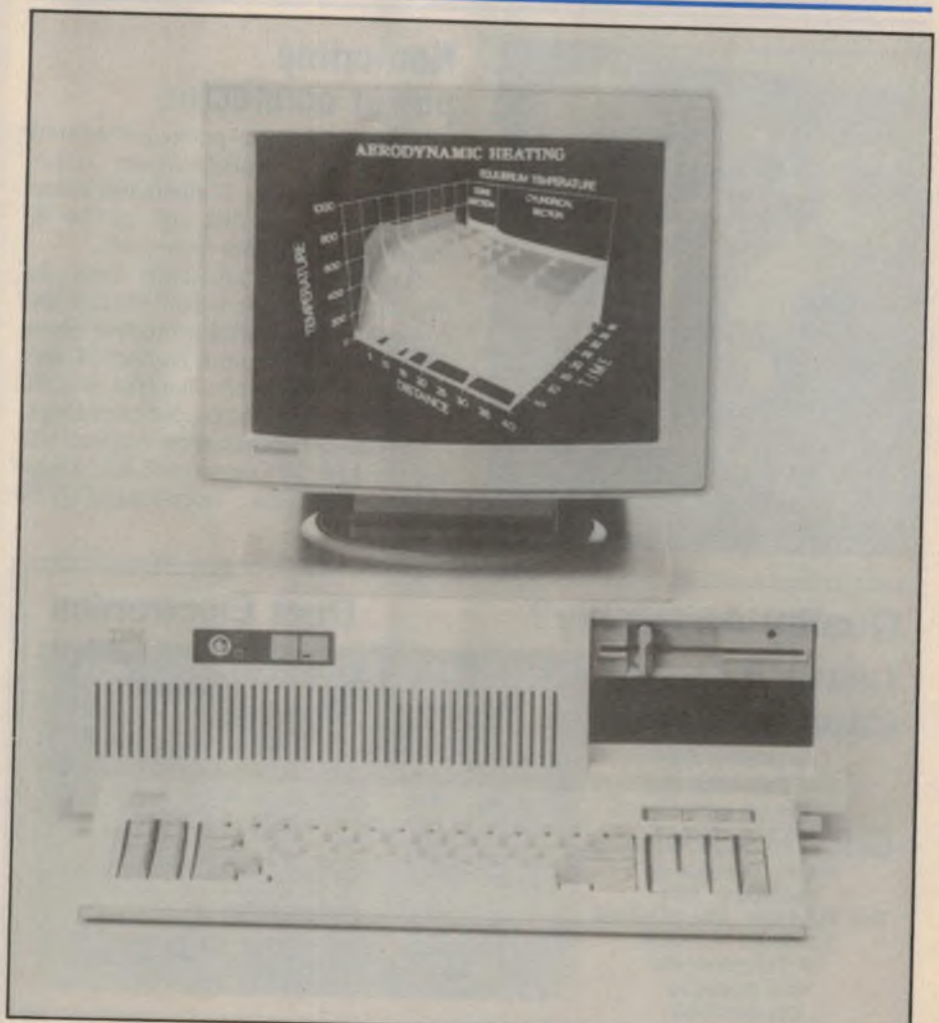
The operating system of the Tandy 1000 EX includes Microsoft's MS-DOS 2.11 with GW BASIC. It has a 256K RAM that is expandible to 640K using PLUS Expansion Boards and Upgrade Boards. The new system uses the Intel 8088 and is clocked at 7.16/4.77MHz.

For further information contact Tandy Electronics, 91 Kurrajong Avenue, Mt. Druitt, NSW 2770. Telephone: 675 1222.

Tektronics PC graphics

Tektronics has released a new line of high performance colour graphics products for the IBM PC XT and AT and compatibles.

The product family includes the PLOT 10 PC4100 Graphics Co-processor Board and a 640 x 480 Multiple Line Rate Graphics Monitor and two software emulation packages called PLOT 10 PC-054 and PLOT 10 PC-07. The Tektronix PC Graphics products are targetted for applications such as computer-aided design (CAD), technical data analysis (TDA) and business presentation graphics.



The PLOT 10 PC 4100 Graphics Co-processor board uses the Texas Instruments TMS34010 Graphics System (GSP) chip for fast, high-level graphics functions. The co-processor has two memory banks on its board — the display memory and one megabyte of general-purpose interface (TGI) custom microcode for specialised graphics requirements.

The PC4100 graphics board features 256 simultaneous colours for a palette of over 16 million colours. This makes it suitable for complex applications that involve shaded images.

For further information contact Tektronix Australia Pty Ltd, 80 Waterloo Rd, North Ryde, NSW 2113. Telephone: (02) 888 7066.

