BONUS ALTRONICS CATALOG

★ SPECIAL FEATURE ON POWER SUPPLIES ★

Australia's Top Selling Electronics Magazine

Electronics Australia

FEBRUARY 1988

Aust* $3.50
NZ $4.95 Incl GST

Registered by Australia Post publication No. NBP 0240

Australia's hi-tech CD record factory

WIN A $7500 PIONEER HIFI!

GREAT PROJECTS: Universal MIDI Interface, Simple FM Transmitter, Low Cost Transistor/FET/Zener Tester

NEW "SUPER THEATRE" & PLANETARIUM FOR PERTH

1ST PRIZE

A Pioneer home stereo hi-fi system, including an A717 "Reference Series" amplifier and twin power transformers; an F717L "Reference Series" digital quartz AM/FM stereo tuner, with 16-station preset frequency synthesis tuning; a top-of-the-range CT1380WR twin programmable stereo cassette deck, with cordless remote control; a PD-M60 Compact Disc player, with 6-disc multiple play and cordless remote control; a PL-L70 programmable linear tracking turntable, with quartz PLL direct drive motor; two S-701 "Digital Realism" 3-way speakers with 32" woofers and beryllium ribbon tweeters; a pair of matching CP-500 speaker stands; and a CB-C900 deluxe system cabinet. A complete ready-to-go system, valued at $7,762!

2ND PRIZE

A powerful Pioneer car stereo system, comprising a top-of-the-line KEH8080B quick-release AM/FM radio cassette player, with quartz-PLL synthesiser tuning, music search and automatic "best station memory", bass and treble controls, Dolby-B noise reduction and twin 20W outputs; a GM203 add-on booster amplifier; a pair of TS1609 160mm 3-way speakers; and a pair of TS1080 100mm 2-way car, van, boat or recreational vehicle, this top-quality system is valued at $1,532!

3RD PRIZE

A Pioneer PD-M60 multiplay Compact Disc player, with 6-disc magazine, cordless remote control, random programming for up to 32 tracks, digital filtering, 2-speed manual search and built-in headphone amplifier. An excellent addition to any hi-fi system, and valued at $899!

Subscribe Now to Electronics Australia for only $42.00 and you could be the lucky winner of this superb Pioneer stereo hi-fi system worth over $7,700.

OR

the second prize winner, of a Pioneer car stereo system worth over **$1,500.**

OR

the third prize winner of a Pioneer programmable 6-disc compact disc player with cordless remote control, worth **$899**

WOW

Regular readers of Electronics Australia know it's the one that gives you best value for money. We already give you the best news, the best construction projects, the best feature stories to keep you abreast of the latest developments — in short, the most interesting and valuable electronics reading every month.

By subscribing, you make sure of getting Electronics Australia every month — delivered right to your mail box. And automatically enter the draw to win one of the 3 Pioneer hi-fi prizes!

BUT THAT'S NOT ALL!

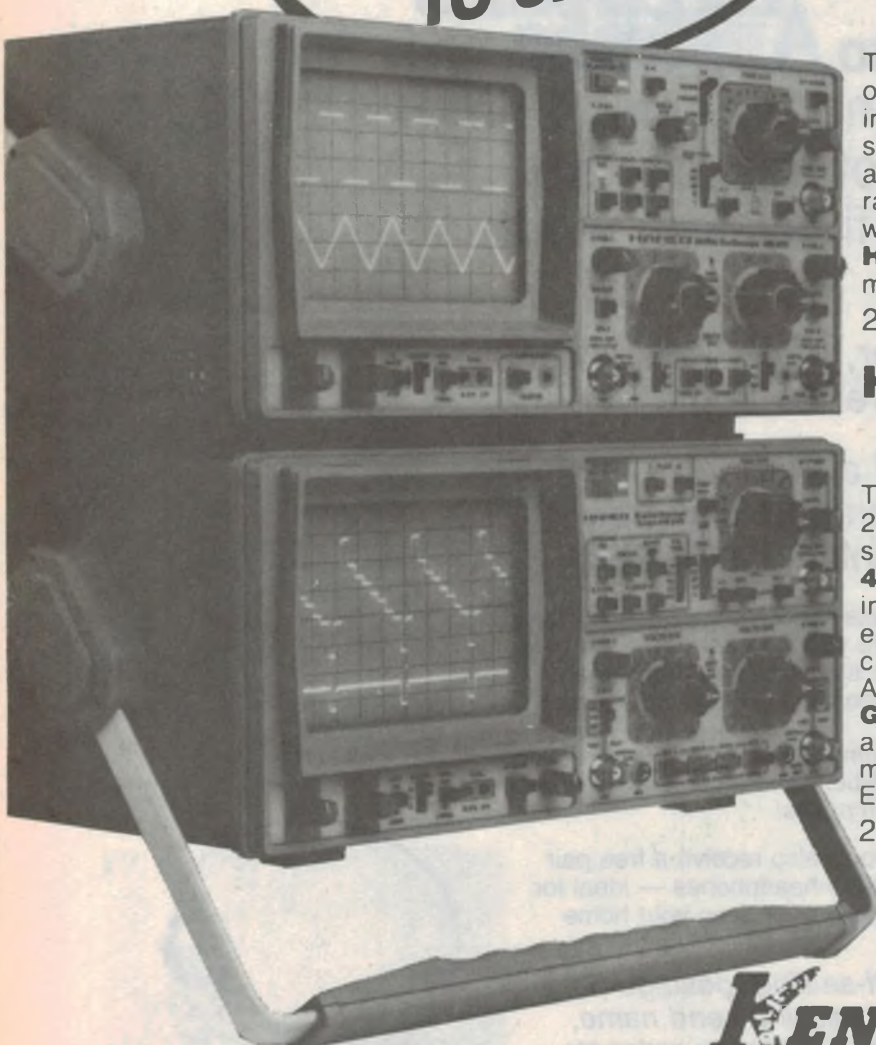
As well as entering the competition you'll also receive a free pair of high quality ARISTA lightweight stereo headphones — ideal for a portable cassette player, radio, CD player or even your home stereo or TV. **Valued at over $10.**

Simply fill out the enclosed self-sealing, postage-paid envelope/coupon and mail or if missing send name, address, telephone no. and cheque/money order to: Pioneer Hi-Fi Competition, Freepost No. 4, P.O. Box 227, Waterloo, NSW 2017. No stamp required

For any enquiries Ph: (02) 693-9515 or (02) 693-9517.

Two of our best Performers

NOW TURBOCHARGED TO 5MHz



HM205

an outstanding Oscilloscope with digital storage

This new oscilloscope offers all the features of a state-of-the-art **20MHz** realtime instrument. In addition it provides digital storage capability for signals between **50s** and **0.3ms** duration, with a max. sampling rate of **5MHz.** Especially when working with comparatively slow phenomenae, the **HM205** can easily replace considerably more expensive digital storage scopes.

2 Probes × 1/ × 10 incl.

HM208

the high tech Storage Scope with 20MHz sampling rate

The **HM208**'s high sampling rate of max. 20MHz facilitates storing of relatively fast single shot events. Max. memory is **4096 × 8** bit, conveniently divided into two independent blocks. **XY-storage** capability enables easy viewing and recording of characteristic curves and Lissajous figures. An XY-recorder output and the optional **GPIB-Interface** allow full integration in automatic measurement systems. With more than **5000** units sold, this is one of Europe's best selling digital storage scopes.

2 Probes × 1/ × 10 incl.

KENELEC PTY. LTD.
(INCORPORATED IN VICTORIA)
VIC. (03) 560 1011, FAX (03) 560 1804 NSW (02) 439 5500
QLD (07) 393 0909 SA (08) 223 2055 WA (09) 322 4542

WorkSouth 293

Electronics Australia

Volume 50, No.2

February 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Perth's new Omnimax theatre

Perth now has a new hi-tech entertainment centre, fitted with Omnimax super-70mm hemisphere movies — plus a planetarium. Our story starting on page 10 explains its wonders . . .

New tester for transistors/FETs/zeners

One of this month's construction projects is a new version of our very popular Transistor/FET Tester. Now it checks both bipolars and zeners for breakdown voltage, as well! See page 82.

Power supplies feature

Our special feature this month is on power supplies. There's news of a local breakthrough, an explanation of how switching supplies work, a glossary and news of the latest products. It all starts on page 96.

ON THE COVER

Checking the grip of a robot arm, used to retrieve freshly moulded compact discs at Disctronics' newly upgraded Melbourne plant. See our story starting on page 20. (Photo courtesy Disctronics)

Features

Entertainment Electronics

Projects and Technical

News and Comment

Departments

MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE

EDITORIAL STAFF
Rob Evans, CET (RMIT)
Henk Mulder, HTS EE
Mark Cheeseman

DRAFTING
Karen Rowlands

PRODUCTION EDITOR
Carmel Triulcio

GRAPHIC DESIGNER
Brian Jones

ART PRODUCTION
Alana Horak
Larry Leach

PRODUCTION
Kylie Prats

SECRETARIAL
Angela Pagones

ADVERTISING PRODUCTION
Brett Baker
Neville Lawton (Vic)

ADVERTISING MANAGER
Selwyn Sayers

PUBLISHER
Michael Hannan

HEAD OFFICE, EDITORIAL & ADVERTISING
180 Bourke Road, Alexandria, NSW 2015
P.O. Box 227, Waterloo 2017.
Phone: (02) 693 6620
Fax number: (02) 693 2842 Telex: AA74488

INTERSTATE ADVERTISING OFFICES
Melbourne: 221a Bay Street, Port Melbourne, Vic. 3207.
Phone: (03) 646 3111 Fax No: (03) 646 5494
Representative: Nikki Roche
Brisbane: 26 Chermside Street, Newstead, Qld 4006.
Phone: (07) 854 1119 Fax No: (07) 252 3692
Representative: Bernie Summers
Adelaide: John Fairfax & Sons Ltd, 101 Weymouth Street, Adelaide, SA 5000.
Phone: (08) 212 1212
Representative: Mike Mullins
Perth: 48 Cleveden Street, North Perth.
Phone: (09) 444 4426
Representative: Des McDonald
New Zealand: Rugby Press, 3rd Floor, Communications House, 12 Heather Street, Parnell, Auckland New Zealand.
Phone: 796 648 Telex: NZ 63112 "SPORTBY"

ELECTRONICS AUSTRALIA is published monthly by The Federal Publishing Company Pty Limited.

Typeset and printed by Hannanprint, 140 Bourke Road, Alexandria, NSW for The Federal Publishing Company Pty Ltd.
Distributed by Newsagents Direct Distribution Pty Ltd, 17 Doody Street, Alexandria NSW 2015

Registered by Australia Post — publication No. NBP 0240 ISSN 0313-0150

*Recommended and maximum Australian retail price only.

Letters to the editor

Marine supplier

In reference to your Marine Electronics feature, *Electronics Afloat*, we wish to inform you that Ansett Technologies also supply the following:

Weather Fax, Sat NAV, Depth Sounders, Emergency Beacons, Auto Pilots and Instruments.

The above was not shown in the table of suppliers. We would be most grateful if something could be done to remedy this.

R.J. Degreyte,
Regional Manager,
Ansett Technologies,
Marrickville, NSW.

Comment: Sorry for the inadvertent omission — I hope this corrects it!

Ferric chloride stain removal

Congratulations to Ian Page for the article "Low cost techniques for making hobbyist PCBs" (October 1987). The article showed an extremely handy way of producing PCBs.

At the end of the article, Ian says that ferric chloride is one of the most permanent stains he has come across. I agree with this statement, but have found a very effective way of removing these stains.

After remembering my science test last year, the Fein $FeCl_3$ is a metal. I then remembered a product called Rustiban, which removes rust stains. I conducted a little experiment and found it worked. Rustiban will remove rust stains (ferric chloride) from silks, woollens, cottons, nylons and rayons. The directions say firstly wet stained material, then shake a few drops of Rustiban onto the stain. Rub these drops in with a cotton bud (not a finger!!) until stain has gone. Wash out thoroughly with clean water, and finally with soap and water.

It is important to note, however, that Rustiban is a highly corrosive and poisonous (S6) product, and contact with skin, or breathing in the vapour is extremely dangerous. Contact with the eyes can cause blindness. Rustiban contains about 10% Hydrofluoric acid. It is not suitable for use on metals or khaki dyed material.

I bought the 50ml bottle at a local Soul Pattinson chemist for around $7. It may be possible to buy it from other places as well, such as other chemists or chemical stores. The address for contacting the company which appears on the bottle is:

Fleischmann Chemical Co.,
Parsons Knob Road, Nambour
MS2078, Queensland 4560

The bottle was bought some time ago, so I am unsure if the address is still correct. Hope it solves some stains problems for you; it certainly has for me.

Michael Dobbins, Kotara, NSW.

Comment: Thanks for the helpful advice, Michael. I don't know which sounds more nasty — the ferric chloride or the stain remover!

TV colour

As a one time Kodak and one time CSIRO physicist, I have read with interest your article "TV Colour Revisited" (Forum, November 1987).

It seems to me that two points should be made:

1. Photographic and electronic systems do not reproduce colour. They produce a pleasing rendition of the scene. A Kodak advertisement of 1967 made this point rather neatly, with regard to the use of colour photography in science: "It frightens us to see how some scientific workers use colour photography. We have too much stake in it to let them go unwarned of where they are misplacing their confidence. That we are reputable and trustworthy they know, and they surmise that we claim our various systems of colour photography record, retain, and precisely reproduce all the colours of the real world. *We make no such claim nor does any other reputable photographic manufacturer.*"

2. There is no simple relationship between the quality of the light reflected from a point in a scene and the colour perceived by the eye. The eye has an extraordinary (and not understood) capacity to perceive colour accurately even though the relationship between the primary colours of the incident light can vary be a factor of three or more, as happens with daylight under various conditions.

It appears that the eye processes each

colour channel for the whole scene separately before deciding what the colour is at a particular point in the scene. The Retinex theory of E.H. Land, the Polaroid inventor, is one attempt at an explanation.

G.F. Byrne, Director,
Powerscourt Pty Ltd, O'Connor, ACT

Comments on DAT

According to your review in the December 1987 issue, the DAT's technical performance is certainly excellent under the conditions of test which applied at the time. It would be interesting to repeat the test after three weeks exposure to an atmosphere of 100% relative humidity at 30°C.

You referred to the DAT in your article as " representative of the next generation of domestic and semi-professional audio tape decks . . . " As far as I am concerned, any semi-professional machined used to record live musicians must be capable of synchro-play and multi-tracking (at least four tracks). There is no mention of synchro-play in the DAT review, and it is evidently only a two track stereo machine. What a waste of all that high powered technology if you end up with no more facilities than a CD player capable of recording in two track stereo.

I am also suspicious of that very tiny DAT cassette. The mechanism of existing audio cassettes is finicky enough, and it doesn't take much mechanical malfunction to stuff them up to the point where they refuse to fast wind. Also in the tropics, there is the problem of humidity and fungus growth (refer my letter published EA, August 1986). These two factors greatly increase the friction of the tape over the heads and guides — in bad cases to the extent of stopping the tape.

CDs, on the other hand, are easy to inspect for fungus and keep clean, and there is no friction to worry about. Until the manufacturers come up with a much more robust DAT cassette, with multi-tracking and synchro-play facilities, I will remain unimpressed and stick with CDs as the best and most reliable method of sound reproduction to date.

I am waiting for the day when mechanical forms of sound recording will be rendered obsolete by the development of a sufficiently compact solid or solid/liquid state memory.

H.L. Harvey, Cairns, Qld

Comment: Thanks for your views, Mr Harvey. Humidity may indeed turn out to be a problem as it does with helical-scan VCRs.

Editorial Viewpoint

CD Video: more than just the next fad . . .

As I write this, it's about a week since I went to Philips' press preview of its new CD Video system. There's details of the new system overleaf, in our Entertainment Electronics section.

I have to confess that until I actually went to the preview and saw CD-V working, I was pretty lukewarm about it. In many ways it seemed like yet another hi-tech fad, and a rather "mongrel" one at that: neither purely audio nor purely video, but a funny kind of mixture of the two. It seemed likely to have appeal only to a limited group of people, namely teenage 'video clip' addicts. For everyone else I thought it was likely to have little impact, except perhaps as a further muddying of the already rather confused audio and video markets.

But after seeing the Philips demo and reading more about the CD-V system, I've changed my mind. It could just turn out to be one of the "milestone" developments, I believe.

One of the things I didn't realise is that the CD-V system basically integrates the CD digital audio system with an improved version of the Laser Video system. This means that a CD-V player doesn't just play the little 'video clip' discs, with their 6 minutes of video+digital audio plus 20 extra minutes of digital audio. It also plays standard CDs through your stereo, and complete movies through your TV set — with CD-quality stereo sound.

So a CD-V player has the potential to become a "universal" home entertainment player, hooking up to both your stereo and your TV set to play prerecorded audio, video or virtually any combination of the two. With superb quality, and potentially lower cost and higher reliability than any system based on magnetic tape, of course — thanks to the simplicity of the optical recording and playback system.

Philips say that CD-V discs will be priced at a level to encourage "sell through" — or in normal language, at prices low enough to encourage us to *buy* them, rather than rent them from a library. And of course this is quite feasible with CD-V, as the discs themselves are pressed from polycarbonate and are inherently very cheap. Most of the real cost is copyright fee, which can be distributed over huge volumes if you want to encourage mass buying.

When will we see CD-V players and discs in the stores? Philips wouldn't say, but somehow I don't think it'll be long. It might be a good idea to hold off buying that new VCR, if I were you . . .

Jim Rowe

What's New In Entertainment Electronics

Philips previews CD-V in Australia

Philips has unveiled its CD Video system, first announced in Europe earlier last year, to the Australian technical press and selected dealers.

The CD-V system extends existing optical disc and CD technology, to cover high quality video as well as digital-quality audio. This turns it into a complete high quality audio-visual medium.

Featured in the Philips previews was the company's new CDV 475 player, which plays not only standard 12cm compact audio discs, but three different sizes of CD Video discs: a 12-cm size designed for video 'clips', a 20cm 'extended play' size and a 30cm size for movies. The player will also handle existing 30cm Laser Video discs, although these use a different system.

The new CD-V system records video and audio on the same "track" of microscopic optical pits, using FM (frequency modulation) for the video combined with the standard digital PCM system for the audio. This gives higher video quality than typical VCRs, combined with CD-quality audio.

The 12-cm CD-V discs provide a single audio-visual track up to 6 minutes long — adequate for the typical video 'clip'. Along with this track they also provide space for up to 20 minutes of regular audio-only CD information.

Unlike the 12-cm discs, the larger 20-cm and 30-cm discs are double sided. They are designed for audio-visual material over the whole of both sides, providing for up to 20 minutes and 2 hours respectively. Like normal audio CDs, they play back at a constant linear velocity (CLV). Previous Laser Video discs have used a constant angular velocity (CAV) system.

The Philips CVD 475 player automatically identifies disc size and type. It displays all functions on the TV screen if desired, and also features a newly developed disc transport mechanism, with 'tilt servo' to ensure optimum tracking. Audio decoding uses 16-bit 4-times oversampling and dual D-to-A converters with digital filtering. Both modulated RF and RGB outputs are provided for the video.

According to Philips spokesmen, CD-V players and software should be available in Australia "soon after they're launched in the USA and Europe".

World's quietest audio tape?

Claiming to have the quietest tape in the world is a statement not to be made lightly, however TDK's SA-X audio cassette tape with a bias noise figure of –63dB is claimed to be just that.

"This tape has the lowest bias noise of any type II audio cassette on the market today", said Ken Kihara, general manager of TDK (Australia).

TDK claims that the new SA-X tape has achieved this previously unobtainable lower bias noise level by a process called "particle micronization". Generally, bias noise can be reduced if the magnetic particles (Super Avilyn) are made smaller; however small particle size is not the total answer. As particle size is made smaller an unwanted phenomena known as print-through becomes worse. Print-through is the unwanted transfer of a recorded signal from one layer of the tape through to an adjacent layer. It can be heard as an echo on playback.

TDK claims it has been able to lower bias noise without sacrificing print-through value by smaller particle size, greater packing density, smoother surface and improved binding and coating technology.

Flush-mounting speaker

The Boston Acoustics 360 is a two-way loudspeaker designed for flush installation in the walls or ceilings of rooms where the decor makes conventional speaker cabinets undesirable or inappropriate. Although it is small enough to instal unobtrusively in new or existing construction, the 360 offers the sound quality of a fine home loudspeaker system.

Each 360 features a specially-designed 6 1/2" long throw woofer for extended low bass reproduction, and a high performance 1" CFT dome tweeter for smooth highs throughout the listening area. Frequency response extends from 48 — 20,000Hz ±2dB. Impedance is 8 ohms, and recommended amplifier power is 5 to 60 watts. The 360 measures 213 x 300mm and requires only 75mm mounting depth. It is supplied in a matte white finish, ready to install as-is, or it can be painted to match the room environment. An optional kit will be available for mounting the 360 in walls where studs are 16" apart. Suggested retail is $599.

Further details from Falk Electrosound, 28 King Street, Rockdale 2216.

Sharp's new digital VCR

Using an advanced digital memory — similar to that of a small computer — Sharp's versatile new Digital Special Effects (FX) video recorder is set to revolutionise home viewing with a variety of amazing special effect capabilities.

The Sharp Digital FX Video allows users to both freeze frame and vary the screen picture speed (using a strobe effect) — not only for a video tape, but also any television program being broadcast.

The new VCR also features a two-picture function which lets the user insert a small picture of a TV channel on screen while watching a video tape. A second touch of the control and the pictures are reversed, with the TV on the main screen and video on the sub-screen.

Another key feature is the channel search function. One push of a button and Sharp's Digital FX Video will search all the available TV channels, displaying up to 9 channels at a time on your TV screen. Avoiding channel jumping and program guides, you can instantly select your program from the channels displayed on the screen.

Tape head cleaner/demagnetizer

According to Amaray's general manager, Chantal Dray, the Trackmate cleaner and demagnetizer is a totally new and major advance in the convenience of the total tape care.

"The cleaner and demagnetizer is engineered to give not only the quality of cleaning that you would expect from Trackmate" says Chantal Dray, "but also a complete demagnetization of the tone head and tape guide. Using a sophisticated ceramic component called the Field Discharge Chip (FDC) it will demagnetize in about 15 seconds while the brushes complete the cleaning."

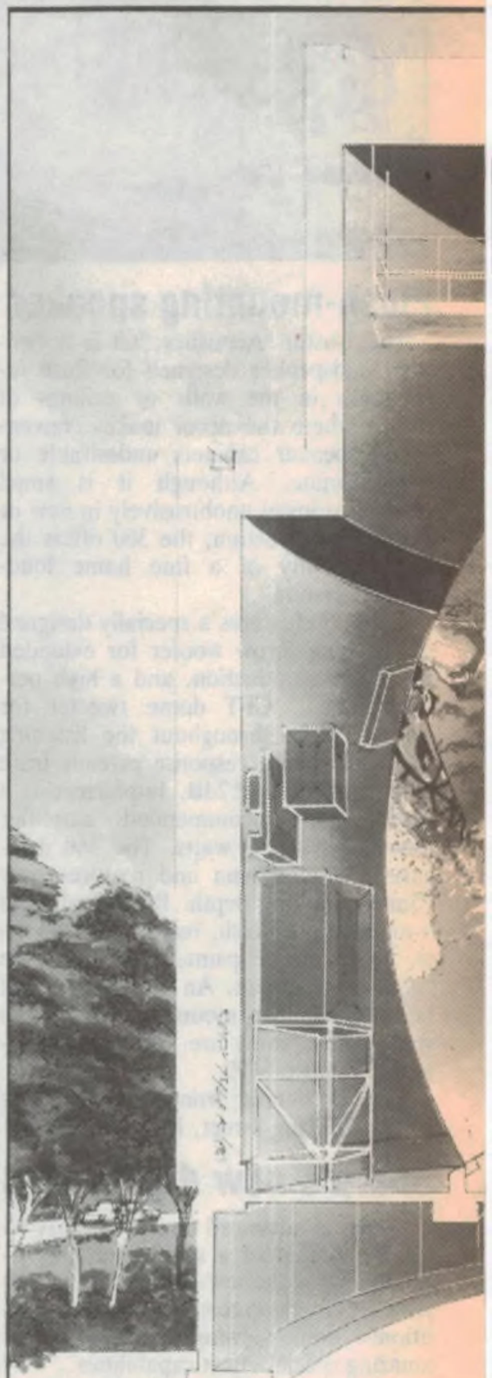
Another feature of Trackmate is that you can actually hear it working. The sound produced is much like a heartbeat and the signal sent through the hifi system is evidence of its function.

For further information contact Amaray International, 45 Burns Bay Road, Lane Cove 2066.

Perth's new Omnimax

Not to be outdone by developments on the east coast, Perth has just gained the fanciest theatre and planetarium complex in Australia. It's just bulging with the latest in high-tech entertainment technology . . .

by JIM ROWE



Hard on the heels of the opening of Australia's first giant-screen Omnimax theatre, which opened a couple of months ago in Townsville, Perth has recently seen the opening of a new complex which goes one better: it combines Omnimax with the latest Spitz planetarium instrument and multi-projector audiovisual setup. Everything operates inside a 17-metre hemispherical dome, and both the dome and the theatre's 200 seats are tilted at 30° to the horizontal to give optimum viewing.

The new theatre-planetarium is located in West Perth, and has been built by Omni Theatres International — a subsidiary of Parry Corporation. It was opened by Mr Kevin Parry at the end of October, and began public showings shortly after.

Perhaps the most spectacular aspect of the new complex is the Omnimax large-format movie projector, which is a development from the Imax system. Details of this were given way back in our February 1972 issue; basically it is a special system using conventional 70mm movie film, but running horizontally instead of vertically, and with a picture three times larger than on conventional 70mm film.

Because the film runs at nearly four times the linear speed of conventional 35mm film, Imax and Omnimax projectors can't use either the "Maltese Cross" or pulldown "claw" intermittent mechanisms used to advance the film picture by picture. The necessary film acceleration would rip its sprocket holes, in short order. Instead they use a special intermittent mechanism known as the Rolling Loop, invented in 1967 by Australian inventor the late Ron Jones, of Brisbane.