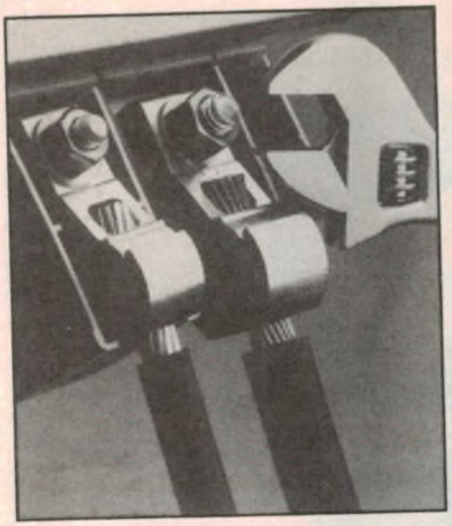
New Products...

SWR/power meter

Designed for testing cellular mobile telephones, the Model 03-801 SWR/Power Meter accurately measures power and SWR in the 800-900MHz region.

The unit is Australian made and comes with a detailed instruction manual. It is ideal for use by installers who need a rugged instrument for checking antennas and cabling.

For further information contact Call Me Communications, 28 Parkes St, Parramatta, NSW 2150. Telephone (02) 633 3545.



Non-crimp power connector

A new concept in power cable termination is now available from Utilux. Known as Cytolok, it eliminates crimping machines and dies and can be installed with a spanner or wrench.

The connectors are made from aluminium alloy which is heat treated and covered with a special protective finish. They are available in a number of sizes and can be used with standard or compacted aluminium or copper conductors.

For further information contact Utilux Pty Ltd, 14 Commercial Rd, Kingsgrove, NSW 2208. Telephone: (02) 50 0155.

DIP socket & terminal connector

Augat Inc's Interconnection Components Division has announced the development of a new Shrink DIP socket.

The new DIP socket accepts devices on 0.07-inch pin to pin spacing, as opposed to conventional DIP sockets which have a 0.1-inch pitch. The tail is extended through the insulator, not the body of the sleeve, which helps prevent solder bridging when wave soldering.

All devices that are currently manufactured by Hitachi, Motorola and Mitsubishi with a 0.07-inch pitch can be used with the new DIP socket. They are available in 28, 30, 48, 52 and 64 pin configuration.

Also available from Augat is the new 2-ID terminal block which provide for factory or field wirable connections in seconds without special tools. Main specifications of the unit include 0.2-inch centre spacing, a 10A 300V rating, and integral standoffs to allow for more effective flux removal. The unit is available in direct solder-in or de-pluggable styles and accepts 18-22 AWG standard PVC insulated wire.

For further information contact Augat Pty Ltd, Unit 8, 158 South Creek Rd, Dee Why West, NSW 2099. Telephone: (02) 982 5666.

Logic devices from Fairchild

Fairchild Australia has recently released two new F100K ECL subnanosecond logic devices — F100104 and F100121. These devices are designed to simplify the job of converting from TTL to high-performance ECL designs.

The F100104 has five AND gates with true and complementary outputs. The availability of complementary outputs provides numerous opportunities to reduce package count. A function output that is the wire-NOR of all five gate outputs is also available for increased flexibility.

The device is available in ceramic DIP or Flatpak packaging.

The F100121 is a 9-bit inverting buffer with single input and output. All inputs have 50kΩ pull-down resistors. The F100121 has a maximum propagation delay of 1.6ns (1.9ns for F100104) and is also available in ceramic DIP or Flatpak.

For further information contact Fairchild Australia Pty Ltd, 366 Whitehorse Road, Nunawading, Vic. 3131. Telephone: (03) 877 5444.

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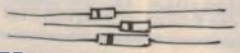

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7818uC	.50	.49	.48
7818KC	1.50	1.40	1.20
7905uC	.70	.60	.55
7912uC	.70	.60	.55
uA323KC	4.50	3.90	3.75

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Q10504	MU45 0-100uA	8.50	7.95	7.75
Q10505	MU45 0-50uA	8.50	7.95	7.75
Q10510	MU45 0-5A	8.50	7.95	7.75
Q10518	MU45 0-1A	8.50	7.95	7.75
Q10520	MU45 0-20V	8.50	7.95	7.75
Q10535	MU45 VU	9.50	8.95	8.75
Q10530	MU52E 0-1mA	9.95	8.35	
Q10533	MU52E 0-5mA	9.95	8.35	
Q10538	MU65 0-50uA	12.50	11.35	10.90
Q10540	MU65 0-1mA	12.50	11.35	10.90
Q10550	MU65 0-100uA	12.50	11.35	10.90
Q10560	MU650 0-20v	12.50	11.35	10.90