The Jones Rolling Loop technique uses a large rotor, which combines the functions of the intermittent movement and shutter of a conventional projector. Rollers on the rotor gently push small loops of film around a fixed outer drum, and the loops themselves advance the film by one picture each time. This results in very low strain on the film, and extends the life of prints to somewhat more than 1000 screenings (compared with 250-300 screenings for conventional 35mm prints).

Another advantage of the Jones Rolling Loop is that the film sits on fixed register pins while each frame is actually being projected. This gives exceptional picture steadiness; jitter is around .03%, or about 16 times better than conventional projectors — a big advantage when the picture is being blown up to very large dimensions.

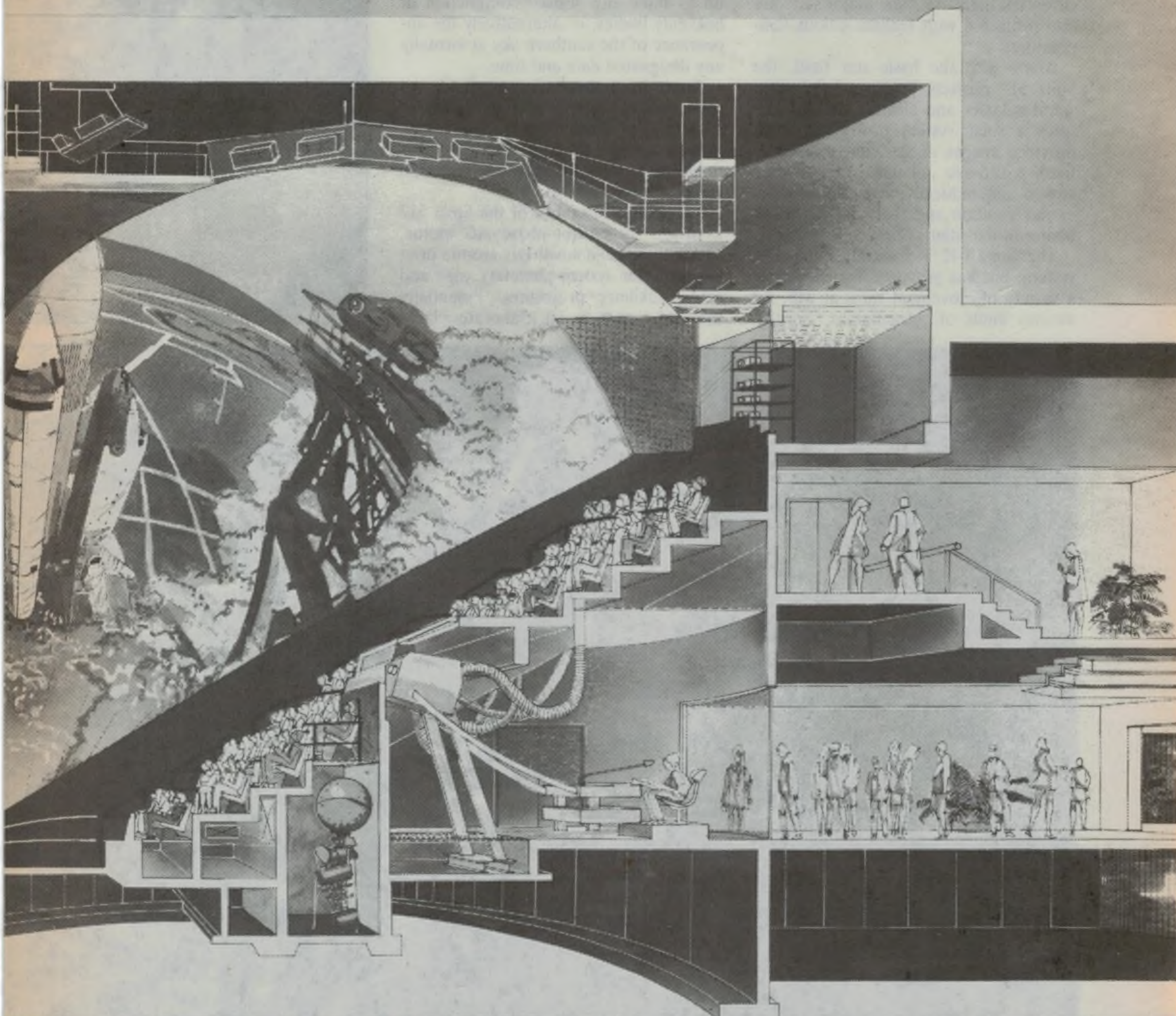
The original Imax system is used to project conventional rectangular pictures on a vertical screen. The Omnimax system uses the same basic camera and projector, but both are fitted with a special short focal length "fish-eye" lens to allow coverage of about 86% of a hemisphere. The Leitz lens in the projector covers 180° in the horizontal direction, and 125° vertically.

The Imax/Omnimax projector consists of two basic sections: the projector itself, with the rolling loop mechanism, lamphouse and projection lenses, and the film spooling unit. In the Perth theatre the projector unit is threaded up in a room beneath the domed auditorium, and then raised up by an elevator into the centre of the dome for projection. The spooling unit remains fixed in the lower room.

The theatre's dome screen is coated with a patented directionally lenticular latex, light grey in colour. This has a reflective coefficient of about 0.3, chosen to prevent the interior reflection problems associated with white domes. Because of the screen characteristics and the very high degree of magnification involved, the Omnimax projector uses a very high power and high intensity light source. Inside the lamphouse is a massive 15kW Xenon arc lamp, with water-cooled beam folding mirrors and a water-cooled "dowser" shutter.

The sound tracks of Omnimax films reside on a separate 35mm film, which is replayed via a Magna-Tech dubber reproducer. This runs at 30 inches per

theatre & planetarium



second, in electronic lock with the Omnimax projector.

To complement the Omnimax film projection system, there is a Spitz 512 planetarium instrument. This projects a star field of some 4050 separate stars, which revolve as a whole to simulate the rotation of the earth. Although all of the stars are projected as "points",

An artist's impression of the new Perth Omnimax theatre and planetarium, showing the domed screen and seating — both tilted at 30 degrees. At the centre are the Spitz planetarium instrument and the 70mm Omnimax projector, with its special Leitz "fish-eye" wide angle lens. The projector mechanism is threaded down below in the control room, and elevated to present the show.

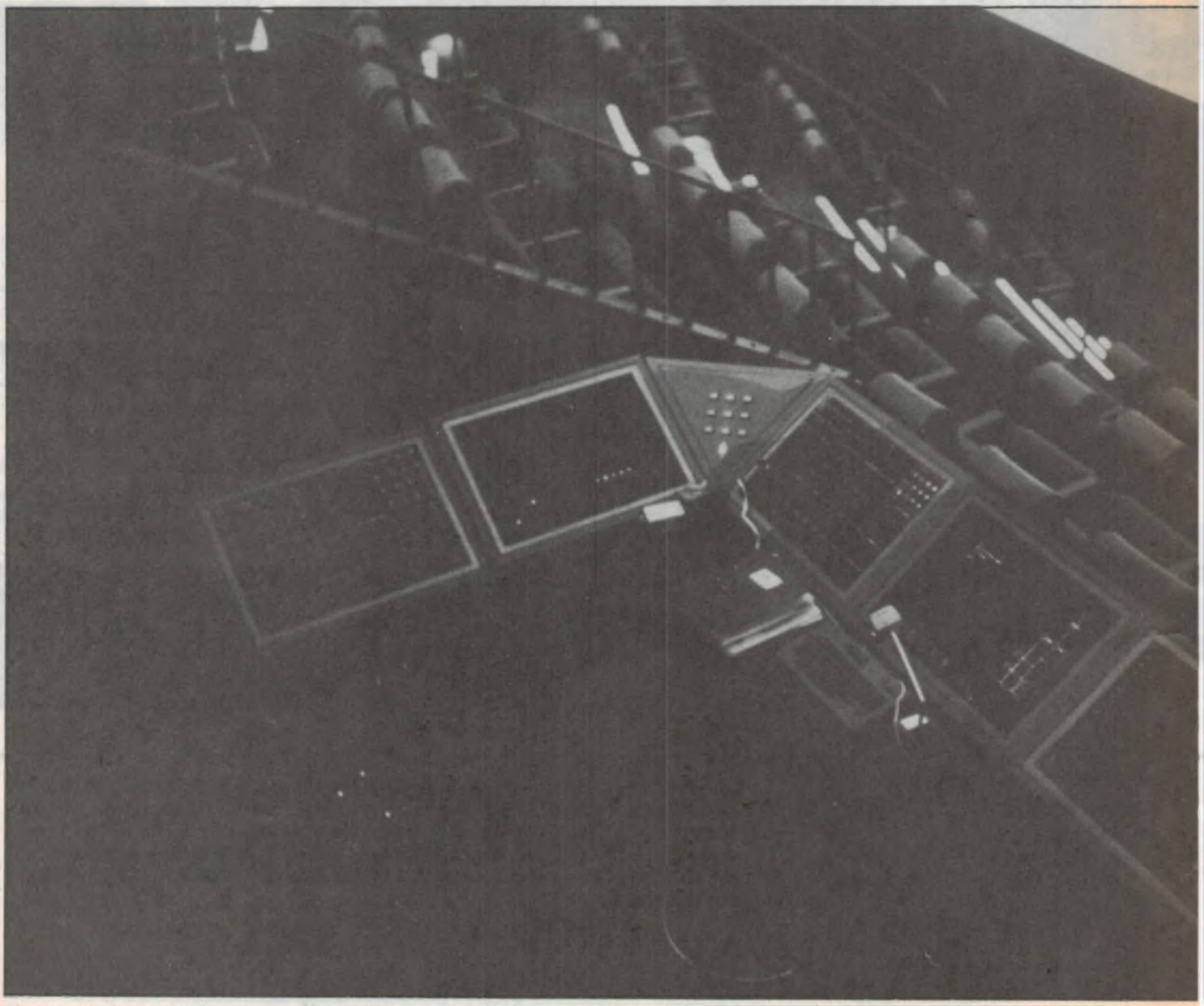
as they are seen in nature, they have a range of brightness levels to simulate the visual magnitude differences apparent in the night sky. The major stars are also projected with realistic colour temperatures.

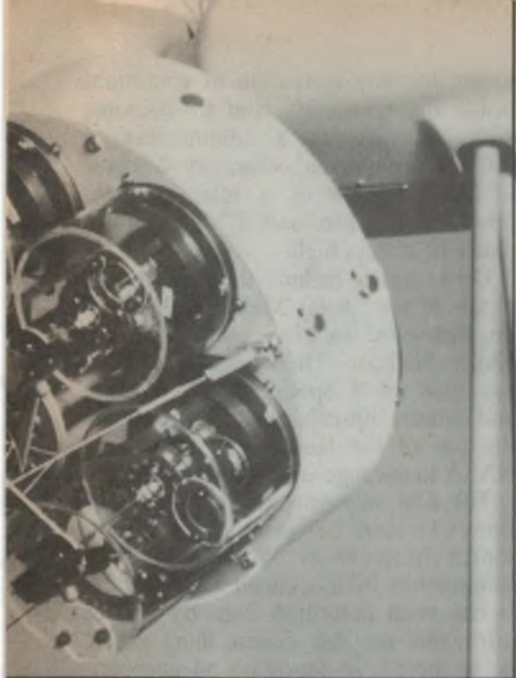
Along with the basic star field, the Spitz 512 projects images of the main spiral galaxies and clusters. It also features a solar system projector, which provides images of the sun, moon and five naked-eye planets. These are moved automatically according to the earth's rotation and that of the various bodies in the solar system.

The Spitz 512 is basically an analog system, but has provision for simulating a variety of movement rates at will, for various kinds of presentation. For example the annual precession rate can be varied from 48 minutes down to 1.5 minutes. The instrument can also be set up to show any desired conjunction of heavenly bodies, or alternatively the appearance of the southern sky at virtually any designated date and time.

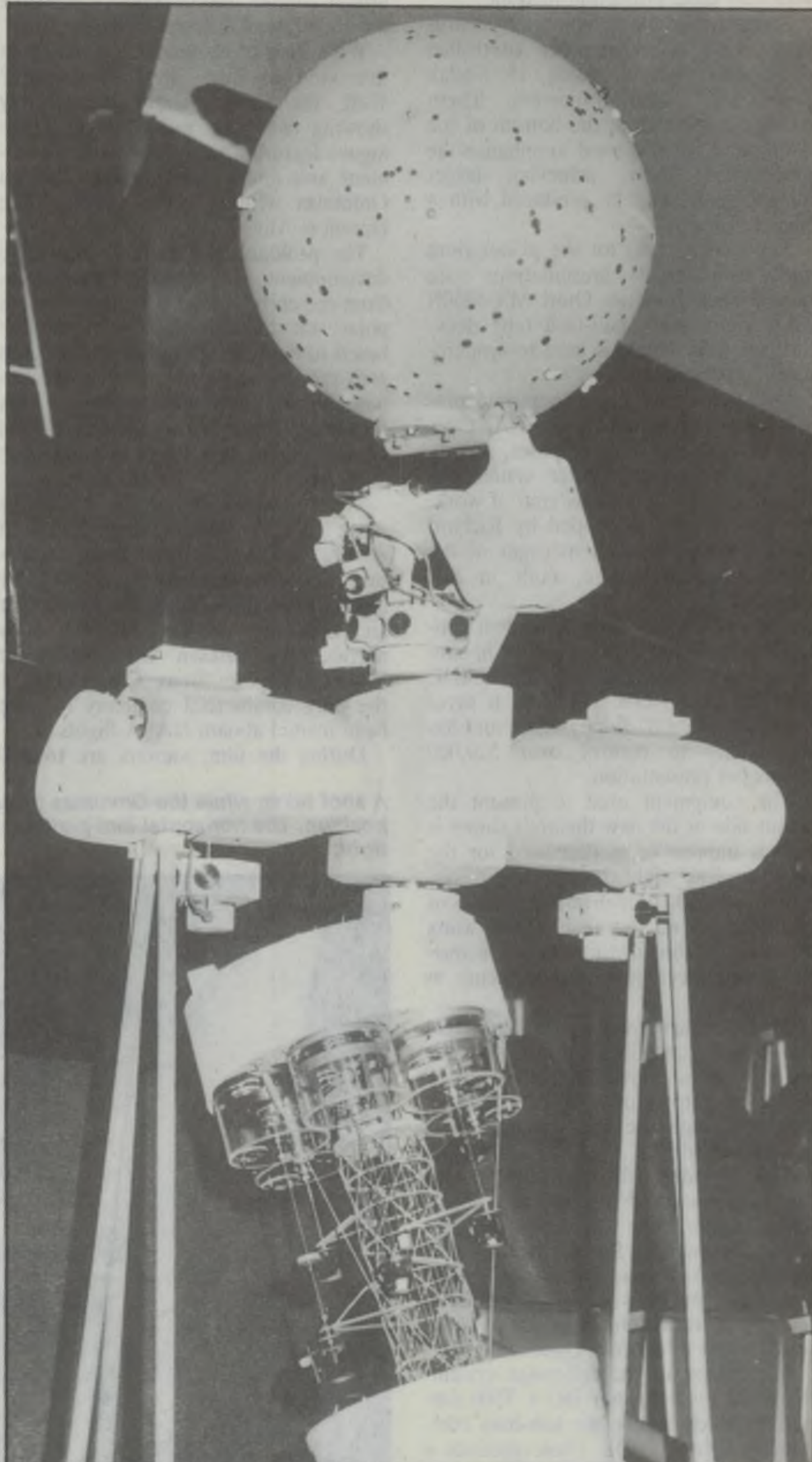
Apart from the basic star field and solar system projectors, it also provides a number of auxiliary projectors which provide outlines of things like constellations, pole position, satellites, cardinal compass points and so on.

The main mechanism of the Spitz 512 is driven by a three-phase AC motor, with a number of small DC motors driving the solar system planetary cage and other auxiliary projectors. Essentially the instrument is an elaborate clock,





Left and below: Two views of the Spitz 512 planetarium instrument, which is essentially a clock with a very elaborate and unusual readout system! The ball at the top projects the main starfield, while the lower cluster of projectors handles the solar system.



Left: A view of the theatre's control console. Virtually all of the presentations are under the control of an R.A.Gray MC-10 media control computer, which has 120 independent control channels and the ability to control over 520,000 events per presentation.

with very large projection readout!

Augmenting the planetarium instrument itself is a computer controlled audio-visual system, using 15 Kodak S/AV 2050 slide projectors. These create a panorama at the bottom of the dome, and are also used to enhance the planetarium show, achieving larger images than could be produced with a single projector.

The sound tracks for the planetarium and audio-visual presentations are played back from an Otari MX-5050B MkII eight track, half-inch tape deck. SMPTE time coding is used to synchronise the presentations.

Management of the planetarium presentations is handled by an R.A. Gray MC-10 media control computer, a dedicated Z-80 microcomputer system designed specifically for this kind of work. The system was developed by Richard Gray while production manager of the first Omnimax theatre, built in San Diego in 1973.

The MC-10 has 120 independent control channels and is programmed in convenient scripted commands like FADE CHANNEL 5 NOW TO 25%. It saves the program on 8" floppy disks, and has the ability to control over 520,000 events per presentation.

The equipment used to present the sound side of the new theatre's shows is just as impressive as that used for the pictures. The eight-channel sound system is capable of delivering a total of (wait for it!) no less than 12,000 watts of audio — enough to make the acoustic environment just as convincing as the visual!

The full-range system consists of eight BGW SPA-3 amplifiers, each with three output stages delivering 250W into 8 ohms, or a total of 6000W. The eight JBL full-range speaker systems use a 2240H bass driver, a 2202H mid-range, a 2382 bi-radial HF horn and a 2445J HF compression driver in each Sonics 4WS cabinet. The cabinets are especially designed by Sonics Inc., of Birmingham, Alabama, for use in domed theatres. They are designed primarily for direct radiation, with large sideboard wings to improve directionality.

In addition to the full-range system, there are eight further BGW 7500 amplifiers which handle the sub-bass components below 100Hz. These produce a further 750W per channel, which is fed into a set of eight JBL 2245H bass drivers in Sonics SQ8 ported bass reflex bins.

A computer-controlled active third-octave equaliser system is used to keep the overall theatre system tuned for optimum sound reproduction, adjusting for the effect of different audience sizes.

What kind of shows do you put on in this kind of ultra high-tech theatre? Well, the Perth theatre is currently showing two basic productions: a prologue, featuring the planetarium instrument and audio-visual system, and an Omnimax feature film called "The Dream is Alive".

The prologue presentation shows the development of celestial navigation, from the early explorers using the North polar star through to current satellite based navigation. The presentation ends with satellite shots of the West Australian coast, accompanied by NASA recordings made during astronaut John Glenn's flight over Perth in Friendship 7, in 1962.

The Omnimax film "The Dream is Alive" is a dramatic 37-minute look at America's Space Shuttle program, featuring spectacular footage shot by NASA astronauts during the Challenger and Discovery missions in 1984. It is narrated by veteran US broadcaster Walter Cronkite. Imax Corporation is the only commercial company to have been invited aboard NASA flights.

During the film, viewers are treated to an uncanny recreation of conditions inside the spacecraft, and to awesome views outside as a communications satellite is deployed. Also very dramatic is the extension of a solar collector array, from a box only 7" deep into a panel 10 storeys high.

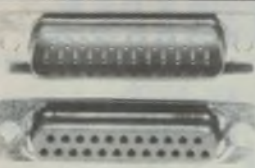
Other scenes include the capture and repair of the "Solar Max" satellite and the first space walk by woman astronaut Kathy Sullivan. There's also a pilot's eye view of a Space Shuttle landing, and Shuttle lift-offs as seen from both the top of the launch pad tower and NASA long-range tracking stations.

The film was originally produced by Imax's Graeme Ferguson for the Smithsonian Museum in Washington, with sponsorship by Lockheed Corporation. It has been described even by various astronauts as "the closest thing yet to being there". In short, it's an appropriately spectacular high-tech production, to launch Perth's new high-tech theatre. But it'll be a hard act to follow — I wonder what the Omnimax people are planning for their *next* attraction?

Apart from that, the only other question is this: now that those bustling metropolises of Townsville and Perth have their own gee-whizz Omnimax theatres, when are the poor citizens of poor little Sydney and Melbourne going to be given a similar high-tech treat?

A shot taken while the Omnimax projector was being lowered to its threading position. The horizontal film platters remain fixed, and are visible at lower right.

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



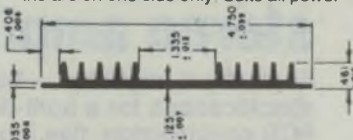
23 Pin "D" Connectors

No it's not a misprint - there are now 23 pin D-connectors on a couple of the newer PC's. So if you're finding it hard to get plugs and sockets to match, Geoff of course has 'em.

Connectors - Male **$3.50** Female **$3.50**
Backshell **$3.50**

Thermalloy Heatsink 6129

Geoff is stocking the 6129 because of its low (under half an inch) profile. Easy to install - Fins are on one side only. Suits all power



devices. Excellent thermal resistance. 3" long with mounting holes on 2.5" centres. **$2.50** (1-9) or **$2.00** (10+)

National Miniature Relay Special

Genuine Matsushita DS-Series double pole changeover relay with a contact rating of 60W, 125VA. Will handle 240Vac and upto 2A switching. 12V coil. Measures only 20mm x 10mm x 9.3mm. 1500V surge rating. Fits standard IC socket.

Only
$3.50

Seven Segment Display Specials

HD1107R Common Cathode 10mm (0.4") character height with right hand decimal point. Typical 350uCd intensity at 10mA. Measures 13.1mm x 10mm x 7.2mm. Standard PC grid.
Only **$1.50** each or **$1.25** for 10+.

LT4940AHR High Efficiency
High efficiency type means a luminous intensity between 1400 and 2400uCd at 10mA. 10mm (0.4") character height with right hand decimal point. Measures 18.75mm x 9.8mm x 5.1mm.
Only **$1.50** each or **$1.25** for 10+.

Audio Alarm Special

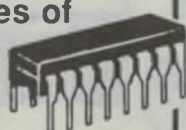
Geoff has secured a limited quantity of electronic warbling alarms. Contains a 5 transistor circuit and small loudspeaker in a weather resistant horn type case measuring 90mm dia x 60mm deep. Also has adjustable mounting bracket. Works off a nominal 12V dc supply.

Only $12.50.

10-Way IDC Male Connectors

So many people have been asking for a simple, inexpensive IDC connector to fit the usual 0.1" grid. Now Geoff has tracked 'em down. 10 way, easy to install and only **$2.50.**

Get a few tubes of these Gates...



74LS27 $2.50 for a tube of 25 - that's only 10c each!
SN74S00N $7.50 for a tube of 25.Genuine TI - that's only 30 cents each!
Or you can have them in 100's for **$22.50.**

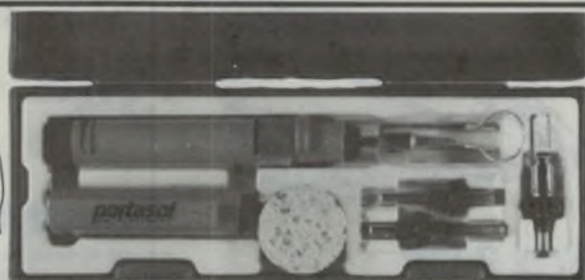
Cheap Transistors

MJE13007
NPN, 400V 8A, hfe 5-30, Ft 4MHz, TO-220
$1.00 each (10-99 **80c** or 100+ **50c**)

BD646
PNP, Silicon Darlington, 60V 8A, hfe 750min, Ft 100kHz typ. TO-220
50c each
(10-99 **45c** or 100+ **30c**)

Adjustable iron 10-60W

Built-in Flint Lighter



AVAILABLE AT LAST ...

PORTASOL PROFESSIONAL COMPLETE KIT

It's a gas soldering iron...it's a blow torch...it's a hot knife...it's a hot blow. And it comes in a neat carry kit complete with a bit wiper. No cords or batteries yet it gives the equivalent of a 10 to 60W iron. You can get up to 90 minutes average continuous use from a single fill. And you refill it in seconds using a standard butane gas lighter refill. Tip temperatures as high as 400°C can be set. The kit includes one soldering tip, a hot knife, blow torch and hot blow. The cap contains a flint lighter. The complete kit comes in a handy case (with stand for the iron) which just about fits in your pocket.
Porta-Sol Professional is $81.00.

PORTASOL STANDARD SOLDERING IRON
Geoff has sold hundreds of 'em to servicemen and technicians. Complete and ready to use like the Professional but you only get the iron and bit
$39.95.

PORTASOL TIPS
Expand the capability of your Portasol Iron with spare tips -available for standard iron in 1mm, 2.4mm, 3.2mm, 4.8mm and hot knife tip. Professional tips come in same sizes plus hot blow and blow torch. Tips are not interchangeable between irons, so specify Standard or Professional when ordering. Tips are all **$12.95** each.

8.30 to 5 Monday to Friday. 8.30 to 12 Sat.
Mail Orders add $5.00 to cover postal charges.

All prices INCLUDE sales tax.

Tax exemption certificates accepted if line value exceeds $10.00.

BANKCARD, MASTERCARD, VISA, CHEQUES

GEOFF WOOD ELECTRONICS P/L
INC IN NSW
(02) 427 1676

229 BURNS BAY RD.
(CORNER BEATRICE ST.)
LANE COVE WEST N.S.W.

TWX 71996
P.O. BOX 671
LANE COVE N.S.W. 2066

OR CASH CHEERFULLY ACCEPTED

specialising in electronic components for the professional and hobbyist.

BUILD A BICENTENNIAL KIT

FEATURE KIT!

Build a low cost (high spec) stereo amplifier!

Economy it might be — but in name and price only! Outstanding specifications for a built-it-yourself stereo amp — just look! Single PCB construction, five inputs, around 9W/channel with less than 0.05% THD . . . it'll be perfect for your stereo system and it WON'T break the bank.

Housed in an attractive slim-line steel case with screened front panel included! Cat K-4001

- Perfect for the flat, unit, home!
- Great specifications!
- Very low cost!
- Looks great!

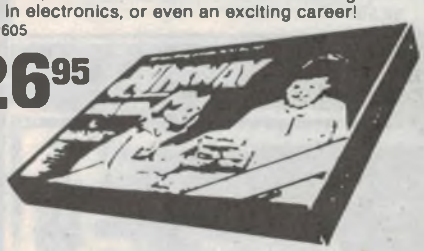
Cat K-4001

All this for only $129.95

FunWay 1 Gift Box

Makes an ideal birthday or Christmas present... and who knows, it could be the start of an absorbing hobby in electronics, or even an exciting career! Cat K-2605

$26.95



FunWay 2 Gift Pack

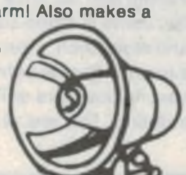
Here's a gift bargain! Over $50 worth of value for less than $40! This gift pack has been specially selected for quality and for value. Cat K-2620

$39.95

Electronic Siren

Just what you need with the alarm! Also makes a great sound effects circuits — and FunWay 2 tells you what to do! Cat K-2636

$6.99



Mini Stereo Amp

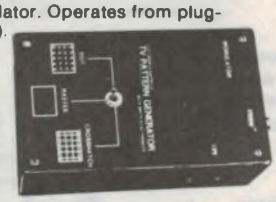
Want an amplifier for the 'walkie' stereo or radio? Don't be tied to 'phones: use this project and listen in comfort! Or you can build this into a mini PA amplifier. Cat K-2667

$18.65

TV Pattern Generator

A build-it-yourself bargain for the serviceman. With just seven IC's you get three patterns: dot, crosshatch and blank raster. Includes deluxe front panel and VHF modulator. Operates from plug-pack adaptor (9V DC). Cat K-3472

$34.95



Infrared Remote Switch

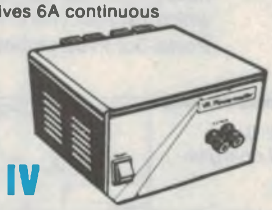
With the fantastic Infrared Remote Control Switch you can switch on or off the TV, lamp, radio or many mains appliances without moving from the comfort from your chair. It will operate up to 12 metres from the switch

$69.95 Cat K-3428

VK Powermaster

Huge 25A peak with suitable transformer! That's power... and it's simple to build. For HF gear, linears, and so on, this one has the oomph you need. Short-form kit: you choose the transformer you want to suit the output required:
M-2010 transformer gives 14A continuous
M-2000 transformer gives 6A continuous
Cat K-3448

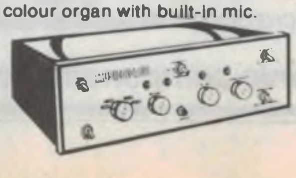
$129.95



Musicolor IV

What's better than a colour organ and chaser? The Musicolor Mk IV: it combines both in one unit! Four chase patterns plus auto chase and reverse chase AND four channel colour organ with built-in mic. Cat K-3143

$135

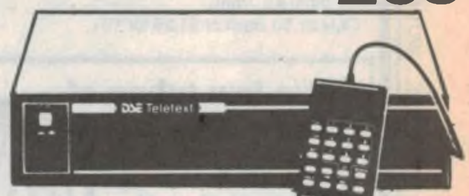


Free Teletext!

Yep, the Teletext transmissions are yours absolutely free of charge, courtesy of your local TV station (not in all areas — sorry!). All you need is a Teletext decoder to pick up the latest news, sports results, financial info, stocks & shares, recipes, etc.

Build your own Teletext decoder — it works through your VCR so you save a fortune. Complete with hand controller. Cat K-6315

$269



Total Sound Control!

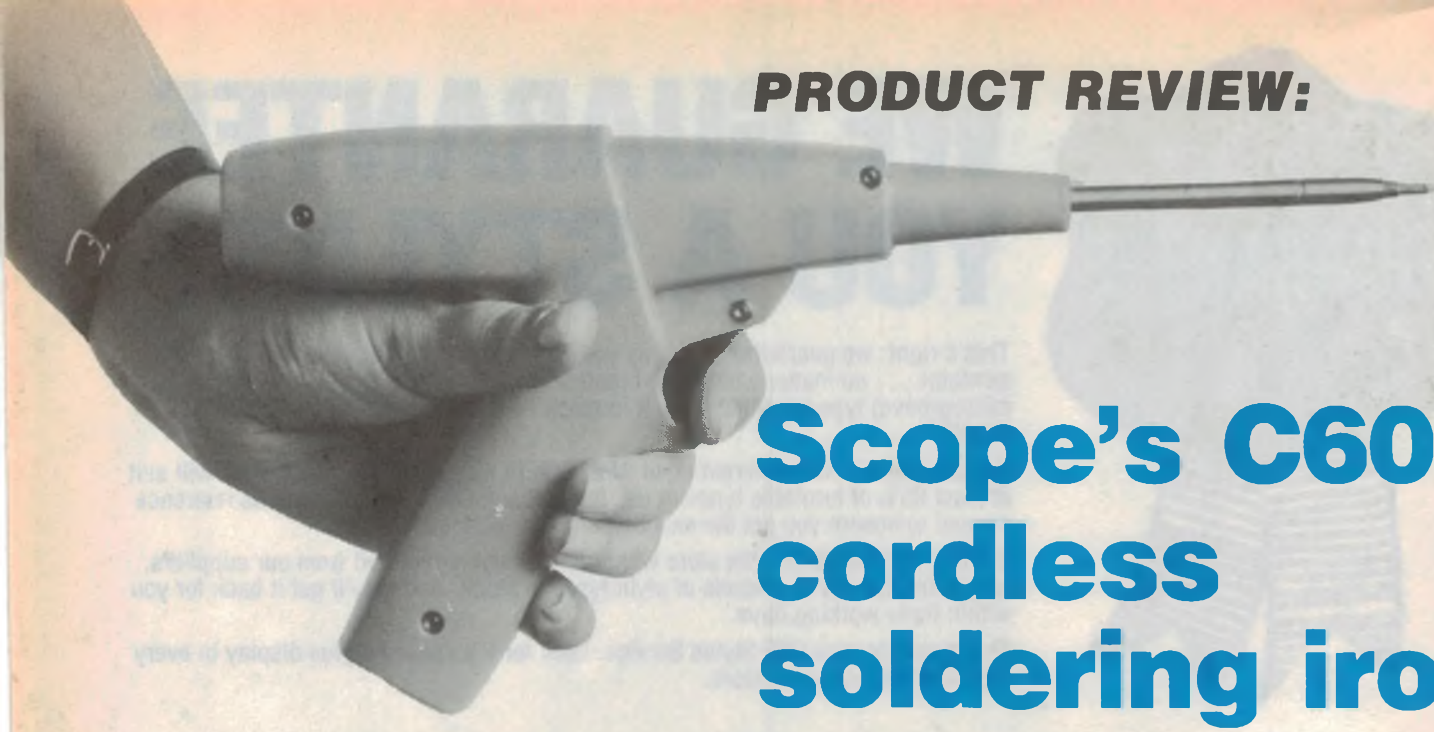
How's this? An infra red remote control for your sound system that also gives you full tone, balance, volume and switching control from your armchair! It's great to be able to settle back in your armchair and change the sound!

Complete kit includes remote control handpiece, adapts to virtually ANY audio system. Cat K-4003

$259

DICK SMITH ELECTRONICS PTY LTD

Also available through DSXpress
Toll Free (008) 22 6610



Scope's C60 cordless soldering iron

Have you tried one of the new generation of cordless soldering irons? We hadn't as yet, so we decided to check them out. Well-known Aussie soldering tool maker Scope Labs loaned Jim Rowe one its popular C60 models, and here's what he found:

Scope Laboratories has been making soldering irons in Australia for so many years now, that nowadays the name "Scope" almost seems synonymous with "soldering iron". I can still remember when the firm came out with its original carbon-element iron, back in 1949. I was only a kid at the time, but I remember that it created a great deal of interest, because of the then-quite revolutionary principle on which it operated.

Incidentally the carbon-element system is a patented Scope invention, dreamed up by Richard Seligman — the man who founded the company in the late 1940's. Mr Seligman came to Australia from his native Czechoslovakia after WW2, and originally started the company to manufacture oscilloscopes (hence the name "Scope"). But soldering systems attracted his interest, and he moved the firm's activities over into that area instead.

Over the years Scope irons went on to become an established part of the soldering scene, not only here in Australia but in a variety of overseas countries as well. Barry McIntosh of Scope tells me that the firm has exported quite large numbers to New Zealand, PNG, Fiji, France and the UK. In recent years they've also become established in the USA — quite an impressive Aussie export success story.

Of course nowadays there's not just the latest version of the original Scope iron (now called the Super Scope), but a variety of other models as well — some using the same carbon-element principle, and others the more conventional wire heating element. There's the Mini Scope, for example, which is basically a smaller brother of the Super Scope. Also a 12V Super Scope, to operate from a standard car or tractor battery. Then there are two conventional 240W irons, a 20W and a 60W, the latter with adjustable temperature control. Plus a 60W soldering station, with full temperature readout and control.

But more of interest here at present is the latest addition to the Scope range, the C60 Cordless. This is basically a cordless version of the Mini Scope, offering the same advantages of manually adjustable power (about 10 — 60W), together with the convenience of cordless operation from inbuilt rechargeable NiCad (nickel-cadmium) batteries.

For the benefit of those who've never looked inside a Scope iron or seen an explanation before, here's a quick rundown on the way they work.

As you probably know, a conventional iron usually has a fairly sizeable carbon bit. A significant part of the bit extends inside the iron's barrel, and wound around this section (with suitable insulation between the two) is a heating element. This is basically a coil of resistance wire, rather like that in a toaster, and designed to operate either directly from the 240V mains or from a step-down transformer providing say 12V.

The wire element heats up, and heat flows through the insulation into the copper bit. Or to be more exact, *some* of the heat does this — the rest of it goes the other way and heats up things like the iron's barrel and handle, as you'll know only too well if you've used one!

In contrast, the Scope iron uses a considerably smaller copper bit, which ends in a flat surface just inside the barrel. The bit and the barrel are connected to one side of a low voltage supply (either AC or DC), usually about 3 or 4 volts, and the other side of the supply is connected to a small block of carbon on the end of a metal rod. The rod is fitted with ceramic insulators, which allow it to slide inside the iron barrel.

To make the iron heat up, you either press a slide ring or control lever, or in the case of the C60 squeeze the trigger. In each case this pushes the rod along inside the barrel, until the carbon block touches the back of the bit. A heavy current then flows, and this causes a great deal of heat energy to be generated at the point where the carbon block contacts the copper bit. I suspect that this is due to the formation of thousands of tiny carbon arcs.

Virtually all of this heat passes into the copper bit. So the bit heats up very rapidly indeed — in about 5-6 seconds, compared with a normal iron, which takes many minutes.

As well as providing very rapid warm-up, this type of carbon-element iron offers the ability to control the effective heating power, over quite a wide range. You do this simply by adjusting the time you press the lever or squeeze the trigger, and to a smaller extent the pressure exerted. Brief and light pressure produces the equivalent of a low-power iron, of say 10 watts; longer and higher pressure produces considerably more — roughly equivalent to around 60-70W.

In fact if you keep up the pressure for too long without having the bit in contact with a job of some kind, to conduct away the heat, the bit will become red hot!

Needless to say you wouldn't normally want to do this, as it tends to shorten the life of both bit and element. Luckily it's quite easy to avoid it, once you get the hang of things. The main point it demonstrates is that the carbon-element system can generate a lot of heat.

As a result, Scope irons tend to be very flexible, and suitable for a wide range of jobs. Almost everything, in fact, from soldering IC pins into PC boards to minor plumbing.

The new C60 Cordless model carries this even further, with its inbuilt NiCad battery supply. This uses a pair of "D" size rechargeable NiCads, inside the handle and rear, to provide power for between 40 and 400-odd solder joints per battery charge. The exact number of joints per charge depends on the kind of jobs you're doing, of course.

The batteries can be recharged in three ways, all of them optional. One is via a small "plug-pack" supply; another an adaptor to plug into the lighter socket of a car or tractor; or finally a connector to hook up to one of the standard bench transformers used for the Super Scope or Mini Scope. So if you have an existing Scope iron, there'll be no need to buy a special charger for the C60.

In each of these charging options the charging cable plugs into a small socket at the base of the pistol-grip handle.

The rear of the C60 also features a small LED, which glows green to give an indication of the state of the batteries. When you squeeze the trigger, the LED comes on first and quite brightly, as this is just before the carbon element touches the rear of the bit. Then when you squeeze further, the element and bit make contact, and the LED dims noticeably. As the batteries lose their charge, this dimming becomes greater — and the iron gradually takes longer and longer to heat up.

Actually the LED can also indicate when the carbon element is getting near the end of its life, and/or the back of the bit is dirty. When either of these things occur, the LED *doesn't* dim as much as it should, when you press the trigger. So all in all, the LED is quite a nifty little diagnostic feature — it's a pity you don't get one on other models!

But enough of this description, I hear you ask — how does the C60 actually work out in practice?

Thanks again to Barry McIntosh, I've been able to try one out for myself over the last couple of weeks. It's been used for a variety of things — mainly soldering components into PC boards, but also for a few little exercises I dreamed up to test its "grunt" and staying power. Things like soldering up a few pieces of tinplate, brass and copper plate . . .

Frankly, I was very impressed. It does indeed seem to combine all of the existing Scope iron features, with the convenience and "freedom" of a cordless tool.

I did take a little while to get used to the "squeeze for more heat" system, because it's a few years since I last used a Scope iron. However I soon got the hang of things again. After a while you don't even think about it, but automatically adjust your squeezing to suit the particular joint you're making and the heat required.

It was no trouble at all to make either delicate joints on PC boards, or quite large seams along metal plate. Not heavy plate, of course, but the kind of thing you come across in typical electronics work. Scope claims that the C60 is the most powerful cordless iron available, and I can quite believe it. No doubt this is due to the high efficiency of the carbon-element principle.

The other thing I noticed about the C60 was its fast warmup time, again no doubt due to the carbon-element system. This seems even more important for a cordless iron than with a non-cordless type, somehow. Perhaps it's because fast warmup means the iron doesn't have to be gobbling up battery power between joints, just so it's hot when you want to make the next one.

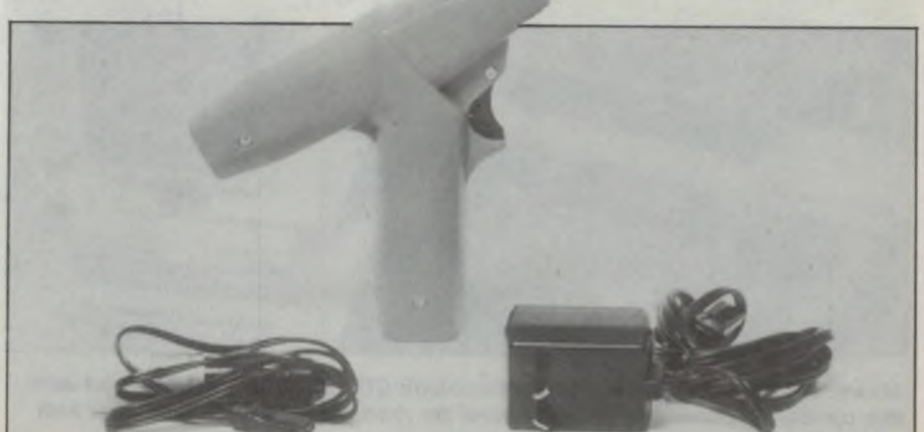
Actually my impression was that the C60 heated up *even faster* than the original Scope irons running from a stepdown transformer, and when I asked Scope founder/inventor Richard Seligman about this, he confirmed that it's true. Apparently with the original irons, the power transformer tends to saturate, and limit the current. With the C60, the NiCad batteries can deliver the full peak current needed, so warmup is even faster . . .

In fact when you think about it, the carbon-element system is really ideal for this kind of application. Very fast, powerful when you want it to be, yet easy on the battery. A very elegant solution — what more could one ask from a cordless iron?

Small wonder it's becoming popular, both here and overseas. And the nice thing is that it's designed and manufactured right here in Australia.

The C60 isn't exactly cheap, I've discovered. The iron itself has a trade price of $83.00, plus 20% sales tax if applicable. But replacement carbon elements and copper bits cost less than a dollar each, so keeping it going won't cost much.

Like other Scope products, the C60 is available from most of the major electronics stockists. Further information is also available from Scope Laboratories, PO Box 63, Niddrie, 3042. (J.R.)



Melbourne CD factory upgraded

Australia's only compact disc manufacturing plant is now well and truly one of the world leaders in this field. As well as having achieved very high yields from its automated pressing equipment, Disctronics has now installed the latest generation of mastering facilities in its Braeside factory.

by JIM ROWE

One of the things I missed, while away from the magazine for a while was the opening of Australia's first — and as yet, only — compact disc manufacturing plant early last year. When I mentioned this to the Disctronics PR people recently, they went out of their way to organise a tour of the plant, at the first available opportunity (thanks, folks!).

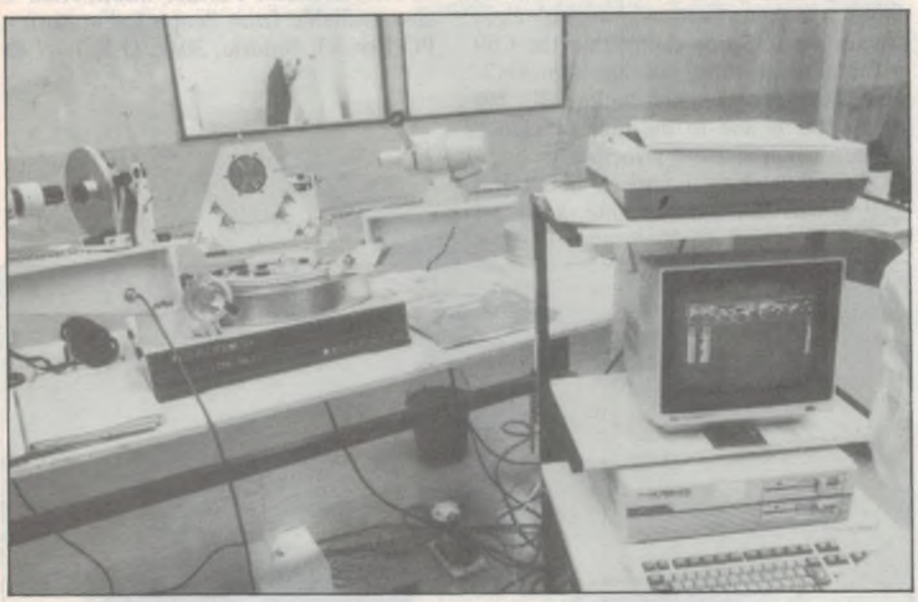
As it happens, the opportunity came about almost immediately, because the plant was just being expanded with the addition of a complete mastering facility. So it was an excellent time not only to see the existing hi-tech pressing plant, but also to see the new mastering setup before it became fully operational and harder-to-reach in its ultra clean-room environment.

The Disctronics factory is located in the Melbourne suburb of Braeside, just near Moorabbin airport. It began pressing CDs early last year, using pressing masters made overseas. Like all major CD producers world wide, it operates under licence from Philips. Disctronics itself is an unlisted public company, and a subsidiary of Quatro Ltd and Pro-Image Studios.

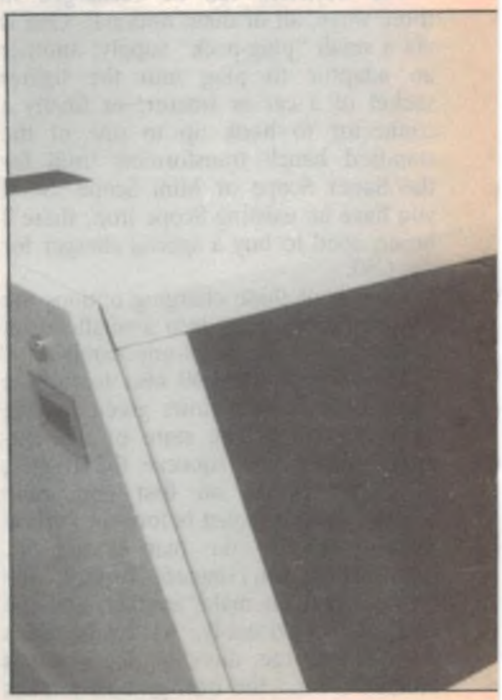
When I did get to visit the factory, the first thing that struck me was how unlike a traditional vinyl record pressing plant it was. There were no smells of hot plastic, no bins full of trimmings, no grime or dirt. In fact inside it was a bit like visiting a hospital, things seemed so clean and clinical. The only evidence of plastic moulding waste was in bins outside the factory at the back: I noticed these appeared to contain the remains of CDs that had been pulverised, perhaps for copyright reasons.

In many ways the CD plant reminded me of a hi-tech semiconductor factory, no doubt because the level of cleanliness and manufacturing precision required for CD manufacture is basically much the same as for state of the art ICs. The latest ICs are being fabricated with circuit details at the 1 micrometre (1um) level or below, while CDs have moulded pits measuring 0.4 x 0.1um on a pitch of 1.6um. And these must ultimately be "played" by a laser beam focussed to 1um in diameter, which reads the pits *through* the moulded polycarbonate disc. So it's not surprising that they call for similar requirements.

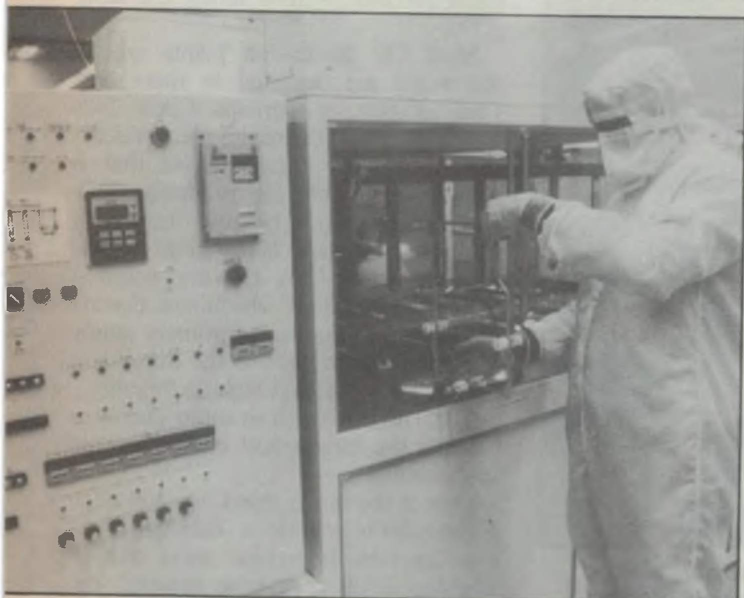
Actually CDs are by far the most precise plastic moulded product ever tackled on a mass production basis. The fact that the Disctronics factory has been achieving manufacturing yields of up to 95% regularly is therefore very impressive, as is the extremely high quality of its locally pressed discs — which are apparently equal to the best produced anywhere.



Above: After coating with photoresist, blank CD master discs are tested with this optical ellipsometer, to make sure the resist layer is sufficiently flat and even.



Above: A view of the master disc preparation area. The photoresist spinner/applicator is at rear, with the curing oven and developing machine to the right.



Above: Putting a polished glass master disc into the 18-stage automated cleaning machine. This uses water purified to 18 megohm resistivity.

Above: Sony engineers training a Disctronics engineer on operation of the DMC-1200 laser recording electronics. The source is a PCM digital master tape.

Left: Inserting a resist-coated master disc into one of the two Sony DMC-1200 laser cutting machines, for recording exposure.

Above: Checking operation of the automated top-coating machine, which applies the clear protective acrylic over the metallisation of newly pressed compact discs.

CD factory

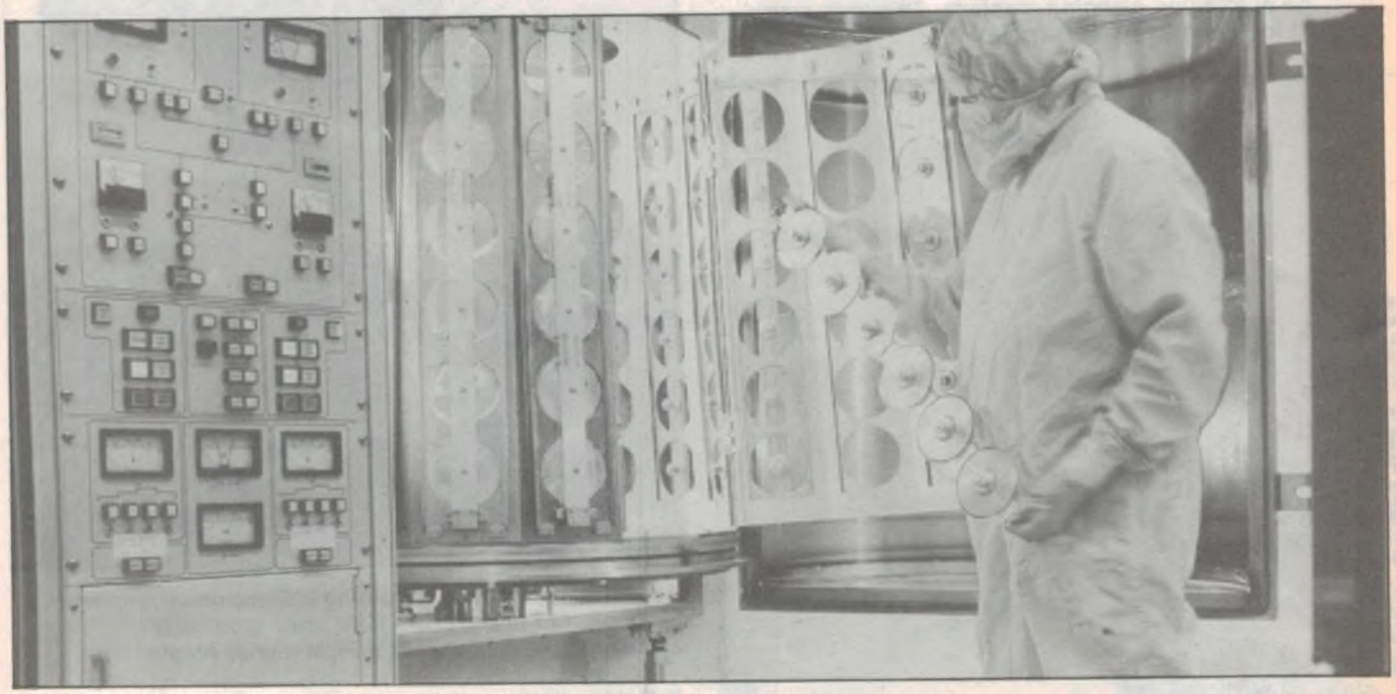
To achieve these results, the factory was built right from the start with a clean-air system meeting the highest available standards. In fact it has to circulate thousands of cubic metres of air per hour, filtered to "Class 100" requirements in all the critical areas. This means that there are fewer than 100 particles of 0.5um size, per cubic foot of air.