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PN3463	.15	.13	PN3565	.12	.11
PN3566	.15	.13	PN3567	.10	.08
PN3569	.18	.16	PN3639	.18	.16
PN3640	.18	.16	PN3641	.10	.08
PN3642	.10	.08	PN3643	.10	.08
PN3644	.15	.13	PN3645	.15	.13
PN4250A	.15	.13	PN4355	.16	.14
PN4356	.16	.14	MPSA42	.23	.20
MPSA43	.23	.20	MPSA55	.15	.14
MPSA56	.15	.14	MPSA92	.22	.20
MPSA93	.22	.20	SC1410	.85	.75
BU126	1.50	1.25	BUX80	2.75	2.55
BU208	2.50	2.20	2SD350	3.75	3.40
BU326	1.75	1.60	BC547	.07	.06
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BC557	.07	.06	BC558	.07	.06
BC559	.07	.06			

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Z10110	IN4007	0.10	0.06	0.05	0.04
Z10115	IN5404	0.18	0.14	0.09	0.08
Z10119	IN5408	0.20	0.16	0.10	0.09

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P10901	DB25 Skt.	1.10	0.75	0.70
P10902	DB25 Cover	0.80	0.65	0.55
P12210	Cent. Solder	3.50	3.15	2.50
P12200	Cent. Crimp	4.50	4.00	3.50
P10880	DB9 Plug	1.30	1.20	0.90
P10881	DB9 Skt. 1.40	1.30	1.00	
P10882	DB9 Cover	0.60	0.55	0.50
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W12626	26 Way	34.00	32.00	29.00	26.00
W12634	34 Way	44.00	42.00	39.00	34.00
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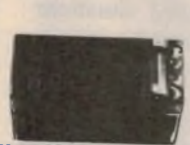
M12155 2155 240V 6-15V 1A tapped	6.00	5.75	5.50
M12156 2156 240V 6-15V 2A tapped	9.00	8.75	8.50
M12840 2840 240V to 9V C.T. at 150mA	3.50	3.30	3.10
M12860 2860 240V to 15V C.T. at 250mA	3.50	3.30	3.10
M16672 6672 240V 15-30V 1A tapped	8.95	8.75	8.40

Plus 20% tax where applicable



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R15137	.0012uF	0.06	0.04	.03
R15138	.0015uF	0.06	0.04	.03
R15140	.0022uF	0.06	0.04	.03
R15142	.0033uF	0.06	0.04	.03
R15143	.0039uF	0.06	0.04	.03
R15145	.0047uF	0.06	0.04	.03
R15146	.0056uF	0.06	0.04	.03
R15147	.0082uF	0.06	0.04	.03
R15148	.01uF	0.07	0.05	.04
R15150	.015uF	0.07	0.05	.04
R15152	.022uF	0.07	0.05	.04
R15154	.033uF	0.07	0.05	.04
R15155	.039uF	0.07	0.05	.04
R15156	.047uF	0.08	0.06	.05
R15157	.056uF	0.08	0.06	.05
R15158	.068uF	0.08	0.06	.05
R15159	.082uF	0.08	0.07	.05
R15160	.1uF	0.09	0.08	.07
R15162	.15uF	0.11	0.10	.09
R15164	.22uF	0.15	0.14	.13
R15165	.27uF	0.16	0.15	.14
R15172	1uF	0.70	0.55	0.50
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Conducted by Neville Williams

The DAT pill: too bitter to swallow?

The correspondent who complained, last month, about the relentless on-rush of technology must be laughing. Faced with DAT, the tape equivalent of DAD, one part of the hifi industry is pushing ahead with it, another part wants to bury it, while the rest prefer to sit on their hands until they can work out how best to react.

For the sake of those who may not be quite up with their acronyms, "DAD" has nothing to do with Steele Rudd's famous character from the Australian bush. It is an umbrella term covering digital audio discs in general but, in practice, is most commonly associated with the now solidly entrenched compact disc. Indeed, back in October 1982, when Sony unveiled their then new CD equipment in Sydney, they invited all present "to meet DAD".

DAT, on the other hand, stands for "digital audio tape" — an umbrella term that rightly covers all digital tape recorders, including those that have been around in professional situations for a decade or more. However, in current consumer audio literature, and in audio-video exhibitions around the world, "the new DAT system" invariably refers to the recently released digital tape cassette format that is poised to take over from the one we've been using for the past 20-odd years.

As a hifi medium, present-day analog audio cassette technology, even at its expensive best, falls well short of that employed for compact discs, and tape interests have realised for years that they needed a major breakthrough to close the gap.

The FM-stereo technique devised for the sound track of VHS and Beta video tapes offered one possibility, in conjunction with the new 8mm video cassette. However, it did not get beyond the prototype stage, undoubtedly because the major manufacturers could forsee the advantages of a full digital approach.

Time to meet DAT

In due course, after more than three years of discussion (June 1983 to August 1986) involving 85 separate companies, the so-called "DAT Conference" reached agreement on a world standard format for consumer digital audio tape players and cassettes. Now all that remains is for the aforesaid companies to develop and prove prototype products, identify the appropriate time to launch, set up production lines, organise marketing and publicity, and get cracking.

Nothing to it . . . well, er . . . there does seem to be a certain amount of hesitation.