Compare this with a typical hospital operating theatre, which usually meets Class 100,000 — 1000 times less stringent.

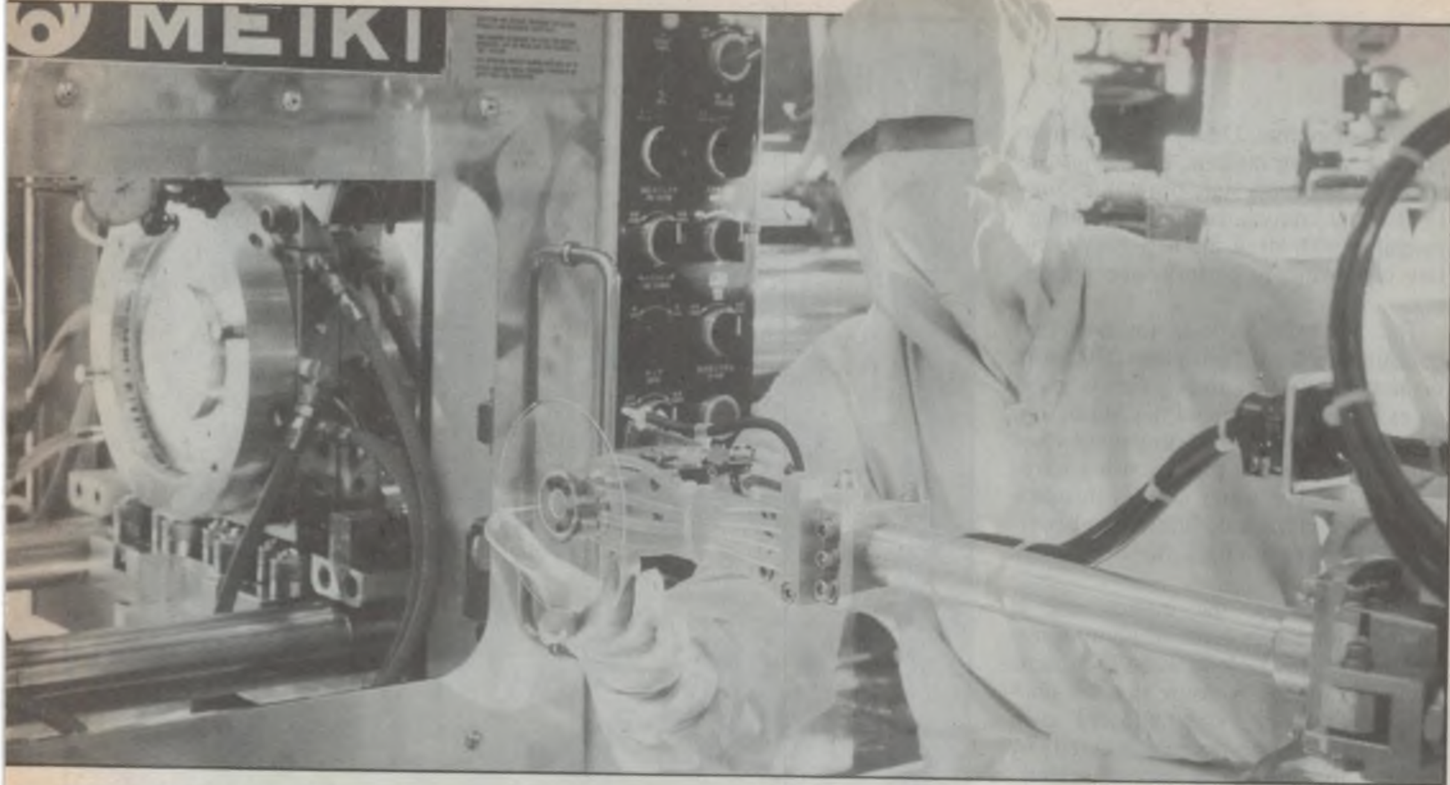
Most CD production plants around the world are designed to meet only Class 10,000 or perhaps Class 1000 standards. The Disctronics plant was designed to meet Class 100 so that it would be suitable for producing CD-ROM discs, which because they carry computer data are much more critical than music-type CDs. However needless to say the additional cleanliness doesn't go amiss in producing ordinary music discs, and contributes to the impressive production yields and high disc quality.

The Disctronics clean-room facility is actually the largest and most advanced in Australia.

One of the things that Class 100 clean air standards require is that you can't even go into the critical areas without donning a full "operating theatre" rig-out — coveralls, booties, gloves, cap



Unloading discs from one of the Shinkron evaporative metallising machines, after the metal layer has been applied. Disctronics also uses a Leybold-Heraeus continuous sputtering metalliser.



Checking the grip of one of the Sailor Pen robot arms, used to retrieve the moulded compact discs from Meiki moulding presses. All production processes take place in Class-100 clean air conditions.

and facemask. All lint free and cleaned to very high standards, and all usable only once.

As it happens, the main plastic moulding/metallising/coating area was the only area operating to full Class 100 at the time I visited the Disctronics plant, and as it was possible to see most of the goings-on inside via large viewing windows from the corridor outside, I elected to pass on the surgeon's outfit.

Disctronics' impressive array of 12 CD moulding machines is fully automated as far as I could see, with automatic feeding of the clear polycarbonate pellets into the moulding machines via piping (from outside the pressing room), and robot arms to remove and stack the pressings.

The full production setup was provided as a turnkey operation by the Meiki company of Japan, world leaders in CD production technology, and the presses themselves are by Meiki. The rest of the equipment is from a number of specialist subcontractors: Sailor Pen robots, metallisers from Shinkron and Leybold-Heraeus, and top-coating machinery from Dai Nippon subsidiary Global Machinery. The polycarbonate moulding pellets come from Teijin and General Electric.

After pressing, the still-transparent discs must be given an optical reflective coating on the side with the moulded microscopic pits. Generally the coating is of aluminium, although Disctronics is also producing special "premium" quality discs with a gold coating.

The metal coating is applied in one of two ways. The first system used by Disctronics is evaporative deposition, where the discs are loaded around the walls of a vacuum chamber pits-side inwards. When the chamber is pumped down to the appropriate level of vacuum, a pellet of aluminium (or gold) is vapourised in the centre. The resulting metal vapour condenses on the discs, giving them a very even and precise coating. This is virtually the same process used for metallisation of IC chips.

As the loading and unloading of the vacuum chamber in these Shinkron metallisers must be done manually, Disctronics is gradually replacing this process with a newer technique known as *ion sputtering*. In the Leybold-Heraeus metalliser the discs are "sprayed" or sputtered with metal particles, by an ion gun. This still requires a vacuum, but the discs pass along an automatic conveyor line through various airlocks, and the process has rather higher throughput.

After metallisation, the discs must be given a further coating, this time of acrylic to protect the very thin metal layer from scratching, moisture or other sources of damage. Then they are screen printed with the labelling information.

Along the way, they receive very stringent quality control testing using computer-controlled laser testing equipment. This doesn't just test for gross things like whether the discs are "playable" or not, but for more subtle and technical parameters such as *block error rate* or BERT. This is a measure of the degree to which the CD player's error correction circuitry will need to "work" at fixing any tiny errors, due to specks of dust or microscopic bubbles in the plastic, or pinholes in the metallising.

Needless to say if the BERT of a particular disc is above a certain acceptance level (which is quite low), the disc gets rejected. If this should happen to a number of discs in a row, alarm bells would start to ring!

All of the production processes just described take place inside a large Class 100 clean room, with heavy plastic curtains dividing up the area into cubicles and guiding the air flow from filters in the ceiling.

This part of the plant has been in full production since March 1987, only weeks after the Meiki engineers placed it in commission. But up until very recently, the master discs to produce the pressing stampers have been made overseas, and either the duplication masters or the stampers imported.

CD factory

Now, of course, Disctronics is able to produce its own masters, having just installed a pair of state-of-the-art Sony DMC-1200 automated laser "cutting" machines with all of the necessary ancillary equipment to perform disc mastering.

The mastering process involves first polishing a disc of float glass, 220mm in diameter and 6mm thick. This is given an extremely smooth and flat finish, and then goes through an thorough 18-stage automated cleaning process using ultrapure water. The water used in this process is demineralised, filtered and purified by Disctronics itself, to a resistivity of 18 megohms.

After cleaning, the master disc is coated with a thin layer of photo-sensitive resist. This is done while the disc is spinning rapidly, to ensure that the photoresist forms a very thin and even layer. Then the photoresist is cured, by heating the disc in a special "clean" oven in which very pure nitrogen gas is circulated.

Just to make sure that the photoresist layer is indeed very flat and even, it is then tested on a optical ellipsometer. This bounces a thin beam of red light from a helium-neon laser from the surface of the disc, and measures the interference pattern set up by reflections from the top and bottom surfaces of the photoresist layer, as the disc rotates.

Incidentally even though the ellipsometer test involves bouncing a beam of light off the sensitised master disc, this doesn't upset the photoresist because this is arranged to be sensitive only to blue light.

Assuming the disc passes the ellipsometer test, it is then exposed in one of the laser "cutting" machines, to transfer onto it images of the millions of tiny pits forming the digital program information. The program material comes from a PCM digital master tape, in a Sony U-matic cartridge machine.

The Sony DMC-1200 laser cutters are relatively unexciting-looking rectangular machines from the outside, but inside they're a mass of high-precision mechanics and laser technology. The engineers were still assembling one of them when I went through the mastering section, and it was quite impressive.

After the master disc is exposed, an automatic developing machine then develops the photoresist, and etches away the exposed areas to produce the pits. The disc surface is then coated with a fine layer of nickel, using another argon-ion sputtering technique, to produce the final CD "master".

All compact discs products at Disctronics are subjected to rigorous quality control, using computer-controlled test equipment. The manufacturing yield rate is frequently as high as 95%.

As with traditional vinyl records, the glass master disc is used to produce a number of mirror-image "mother" copies on metal, using electroplating. The mother discs are then in turn used to produce the actual pressing stampers. Each stamper can be used to press up to 12,000 compact discs.

You've hopefully gathered from all this that producing a CD master disc and its derivative mothers and stampers is a pretty hi-tech business. That was certainly my impression, after touring the Disctronics plant. I came away just as impressed as I've been when visiting hi-tech IC chip manufacturing plants, and for much the same reason. It's a far cry from the old vinyl record factories.

All in all, it's nice to know that Disctronics has built up this state-of-the-art technology in Australia, and that its locally produced compact discs are rated among the best in the world.

My thanks to Alan Bremner, manager of engineering and development at Disctronics, for his courtesy in showing me around the Braeside plant and for answering my many questions then and later. Thanks also to PR lady Kerry Hill, for her help in providing further information.

Signal processing breakthrough by the CSIRO

Analysing, processing and manipulating electronic signals in "real time" is one of the most important, and sometimes one of the most difficult, procedures in today's technology. A new Fast Fourier Transform chip now under development at the CSIRO could prove a very significant advance in signal processing, in many applications.

by PAUL GRAD

A development program recently announced by the CSIRO and Austek Microsystems, of fast, special-purpose, digital signal-processing microchips, is set to provide another confirmation of Australia as a force to be reckoned with in the area of research.

With the assistance of the GIRD schemes, CSIRO's Division of Radiophysics and the Adelaide-based company Austek Microsystems are developing microchips which they claim are capable of performing a Fast Fourier Transform (FFT) for specific applications, at a much higher speed and at a lower cost than any other chip available in the market.

Fourier transformations are calculations which allow a convenient and important kind of signal processing in the large number of cases in which an electronic signal can be broken down into a series of sinusoids. An improvement in the necessary mathematical procedure, introduced about 20 years ago, leading to a so-called Fast Fourier Transform (FFT), has provided a very powerful tool for many signal-processing applications.

Several microchips have been developed in various parts of the world to provide FFTs. However, according to the CSIRO, these have been general-purpose chips, and as a consequence, somewhat slow for many important applications, especially where real-time or nearly real-time signal processing is required.

Dr John O'Sullivan, signal processing group leader at the CSIRO's Division of Radiophysics, said the new chip's main distinguishing feature will be its ability to allow concurrent processing tailored to a specific application. This makes it possible for the chip to compute at exceptionally high speeds, for a specific application.

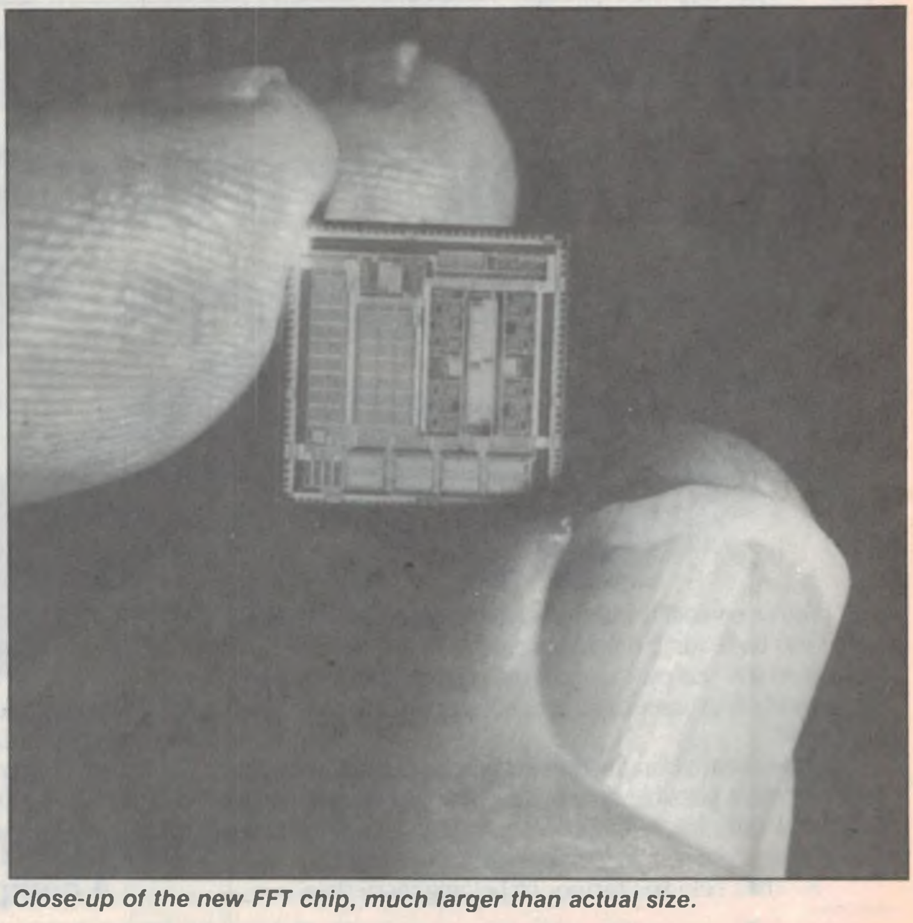
The chip was designed to perform up to 256 transforms with a selectable 16, 20 or 24 bit fixed-point arithmetic.

The "proof of concept" version of the chip consists of about 90,000 transistors and is being currently implemented in a 2.5um HMOS process with internal clocking at 20MHz. The design is being converted to a 1.5um CMOS process using a 40MHz internal clocking rate, allowing each 16 bit, 256-point transform to be performed in 0.1ms.

All data storage required to meet the above specifications is provided on the chip, which is thus capable of independent operation. Provision has been made for cascading or paralleling multiple FFT chips to allow performing longer transforms, or to allow greater computing speed.

The CMOS configuration was chosen as the best compromise taking into account the cost and ease of fabrication, power consumption, size and operating speed. Although a bipolar configuration would provide a faster operating speed, the CMOS version offers the advantage of smaller size, which is also important in many applications.

Some of the most promising applications of the new chip are in video and image processing, high-quality audio processing, communications systems, radar and surveillance signal processing, and medical signal processing (for example, magnetic resonance imaging).



Close-up of the new FFT chip, much larger than actual size.

ADCOLA E024 SOLDER SYSTEM

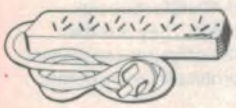
The E024 is a top quality Australian made soldering station suitable for use with either the Adcola CT-6, CT-7 irons or desoldering pencil. The E024 features a continuosly adjustable temperature range from 200°C to 400°C. The E024's electronic temperature control circuit monitors the temperature element in each of the irons, allowing it to maintain a constant temperature to within an incredible +/− 5°C of the temperature dial setting on the front panel.

Power to the irons is via a "zero crossing" controller. The power to the irons is switched on/off at a point on the AC power supply where the voltage passes through zero. Hazardous spikes caused by commutated AC are avoided using this technique.

Mains spikes are virtually eliminated by an electrostatic shield wound between the primary and secondry of the power transformer, an important safegaurd for easily damaged MOS devices. To further safegaurd sensitive components, an auxiliary ground lead earths the equipment to be soldered to the same level as the solder station, limiting the effective tip EMF to approximately 10mV. (Well below the damage level for MOS devices). If static control is important the E024 unit is an excellent choice.

E024 Base Station with:
CT7 Iron.
Cat.T12570 .... **$165**

Base Station with:
CT7 Iron & Desoldering Tool
Cat.T12580 .... **$220**



SURGE BUSTER!

6 PROTECTED POWER OUTLETS!
Protect your valuable electronic equipment from damaging power surges. Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc.

SPECIFICATIONS:
Electrical rating: 240V AC, 50Hz, 10A
Complies with Australian Standards Approval number N10084
3 x Metal Oxide Varistors (MOV)
Surge/Spike Rating (each MOV) 4,500 amps (8x 20us)
Energy Absorbtion Factor each MOV 75 joules (10 x 1000us)
Maximum Clamping Voltage each MOV 710 volts at 50 amps
Response time: Less than 25 Nanoseconds

X10086
.... **Normally $69.95**
Introductory price $47.95

PC BOARDS

Make your own kits!

ETI478SA	2.80	ETI153	3.60
ETI478SB	2.50	84AU1	3.00
ETI478SC	2.50	ETI610	4.35
ETI478SD	2.50	ETI678	3.55
82A03B	4.20	80PG6	7.65
81FM10A	10.45	81DC2	2.50
81FM10B	4.90	82GA5	3.15
ETI1405A	3.60	84US6	4.00
ETI1405B	5.40	ETI147	4.30
ETI478MC	3.75	ETI458	4.90
ETI478MM	3.75	ETI071	2.40
ETI755A	8.35	ETI485	5.40
ETI755B	2.70	81MC8	11.35
ETI755C	2.40	ETI480	4.30
84MA11	3.45	82IV6	9.85
82TA10	2.70	ETI163	9.10
ETI755B	2.95	ETI159	3.40
84EC11	12.45	ETI466	9.85
ETI477	10.45	ETI280	4.00
ETI668	5.65	ETI675	5.00
ETI494	3.85	ETI671	3.85
ETI471	17.85	ETI461	4.90
ETI1421	4.15	84TP2	4.15
ETI585T	2.20	ETI268	2.05
ETI585R	2.70	ETI712	2.40
82IV6	9.85	83GA6	9.00

COMPUTER CABLE

CIC6 6 conductor computer interface cable. Colour coded with braided shield. (to IE422 specifications) Copper conductor 6 x 7/0.16mm

1-9 metres	10+ metres
$1.90/m	**$1.70/m**

CIC9.100 9 conductor computer interface cable. Colour coded with mylar shielding. 9 x 7/0.16mm

1-9 metres	10+ metres
$2.50/m	**$1.95/m**

CIC12 12 conductor computer interface cable. Colour coded with mylar shielding. 12 x 7/0.16mm

1-9 metres	10+ metres
$2.70/m	**$2.50/m**

CIC16 16 conductor computer interface cable. Colour coded with mylar shielding. 16 x 7/0.16mm

1-9 metres	10+ metres
$3.90/m	**$3.40/m**

CIC25 25 conductor computer interface cable. Colour coded with mylar shielding. 25 x 7/0.16mm

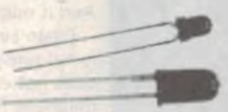
1-9 metres	10+ metres
$4.90/m	**$4.40/m**

P.A. SPEAKERS

Low dual cone, wide range 200mm (8in.). Ideal for public address, background music, etc. Tremendous Value at these prices!
Cat. C12000 **$7.95**

SPECTROL 64Y MULTI TURN TRIMPOTS

Cat No	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20



QUALITY 3mm LEDS

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

QUALITY 5mm LEDS

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

CODE KEY PAD

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

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

20% OFF THE PRICE OF SPECTROL MULTIDIALS

MODEL 15-1-11

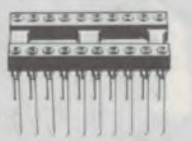
Number of turns: 10
Minor Scale Division: 1/500 turn
Shaft Bore: 6.35mm (1/4")
Finish: Satin Chrome
Body Size: 25.4 x 44.45mm (1 x 1 3/4")
Depth: 25.4mm (1")
Weight: 45.4g (1.6oz.)
Cat. R14405 .... **$45.95**
SPECIAL, $35.95

MODEL 16-1-11

Number of turns: 15
Minor Scale Division: 1/50 turn
Shaft Bore: 6.35mm (1/4")
Finish: Clear Anodize
Body Size: 22.2mm diameter (.875")
Depth: 22.2mm (.875")
Weight: 19.8g (0.7oz.)
Cat. R14400 .... **$26.95**
SPECIAL, $21.50

MODEL 21-1-11

Number of turns: 15
Minor Scale Division: 1/100 turn
Shaft Bore: 6.35mm (1/4")
Finish: Satin Chrome
Body Size: 46.04mm diameter (1.812")
Depth: 25.4mm (1")
Weight: 85.g (3oz.)
Cat. R14410 .... **$46.95**
SPECIAL, $37.50



WIRE WRAP IC SOCKETS

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

Cat.No.	Description	1-9	10+
P10579	8 pin	$1.50	$1.40
P10580	14 pin	$1.85	$1.70
P10585	16 pin	$1.95	$1.80
P10587	18 pin	$1.95	$1.80
P10590	20 pin	$2.95	$2.70
P10592	22 pin	$2.95	$2.70
P10594	24 pin	$3.95	$3.50
P10596	28 pin	$3.95	$3.50
P10598	40 pin	$4.95	$4.50

CORDLESS RECHARGEABLE SOLDERING IRON

- Built in solder point illumination
- Easy replacement of solder tip
- Protective stand which also functions as charging unit
- Sponge pad attach to stand
- Plug pack power adaptor
- Includes Nicad battery
- Instruction manual
- 12 months warranty

Cat. T12480 .... Normally $79.95
SPECIAL, $69.95

FREE STANDING, FOLD UP MAGNIFIER

An economically priced "hands free" magnifier, lets you take care of all those tricky fine detailed jobs so often encountered in electronics, or any of many other practical uses such as home, work, hobbies etc.
Cat. T10020 **Normally $14.95**
SPECIAL, ONLY $12.95

COMPACT DISC CLEANER

Even compact discs need to be kept clean otherwise the listening pleasure will be spoiled by drop outs or skips.

- Cabinet incorporates working base to place disc
- Soft suede cleaning pad (with pad cleaning brush)
- Spray which will gently loosen contaminents and not damage discs
- With disc cloth for handling discs
- Replacement cleaning pad and spray available separately

A10025 .... **$19.95**

AUDIO LEAD BARGAINS!

Absolute bargains! We've got too many of these leads, so this month we're selling them at the ridiculous price of only $2 each! That's well below half price!
(10 or more, only $1 each!)

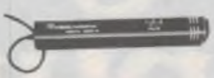
5 PIN DIN, MALE TO MALE
Cat. P32104 1.2 metres
WAS $4.50 .... **NOW $2.00**

4 RCA to 4 RCA MALES
Cat. P32108 1.8 metres
WAS $6.95 .... **NOW $2.00**

5 PIN DIN MALE TO 4 RCA MALE LEAD
Cat. P32106 1.8 metres
WAS $5.95 .... **NOW $2.00**

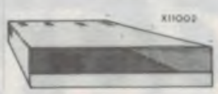
SPOTLIGHT 12V

Quartz halogen spotlight. Hand held with moulded plastic grip. Brilliant beam up to 55W can be seen for miles. Orange lens cover, emergency flasher switch, 3 metre curled cord, cigarette lighter plug and replaceable H3 halogen bulb.
Cat. A15050 **$26.95**



OMNI-DIRECTIONAL WIRELESS MICROPHONE

Tuneable: 92 - 104MHz
Freq. Response: 50 - 15kHz
Range: Over 300 feet in open field
Modulation: FM
Power Source: 9V Battery
Type: Electret Condenser
Dimensions: 185 x 27 x 38mm
Weight: 160 grams
Cat. A10450 .... **$19.95**



DUAL 8" SLIMLINE DRIVE CASE

X11025 Bare Case $109
X11026 Case & Power Supply $275

SINGLE 8" SLIMLINE DRIVE CASE

X11020 Bare Case $109
X11022 Case & Power Supply $179

5¼" SLIMLINE DRIVE CASE

X11001 Bare Case $49
X11011 Case & Power Supply $109

2 x 5¼" SLIMLINE DRIVES CASE

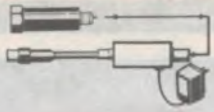
X11002 Bare Case $69
X11012 Case & Power Supply $149

3½" DRIVE CASE

X11042 Bare Case $59
X11044 Case & Power Supply $129

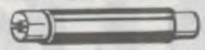
DUAL 3½" DRIVE CASE

X11046 Bare Case $79
X11048 Case & Power Supply $139



10dB IN-LINE COAXIAL AMPLIFIER

Reduces loss from splitters and long cable runs. Suitable for use with antennas, coaxial feed lines and VCR's. A/C adaptor included.
SPECIFICATIONS:
Frequency Range: 5-900MHz
Gain: 10dB
Power Requirements: 12V A/C Adaptor (included)
Input Impedance: 75 ohm
Output Impedance: 75 ohm
Cat. L15043 **$39.95**

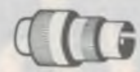


TV INTERFERENCE FILTER

Cuts CB/Ham signals interference
Cat. L11048 **$5.95**

CONNECTOR LEADS

For TV/VTR (using cord 3C-2V) 2.5 metres long
Cat. P32170 Male to Male **$4.95**
Cat. P32171 Male to Female **$4.95**

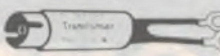


PLASTIC BODY CO-AXIAL CONNECTORS

Plug Cat. P10401 **$0.50**
Socket Cat. P10408 **$0.60**

METAL CO-AXIAL CONNECTORS

Plug Cat. P10402 **$0.95**
Socket Cat. P10408 **$0.95**



MATCHING BALUN TRANSFORMER

Female Type 75-300 Ohm
Cat. L11010 **$2.95**

UHF/VHF OUTDOOR MATCHING TRANSFORMER

75/300 Ohm. Waterproof type.
Cat. L11020 **$2.95**

CO-AXIAL SOCKETS LOW LOSS SPLITTER

Gives 2 standard co-axial outlets from one input.
Cat. L11037 **$4.95**

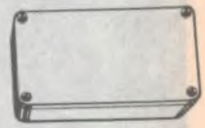
CO-AXIAL SOCKETS DOUBLE ENTRY BOX

One in, two out, without low loss arrangement.
Cat. L11035 **$2.95**

75 OHM TV & FM 4 WAY SPLITTER/COUPLER

- Input/Output 75 Ohm
- Splitting loss 6.8dB
- Isolation 32dB
- V.S.W.R. 1.3

Cat. L11320 .... **$5.95**



DIECAST BOXES

Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

H11451	100 x 50 x 25mm	$ 5.95
H11452	110 x 60 x 30mm	$ 6.50
H11453	120 x 65 x 40mm	$ 6.95
H11461	120 x 94 x 53mm	$11.50
H11462	188 x 120 x 78mm	$13.50
H11464	188 x 188 x 64mm	$29.50

ROTATING LIGHT

Motor driven rotating reflecting mirror with a flash rate of about 150 per minute. Large lens fit right to base, making unit weatherproof. Spare globe included.