Technically, the DAT conference appears to have come up with a format that pushes audio tape technology to its present logical limit and, as such, the details make interesting reading.

The tape itself falls within well proven parameters: 3.81mm wide (the same as that in present-day audio cassettes); the total thickness, 3.3 microns (similar to that in the current C-90's); and the coating formulation, metal particle with appropriate but not revolutionary magnetic properties.

However, the size of the cassette has been reduced to about half that of its current "compact" counterpart, at 73 x 54 x 10.5mm. Despite this, playing time has been extended to 120 minutes continuous "in standard mode" — a qualification that would suggest that a longer-play mode is envisaged. The cassette, incidentally, is a single-pass, not a flip-over design.

For such figures to be possible, the traverse speed has had to be drastically reduced — in fact by more than 5:1, from 47.5mm/sec to 8.15mm/sec. At the same time, the writing speed has been greatly increased by the use of rotary heads which scan obliquely across the tape, as in a video recorder.

(If you want to add to your stock of techno-jargon, the DAT Conference is said to have looked closely at S-DAT — stationary head designs — before settling on R-DAT (rotary heads) as the basis for the new DAT or DT-46, DT-60, DT-90 or DT-120 cassettes).

As in the case of compact discs, the DAT system is basically designed to accommodate 2-channel stereo sound, with the channels being encoded digitally and recorded at a level which exploits the full saturation range of the coating.

As explained in the recent articles covering digital recording, such systems are not sensitive to the magnetic linearity or the noise level of the tape. Quality, in terms of distortion, noise and frequency response, depends primarily on accurate recovery and processing of the recorded pulse train.

Furthermore, because the recovered pulses are fed into a memory store and clocked out with crystal precision for decoding into analog audio, there are no problems with speed regulation, wow or flutter.

Again, as with compact discs, the new DAT cassette system features comprehensive error detection and correction — the "Double-Encoded Reed-Solomon" system — to ensure "smooth and accurate sound". Indeed, it goes one better than disc, with a protective lid to keep errant fingers away from the tape surface!

It also features sub-code signals, recorded on the tape, such as "start ID" (for fast access), "skip ID" (for skipping unwanted segments) and "program number" to facilitate high-speed search, a cue/review function, direct music selection, &c. And, while access to tracks and codes can never be as facile for tape as for disc, the format has been de-

Sony's new DAT player — gee-whiz technology but a challenge for compact discs and a headache for software copyright owners.

signed to minimise wear and to cope reliably with repeated rapid search and spooling.

Typical DAT players

For the most part, the major hardware manufacturers are saying little or nothing about their plans for DAT although, mindful of their image as pacesetters, both Sony and Matsushita (National) launched a DAT player on to the Japanese domestic market, early this year — as one spokesman put it: "to test the water".

At about the same time, Sony Australia were at pains to emphasise to local journalists that "no plans have been made to release DAT products outside of Japan in the forseeable future" — a statement that was at variance with hints of the recent Paris Video and Sound Exhibition of an impending European release. Matsushita, I gather, has been making similar ambiguous noises and, like Sony, would still seem to be sitting on one of its corporate hands.

Along with their player, Sony released the cassettes and hardware necessary for DAT to develop as a viable system, including duplication equipment capable of operating up to 50 DAT slave recorders at one time. A high-speed duplicator using the magnetic contact print system is said to be at the prototype stage.

Cautious they may be, but Sony are certainly not hindered by modesty when it comes to describing their new DTS-100ES DAT deck: rigid aluminium alloy chassis; four direct-drive transport motors; precision SSP (Sendust Slope Sputtering) head; four dedicated microprocessors for precision control; isolation of digital, analog and power supply circuitry; 4-times over-sampling digital filter; 16-bit linear quantisation; dual A/D and D/A converters; IR remote control, &c.

In terms of performance, the specifications are well up there with the compact disc: frequency response 2Hz-22kHz ±0.5dB; S/N ratio 92dB; dynamic range 90dB; THD 0.005% at 1kHz; wow and flutter unmeasurable. The deck can operate at three sampling rates — 48kHz, 44.1kHz and 32kHz — and can accept either analog input or direct compatible digital input.

Not without problems

Technically, as we said, it adds up to a most impressive format, offering to the hifi enthusiast access not only to another state-of-the-art signal source but to a recording facility of a similar standard. But, for at least one section of the industry, the purveyors of software, it is proving to be a pill too bitter to swallow.

From the time that tape recording became a routine domestic facility, owners and distributors of copyright program software have had to live with the problem of consumers making their own copies, with very little inhibition. True, as suggested in October last, the copyright owners have been able to turn the situation to their advantage, but they would obviously prefer to have complete rather than remote control over their own property.