SPECIFICATIONS:

- Available in Blue or Orange
- 150 Revolutions per minute (approximately)
- Shock absorbing rubber mounting legs
- Connecting wire fitted through base
- 12V DC 750mA
- Base diameter: 102mm Height: 140mm

A15042 Blue **$42.95**
A15043 Orange **$42.95**

SUPER HORN TWEETER

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

Cat. C12102 .... **Normally $12.95**
SPECIAL, ONLY $9.95

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. H28630
.... Normally $89.95
SPECIAL, $59.95

PUSH BUTTON DIALLERS

Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.
Cat. A12030 .... **Normally $19.95**
SPECIAL, ONLY $14.95
(Note: Not Telecom approved)

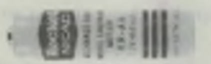
Get more for your dollar with Rod Irving Electronics!

VEROBOARD SPECIALS

VERO 21070H
0·1" pitch strip board
Size 2·5 x 3·75 inches
H21070 Normally $7.50
SPECIAL, $4.95

VERO 21000F
0·1" pitch strip board
Size 3·75 x 17·9 inches
H21000 Normally $25.00
SPECIAL, $17.95

VERO 21012H
DIP Bread board. The design of this board is similar to that of the plug-in range of DIP Boards, except that it is not provided with gold plated contacts. They therefore offer a cost saving in those experimental applications where a plug in facility is not required. In place of contacts, individual mounting pads for terminal pins are provided.
Matrix: 2·54 x 2·54mm
Hole Diameter: 1·02mm approx
H21012 Normally $27.95
SPECIAL, $17.95



NICADS!

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

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

SUPER DELUXE BATTERY CHARGER

- Charges from 1 to 10 D, C, AA, AAA N, and up to 3 x 9V batteries at the same time
- Dual colour LED in first three compartments to designate 1.5V or 9V
- 240V AC/50Hz
- Approval No. N10637

Cat.M23525 **$59.95**

ADCOLA SOLDERING IRONS

These are professional quality precision soldering tools, similar to those used by the Australian Military Services and industry, for the manufacture, repair and rework of advanced electronic circuits and other scientific equipment.

ADCOLA RS30 12 WATT

- 3mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12625 Normally $36.00
Special, only $32.00

ADCOLA RS50 16 WATT

- 5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12630 Normally $36.50
Special, only $32.50

ADCOLA RS60 21 WATT

- 6.5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12635 Normally $39.50
Special, only $35.50

UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less for less chips).
Features include:
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

WITHOUT TIMER
Cat. X14950 Normally $119
Special, $99

WITH BUILT-IN TIMER
Cat. X14955 $139
Special, $119

ARGUS ADJUSTABLE MAGNIFIER WITH LAMP

Perfect for close up work! Intricate PCB's, projects, etc., will be a breeze under this superb, adjustable magnifying lamp.
- Magnifies 1.75 times
- 40 watt incandescent lamp
- 2 external spring-balanced arms extendable to 800mm
- Adjustable head for optimum viewing angle
- Variety of mounting bases available but not included

Cat.T10015 Only **$99**

CLAMP BASE

To suit above Argus Lamp
T10016 **$9.50**

T-BASE

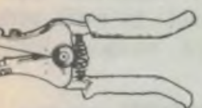
To suit above Arous Lamp
T10017 **$17.50**

CANNON TYPE CONNECTORS SPECIALS

Cat. No. Description	Price
P10960 3 pin line male, Was $3.90	NOW $2.90
P10962 3 pin chasis male, Was $3.00	NOW $2.40
P10964 3 pin line female, Was $4.50	NOW $3.25
P10966 3 pin chasis female, Was $4.95	NOW $3.45

TDK LINE FILTERS

240 V 3A
Cat. **$12.50**



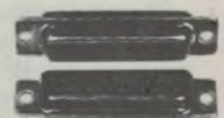
AUTOMATIC CABLE STRIPPER

- Strips cable with diameter of 1, 1·6, 2, 2·6, 3·2mm
- Fully automatic action. Squeeze grip will simulataneously strip and eject insulation
- Length 180mm (7")

T11532 **$19.95**

DELUXE UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for up to 8 pieces of any size, (D, C, AA or AAA type batteries) at once, plus positions for a button and cell battery. Two times 9V and one times N type batteries.
Recharging lead with alligator clips, 9V clip and 4-way universal. Select currents from 2-5-3V 150mA, 1·2-1.5V 80mA, 1·2-1.5V 25mA, 6-9V 14mA, 12V 50mA. Includes detailed instructions.
Cat. M23535 **$49.95**

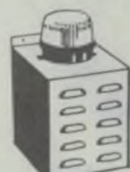


DB25 MALE (P10900)

1-9	10+	100+
$1.00	$0.90	$0.80

DB25 FEMALE (P10901)

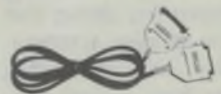
1-9	10+	100+
$1.20	$1.00	$0.90



EXTERNAL SIREN & FLASHING LIGHT

Housed in a waterproof, metal case, with tamper switch.

SPECIFICATIONS:
Siren:
DC 12V 450 mA
Impedance 8 ohm
S.P.L. (dB/W) 110
Dimensions: 135 x 150mm
Flashing Light:
DC 12V
100 flashes per minute
Dimensions: 82 x 100mm
$89.50



RS232 DIP SWITCH LEAD

- 10 Way Dip Switch
- DB25 male plug to DB25 male plug
- Length: 2 metres
- Instructions included

Cat. P19031 **$59.95**

PC BOARD HOLDER

Better than an extra pair of hands! A must for all PCB work.
Cat. T12444 **$9.95**

METEX 4500H MULTIMETER

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

The Metex 4500H is perfect for the technician, engineer or enthusiast who requires the higher accuracy of a 4½ digit multimeter. This meter is exceptionally accurate, (just look at the specifications), and yet still retains an exceptionally low price!

The Metex 4500H features digital hold which is normally only found on very expensive multimeters. This enables you take a reading and hold that reading on display even after you have removed the probes, simply by pressing the hold button.

CHECK THESE FEATURES...
- Readout hold
- Transistor Tester
- 4½ digit x ½"(H) LCD
- Audible continuity tester
- Push-button ON/OFF switch
- Quality set of probes
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Built in tilting bail
- Instruction manual
- Full overload protection
- hFE test
- Battery and Spare fuse
- Diode Tester
- Vinyl case

Q91560 Normally $175
Special, only $159

CRYSTAL SPECIALS!

These crystals were $4.90 each, this month they're only $2.00 each. Ten or more only $1.50 each!

Description	1-9	10+
4.194304 MHz	$2.00	$1.50
4.433618MHz	$2.00	$1.50
4.75 MHz	$2.00	$1.50
4.9152 MHz	$2.00	$1.50
7.1590 MHz	$2.00	$1.50

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
Fax: (03) 543 2648

KEY SWITCHES

Cat. S12500 Normally $7.95

1-9	10+	25+
$4.95ea	$4.25ea	$3.95ea

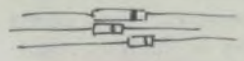
TEXTOOL SOCKETS

P17016 16 pin	$14.95
P17024 24 pin	$18.50
P17028 28 pin	$24.95
P17040 40 pin	$29.50

RS232 BREAK OUT BOX

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

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket.
Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR, (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm
X15700 **$94.95**



DIODE SPECIALS

We have millions of diodes in stock!

1-99	100+	1000+
IN4148 Small signal Cat. Z10135		
3¢	2½¢	2¢
IN4004 400V 1A Cat Z10107		
4¢	3½¢	3¢

MAIL ORDER HOTLINE

008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES
(03) 543 7877

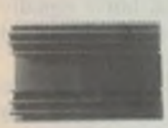
POSTAGE RATES

$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.



HIGH EFFICIENCY RADIAL FIN HEATSINK

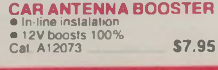
Black anodised with a thick base plate, this radial fin heatsink can dissipate large amounts of heat for maximum efficiency.
Designed by Rod Irving.

H10520	105 x 30mm	$ 3.50
H10525	105 x 75mm	$ 4.95
H10529	105 x 100mm	$ 5.50
H10534	105 x 140mm	$ 7.90
H10535	105 x 150mm	$ 8.90
H10538	105 x 170mm	$ 9.95
H10542	105 x 195mm	$10.95
H10543	105 x 200mm	$10.95
H10546	105 x 225mm	$11.95
H10549	105 x 300mm	$12.95
H10560	105 x 600mm	$26.95

BIG MOUTH CAR ALARM

FEATURES.....
- Easy installation
- Automatic on/off
- Loud alarm signal
- Auto reset
- Low Price!

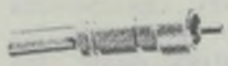
SPECIFICATIONS:
Power: DC 12V battery
Current Consumption: 10mA at 12V DC
Dimensions: 139 x 165 x 136mm
Exit Delay: 60 seconds approx
Entry Delay: 12 seconds approx
Auto reset: 90 Seconds approx
S15048 **$39.95**



CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat. A12073 **$7.95**



RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for laser disc players to get that fantastic sound quality.
Plug Cat. P10151 **$3.75**
Socket Cat. P10150 **$2.95**

RCA GOLD PLATED CHASIS SOCKET

For the ultimate connection!
Cat. P10229 Normally $1.95

1-9	10+	100+
$1.00	$0.90	$0.85

Silicon Valley NEWSLETTER . . .

Philips researchers develop stable superconductor

Researchers at Philips Laboratories in New York have announced a major advance in the development of new superconductor materials that can be stabilised in ceramic oxides at temperatures between 95 and 130K.

While superconductor materials have been created at various laboratories around the world with superconducting characteristics at much higher temperatures, those materials have been very unstable. The Philips development puts the company's superconductor at the leading edge of reproduceable superconductors.

The superconductor was developed by a team headed by Sam Herko, Ramesh Bhagava, and Bill Osborne. According to Philips, their research has shown that there exists a "phase healing temperature" at which the superconducting phase responsible for high critical temperature superconductivity can be annealed into a stable, ceramic oxide material.

This discovery enabled the team to create stable superconductors with critical temperatures (temperature at which superconductivity occurs) between 95 and 130K. The maximum critical temperature achieved with the ceramic-based oxide was 159K (-114°C).

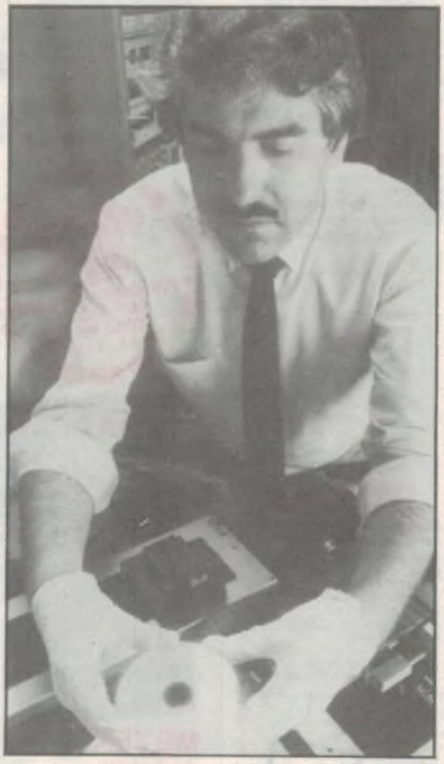
The Philips superconductor is of the same barium, yttrium, copper oxide variety that formed the basis of most of the new superconductor materials. In a slight variation, however, they added very small quantities of fluorine, resulting in higher critical temperatures.

A key discovery of the team involves the "phase healing process" that is apparently critical to the formation of superconductors. The Philips team found that the established 95K critical temperature of the BYC superconductor rose in stages when the material was subjected to "temperature cycling," (alternately heating and cooling).

By heating the material to slightly above 240K, the so-called "phase handling temperature", and subsequently lowering it again, electrical resistance began to drop rapidly to almost zero at ever increasing critical temperatures, up to 159K in one instance when a large amount of fluoride was added.

Data storage breakthrough

A group of scientists at IBM's General Products Division in San Jose has developed a revolutionary new magnetic data storage technology which allows a



3.5" disk to hold up to 10 billion bytes of data (10 gigabytes). This is 50 times more information than today's highest density magnetic disks are able to store, and equivalent to 625,000 standard type-written pages.

The development was announced after a dozen IBM researchers worked on the project for more than two years. The disks are produced with the same kind of technology used in the production of today's state-of-the-art semiconductors.

The researchers used an E-Beam lithography system to actually etch the memory cells and track into a photo resist placed on the surface of the disk. As a result, the scientists were able to make the cells as small as 0.5 x 0.5 microns. One of the key discoveries the IBM scientists made was the memory cells maintained their magnetic interaction characteristics despite their miniscule size.

Individual tracks were spaced just 200 microns apart. According to an IBM spokesperson at the Almaden Research Lab, future developments could further reduce the size of both the memory cells and track spacing, creating disks with even greater densities and storage capacities.

Much research still will be required before the discovery will make its way to the marketplace. For one, IBM will have to develop the read-write technology that will be able to work with such densely packed memory cells.

Mergers cut 1000 more jobs

National Semiconductor and Advanced Micro Devices have laid off an additional 500 workers each. In both cases, the workforce reductions resulted from the elimination of duplicate jobs following their mergers with Fairchild and Monolithic Memories respectively.

After cutting some 400 marketing and sales positions earlier, National said the latest round of consolidation-related cuts affected mostly areas of administration and engineering in the semiconductor division of the company. About one-third of the lay-offs have taken place at Silicon Valley-based operations, while the other 350 were spread out over National and Fairchild facilities around the world. No further reductions are expected. According to a National official, the lay-offs have been divided fairly equally among both National and Fairchild workers.

At AMD, the lay-off of 500 people was made in an effort to reduce the company's research and development expenses by about $US10 million per quarter. During the past two years, AMD's R&D expenses have been around 25% of gross sales, an uncommonly high level of spending in the industry. Following the reduction, the R&D budget will count for about 20% of sales.

Sony acquires CBS Records

In one of the largest cash transactions in history, Sony of Japan has agreed to pay $US2 billion for CBS Records, the music recording division of the broadcast network.

CBS Records is the world's largest record company and includes such recording stars as Michael Jackson and Bruce Springsteen.

The sale to Sony marks the final phase of a series of sell offs that have transformed CBS from the highly diversified entertainment company it was just five years ago, back to its origins of radio and television news and entertainment programming.

US-Singapore joint semi venture

In a major breakthrough for the Singapore electronics industry, National Semiconductor and Sierra Semiconductor of San Jose announced the forming of a joint venture that will bring state-of-the-art semiconductor wafer processing to Singapore.

The company, "Chartered Semiconductor", will be 78% owned by the Singapore Technology Group, a government-run industrial conglomerate which is putting up most of the financing for the project. National and Sierra, which will own 9% and 17% respectively, will provide the necessary processing and manufacturing know-how.

Construction of the $40 million facility has already begun.

The presence of a wafer fab in Singapore would be particularly advantageous for National, since the giant chip firm has already established most of its chip assembly operations there.

US retaliates against Brazil

The US government has slapped $US105 million worth of tariffs on imported goods from Brazil, in retaliation for that country's refusal to allow American computer and software companies to do business there. In addition to the tariffs, President Reagan also imposed a — largely symbolic — ban on all Brazilian-made computer products.

While the US and Brazil have been at odds over high-tech trade issues for some four years, the latest action was triggered by Brazil's refusal in 1987 to allow Microsoft to licence its MS-DOS operation system in this fast-growing South American market. EA

HIFI REVIEW:

NAD's 1130 preamp & 2240PE power amp

NAD Electronics has established a firm reputation over the years for providing high quality hifi equipment at a moderate price. Its power amplifiers also have a reputation for delivering plenty of "peak power". The new 1130 preamp and 2240PE power amp combination maintain both traditions.

There's a third tradition with NAD equipment, and that's a characteristic by low-key, unobtrusive styling. As you can see from the photograph, the 1130/2240PE continue this tradition as well. The colour scheme is basically a "charcoal" or dark grey, with black controls. Frankly we find it quite tasteful, but we've heard others expressing less enthusiasm.

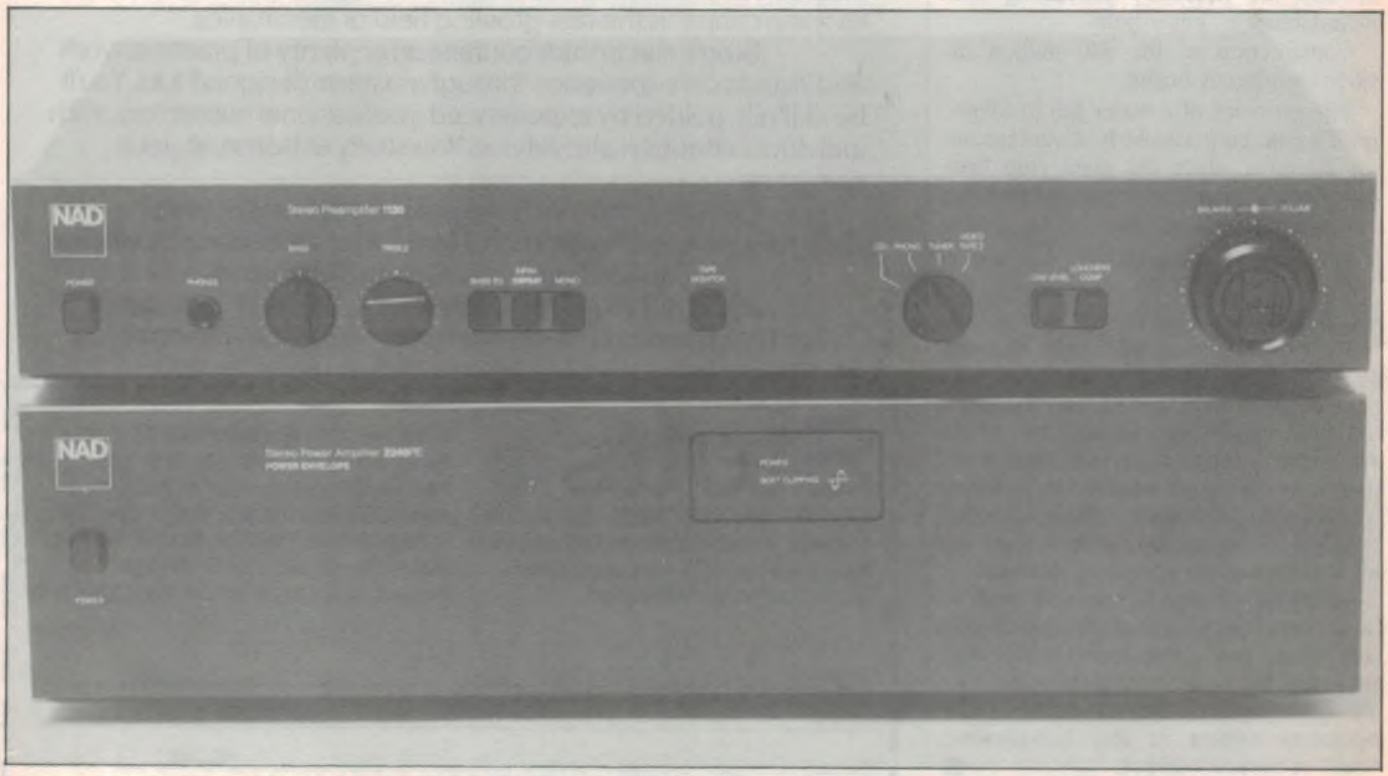
NAD produces a range of amplifier models, in both integrated and separate preamp/power amp combinations. The integrated model 3240PE amplifier was reviewed in our May 1987 issue, while the 1155/2200 combination was reviewed in November 1985. The company itself is based in Boston, USA and London, UK, although nowadays its equipment seems to be manufactured in Taiwan.

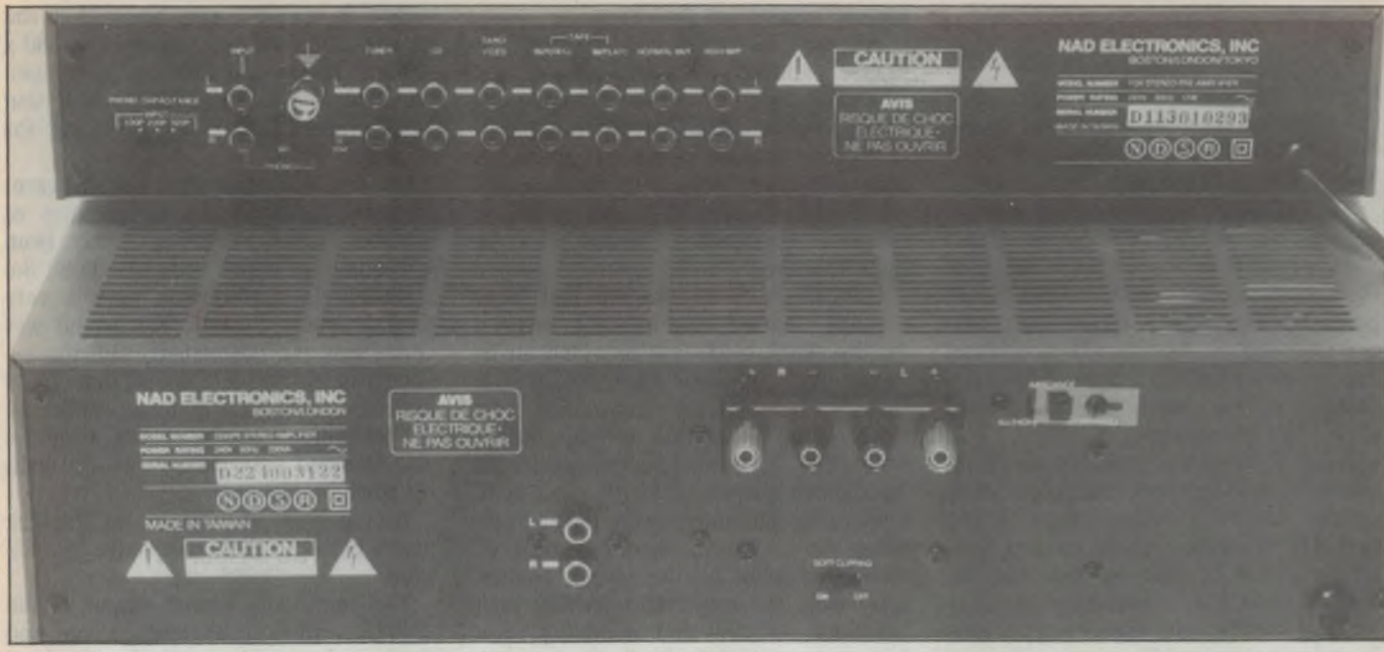
In many ways the 1130/2240PE combination seems to be broadly equivalent to the integrated model 3240PE amp reviewed in May last year, but for the enthusiast who prefers the preamp/control functions separated from the power amp. The separate units would also be suitable for those who want to make use of an existing power amp or preamp, of course — plus those with the resources and inclination to team up a single 1130 preamp with a pair of bridge-connected 2240PE's for higher power.

The 1130 preamp unit offers pretty well all of the usual control functions and facilities: bass and treble controls, input selector, tape monitor switch, headphones socket and volume and balance controls. As with many other NAD models the last pair of controls are concentric, with volume on the outside and the less frequently used balance control inside it. In practice this is quite convenient.

Other facilities provided are a mono switch, rather less common nowadays, and a loudness compensation switch to boost bass and treble at low volume settings — something which will probably irk the purists, but undoubtedly included by NAD because it appeals to many users.

There's also a "bass equalisation" switch, which introduces a small amount of gentle boosting in the 30-70Hz re-





Rear view of the combination, showing the input and output connectors.

gion, to extend the bass response of many speaker systems.

Since the 1130 also includes an "infrasonic" or rumble filter, there's also a switch to disable the filter if desired — for example when playing compact discs, when it strictly won't be necessary. However as the filter has a nominal cutoff of 12Hz, there's hardly any point in switching it out. We should point out that the filter is more effective than most, with a slope of 12dB/octave compared with the usual 6dB/octave. So as well as not having any significant effect on the audible bass response, it should attenuate rumble significantly.

Finally there's a "low level" switch, which reduces the normal stereo output level of the 1130 by a fixed 20dB. This lets you widen the effective range of the volume control, for low level listening, and also improves the effective overall noise figure in the same situations. Otherwise it can act as a muting switch.

The 1130 actually has two sets of outputs, labelled "normal" and "high". The normal outputs are designed to run NAD's own power amplifiers, and other units of similar sensitivity. The source impedance of these outputs is nominally 600 ohms, and they're capable of driving several amplifiers in parallel.