With the release and commercial success of the compact disc, they had sole access to a medium which offered to the home hifi enthusiast a unique level of fidelity — one that could be experienced only by purchasing an original pressing. DAT threatens that vital advantage because DAT owners will henceforth be able to make copies of their friends' CDs, or any other super-quality source, subjectively indistinguishable from the original.

In a recent BBC TV program, replayed here on the ABC's Carleton-Walsh Report, the Beatles' record producer, George Martin, pointed out that, hitherto, tape recordists have been able to make "copies" of commercial software. That was bad enough but, with digital/digital facilities available, they would henceforth be able to clone recordings and to make clones of clones, ad infinitum!

The software industry would undoubtedly have been delighted if DAT had become bogged down in technical or commercial problems but that was not to be. The hardware manufacturers appear to have sorted out any hassles with an expertise gained from past bitter experience. As ever, the attitude of the EIAJ (Electronic Industries Association of Japan) is that they have settled on a format that should appeal to consumers worldwide and they reserve the right to market it, how and when they choose!

In what has all the elements of an east/west confrontation, the most eloquent retort from the non-Japanese software interests is, in effect: "We own most of the copyright and we simply won't release material for DAT. So you'll end up with factories full of hardware and no software to support it".

How to stop dubbing?

Not surprisingly, there has been considerable debate about ways and means of inhibiting the duplication of pre-recorded material, particularly from compact disc. DAT recorders might be designed to switch off it they sensed a CD sub-code; or they might seek out and react to otherwise imperceptible traces of the sampling frequency; yet again, they might look for a deliberate signal-free band at 18kHz, to be a feature of all future CDs.

The truth is that it is incredibly difficult to devise any method of inhibiting dubbing which would, at the one time, be acceptable, enforceable and proof against tampering — particularly when the hardware manufacturers see it as bad for business; their business!

But the Japanese do seem to have made one major concession to the software industry, if specifications of the Sony and National DAT players are to be taken as evidence. They will record or play back digitised signals at a sampling rate of 48kHz (a professional standard) or 32kHz (for satellite broadcasts), but will only play back (not record) at 44.1kHz — the standard used for all compact discs. That should prevent digital "cloning".

Again, if and when software manufacturers begin to produce pre-recorded DAT cassettes from transcriptions of

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CD master tapes, the new players will decode them quite happily at 44.1kHz for analog replay but will be constitutionally unable to copy them on a digital/digital basis.

And that's probably the way it will be for exactly as long as it takes for someone to come up with an affordable outboard standards converter!

In any case, consumers will still be able to re-record commercial DADs and DATs from analog to 48kHz digital and, on a single copy basis, they should sound very little different from digital/-digital transfer. My tip is that, in the long run, DAT will become the preferred sound source for in-car use, with a mixed "diet" of original cassettes and others dubbed from the CD library in the listening room.

Please note that I am not debating the rights and wrongs of all this — simply the reality. Right now, hardware manufacturers are openly marketing compact cassette equipment expressly intended to copy commercial compact discs and tapes. DAT, used for the same purpose, will not be more or less legal or illegal; simply better.

What of the economics?

But, as of now, I wonder how many of the 85 companies, who helped sort out the technology of the DAT system, actually welcome its arrival on the scene. No sooner have they started to benefit by the market swing to compact discs then along comes DAT to complicate the issue for consumers. As with the software manufacturers, many others probably need it like the proverbial hole in the head!

It could even be that the timing is inopportune for the major Japanese manufacturers themselves. With the Yen at its present high, a new and initally expensive piece of technology is likely to have very limited export potential, in the short term at least.

In Japan, the launch price of the new Sony DTC-1000ES was around Y200,000, with the cassettes ranging from Y1200 for a DT-46 to Y2000 for a DT-120. The National player was only marginally cheaper. Allowing for exchange, freight, duty, sales tax and marketing costs, the figures would escalate in Australia to something approaching $3000 for the basic player and $25 each for 120-minute cassettes.

To really get the prices down, Japanese manufacturers will have to work their way along a production learning curve, much as they did in the case of compact disc players. The most obvious course is to manufacture for the Japanese domestic market first, in the hope of trimming costs and bringing them more into line with export requirements. That, presumably is what Sony and National have in mind.

But, ironically, the Japanese hardware manufacturers are no longer in quite so favourable a position to call the tune. Having played a large part in firming specifications for a new format, they face the possibility that it could now be exploited in Europe or in one of the Asian countries where technical expertise is rising faster than their exchange rate.

For sure, to launch DAT would be a daunting prospect for a manufacturer in Taiwan or Korea or Hong Kong. It is one thing to produce enterprising clones of existing computers. It is quite another to cope successfully with the "leading edge" technology involved in DAT.

But who knows? As someone remarked to me recently, the time might have arrived when the Japanese themselves will have to move some of their now-too-costly operations off-shore to remain competitive. "Electronics", he said, "may even have reached the Hyundai stage".

Digital/digital dubbing

Just to round off this rather rambling dissertation on DAT, I can't help wondering about the preoccupation with digital/digital dubbing of compact discs. If there's one thing manufacturers try to prevent from escaping out of a CD player, it's the digital signal. So how do present CD owners get access to it to record it on DAT?

Could it be that the software interests don't trust the equipment manufacturers? How could they possibly believe that they would produce a new generation of CD players with the digital signal deliberately brought out — just as in the new DAT players? You might even be tempted to update to one of them!

I also got to wondering about George Martin's reference to cloning. As I remember it, he referred to "thousands of clones", each one a replica of the original recording. Granted that this was probably a colourful exaggeration, it did raise a query in my mind.

I'm quite prepared to accept that, in professional situations involving high-tech equipment, digital recordings can be processed and duplicated as many times as normally necessary, without any perceptible, even measurable, deterioration. That's what it's all about.

But I wonder how far we can push the concept of "perfect" digital copies when using consumer equipment which relies on a single time-multiplexed data channel and comprehensive error correction. Would the "corrected" errors be cumulative in their overall effect and how many times could the cloning process be repeated before such an effect becomes evident?

The figure, I am sure, would be much higher than for analog dubbing but "thousands of times" . . . I wonder? Has anyone even checked it out?

4-channel on CD?

Leaving aside the DAD and DAT question, I discussed in the January issue (p40) the confusion surrounding the possibility of recording discrete 4-channel sound on compact discs. I was fairly sure that it had been mentioned as an option in the early days but nobody I could find at Sony, Philips or Panasonic seemed to remember much about it.

I was almost convinced that I had imagined the whole thing when I came across a provision for 4-channel recording in the on-disc P-Q coding, as listed in the manual for Sony's first commercial CD player to be released in this country, model DEP-101. The 4-digit code for 4-channel, it said, was 1000 without pre-emphasis and 1001 with pre-emphasis.

Beyond that, a blank, so I left the matter open, in the hope that someone might be able to clarify it. In fact, a New Zealand reader, M.F., has obliged with photostat copies of three quotes from early Technics (National) and Sony literature detailing the then very new CD system.

In a table comparing the compact disc (CD) system "proposed by Philips, Holland", and the Audio High Density (HD) format "proposed by Victor, Japan", Technics says:

CD: Stereo 2ch or 4ch.
AHD: 4ch (3ch & colour still image).

A somewhat later synopsis of CD parameters from Technics confirms this with:

Number of channels: 2(4)

But the answer to our question posed in the January issue is supplied in a list of Sony specifications for the CD system reprinted in a special December 1981 issue of the Japanese magazine "Stereo Geijutsu". I quote:

Number of channels: 2 channels (4-channel recording will also be possible at twice the present rotational speed).

Well, what do you know? The possibility we considered in the January issue and promptly rejected as being "commercially unacceptable" was the method seriously considered when CD specifications were being debated. Many thanks for the information, M.F.

It is perhaps significant that the company representatives specifically contacted — Philips, Sony and Matsushita (Technics) — have had so little occasion to think about discrete quadraphonic sound that the original 4-channel option for compact discs had been completely forgotten. Nor have I seen mention of anything other than 2-channel stereo for DAT.

Having in mind that Sony recently announced a digital surround sound synthesiser, offering five modes including SQ and QS, our closing remarks in the January issue, along those lines, could well have been close to the mark. If we're ever to get surround sound from DAD to DAT, it will almost certainly be synthesised.

Information centre

FM wireless transmitter

I have built the radio microphone described in the September 1986 issue and it works very well with a condenser microphone.

So that I can relay radio and tape programs around the house, I tried to modulate the transmitter from my hifi equipment. This resulted in awful distortion, presumably because this applies amplitude instead of frequency modulation.

Could you please let me know how I can modify the circuit so that it can be properly modulated with the above equipment. (J.K., Ballarat, Vic)

• The distortion is probably due to overmodulation of the transmitter or overloading of the preamplifier stage.

The microphone preamplifier should not be used when the transmitter is modulated by high level sources such as from your hifi. Instead, apply the signal directly to the audio input side of VR1, then tune an FM receiver to the transmitter frequency and adjust VR1 for best results.

Playmaster stereo AM/FM tuner

We have constructed the Playmaster Stereo AM/FM Tuner from a Jaycar kit and are having problems with alignment of the AM oscillator. Q4 has been replaced but the voltages still seem excessive at Anode 1 of D3. When VR1 is at the correct bias, the pot is almost at one end of its travel (ie, at low resistance) and at this point oscillation stops.

We have removed turns from L5 as described in the August 1986 errata without success. There are no appreciable waveforms at the collector and base of Q4. There is a strange ringing at A1 of D3 which we assume is enough to forward bias D3.

Is there a way of rectifying this problem without further removal of L5 as we have already broken and replaced one former. (P.N, D.J and C.H, Thomastown, Vic).