The second "high" pair of outputs provide a level around 13dB higher than the first, and have a lower source impedance again — around 220 ohms. Apparently these are designed to drive amplifiers which require a higher input level, including professional gear with 600-ohm input circuitry. These outputs can deliver up to 15V into high impedance loads, or 6V RMS into 600 ohm loads.

The 1130 preamp is quite compact, measuring 420 x 280 x 73mm overall and weighing only 3.4kg. It is double insulated and supplied with a 2-wire mains cable and 2-pin plug, with a terminal provided at the rear for connection to the turntable metalwork and/or optional earth.

Needless to say the rear panel provides the usual array of RCA input and output connectors. There are also two switches associated with the phono input/preamp circuitry: one to select for either a moving magnet (MM) or moving coil (MC) cartridge, and the other to select one of three values for input capacitance to suit particular cartridges (110, 220 or 320pF).

By the way the 1130 also boasts a redesigned phono preamp with all-discrete bipolar transistors, running from a split 45V supply. This is claimed to give particularly good noise and headroom performance.

Turning now to the 2240PE power amplifier, this is rated at a nominal 40 watts per channel continuous output into 8 ohms. However like the 3240PE and other models in the range, it incorporates NAD's proprietary system of dynamic switching of the output stage supply voltage rails, to give considerably higher peak power handling capability.

NAD describes this as "power envelope circuitry", and it gives the amplifiers a dynamic headroom figure of around +6dB, compared with the 1.5 — 2dB figure typical of many conventional designs. This means that the power available for short music peaks is around four times the nominal continuous figure, i.e., in the case of the 2240PE, about 160W per channel. NAD also claims that it can supply this peak power for considerably longer than the 20ms specified in the IHF standard — up to 500ms, in fact, which NAD claims is necessary for faithful reproduction of typical music from digital recordings.

In short, the 2240PE is fairly typical of NAD power amp designs in general, and intended to provide "big sound" from a relatively small and modestly priced package.

Internally the 2240PE appears to be almost identical to the power amp section of the integrated model 3240PE. It even appears to use the same PCB, with the sections used for tone control and other "front end" functions on the 3240 being left unwired.

The front panel is very clean and simple, the only controls being a power switch, and two LEDs to indicate power on and activation of an optional "soft clipping" function. This function is selected via a slider switch on the rear panel.

Also on the rear panel are the RCA input sockets, screw terminals for the speaker connections, and a second slider switch to select nominal speaker impedances as either 8 ohms or 4 ohms. In fact this latter switch really selects power transformer secondary taps for the lower "continuous" supply rails for the output stages. In the 4-ohm position the rail voltages are reduced, to allow the output transistors to supply higher current into lower impedances, without excessive dissipation.

The measured output stage supply rail voltages for the 2240PE for no signal were +/- 42V in the 8-ohm position of the switch, and +/- 37V in the 4-ohm position. The higher supply rails that are switched in dynamically as part of the "power envelope" circuitry are not changed by the switch, remaining fixed at +/- 76V for no signal.

Incidentally out of curiosity we monitored the actual supply voltage envelope on the 2240PE's output stages during the IHF dynamic headroom test (see later), and it became obvious that the "power envelope" switching circuitry actually switches the higher supply rails in and out very rapidly, on an individual transient basis. There's also separate switching circuitry for each of the two channels.

For the IHF tone-burst signal, it was switching the higher rails in and out according to the individual half-cycles, and very smartly indeed. Quite impressive, and it suggests that the dynamic supply-rail technique should introduce very little transient distortion.

As well as using the "power envelope" voltage switching circuitry, the 2240PE amplifier is also claimed by NAD to have output devices capable of delivering current peaks of up to 25 amps. This is to cope with the demands of complex loudspeaker and crossover network impedances, which can be quite reactive.

Harking back to the optional "soft clipping" feature for a moment, this is a facility which NAD has provided on its power amps for some time. The idea is that overload peaks which would normally cause saturation of the output transistors are instead clipped earlier on by a diode shaping network, to a peak level inside the output stage linear operating range. So in theory instead of "hard" clipping by the output transistors, with the resultant relatively high harmonic content and audibility, you have a controlled "softer" clipping with fewer harmonics, and distortion that is less audible.

Whether or not this is preferable in practice is something of a moot point. Frankly we're inclined to think it's better not to have either kind of clipping, by not running the amp into overload at all. In short, don't flog it!

Physically the 2240PE amplifier is housed in a case a little larger than the preamp unit, and measuring 420 x 380 x 110mm. It too is double insulated, and provided with a 2-wire mains cable and 2-pin plug. There is no provision for earthing.

On listening tests with two different pairs of speakers and a selection of familiar tracks, including some from high-quality "DDD" compact discs, the 1130/2240PE combination gave a very good account of itself. The sound was very clean and full-bodied, with the expected much "bigger" sound than you'd normally get from a nominal 40W/channel amplifier. The transient response also sounded very clean, with no audible trace of edginess.

And overall, the results on the test bench bore out these subjective impressions.

The continuous power output of the 2240PE with both channels driven and the impedance selector in the "8 ohm" position was 48W per channel into 8 ohms, 60W per channel into 4 ohms and 55W per channel into 2 ohms. With the switch in the "4 ohm" position these figures fell a little, as expected: 38W into 8 ohms, 46W into 4 ohms and 48W into 2 ohms.

With only one channel driven, the figures were virtually identical in the "8 ohm" position, and only a little higher in the "4 ohm" position for lower load impedances: 46W into 8 ohms, 66W into 4 ohms and 80W into 2 ohms.

On the IHF tests the figures were considerably higher, as expected. The burst power per channel into 8 ohms was 156W, into 4 ohms 200W and into 2 ohms 225W. As you'd expect from the fact that the higher supply voltage rails which provide this burst power are not affected by the speaker impedance switch, these figures were the same in both positions of the switch. However they pretty well confirm NAD's claimed figure of +6dB headroom, particularly if you use the rated output of 40W/channel as the reference power level.

As NAD claims that its "power envelope" circuitry holds up for much longer bursts than the 20ms used in the IHF test, we checked this out as well. The best we could achieve was to get the 2240PE to hold its IHF power figures for around half of a 100ms burst, using a burst repetition rate of about 3 seconds. This is rather short of the "hundreds of milliseconds" which NAD claims, but as no figure for repetition rate is quoted, it's difficult to draw any hard and fast conclusion.

By the way, one of the things that

complicated the power measurements somewhat was the thermal protection circuitry that NAD has built into the 2240PE, to protect the output devices from damage. These tend to throttle back the output stages after a short time, when you try to get higher than rated output. If you persist, they shut things down altogether. It's all perfectly normal and shouldn't worry you when you play music (unless you really try flogging things), but it does mean you have to be pretty quick in making measurements — particularly those for peak power output!

Measured total harmonic distortion (THD) at rated power output into 8 ohms was a commendably low .007%, while that into 4 ohms was .02% — still below the claimed .03%, and very good. The intermodulation distortion (IMD) figures for the same output level were .03% and .08% respectively, still quite good and with only the 4-ohm figure above the level claimed.

Input sensitivities for the overall 1130/2240PE combination, for rated output were 150mV at the line level inputs, 6mV at the phono input in the MM position and 0.5mV in the MC position. Measured input levels for phono preamp overload at 1kHz were 190mV in the MM position and 14mV in the MC position, giving plenty of preamp headroom.

Unweighted signal to noise ratios for the overall combination were 92dB for the line level inputs, 76dB for the phono inputs in the MM position and 61dB in the MC position. These are all relative to 1W output, with the gain control set for nominal input sensitivity in each case, and with the inputs terminated for the noise measurements. The system was also earthed to produce these figures; without an earth the phono figures were degraded by 10-15dB.

These figures are all quite impressive, and significantly better than the corresponding figures for the 3240PE integrated amp reviewed last year. Presumably this is partly the improved phono preamp in the 1130, and partly the separate preamp-power amp configuration. But the results also demonstrate the validity of our view that it's desirable to provide earthing. They also bear out NAD's claim that the 1130 preamp provides over 100dB of dynamic range, for the phono inputs.

Measured channel crosstalk levels for the 1130 preamp by itself were –79dB at 100Hz, –70dB at 1kHz and –50dB at 10kHz, and for the overall combination the corresponding figures were –78dB, –66dB and –48dB. All quite good, but very similar to those for the integrated model.

The measured range of the 1130's tone controls was from –8dB to +7dB at 10kHz, and –10dB to +8dB at 100Hz. A little less than usual, but still quite useful. The "bass equalisation" boost switch produced a peak of just over 4dB at approximately 40Hz, with the response down to 0dB again at about 25Hz and rolloff at about 15dB per octave, again quite useful. The "infrasonic" or rumble filter produced a –3dB point around 13Hz, with rolloff at around 12dB per octave — making it more useful than most.

To summarise, then, the 1130 preamp and 2240PE power amp give a very good account of themselves, and certainly do nothing to tarnish the NAD reputation for providing clean "big" sound from moderately sized and very reasonably priced gear.

The quoted RRP for the 1130 preamp is $399, and that for the 2240PE is $499. For further information and details of your nearest NAD dealer, contact distributors Falk Electrosound, at 28 King Street, Rockdale 2216. (J.R. and R.E.)

Compact Disc Reviews

by RON COOPER

MOZART

Horn Concertos
& Concert Rondo
Richard Watkins (horn)
Conducted by Richard Hickox
with City of London Sinfonia
IMP PCD 865
Playing Time: 56 min 36 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

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

Mozart had a lifelong friendship with Herr Leutgeb, a virtuoso horn player of the time, and it was this that inspired Mozart to write these concerti. However, sections were written at various times and the first work did not have its orchestration completed. It is restored on this recording by Erik Smith.

Further references to the original scores suggest Mozart's joking with Herr Leutgeb, with different coloured inks and curious teasing remarks which show the kind of rapport the young Mozart had with this family friend (who was old enough to be his father).

This is another new budget price CD from IMP, and offers excellent value for money with the four Concertos plus the concert Rondo. It is a new digital recording and the playing here by Richard Watkins is quite brilliant.

Soundwise the recording is very clear and noise free, and will appeal to most. I would have preferred a different microphone arrangement, as I feel the acoustic sound of the recording, particularly the orchestra could be improved. It is quite open and airy, but somehow a little distant.

Nonetheless it is still a worthy addition to your collection and has excellent cover notes on the works and the players.

DVORAK

Suk Trio
Trio No.1 in B flat major, Op.21
Trio No.2 in G minor, Op.26
Denon 33CO-1409
Playing Time: 68 min 34 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

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

Dvorak was attracted to piano trios and wrote four. A piano trio is a chamber work for three instruments including a piano.

The title of this disc is somewhat misleading, as it is titled the complete trios. This is followed by a small "I", indicating that it is obviously Volume I — which I think should have been the main title. The disc contains the first two trios, but is good value timewise at 68 minutes.

All this aside, the performance here of this delightful chamber music is brilliant. The Suk Trio is led by Josef Suk, grandson of the Josef Suk who was Dvorak's son in law. All the players are very experienced and obviously have a real affinity for the music of Dvorak.

The first trio here shows the influence of Schubert and Schumann, both of whom Dvorak held in high regard. The other trio is more melancholic in nature, reflecting the fact that this was the first work he composed after the death of his eldest daughter.

The sound of this disc is quite bright with just the right amount of natural reverberation. The balance is first rate, although I would have preferred a little less string sound from the piano. The violin tone is inclined to be slightly hard, but overall a very good recording.

ANTONIO VIVALDI

Il Cimento dell'Amonia e
dell'Inventione (Vol.1)
Concerti Op.8, Nos.1-6
Denon 33CO-1471
Playing Time: 61 min 21 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

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

I think I have lost count of the number of Vivaldi *Four Seasons* on compact disc, and yet here is another new recording. This issue has a bonus of two extra concerti — "La Tempesta di Mare (Storm at Sea) — and "Il Piacere" — (Rapture). The former, unlike the Four Seasons has no descriptive sonnet and on first hearing, typical of Vivaldi, has instant appeal with its brisk rhythms.

The playing on this disc is excellent as you would expect from this fine Italian ensemble playing Italian music. Nothing is overdone — tempos are what they should be, and so it may be called a "traditional version." I found it extremely enjoyable, unlike some versions where you need to listen a few times to adjust to someone's "revised" interpretation (maybe I'm old fashioned). Either way, this disc certainly gets my vote.

The sound quality is faultless but not stunning, so here again I leave myself open. The string sound is fine, everything is fine, but I have heard better sound. I'm probably more apt to "nitpick" because I do hear a lot of top class recordings, but I'm sure most listeners will find the sound quality first rate — so don't be put off by me.

BOOKS

HANDS ON

Practical tips and useful programs for IBM PC's from the editors of PC World

A collection of the best tips, programs, and routines for IBM computers from the popular "Hands on" and " " columns. Covering both hardware and software, the book is organised so that you can quickly find information on virtually everything you need to know.

B20100 .... **$34.95**

USING PC DOS

"Using PC DOS" is the only combination of a beginning tutorial, advanced guide, and lasting reference that gives you ultimate control over your PC's most important software, the operating system!

Beginners will learn how to
- Prepare your diskettes
- Manage DOS directories
- Erase, rename, and copy files
- Print what appears on your screen
- Avoid disastrous errors

Advanced users will learn
- Master path names
- Maneuvering through directories
- Customise DOS
- Use RAM disks
- Create AUTOEXEC.BAT files

Regardless of your level of expertise, you can use the Command Reference section to
- Gain quick access to 63 most frequently used DOS commands
- Recognize valid DOS command phrasing
- Cope with frustrating DOS error messages

Cat.B20200 .... **$49.95**

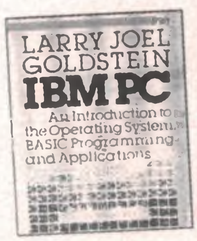
UNDERSTANDING UNIX

-James R. Groff, Paul N. Weinberg

The exploding popularity of the UNIX operating system is one of the most important trends in computing in the 1980's. UNIX is available on hundreds of different computers ranging from personal computers to mainframes and supercomputers. *Understanding UNIX* offers an overall perspective on UNIX including a discussion of where UNIX fits in the worlds of computing business, and education. Individual chapters address the UNIX structure file system, multiuser capability, specific applications tools, and more.

"A book that balances scope with depth; comprehensiveness with brevity." -Alan Kaplan

Cat.B21240 .... **$44.95**



IBM PC

An introduction to the operating system, Basic programming, and applications

-Larry Joel Goldstein

This classic and latest edition is the most comprehensive learning tool available for understanding and programming the IBM PC family. Features include a thorough explanation of the MS DOS and PC DOS operating systems, a "hands-on" approach to BASIC programming, chapters on memory, printer graphics, flow charting, file handling, games, screen graphics and sound.

B20020 .... **$39.95**

GETTING STARTED WITH THE IBM* PC* AND XT*

-David Arnold

An authoritive guide from the PC World Library to using the PC* and its more powerful cousin, the XT*. If you're new to computing you'll appreciate their tutorial approach as you become familiar with keyboard, disks, and operating system (DOS 1.10 and 2.00). You'll learn to set up and handle electronic files, evaluate your software needs and program in BASIC.

B20030 .... $34.95

APPLE II ASSEMBLEY LANGUAGE

-Dr. Marvin L. De Jong

- Teaches assembly language programming at the beginning level - no prior knowledge of 6502 assembly language needed
- Directs you in hands-on computer exercises and experiments, with both software and hardware
- Enables you to interface the Apple II to outside devices, eg. a/d and d/a converters, timers, etc.
- Provides interfacing circuits and programs that can be used on the Apple II without modification
- Enhances your power as a programmer in your use of the Apple II
- Gives you a more general understanding of how microcomputers work than can be obtained by programming in BASIC or any other high level language

Cat.B20940 .... **$36.95**

IBM PC TROUBLESHOOTING & REPAIR GUIDE

-Robert C. Brenner

Keep your IBM PC in top operating condition with this handy reference book. Inside you will find pages of schematics, photos and block diagrams to help you identify problems. Simple instructions tell you what's wrong and how to fix it last.
- Make most repairs with few or no tools
- Quickly zero-in on a malfunctioning component
- Reduces downtime
- Pays for itself many times over in repair savings
- Easy to understand circuit diagrams

The IBM PC Trouble Shooting and Repair Guide will make even the computer novice feel comfortable with the complex world of electronic trouble shooting. This fully illustrated book is recommended for anyone who uses an IBM PC.

Cat B20115 .... **$49.95**

DISKS, FILES AND PRINTERS FOR THE APPLE II

-Brian D. Blackwood,
-George H. Blackwood

Learn how to create and use text files while running a computer program and to make hard copies of the results on a printer. Covers Apple II, II+, IIe and Franklin Microcomputers. You will discover
- Using the system includes booting DOS master, initializing disk backup disk, accessing the drives, verifying, saving programs and loading programs
- DOS commands enable you to operate the disk drives and printer from the keyboard and to change languages (Integer BASIC to Applesoft or vise versa)
- Sequential files include creating, updating, reading, extending, refining, and multisection
- Random access files are faster and take less memory
- Executive files can be used to control a series of steps that do not require the operator to make keyboard inputs
- Deficiencies of TAB and SPC can be overcome in 80 characters per line printers

Cat B20950 .... **$34.95**

INTRODUCTION TO BASIC

-Jeffrey B Morton

This book is lucidly written and is in two parts. The first teaches BASIC and the second consists of a dozen carefully constructed projects. These are wide-ranging and set the language into the context of solving real-world problems. Each project is laid out with a set of variables to give the reader insight into the practical applications of the language. Any version of BASIC can be used to solve the projects and the other excellent examples scattered throughout the book.

Cat B21245 .... **$16.95**

"C" SELF STUDY GUIDE

-Jack Purdum

Learn at your own pace as this self directed study guide takes you through the basics and into advanced areas of the C programming language. The unique format allows you to advance quickly or proceed slowly. The book is divided into two parts.

Questions: of varying degrees of difficulty to guide beginners over the rough spots and to challenge the more experienced C programmers.

Answers: that include many complete programs for testing new functions and for illustrating tips, traps, techniques and short cuts.

Cat B20690 .... **$37.95**

CP/M PROGRAMMER'S ENCYCLOPEDIA

-Bruce Brigham

The CP/M Programmer's Encyclopedia is a time saving comprehensive reference for serious CP/M users. Covering all the commands and syntaxes for CP/M 2.x and CP/M 3.0, this encyclopedia gives you the information you need in an easy-to-use format especially designed for programmers. The CP/M Programmer's Encyclopedia is the only major compilation of CP/M commands and syntaxes. If you use CP/M extensively, you should not be without this important reference guide.

Cat B21260 .... **$44.95**

INSIDE THE IBM PC

(Revised and expanded edition)

-Peter Norton

The widely acclaimed guide to the IBM PC's inner workings. The latest edition now covers every model of the IBM micro, PC, XT and AT, and every version of DOS from 1.1 to 3.0.

B20080 .... **$44.95**

HARD DISK MANAGEMENT

For IBM PC XT, AT & compatibles

-Thomas Cain and Nancy Woodard Cain

Now you can use a hard disk to its fullest advantage with this guide to managing your hardware using DOS, batch files, and menu systems. It introduces you to various disk management concepts you need to know, while providing step by step techniques for dealing with them. Key topis include partitioning, formatting, the TREE command, sub-directory usage, and file/memory capacity. It also offers extensive information about DOS along the way, how it fits in, and how hard it can work for you.

B20070 .... **$39.95**

APPLE II CIRCUIT DESCRIPTION

-Winston D. Gayler

- Covers all Apple II motherboard and keyboard versions
- Helps you learn about microcomputer hardware in general and Apple II hardware in detail
- Provides you with accurate schematics and verified waveforms to rely on for servicing and repair
- Explains the advanced concepts of daisy chains, interrupts, direct memory access, and the ready line
- Gives you many valuable hints for successful interfacing
- Contains tutorials on video signals, memory IC's and the 6502 microprocessor, as well as full explanations of advanced concepts
- Each chapter contains an overview for the beginner and a detailed section for the more adventurous
- Ideal for students, technicians, hobbyists, engineers, and others who need Apple II technical information

Cat B20960 .... **$54.95**

INTERFACING TO THE IBM PERSONAL COMPUTER

-Lewis C. Eggebrecht

This book describes the interfaces, resources, and functions of the Personal Computer. While not presenting specific interface designs or projects, it provides information and techniques that can be used in various projects.
- Describes the components of the Personal Computer
- Examines the processor card and its functions
- Reviews the 8088 microprocessor
- Discusses fully the PC bus system, its signals, its timing, its characteristics
- Examines the system interrupts and the modes of operation of its timers and counters
- Looks at the PC memories and describes its methods of data transfer
- Describes interface signal conditioning and some BASIC interfacing commands

Essential reading for everyone who owns or uses an IBM PC!

Cat B20075 .... **$34.95**

PASCAL PRIMER

-Mitchell Waite, David Fox

If you are learning programming or have dabbled in the popular language BASIC and wish to learn the capabilities of Pascal, this book is definitely written for you. Written and illustrated with a touch of humour, the informative text describes Pascal program structure, Pascal variables, Pascal procedures, and many other features. There are chapters on decision making statements, numeric functions, string functions, arrays and sets, and much more. The eight appendices present facts about the advantages and disadvantages of Pascal, components of a Pascal system, interfacing assembly language routines, and other useful information.

Cat B21120 .... **$34.95**

1-2-3 TIPS, TRICKS & TRAPS

-Dick Anderson, Douglas Cobb

Contains a collection of valuable techniques to help users of Lotus 1-2-3 get the maximum benefit from this powerful integrated software package. Designed as a quick reference, this book shows you hundreds of shortcuts, offers help with unexpected problems, and suggests techniques for using some of 1-2-3's little known capabilities.

Cat B20140 .... **$44.95**

1-2-3 BUSINESS FORMULA HANDBOOK

An invaluable source of tips and techniques for creating, editing, and using 1-2-3 formulas in a wide range of personal and business applications.

To help you use each formula, the Handbook presents all formulas in sample 1-2-3 templates with complete cell listings so that you can easily re-create any formula in the book.

Cat B20138 .... **$44.95**

THE C PROGRAMMER'S HANDBOOK

-Thom Hogan

While other books will tell you how to learn C, this one shows you how to use it. It's a literal encyclopedia of the information you'll need to get it to work for you efficiently and effectively. Handy and well organized, it gives you quick access to the things you need, when you need them, plus a clear definition of C language with examples and explanations of restrictions and defaults. You won't find an approach this understandable and objective anywhere else.

B20120 .... **$39.95**

PRESENTATION GRAPHICS ON THE IBM* PC & COMPATIBLES

How to use Microsoft Chart to create dazzling graphics for professional and corporate applications

-Steve Lambert

With Microsoft Chart (version 2) your IBM PC or compatible, and your printer, you have what it takes to produce clear, colourful business charts in a matter of only minutes. Author Steve Lambert hows how you can easily select, create, and modify the chart - column, bar, line, pie, high-low, area, scatter, or a combination chart, that best communicates your message. And with more than 60 state-of-the-art output devices to choose from. From plotters to slide makers to colour printers, you can create professiona quality charts that will give all your presentations dramatic and convincing impact!

Cat. B20000 .... **$39.95**

ESSENTIAL APPLICATIONS FOR THE IBM PC AND XT

-Patrick Plemmons

If you bought your personal computer to streamline just one activity, you're really missing out! This essential volume in the PC World Library demonstrates the amazing breadth and power of the PC, and helps you to take advantage of the computer's potential as a personal and professional tool. It explains the principal categories of application: spreadsheets, word processing, data base management, account/finance, graphics, and integrated software, and the major software packages in each category. It tells you how to suit the software task at hand, and how to use the computer most efficiently.

B20090 .... **$34.95**

ROD IRVING'S RED HOT IC SPECIALS!

TAKE 50% OFF EVERYTHING IN RED PRINT!