• From the photographs enclosed with your letter it is apparent that the AM local oscillator is not operating correctly. This could be due to insufficient turns on the feedback winding of L5 (ie, between terminals 5 and 6).

Another possibility is that one of the other windings is incorrect or has been wound in the wrong direction.

Once the oscillator is functioning correctly it may be necessary to adjust the feedback winding to ensure full coverage of the AM broadcast band. This is done by peeling a small portion of the feedback winding from beneath the ferrite ring until full coverage is obtained.

Finally, note that VR1 should be used to set the voltage at the emitter of Q4 to 3.2V for minimum noise.

Full cycle nicad battery charger

My son has a model car which uses a 7.2V, 1200mAH nicad battery. We wish to use the Full Cycle Nicad Battery Charger published in March 1987 to charge it. Is this possible and if so what value resistors do I use? (D.W., Frenchs Forest, NSW).

• The EA battery charger is suitable for charging 1200mAH, 7.2V nicad batteries provided that the resistor values listed in Table 1 of the article are changed. The battery should be connected in a similar manner to a 9V battery, with RC = series 18Ω + 18Ω, 1W; RT = 56Ω, 0.5W; RD = 15Ω, 5W and R1-R4 = series 39kΩ + 5.6kΩ 0.25W resistors.

These values will give a 120mA charge with a 30mA trickle charge rate.

Playmaster 60/60 amplifier & stereo AM/FM tuner

I have recently constructed the Playmaster 60/60 amplifier and stereo AM/FM tuner, both of which perform impressively. The following comments may be of interest to readers.

Initially I experienced a switch off thump with the 60/60 amplifier. This was caused by the NE5534 op amps latching up before the relay drop out. The problem was cured by replacing the 2.2kΩ resistor at the base of Q21 with a series 1kΩ resistor and 8.2V zener diode. Now the relay drops out almost immediately when the power is switched off.

I also installed a 0.1μF 3kV suppression capacitor across the power switch. It is also worth noting that the supplied kit did not contain the specified NE5534AN op amps but the AP and N versions. These may not have the same low noise figures as the AN device.

All the voltages checked out with the exception of –5.5V on the drain of Q5. This voltage was closer to –8V in both channels, giving a higher operating current for the phono input stages. Nevertheless, the noise level of the phono stage is negligible.

Concerning the AM/FM tuner, there are several electrolytic capacitors shown with incorrect polarity apart from those already identified in the errata. In the FM section, the audio coupling capacitors between IC2 and IC3 are shown with incorrect polarity in both circuit and layout diagrams. The bypass 10μF capacitor at pin 7 of IC13 is shown with incorrect polarity on the overlay diagram.

Some voltages around the AM stereo decoder deviate from those specified. While the voltage at pin 19 of IC4 is close to 4V, the voltage at pin 10 is about 12V. I infer from previous information centres in connection with the AM stereo decoder that a high voltage at pin 10 indicates that the decoder is in lock.

My Jaycar kit was supplied with a 50pF compensation capacitor for the 3.6MHz oscillator in the AM stereo decoder. Is there any reason to change this to 30pF as indicated in the errata?

Initially, I experienced serious electrical interference from a dishwasher operating near the tuner. After being switched off the tuner would not power up when switched on again. When switched off and on at the mains, it was found that some of the memory settings had been corrupted.

This problem was cured by installing a 0.22μF ceramic capacitor from the PC earth to the chassis at the audio output socket. For good measure, interference suppression capacitors were installed on the transformer secondaries and the input to the 7805 standby regulator.

I encountered a problem with the AM local oscillator at the low frequency end of the band. This problem, as you have pointed out in an erratum, is due to excessive output from the oscillator forward biasing the varicap diode. With VR1 set for a reading of 1.6V at the emitter of Q4, I measured about 12V p-p at the secondary (pins 2 and 3) of L5. Little wonder the varicaps were being forward biased! I tried reducing the nine turns on the feedback winding at pins 5 and 6 of L5 but could not achieve reliable operation of the oscillator. I had some trouble winding 0.2 of a turn.

The output level of the local oscillator can be varied by adjusting VR1 and I finally achieved acceptable performance by reducing VR1 to give a reading of 0.6V on the emitter of Q4. VR1 was changed to a 200Ω trimpot to provide easier adjustment. The oscillator waveform at the secondary of L5 looks good and is now 5V p-p. The oscillator still occasionally stops on seek. Any comments? (J.T., Elermore Vale, NSW).

• Thank you for your comments concerning the switch-off thump on the 60/60 amplifier. Our recomendation to readers experiencing this problem is that they increase the 1000μF capacitor on the positive rail to prevent this rail falling faster than the negative rail. However, your suggestion that the 2.2kΩ resistor on the base of Q21 be replaced with a series 1kΩ resistor and 8.2V zener diode (cathode to base) is equally valid.

The correct voltage on the drain of FET Q5 can be obtained by decreasing the value of the 390Ω source resistor.