(THIS MONTH ONLY OR UNTILL SOLD OUT)

MELBOURNE 48 A'Beckett Street, Phone (03) 663 6151. **NORTHCOTE** 425 High Street, Phone (03) 489 8866.
MAILORDER HOTLINE: (03) 543 7877

SERIES 4000

4000	.75
4001	.45
4002	.45
4006	1.55
4007	.45
4008	1.70
4009	.90
4010	.90
4011	.45
4012	.45
4013	.70
4014	1.45
4015	1.45
4016	0.70
4017	1.35
4018	1.50
4019	.80
4020	1.40
4021	1.50
4022	1.45
4023	1.45
4024	1.30
4025	0.45
4026	2.40
4027	0.85
4028	1.15
4029	1.50
4030	1.50
4031	2.95
4032	2.30
4033	2.75
4034	3.10
4035	1.80
4038	2.25
4040	1.20
4041	1.50
4042	1.50
4043	1.20
4044	1.25
4045	4.90
4046	1.90
4047	1.90
4048	1.20
4049	0.60
4050	0.60
4051	1.20
4052	1.20
4053	1.20
4054	3.90
4055	3.90
4056	4.20
4060	2.50
4063	2.00
4066	0.80
4067	9.90
4068	0.50
4069	0.50
4070	.50
4071	.50
4072	.50
4073	.50
4075	.50
4076	1.40
4077	.50
4078	.50
4081	.50
4082	.50
4085	2.20
4086	2.30
4093	.80
4094	3.35
4095	2.40
4096	2.40
4097	6.50
4098	2.90
4099	3.90
4194	1.70
4510	1.40
4511	1.45
4512	1.40
4513	2.65
4514	2.60
4515	2.90
4516	1.60
4517	4.80
4518	1.50
4519	0.90
4520	1.50
4521	3.40
4522	1.90
4526	1.90
4527	1.90
4528	1.95
4558	2.25
4584	.90
4585	2.10

74 SERIES

7400	.80
7401	.90
7402	1.00
7403	1.00
7404	1.00
7405	1.00
7406	1.00
7407	1.00
7408	1.00
7409	1.00
7410	1.20
7411	1.00
7412	1.20
7413	1.00
7414	1.50
7416	1.20
7417	1.20
7420	.90
7425	1.20
7427	1.20
7430	1.00
7432	1.00
7437	1.00
7438	1.00
7440	1.00
7442	1.50
7445	1.95
7446	1.20
7447	1.75
7449	1.20
7450	0.90
7451	1.00
7473	1.20
7474	1.00
7475	1.20
7476	1.50
7485	1.50
7486	1.20
7489	3.90
7490	1.20
7493	1.25
7495	1.20
7497	2.75
74100	1.65
74107	1.20
74109	.90
74110	1.50
74121	.90
74122	.90
74123	1.50
74125	1.00
74128	1.80
74132	1.00
74139	1.50
74145	1.45
74150	1.90
74151	1.20
74154	2.50
74155	1.20
74161	1.20
74163	1.40
74164	1.20
74165	1.50
74166	1.95
74174	1.45
74175	1.20
74180	1.20
74190	1.00
74191	1.45
74192	1.00
74193	1.50
74194	1.10
74195	1.00
74197	1.20
74221	2.50
74367	1.50
74368	1.10
75107	2.50
75110	2.50
75150	2.50
75154	2.50
75450	1.50
75451	.90
75452	.90
75453	.90
75461	1.50
75462	1.50
75471	3.00
75472	3.00
75491	2.00
75492	2.00
75493	1.00

74C

74C00	1.00
74C02	1.00
74C04	1.20
74C08	1.00
74C10	1.00
74C14	1.75
74C20	1.00
74C30	1.00
74C32	1.10
74C42	2.25
74C48	2.95
74C73	1.75
74C74	2.40
74C76	2.25
74C83	3.95
74C85	3.95
74C86	1.50
74C89	9.90
74C90	2.90
74C93	2.90
74C95	2.90
74C107	2.95
74C150	7.50
74C151	5.95
74C154	9.95
74C157	6.50
74C160	2.95
74C161	3.35
74C162	2.75
74C163	2.95
74C164	3.50
74C165	3.50
74C173	2.50
74C174	2.50
74C175	2.50
74C192	1.50
74C193	3.00
74C195	3.95
74C200	14.00
74C221	3.95
74C240	3.75
74C244	3.95
74C373	6.95
74C374	5.95
74C901	3.95
74C902	3.90
74C903	3.90
74C904	3.90
74C905	15.00
74C906	2.90
74C907	3.95
74C908	3.75
74C910	15.00
74C911	15.50
74C912	17.95
74C914	2.95
74C915	4.85
74C917	17.95
74C918	3.95
74C920	12.50
74C921	14.60
74C922	9.95
74C923	9.95
74C925	9.90
74C926	13.90
74C927	12.50
74C928	9.90
74C929	9.90
74C930	3.95
74C932	3.50
74C941	2.95
74C946	12.90
74C980	12.50

74F SERIES

74F00	.79
74F02	.79
74F04	.92
74F08	.79
74F10	.79
74F20	.79
74F32	.79
74F64	.79
74F74	.89
74F86	1.19
74F109	.99
74F138	1.79
74F139	1.99
74F151	1.79
74F153	1.79
74F157	1.79
74F158	1.79
74F175	2.76
74F181	5.98
74F182	2.73
74F189	7.44
74F191	4.86
74F193	5.86
74F194	2.41
74F241	3.72
74F243	4.34
74F244	3.72
74F245	5.50
74F251	1.93
74F253	1.93
74F257	1.93
74F258	1.93
74F283	2.40
74F350	4.34
74F352	1.93
74F353	1.93
74F373	4.84
74F374	3.95
74F399	2.78
74F521	4.22
74F533	4.84
74F534	4.84

74HC SERIES

74HC00	.75
74HC02	.75
74HC04	.75
74HC08	.75
74HC10	.75
74HC11	.75
74HC14	1.60
74HC27	.60
74HC30	.60
74HC32	.90
74HC51	.90
74HC74	1.10
74HC76	1.10
74HC80	1.25
74HC85	1.40
74HC86	1.10
74HC123	1.40
74HC138	1.40
74HC139	1.40
74HC157	1.25
74HC161	2.25
74HC164	2.25
74HC165	2.50
74HC174	1.40
74HC175	1.40
74HC221	3.60
74HC240	3.20
74HC244	2.75
74HC245	3.90
74HC273	2.75
74HC367	1.85
74HC373	2.90
74HC393	2.75
74HC4020	2.90
74HC4040	1.65
74HC4049	1.65
74HC4060	3.95
74HC4066	1.70
74HC7266	1.20

74LS

74LS00	.75
74LS01	.60
74LS02	.60
74LS03	.60
74LS04	.75
74LS05	.75
74LS08	.60
74LS09	.80
74LS10	.60
74LS11	.75
74LS12	.80
74LS13	.90
74LS14	.80
74LS15	.80
74LS19	.90
74LS20	.60
74LS21	.90
74LS22	.90
74LS24	.90
74LS26	.90
74LS27	.90
74LS28	.90
74LS30	.60
74LS32	.60
74LS33	.60
74LS37	.70
74LS38	.80
74LS40	.80
74LS42	1.20
74LS47	1.80
74LS48	1.80
74LS49	1.80
74LS51	.70
74LS54	.80
74LS55	.80
74LS63	2.80
74LS73	.60
74LS74	1.00
74LS75	1.00
74LS76	1.00
74LS77	1.00
74LS78	1.10
74LS83	1.20
74LS85	.85
74LS86	.60
74LS90	1.20
74LS91	1.20
74LS92	1.20
74LS93	1.50
74LS95	1.20
74LS96	1.20
74LS107	.90
74LS109	.90
74LS112	.70
74LS113	.70
74LS114	.80
74LS122	1.30
74LS123	1.30
74LS125	1.00
74LS126	1.00
74LS132	1.00
74LS133	0.90
74LS136	1.20
74LS138	1.20
74LS139	1.00
74LS145	1.50
74LS147	2.50
74LS148	1.90
74LS151	1.20
74LS152	1.95
74LS153	1.00
74LS154	3.80
74LS155	1.50
74LS156	1.50
74LS157	1.20
74LS158	1.00
74LS160	1.50
74LS161	1.00
74LS162	1.50
74LS163	1.10
74LS164	1.40
74LS165	1.20
74LS166	2.55
74LS169	2.95
74LS173	1.20
74LS174	1.20
74LS175	1.00
74LS181	4.00
74LS190	1.50
74LS191	1.20
74LS192	1.20
74LS193	1.20
74LS194	1.20
74LS195	1.20
74LS196	1.00
74LS197	1.35
74LS221	2.00
74LS240	2.40
74LS241	2.40
74LS242	2.40
74LS243	2.10
74LS244	2.50
74LS245	2.95
74LS247	1.30
74LS248	1.40
74LS249	1.50
74LS251	1.50
74LS253	1.35
74LS257	1.20
74LS258	1.20
74LS259	2.25
74LS261	2.50
74LS266	0.70
74LS273	1.95
74LS275	6.80
74LS279	.80
74LS280	2.60
74LS283	1.20
74LS290	1.20
74LS293	1.10
74LS295	1.50
74LS297	6.50
74LS298	1.20
74LS299	3.90
74LS320	3.95
74LS321	3.95
74LS322	6.75
74LS323	6.50
74LS324	2.20
74LS326	2.20
74LS327	2.20
74LS352	2.20
74LS353	2.20
74LS354	3.95
74LS365	1.00
74LS366	1.00
74LS367	1.00
74LS368	1.00
74LS373	2.00
74LS374	2.00
74LS375	1.00
74LS377	2.15
74LS378	1.20
74LS379	1.90
74LS386	1.00
74LS390	1.80
74LS393	1.80
74LS395	2.00
74LS396	2.50
74LS398	3.00
74LS399	1.90
74LS424	5.50
74LS440	5.50
74LS441	5.50
74LS442	5.50
74LS443	5.50
74LS445	2.20
74LS446	5.50
74LS447	1.90
74LS448	5.50
74LS449	5.50
74LS490	3.20
74LS540	2.95
74LS541	3.50
74LS574	4.90
74LS601	5.90
74LS621	2.75
74LS622	2.75
74LS623	5.95
74LS629	5.95
74LS640	3.95
74LS642	2.75
74LS643	2.75
74LS644	2.75
74LS645	2.75
74LS668	1.75
74LS669	1.75
74LS670	2.75
74LS673	12.55
74LS674	12.55
74LS690	3.95
74LS691	3.95
74LS692	3.95
74LS693	3.95
74LS696	3.95
74LS699	3.95

74S SERIES

74S00	1.00
74S02	1.00
74S03	1.00
74S04	1.20
74S05	1.50
74S08	1.00
74S09	1.50
74S10	1.00
74S11	1.00
74S15	1.60
74S20	1.20
74S22	1.50
74S30	1.00
74S32	1.50
74S37	1.70
74S38	1.70
74S40	1.20
74S51	0.80
74S64	1.20
74S65	1.20
74S74	1.30
74S86	1.60
74S109	2.50
74S112	1.30
74S113	1.30
74S133	1.20
74S134	1.20
74S135	1.30
74S138	3.30
74S139	3.30
74S140	1.90
74S151	3.10
74S153	2.00
74S157	3.10
74S158	3.10
74S160	5.90
74S161	5.90
74S162	7.90
74S163	7.90
74S168	11.50
74S169	11.50
74S174	3.50
74S175	1.95
74S181	8.50
74S182	3.40
74S189	8.50
74S194	3.30
74S195	2.90
74S225	10.90
74S226	7.90
74S240	6.90
74S241	6.90
74S244	9.90
74S251	3.90
74S253	4.90
74S257	3.30
74S258	3.30
74S260	2.90
74S280	5.90
74S283	7.90
74S287	3.30
74S288	4.90
74S299	13.90
74S301	13.90
74S373	9.90
74S374	9.90
74S381	9.90
74S387	3.30
74S412/8212	5.90
74S428/8212	7.90
74S470	9.90
74S471	9.90
74S472	9.90
74S473	9.90
74S474	9.90
74S475	9.90
74S482	11.90
74S489	7.90

8000 SERIES

8035	6.90
8039	7.90
8080	7.95
8085	12.50
8086	19.50
8088	19.50
8121	5.00
8123	4.00
8130	6.95
8131	5.95
8136	6.95
8155	6.50
8156	11.50
8185	37.50
81LS95	3.75
81LS96	3.75
81LS97	3.75
81LS98	3.75
8212	2.90
8214	4.90
8216	3.00
8224	3.00
8226	4.90
8228	5.50
8237	19.50
8238	9.50
8243	8.50
8251	8.50
8253	7.50
8255	5.50
8257	16.50
8259	6.50
8275	38.50
8276	28.50
8279	8.50
8283	6.50
8284	8.50
8286	6.50
8287	6.50
82S23	5.95
82S123	5.95
8304	6.95
8748	59.00
8749	58.50
8820	6.95
8830	6.95
8832	6.95
8833	6.95
8834	6.95
8835	5.95
8T13	2.95
8T14	2.95
8T26	3.00
8T28	3.00
8T30	3.00
8T96	1.80
8T97	1.80

LINEAR

LH0002	9.50
LH0042	19.00
LH0070	14.95
LH0071	9.50
TL061	1.50
TL062	2.90
TL064	4.90
TL071	1.20
TL072	2.90
TL073	3.20
TL074	4.90
TL081	1.00
TL082	2.50
TL083	2.90
TL084	3.45
TL494	4.90
TA7205P	3.90
TEA1002	17.50
LM10CH	7.50
LM301	1.00
LM301H	1.20
LM302H	6.50
LM305H	1.50
LM307CN	1.00
LM308	1.00
LM308H	1.80
LM309K	2.90
LM310H	3.20
LM310N	3.20
LM311	1.00
LM311H	1.80
LM317K	4.50
LM317T	2.50
LM318	4.90
LM319	3.95
LM322	6.50
LM324	1.00
LM325	4.50
LM326	5.50
LM329DZ	.90
LM332	6.90
LM335Z	4.00
LM336 2.5V	2.95
LM337T	2.90
LM3442	1.90
LM338K	12.50
LM339	1.20
LM347	4.50
LM348	1.80
LM349	2.95
LM350K	10.50
LM350T	6.50
LM351	1.20
LM351N	1.00
LM353	2.50
LM356N	2.40
LM357	2.40
LM358	1.40
LM361	4.95
LM377	4.90
LM378	6.95
LM380 8 pin	1.80
LM380 14 pin	1.90
LM381	3.50
LM382	3.50
LM383	5.95
LM384	3.50
LM386	1.95
LM387A	3.95
LM387	2.00
LM390	3.90
LM391	2.90
LM392	2.20
LM393	1.00
LM394CH	7.95
LM395T	9.95
LM396K	22.50
LF398	5.90
LM3999Z	2.60
NE544	6.50
NE555	.60
NE556	1.20
NE558	5.00
NE560	4.60
NE564	6.95
NE565	1.95
NE566	2.90
NE567	2.00
NE570	5.90
NE571	5.90
NE592	6.90
NE594	9.50
LM709-14	1.50
LM711	1.20
LM723	.75
LM723CH	1.50
LM725	4.75
LM733	1.50
LM739	2.75
LM741	.80
MC1310	9.50
MC1350	1.95
MC1408L8	7.50
MC1458	1.20
MC1466L	21.50
MC1469R	6.90
MC1488	1.20
MC1489	1.20
MC1494	9.40
MC1495	8.90
MC1496	2.50
LM1596	3.00
MC1648	8.90
LM1812	10.50
LM1830	3.90
LM2907	3.90
LM2917 8 PIN	4.90
LM2917 14 PIN	4.90
MN3001	17.50
CA3028	2.00
CA3046	1.90
CA3056	6.50
CA3059	5.95
CA3080	1.90
CA3086	1.90
CA3100E	7.95
CA3130E	2.90
CA3130T	3.50
CA3140E	2.20
CA3140T	2.95
CA3401	1.00
CA3900	1.20
CA3905	1.75
CA3909	2.95
LM3911	2.95
LM3914	5.90
LM3915	5.90
LM3916	5.90
LM3999Z	2.60
RL4136	1.95
RC4194	3.90
UA710CN	$1.00
UA747	$1.30
UA748	$1.00
UA772	$3.50
UA774	$3.50
UA776	$3.50

CPU

6502	15.00
6502A	15.00
6522	15.00
6522A	15.00
6532	14.00
6551	12.90
6800	6.00
6802	7.00
6808	12.50
6809	10.00
6810	3.50
6821	5.50
6840	6.50
6845	12.50
6847	3.50
6850	7.90
6875	15.00
Z80CPU	5.00
Z80ACPU	5.00
Z80BCPU	12.00
Z80P10	4.50
Z80AP10	4.50
Z80CTC	5.50
Z80ACTC	5.50
Z80DMA	16.00
Z80ADMA	16.00
Z80AS10	13.00
Z80S10	13.00
AD570	69.50
AD590	12.50
AD7524	17.50
AY-3-8910	14.50
AY-3-2513	14.50
MSM5832	16.50
MM58174	19.50
MM5309	14.50
MM5369	4.95
FD1791 (8876)	19.00
FD1793 (8877)	19.00
FD1795	39.00
FD1797	39.00
WD1691	19.50
WD2143	24.50
WD1931	22.50
WD1933	34.00
WD2123	26.50
WD8250	29.50
TR1602 (S1883)	8.50
COM8116	24.00
BR1941	23.00
CRT8002A	59.90

MEMORY

2101 (5101) (8101)	1.90
2102	2.50
2114	4.95
2532	12.50
2708	12.50
2716	12.50
2732	8.95
2764	8.95
27128	9.95
27256	12.95
27512	19.95
4116	2.95
4164	3.95
41256	8.95
5101	7.90
58725 (6116)	5.00
6116	7.95
6264	8.95
8101	7.90

OPTO

4N25	1.50
4N26	1.50
4N27	1.50
4N28	1.50
4N29	1.50
4N30	2.00
4N32	2.50
4N33	2.50
4N35	2.50
4N37	2.50
MCT6	1.50
MCT66	6.90
MCT2	1.50
1LD74	5.90
1LQ74	6.50
FND507	2.00
TIL31A	2.95
TIL81A	2.95
TIL306	22.50
BPW50	2.25
CQY89A	1.95
HP5082-2811	4.95
HLMP6620	3.95
LEDS	
3mm RED	.15
3mm YELL	.30
3mm GRN	.30
5mm RED	.15
5mm YELL	.30
5mm GRN	.30
RED RECT	.30
GRN RECT	.40
YEL RECT	.40
RED CHROME BEZEL	1.20
YELLOW CHME BEZEL	1.20
GRN CHRME BEZEL	1.20

SPECIAL FUNCTION

LM4250	2.45
NE5534N	2.95
NE5534AN	3.50
MC3340	2.90
76489	9.95
8038	6.50
OM335	22.50
OM350	12.50
XR2206	8.95
XR2207	7.95
XR2208	6.90
XR2209	6.90
XR2211	7.95
XR2216	6.95
XR2240	6.90
XR2243	7.95
XR8038	7.50
95H90	8.50
11C90	16.50
LM7555	2.90
LM7556	3.90
MC10116L	1.50
LM13600	3.95
DM2502	22.50
ZN414	1.50
ICL7660	5.90
ICM7216A	69.50
ICM7216B	69.50

ANALOG & DIGITAL

ADC0800LCN	22.50
ADC0801LCN	23.95
ADC0803LCN	7.50
ADC0804LCN	6.50
ADC0808LCN	14.95
ADC0820LCN	24.95
DAC0800	4.95
DAC0808	4.95
DAC0832LCN	6.95
DAC1020LCN	19.95
DAC1220LCN	19.95

TRANSISTORS

AC125	1.20
AC126	1.20
AC127	1.20
AC128	1.20
AC187	1.50
AC188	1.50
AC149	3.40
AD161	2.90
AD162	2.90
AF118	2.90
BC107	.75
BC108	.75
BC182L	.40
BC212	.30
BC318	.30
BC320	.40
BC327	.25
BC328	.25
BC337	.25
BC338	.25
BC546	.40
BC547	.40
BC548	.40
BC549	.40
BC550	.40
BC556	.40
BC557	.25
BC558	.25
BC559	.40
BC635	.50
BC639	.50
BC640	.50
BCY70	1.90
BCY71	1.90
BD139	.60
BD140	.60
BD232	.75
BD233	.90
BD235	.90
BD236	.90
BD237	.90
BD238	.90
BD262	2.00
BD263	2.00
BD647	1.80
BD648	1.80
BD677	1.80
BD681	2.00
BD682	2.00
BDV64B	5.50
BDV65B	5.50
BDX63	5.50
BDY96 (BUX80)	4.90
BDY97 (BUX80)	4.90
BF115	1.50
BF180	1.20
BF182	.90
BF183	.60
BF184	.80
BF198	.60
BF199	.60
BF200	.60
BF245	1.50
BF337	1.50
BF338	1.90
BF458	1.00
BF459	1.00
BF469	1.00
BF470	1.00
BF494	.90
BF495	.90
BFW10	1.50
BFW11	1.50
BFW16	1.50
BFY50	1.20
BFY90	1.90
BU126	3.95
BU208	4.90
BU326	3.90
BUX80	4.90
MFE131	1.50
MFE3001	9.90
MFE3003	6.95
MJ413	5.90
MJ802	7.50
MJ901	2.90
MJ1001	3.90
MJ11011	8.90
MJ11015	14.50
MJ11016	14.50
MJ15003	6.50
MJ15004	6.50
MJ15024	10.00
MJ2501	8.90
MJ2955	2.50
MJ3001	8.00
MJ4032	12.50
MJ4502	6.90
MJE340	1.50
MJE350	1.95
MJE371	2.95
MJE521	2.50
MJE700	3.50
MJE800	2.95
MJE2801	3.95
MJE2955	2.95
MJE3055	3.90
MJE13005	5.90
MJE13007	7.90
MJE13009	12.50
MPF121	2.90
MPF131	2.90
MPSA05	1.00
MPSA06	1.00
MPSA10	1.00
MPSA12	1.00
MPSA13	1.00
MPSA14	1.00
MPSA20	1.00
MPSA42	1.00
MPSA43	1.20
MPSA55	1.00
MPSA56	1.00
MPSA63	1.00
MPSA65	1.00
MPSA92	1.00
MPSA93	1.20
MPF102	.90
MPF103	.90
MPF105	.90
MPF106	.90
MPF109	.90
MPSL01	1.50
MPSL51	1.50
MPSU02	1.75
MPSU52	1.90
MPSU56	1.90
MPF131	2.75
MRF221	19.50
MRF237	5.90
MRF238	29.50
MRF245	53.50
MRF455	37.00
MRF475	12.50
MRF603	19.50
MRF641	49.00
MRF646	53.00
MRF901	2.90
TIP31A	1.00
TIP31B	1.00
TIP31C	1.00
TIP32A	1.00
TIP32B	1.00
TIP32C	1.00
TIP41C	1.90
TIP42A	1.90
TIP42C	1.90
TIP49	1.90
TIP50	2.20
TIP53	2.90
TIP111	1.50
TIP112	1.50
TIP116	1.50
TIP117	1.50
TIP120	1.50
TIP121	1.50
TIP122	1.50
TIP125	1.50
TIP127	1.50
TIP145	3.50
TIP2955	3.50
TIP3055	1.50

2N

2N301	4.00
2N697	1.00
2N918	1.00
2N1304	1.00
2N1613	1.00
2N2102	1.00
2N2219	.80
2N2222A	1.00
2N2369	1.00
2N2484	1.00
2N2646	1.95
2N2647	2.95
2N2894	1.00
2N2904	1.10
2N2905	1.10
2N2906	1.10
2N2907	1.10
2N3019	1.90
2N3053	.90
2N3054	1.50
2N3055	1.50
2N3096	.30
2N3109	.30
2N3251	.90
2N3302	1.00
2N3440	1.80
2N3441	2.90
2N3442	3.50
2N3563	.30
2N3564	.30
2N3565	.30
2N3566	.30
2N3567	.30
2N3568	.30
2N3569	.30
2N3638	.30
2N3640	.30
2N3641	.30
2N3642	.30
2N3643	.30
2N3644	.30
2N3645	.30
2N3646	.30
2N3702	1.20
2N3704	1.40
2N3739	4.50
2N3771	5.50
2N3772	7.90
2N3792	7.90
2N3819	.80
2N3866	2.95
2N3904	1.00
2N3906	1.00
2N4030	1.10
2N4032	2.20
2N4033	2.20
2N4036	2.20
2N4121	1.50
2N4123	1.50
2N4236	1.90
2N4237	1.90
2N4248	.40
2N4249	.40
2N4250	.40
2N4258	.50
2N4355	.50
2N4356	.50
2N4360	.50
2N4401	.30
2N4402	.30
2N4403	.30
2N4416	1.50
2N4427	3.90
2N4919	2.90
2N5088	1.00
2N5089	1.00
2N5139	1.00
2N5179	1.50
2N5190	2.50
2N5191	2.50
2N5192	3.30
2N5193	3.30
2N5194	2.95
2N5195	3.30
2N5210	1.50
2N5245	1.50
2N5303	8.50
2N5401	1.50
2N5457	1.00
2N5458	.90
2N5459	.90
2N5461	.90
2N5462	.90
2N5485	.90
2N5486	.90
2N5489	14.50
2N5590	26.50
2N5591	29.50
2N5641	19.50
2N5656	2.50
2N5770	.30
2N5777	1.50
2N5830	.30
2N5831	.30
2N5872	1.40
2N5874	1.70
2N5944	12.85
2N5945	39.95
2N5946	49.00
2N5961	1.90
2N6027	1.00
2N6049	1.90
2N6080	21.50
2N6083	26.50
2N6084	37.90
2N6122	1.90
2N6125	1.90
2N6130	1.90
2N6133	1.90
2N6256	14.50
2N6259	13.50
2N6274	29.50
2N6425	4.00
2N6578	4.50
2SD350A	5.90
2SJ49	8.95
2SJ56	14.85
2SK134	8.95
2SK176	14.95
VN88AF	3.95

DIODES

1N4002	.10
1N4004	.10
1N4007	.10
1N4148	.10
1N5404	.30
1N5408	.30
OA47	.80
OA90	.40
OA95	.40
5082-2800	2.95
5082-2811	4.95
HLMP6620	5.95

400mW ZENER DIODES

1N746A 3.3V	.25
1N747A 3.6V	.25
1N748A 3.9V	.25
1N749A 4.3V	.25
1N750A 4.7V	.25
1N751A 5.1V	.25
1N752A 5.6V	.25
1N753A 6.2V	.25
1N754A 6.8V	.25
1N755A 7.5V	.25
1N756A 8.2V	.25
1N757A 9.1V	.25
1N758A 10V	.25
1N962A 11V	.25
1N759A 12V	.25
1N964A 13V	.25
1N965B 15V	.25
1N966B 16V	.25
1N967B 18V	.25
1N968B 20V	.25
1N969B 22V	.25
1N970B 24V	.25
1N971B 27V	.25
1N972B 30V	.25
1N973B 33V	.25
1N974B 36V	.25

1W ZENER DIODES

1N4728 3.3V	.30
1N4729 3.6V	.30
1N4730 3.9V	.30
1N4731 4.3V	.30
1N4732 4.7V	.30
1N4733 5.1V	.30
1N4734 5.6V	.30
1N4735 6.2V	.30
1N4736 6.8V	.30
1N4737 7.5V	.30
1N4738 8.2V	.30
1N4739 9.1V	.30
1N4740 10V	.30
1N4941 11V	.30
1N4742 12V	.30
1N4943 13V	.30
1N4944 15V	.30
1N4945 16V	.30
1N4946 18V	.30
1N4947 20V	.30
1N4948 22V	.30
1N4949 24V	.30
1N4950 27V	.30
1N4951 30V	.30
1N4952 33V	.30
1N4953 36V	.30
1N4761 75V	.80

5W ZENER DIODES

1N5339B 6.2V	1.50
1N5342B 6.8V	1.50
1N5349B 12V	1.50
1N5352B 15V	1.50

BRIDGES

1.5 AMP	
W005	.50
W02	.40
W04	.50
6AMP	
BPC602	2.90
KBPC604	3.50
KBPC608	4.50
10AMP	
KBPC1002	4.20
KBPC1004	4.90
35AMP	
KBPC3502	5.90
KBPC35014MD	
A3504	6.90
3510	9.90

VOLTAGE REGULATORS

7805UC	.80
7805KC	2.50
7812UC	1.20
7812KC	2.50
7815UC	1.20
7815KC	2.50
7818UC	1.20
7818KC	2.50
7824UC	1.20
7824KC	2.50
7905UC	1.20
7905KC	3.50
7912UC	1.90
7912KC	2.50
7915UC	1.90
7915KC	3.50
7918UC	1.90
7924UC	1.90
78L05	.80
78L12	.80
78L15	.80
78L18	.80
78L24	.80
79L05	1.20
79L12	1.20
79L18	1.20
79L24	1.20
LM309K (7805KC)	1.90
LM317T	1.90
LM317K	4.50
LM317HV	9.50
LM323K	7.50
LM337T	2.90
LM338K	10.50
LM350T	6.50
LM350K	6.50
LM395K	22.50
LM396K	19.50
78S40	3.50
MC1496L	14.50

SCR & TRIACS

SC141D	1.90
SC141E	1.95
SC142E	2.95
SC146D	2.85
SC150D	4.95
SC151D	2.95
SC152D	6.90
C103YY	.90
C103B	.90
C106B	1.00
C122D	2.50
C122E	2.95
C260D	8.90
C260E	9.90
2N2646	1.95
2N2647	2.50
2N6027	.90

CRYSTALS

1MHz	8.50
1.832MHz	6.50
2MHz	5.90
2.3040MHz	6.50
2.4576MHz	5.50
2.7648MHz	4.90
3MHz	4.90
3.5795MHz	2.50
3.93216MHz	4.90
4MHz	2.90
4.194304MHz	3.90
4.433618MHz	2.90
4.44MHz	2.90
4.75MHz	2.90
4.915200MHz	6.90
4.9152MHz	2.90
5.00MHz	2.90
5.0688MHz	2.90
6MHz	2.90
6.144MHz	2.90
6.6670MHz	2.90
8MHz	2.90
8.867238MHz	4.90
10MHz	4.90
10.8445MHz	4.90
12MHz	2.90
14MHz	2.90
14.31818MHz	2.90
15MHz	4.90
16MHz	4.90
18MHz	4.90
18.432MHz	4.90
20MHz	4.90
24MHz	4.90
27MHz	4.90
32MHz	4.90
36MHz	4.90
32.768MHz	4.90

IC SPECIALS!