Thank you for pointing out the reversed capacitors in the AM/FM tuner. This information will be published in notes and errata.

The voltage on pin 10 of IC4 can be any voltage above 4.3V for in-lock operation. The compensation capacitor for the ceramic filter can be either the 30pF 3-pin type (which provides 60pF when the pins are connected in parallel), or the 50pF 2-pin type.

Readers using the 3-pin 30pF capacitor should ensure that the outer two pins are connected in parallel to provide a 60pF capacitor. The use of only two of the capacitor pins will prevent stereo reception.

Upgrading the Playmaster 3-way speakers

I purchased a Playmaster 3-way speaker kit from Dick Smith Electronics some two and half years ago. The drivers and crossover unit are Southern Star brand from Japan. While the performance is good, it certainly falls short of commercial designs and so I have considered trying to improve things.

Could you please advise if fitting a new polypropylene (250mm) woofer, with either a Philips or Foster midrange and tweeter, would make a substantial improvement? Would the crossover unit only need to be changed if I wanted more than 30 watts output than the unit presently gives? (C.C., Ashgrove, Qld.)

• We do not recommend changing the loudspeakers along the lines you suggest. If you wish to change drivers there is really nothing for it but to redesign the system from the ground up. Unfortunately, we cannot make any recommendations for the moment but we will have a look at the possibility of a new design based on currently available drivers.

Ultrasonic burglar alarm

I have just built the Ultrasonic Burglar Alarm as described in the April 1987 issue but I cannot get it to work properly.

The receiver section is OK but the transmitter is unstable about the centre frequency and I am unable to make it run at 40kHz — it jumped from around 38kHz to around 43kHz while adjusting receiver gain down. The unit works somehow at the lower frequency (38kHz). The kit was purchased from Oatley Electronics. I'm using shielded audio cable for both transducers. I have tried another frequency set pot and have experimented with reduced supply voltage to no avail.

Please tell me how to make it work. (J.M., Winmalee, NSW).

• From the symptoms described in your letter, it's possible that you have damaged the gates in the 4049 (IC2). This can easily occur if you are not using a well regulated supply.

Note that the frequency adjustment is fairly critical if the unit is to work correctly. The correct approach to this problem is outlined on page 63 of the June 1987 issue, in the section entitled "Feedback on the ultrasonic alarm".

Notes & Errata

EIGHT CHANNEL IR REMOTE CONTROL (June 1987, File 2/MC/23): due to a printing error the last two pages of this article were transposed with the second two pages. As published, the article should be read with the following page sequence: 44, 45, 52, 53, 48, 51, 46 and 47. We apologise to readers for this unfortunate error.

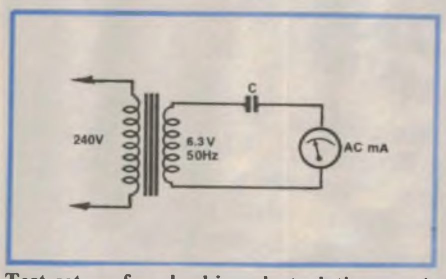
PLAYMASTER STEREO AM-FM TUNER (December 1985-February 1986, File 2/TU/55-57): the two 2.2μF capacitors on pins 2 and 19 of IC3 are shown with incorrect polarity on both the circuit and parts layout diagrams. In addition, the 10μF capacitor on pin 7 of IC13 is shown with incorrect polarity on the parts layout diagram.

Letters to the Editor ... ctd from page 5

(1). If it looks clean, not corroded or deteriorated it is worth testing.

(2). Check it with a high resistance ohmmeter for shorts (discharge it first of course).

(3). Measure the capacitor as follows:



Test set-up for checking electrolytic capacitors. The meter should read 2mA for each μF of capacitance (eg, 8μF should give a reading of 16mA).

If it is over half capacity, use it. Regard the voltage rating of an old electro as about 70% of the stated value.

The idea of six series low voltage electros doesn't appeal by the way. The one with the lowest leakage amount for a given voltage will be over stressed and will usually fail, followed by the remainder, unless derated by about 30% in voltage, or locked by a resistive divider, which is messy.

Regarding high tension chokes: these really are hen's teeth items. However, there is a way out. Ordinary audio output transformers — primary side — if under about 500 ohms (DC) will do. A TV vertical output transformer will also work satisfactorily if it will fit.

A final point I feel is essential. 40-year old power transformers are not terribly reliable. Consequently, two core or figure-eight flex is not a particularly safe system. A three core main cord, earth to chassis, is much less worrying — but the correct identification of the earth pin is vital of course.

B.M. Byrne,
Indooroopilly, Qld.

EA marketplace EA marketplace

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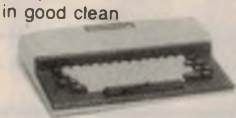

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**Note: although these articles have been prepared for publication, circumstances may change the final content.*

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