Item	1-9	10+	100+
V-20 8MHz CHIP	$14.95	$13.95	
V-30 CHIP	$39.95	$34.95	
4164	$1.95	$1.85	$1.75
41256-15	$5.95	$5.75	$5.50
27128	$9.95	$8.95	$7.95
27512	$19.50	$18.50	$17.50
6264	$6.95	$6.50	$5.95
6116 LP-3 (150ns)	$3.95	$3.75	$3.50
MJ15003	$2.95	$2.85	
MJ15004	$2.95	$2.85	
MX232 CHIP	$11.50	$10.50	
TEA 2000	$11.95	$10.95	$9.95
ZN429	$9.95	$8.95	$7.95
ZNA 234	$39.50	$37.50	$36.50
ZN414	$1.95	$1.75	$1.65
NE5534AN	$1.95	$1.85	$1.75
AM/EF 7910 (WORLD MODEM CHIP)	$19.95	$17.95	
2732	$8.95	$8.50	$7.95

8087 CHIPS!

8087-3 (4.77MHz)	$199
8087-2 (8MHz)	$385
8087-1 (10MHz)	$585
80287-6 (6MHz)	$475
80287-7 (8MHz)	$679

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

Errors & Ommissions Excepted

008 335757 TOLL FREE MAILORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS & INQUIRIES CALL (03) 543 7877

FORUM

Conducted by Jim Rowe

Should hi-fi amplifiers be earthed or not?

For best performance, high gain amplifiers really need to be earthed. Yet for the last few years, many manufacturers of domestic hi-fi amplifiers have been supplying them as "double insulated" appliances, so that legally they mustn't be earthed!

Perhaps the trend had actually started before I took my leave from *EA* back in late 1979, but if it had, I certainly hadn't noticed. I could have sworn that the vast majority of hi-fi amps were still at least nominally earthed, via the familiar 3-wire mains cord and 3-pin plug.

But now, coming back after a few years of playing with computers, I've discovered that just about all of them have become "double insulated". Apart from anything else this means they have the distinctive "concentric squares" symbol on the back, and are fitted with a 2-wire cord and 2-pin plug. And not only are they not earthed, but the law says that this kind of appliance *must not* be earthed . . .

It's all very interesting. Not so long ago, it used to be accepted wisdom that earthing of high-gain amplifiers was virtually essential, in order to get the best performance — lowest hum, minimum pickup of external noise, and so on. Of course the earthing had to be done carefully and correctly, to prevent introducing other problems such as hum loops and feedback via common impedances. This generally meant having only one "master" earth for the overall system, usually via the amplifier itself, with everything tied back to that as reference.

Now as far as I'm aware, the basic physical laws that used to operate in this area still apply today. Yet the fact remains that the majority of domestic hi-fi amps are no longer earthed, and are in fact designed to actively discourage the user from earthing them. So what gives?

Realising that I'd been away from this area for a while, and might perhaps have missed some important development in audio technology, I tried asking a few of the experts. Including famous names like Neville Thiele, of speaker design fame, and amplifier guru Cyril Murray. No, they said, there hadn't been any major developments. In fact as far as they were aware, it was still just as desirable to earth a high gain amplifier as it ever was.

How did they feel, then, about the fact that the majority of today's hi-fi amps were "double insulated" and not only not earthed, but not legally allowed to be earthed? The answer seemed to be that they hadn't really noticed, because it had all happened slowly and imperceptably — over quite a few years. But when it was pointed out and they gave it some thought, they weren't too happy about it at all.

That seemed to be the answer I got from everywhere. Except from the distributors of the equipment themselves, whose basic reaction was "It's all perfectly legal and safe — we've been doing it for years. What's the problem?"

Curiouser and curiouser, I thought. But there was still something else niggling away in the back of my mind.

When the concept of "double insulated" appliances first arose, quite a few years ago, I seem to recall that it was basically in connection with power tools like electric drills and saws. The kind of tools that are used on building sites, or in other hazardous and "heavy duty" situations.

The idea seemed to be that in this kind of situation, it was desirable to have particularly good insulation inside the tool itself, to ensure that it couldn't become a danger to the user. So as well as providing the usual *functional* insulation inside the tool's motor, the makers started providing a second layer of insulation enclosing the metal "frame" of the motor (and gearbox, or whatever). So any exposed metalwork of the tool, if there was any, was *doubly* insulated from the live wiring.

This ensured that even if the functional insulation inside the motor should break down, there was still the second layer of insulation to prevent any exposed metalwork from becoming live and endangering the user.

Fair enough. In itself, this was an entirely laudable development. But one of the things I've never been too clear about was that these double insulated tools were not supposed to be earthed. It's understandable that they didn't *need* to be earthed, at least as much as other tools and appliances, because of the additional insulation. But why did the safety authorities rule that they *should not* be earthed?

I can only assume that it arose from some kind of concern that if the earthing was via the usual 3-wire cord and 3-pin plug, the earth wire might somehow break off inside the plug, and touch the active pin — making the tool's exposed metalwork become very definitely alive and dangerous — despite the double insulation.

On the surface this seems fair enough. Wires can indeed break inside power plugs, and could perhaps move around and over the moulded-in barriers to touch the wrong pins. But of course they can do so just as easily or otherwise for "normally earthed" appliances — with results that are potentially just as fatal. That doesn't seem to have become an argument against earthing *any* appliances though, does it?

If we're dealing in long shots, there's

also the chance that *both layers* of insulation in a double insulated appliance could break down, and again render the outside metalwork potentially lethal. Without any obvious sign of danger, until you picked it up!

Of course if the outside metalwork happened to be earthed, a breakdown of both insulation layers would produce a blown fuse and make it clear that there was a fault.

I have to admit that it does seem rather more likely in a building site environment that an earth wire might break off inside the plug, than that both layers of insulation might fail. So I guess if I was forced to choose between double insulation and earthing, I'd probably plump for the double insulation.

All the same, if it really was me standing in the middle of a puddle of water using a power drill, I'd like the comforting reassurance of knowing that it was BOTH double insulated and properly earthed — even if this meant breaking the law. I'd rather be alive in clink than laid out as a virtuous corpse on a mortuary slab!

Anyway, as far as I can see, even for the original double insulated power tools, the logic behind the rule that they *must not* be earthed is rather dubious, to say the least. But when it comes to hi-fi amplifiers and similar equipment, things get even more hairy.

As I said earlier, the more I thought about the concept of double insulation, the less it seemed to make sense when applied to a typical hi-fi amplifier. After all, the mains wiring here goes simply to the primary winding of the power transformer, as in most other pieces of electronic equipment. So the first and functional layer of insulation would be the primary winding insulation — between primary and core/frame, and primary and secondaries. In other words, the usual moulded plastic bobbin, mylar tape, varnish and whatever.

But where would the second, protective layer of insulation go? To perform the original purpose of double insulation, it would really need to go in *two* places:

1. Between the transformer core/frame and the amplifier chassis, to prevent the chassis becoming live in the event of primary/core breakdown; and
2. Between the transformer core/frame and its secondaries, to prevent the amplifier circuitry itself from becoming live in the event of primary/secondary breakdown.

The second of these might seem a bit fatuous, but in theory it's just as important as the first. This is because by its very nature, a domestic hi-fi amplifier's circuitry must be directly connected to exposed metalwork: speaker connectors, RCA input connectors and so on. So if there were a primary-secondary breakdown, this exposed metalwork would inevitably become alive.

In reality both of these criteria can be met by using a transformer with totally separate bobbins for the primary and secondary windings, providing that the transformer's core/frame is also fully insulated from the chassis. But this is a fairly expensive approach, and from my inspection of various samples of modern "double insulated" hi-fi amps from different manufacturers, my impression was that none of them had actually done this.

Certainly some had separate primary and secondary bobbins, but few if any appeared to have insulation between the transformer core and chassis. So how could they be double insulated?

The answer to this came when I contacted Ron Profit, from the Standards Association of Australia (SAA). This is the national organisation delegated by the electrical safety authorities in each state to define and administer the various safety regulations.

Mr Profit explained that some time back, the definition of double insulation was changed. It no longer involves the concept of two distinct levels of insulation, but nowadays is defined instead in terms of an overall effective insulation rating. In fact, if the insulation between mains wiring and exposed metalwork will withstand 3750 volts RMS for a prescribed period of time, without breakdown, the appliance concerned is effectively double insulated.

So today's "double insulation" is not really the same as the original definition, but I guess even a single layer of insulation capable of withstanding 3750V must offer a pretty high degree of protection.

Having at least cleared this up, and while I had Mr Profit on the 'phone, I took the opportunity of sounding him out about the law that supposedly says you *mustn't earth* double insulated appliances. Was that indeed the case?

Yes, it was quite true, he confirmed. Double insulated appliances must be provided with a 2-wire cable and 2-pin plug, and must not be earthed. It's all there in SAA Regulation 3250, 1982, Section 5.2.

But when I asked *why*, he couldn't answer. To the best of his memory, it had been decided many years ago, by some committee whose members had probably long since retired. Exactly what rationale they used to make the decision against earthing was probably anyone's guess, nowadays!

So there you have it, at least from the SAA's point of view. Providing an amplifier or any other appliance has insulation capable of withstanding 3750V, it's "totally safe" as a double insulated appliance. It can be given the "concentric squares" label and fitted with a 2-wire cord and 2-pin plug. And if this is done, it cannot legally be earthed.

Frankly I for one am still not convinced about the safety angle, particularly when it comes to the prohibition against earthing. But I get the feeling I'm flogging a dead horse. So let's drop that for the present, and turn to the matter of amplifier performance.

Let's think for a moment about what happens when a piece of electronic equipment, powered from the mains via the usual stepdown/isolation transform-

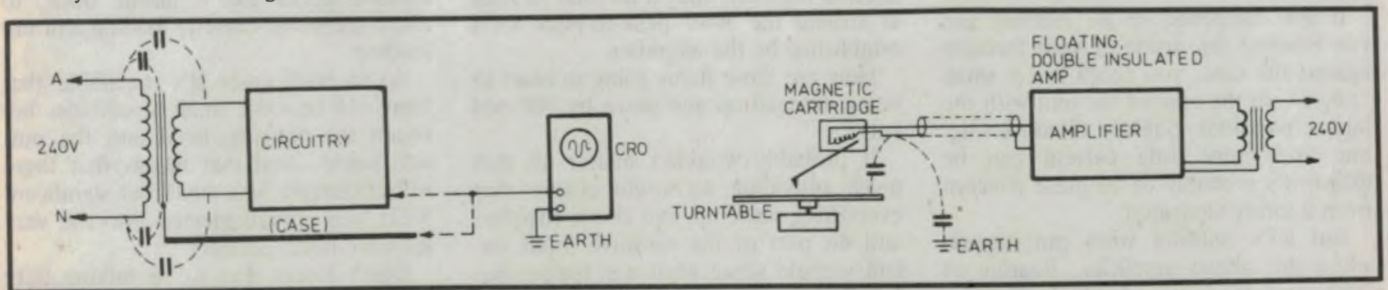


Fig.1 (left): Stray capacitance in the power transformer causes an unearthed double-insulated amplifier to "float" at up to hundreds of volts with respect to earth. Fig.2 (right): this can induce hum via the pickup cartridge wiring, for example.

FORUM

er, is double insulated.

Instead of being electrically "tied down" to the same potential as virtually all of the large objects around — including the largest of the lot, the earth itself — the chassis and circuitry are left "floating". What this means is that the potential they adopt becomes determined by whatever nearby potentials may be coupled to them via mutual coupling impedances.

In most cases, the dominant potential will be that of the 240V mains wiring, coupled in mainly via the stray capacitances between the transformer primary, its frame and the secondary winding(s). So we have an AC potential of hundreds of volts, coupled to the chassis and circuitry via significant capacitance.

What happens is that the complete metal chassis and circuitry adopts a nett AC potential somewhere between mains active and neutral. In other words, they will wobble up and down with respect to true earth, by an AC voltage somewhere between 678 volts peak-to-peak (240V RMS) and zero.

Find this hard to believe? It's absolutely true. I carried out measurements on a couple of typical double-insulated hi-fi amplifiers, using both a DVM and a CRO with 10:1 high impedance divider probe. In one case the DVM read 32.8V RMS, and the CRO showed 175V peak to peak; in the other case the DVM read 88.9V and the CRO showed 305V peak to peak.

In both cases these were the voltages of the chassis/metal case and circuitry, measured with respect to mains earth. In neither case was there any difference between the case and the circuit potentials.

Of course these voltages are at a high impedance level, due to the stray capacitance effectively in series with the "generator". So if you try to draw any significant current, the voltage drops dramatically.

If you happened to be earthed and you brushed the inside of your forearm against the case, you could feel a small "tingle", in the case of the unit with the higher potential. Slightly disconcerting, but since very little current can be drawn it's probably of no great concern from a safety viewpoint.

But let's consider what can happen when the above amplifier, floating at 300V peak-to-peak, is hooked up to the usual array of companion equipment: a record turntable with magnetic pickup cartridge, a cassette deck and an AM/FM tuner.

These are all likely to be double insulated too, but typically with smaller power transformers and a higher "floating" impedance. So when they're all hooked together, they'll all tend to float at around the 300V peak-to-peak level established by the amplifier.

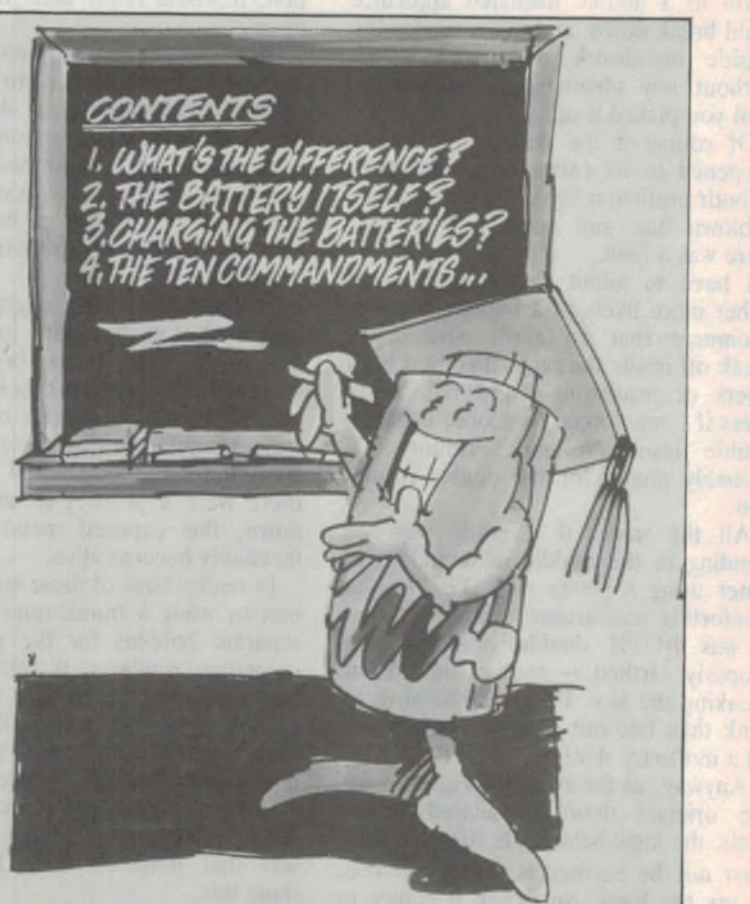
How are these items going to react to being dragged up and down by 300 odd volts?

It probably wouldn't matter all that much providing we could ensure that everything went up and down together and no part of the sensitive input circuitry could sense what was happening. In other words, if there were no stray capacitance to the "real" earth, from things like the pickup cartridge coils and leads, or the cassette deck's tape heads.

Unfortunately in practice this is virtually impossible to achieve. Most pickup cartridges are at least partly made of plastic, and most headshells are open at the bottom. Similarly, the front of most cassette decks has a plastic door, to allow access for cassette loading and unloading.

So in both cases it's inevitable that there will be some small capacitance between the cartridge/head and the outside world. And that means that there will effectively be a small but significant 50Hz hum signal injected into the very sensitive input circuitry.

Don't forget that we're talking here about parts of the overall audio system working at a fairly high impedance, and at normal signal levels of only a couple



Shortly after our January issue went to press with the Forum column on NiCad batteries, news arrived of a 24-page full colour booklet on the subject which has just been released by Arlec. Called "Rechargeable Batteries — Answers to the Most Asked Questions", it is said to provide easy to understand and not-too-technical explanations for both the consumer and salesperson. Chapters cover the differences between rechargeable and disposable cells, how NiCads work, charging and correct battery care. Copies are apparently available from Arlec dealers, or from Arlec itself at 30-32 Lexton Road, Box Hill 3128.

of millivolts, and followed by amplification of around 20,000 times. This is at mid frequencies; in both cases the equalisation characteristic is such that there will be even higher gains at lower frequencies, like 50Hz.

With the complete amplifier system swinging up and down by 300V p-p, it's not going to take much stray capacitance at the input to generate quite noticeable hum.

In practice that seems to be what happens. In some cases the hum can be quite intolerable, particularly via the pickup cartridge. Presumably this will depend on whether the turntable metalwork happens to be tied back to the "earthy" side of the pickup leads, or not — and if not, upon the floating potential adopted by the turntable (relative to that of the rest of the system).

We've certainly found evidence of this kind of problem ourselves, when we've been testing various double insulated amplifiers sent to us for review. Even "on their own", without being hooked up to a magnetic pickup or cassette deck, and with the inputs carefully terminated, we generally find there's quite an improvement in the measured signal to noise/hum ratio if the amplifier is earthed.

If you try hooking up a system to a TV set, to feed the TV sound via the hi-fi, things can get even more complicated. Many modern TV sets are also double insulated, so they too can introduce a further source of "floating" potential — possibly with significant harmonic and high frequency content due to the switch-mode power supply.

It's all very unsatisfactory. I've been hearing of people who've been so troubled by the hum that they've taken an amplifier back to the hi-fi store, thinking it must be faulty. Needless to say the store usually tries it out with the rest of their system (which is often quietly earthed somewhere, I suspect), and proclaims it "perfectly OK". The poor customer is generally sent home with it, and advised to have their house wiring checked out because it "must be faulty". Which is basically quite misleading, because the wiring probably isn't faulty at all. It certainly doesn't have to be, to produce the effect.

What's to be done? In the short term, I'd suggest to anyone who experiences hum trouble that they simply try earthing the system somewhere — either to mains earth, or better still to a water pipe. Technically you'll be breaking the law, of course, but I can't see that it'll do any great harm. In any case, the law concerned is virtually unenforceable — as well as being based on rather dubious and debateable logic.

There should only be a single earth, of course, to prevent the formation of an earth loop (which will generate more hum again, but another way!). I'd suggest it be connected to the amplifier, *or* to the turntable metalwork — whichever gives the lowest hum level. But not to both . . .

In the longer term, I'd suggest to the IREE Audio Group, hi-fi enthusiasts and anyone else concerned with the *performance* of domestic audio systems, as well as with their safety, that they apply pressure to the SAA and the various state authorities to have this whole business of double insulation re-examined.

Fairly obviously the concept is not really appropriate in the context of hi-fi systems, which are rarely used on building sites by chippies standing in the middle of puddles, or at the end of long extension cords with dubious earth wires. To insist that they must be treated as if they were is surely quite illogical, especially since it prejudices performance.

The sooner we tidy up this rather crazy situation, the better. EA

The Serviceman

Not just one "dog" — a whole litter!

Radio/TV servicemen don't need any introduction to the term "dog", signifying a particularly tricky and obscure fault that usually absorbs far more time than is ever paid for. This story has to do with a number of inter-related "dogs" — a complete litter!

I'm happy to say that the story did not involve me, beyond the fact that it has fallen to my lot to re-tell it. The actual participants are a retired engineer-friend, who related the story to me, and a serviceman attached to a large Sydney radio/TV service organisation.

The friend in question has a technical background, but prefers nowadays to rely on a service contract to cover any faults in the family TV receiver, rather than having to worry about them himself. The receiver, by the way, is a 63cm solid state series 104 English Decca.

The set had apparently given excellent service over several years but, a few months ago, it developed a problem in its Australian-made Philips tuner. The tuning started to drift spasmodically, producing sound bars across the screen and requiring frequent readjustment to the touch-tune preset potentiometers.

Then channels 0 and 2 suddenly disappeared completely, and my friend decided that it was time to ring for service, being careful to explain the nature of the problem.

Within hours, a serviceman was on the doorstep and, after observing the fault, decided to replace the tuner module — a job that looks messy, but not really difficult for someone who has done it before! The serviceman explained that it was better to instal a replacement tuner (in this case a new one) rather than try to troubleshoot the old one in the home.

Said he: "They can repair it much better in the workshop, where they have instruments and test jigs."

With the new tuner installed, the set worked as well as it ever had and my friend was quite happy. He reckoned that his insurance fee for the year had been accounted for in that one job. Little did he realise what the receiver had in store for another, less fortunate serviceman.

The first "dog"

A few months later, he began to notice occasional sound bars again but, this time, the tuner did not appear to be to blame, the touch-button potentiometers being still spot-on.

Then he noticed something else: the sound bars were evident more frequently on advertisements than on ordinary programs — a seemingly crazy notion, so he chose to ignore it for the time being.

But, one evening, the picture suddenly flickered a couple of times and collapsed to a single bright line across the centre of the screen. The vertical deflection had obviously failed and he hastened to turn the receiver off, rather than risk burning a line across the screen.

However, when he turned it on again half an hour later, it came up with a perfectly normal picture, and stayed that way for the rest of the evening. So, before going out next day, he told his family that they could use the receiver — but warned them against leaving it unattended, even for a few minutes.

Just as well because, while they were able to watch most of their favourite programs, the set did fail a couple of times. So he rang for service next morning, pointing out to the company that the fault was intermittent and likely to pose a problem on that account.

While waiting for the serviceman to arrive, my friend more or less idly tapped the cabinet and noticed that the picture flickered slightly. In fact, the receiver appeared to have become "microphonic", and he realised that here was a possible explanation for the strange sound bars he had noticed earlier.

If the picture could be affected by light tapping on the cabinet, it was reasonable to expect that it might also react to sound vibrations from the loudspeaker — especially with loud advertisements: sound bars of a novel kind! Perhaps it was the same basic fault that, at other times, had collapsed the picture completely.

Missing: one dog!

Fortunately, the receiver continued to misbehave for the serviceman, leaving no doubt as to the existence of a problem. But no amount of looking or tapping or flexing gave any clue as to its source. Finally, the serviceman had to give up, promising to return the next day with a replacement vertical deflection board, which he felt sure, would overcome the problem.

But during the evening, the receiver suddenly stopped altogether: no line across the screen, no sound, no anything! It seemed to suggest that the problem might really be in the vertical output circuit, and serious enough to take out the power supply. So, first thing next morning, my friend rang the service company to advise them of the unexpected development.

Thermistor lead

This time, the serviceman had to get the receiver going again before he could resume his search for the original intermittent. After a deal of circuit tracing, he tracked the cause of the breakdown to a faulty lead on a negative temperature coefficient thermistor (R652, VA-1104) in the power supply — a component that he said rarely gave any trouble and for which he had no replacement in his kit.

It was unclear whether the lead had been faulty for some time, or had simply failed due to recent probing. It may or may not have had something to do with the reported problems.

All the serviceman could do was to patch it up, in the hope that it would hang together until he could return next day with a new one. In the meantime, he substituted the replacement vertical deflection board, on the basis that, with a bit of luck, there would be no further sign of the intermittent fault.

Three minutes later

But the receiver operated for about as long as it took him to get to the end of the street. So that next day, after replacing the thermistor as promised, he was really none the wiser as to whether replacing the vertical deflection board had cured the intermittent or not.

Certainly the receiver now appeared to be behaving itself, and the serviceman was optimistic. He'd replaced the deflection board, the prime suspect, and also a faulty thermistor.

"Here's hoping" he said, as he took his leave.

Visit four

But an hour later, the receiver was "acting up" worse than ever. It didn't actually stop and the picture didn't actually collapse but it was woefully intermittent and microphonic. Said my friend:

"I felt sorry for the serviceman, having to ring for the fourth day in succession, but I suggested that they call me back an hour before he was due to come. I would switch the set on, to give it time to get hot and start playing up."

"To make things easier, I set up a wall mirror so that he could work behind the set and watch every detail of the picture."

Perhaps it was just as well because, by the time the serviceman arrived, the receiver was sensitive to almost any vibration, making it very difficult for him to localise the fault. But he worked his way methodically around the whole set, even re-soldering one suspect lead to the original replacement tuner. But, in the end, he was back at the vertical deflection board.

"You know", he said, "I think we've ended up with a second faulty deflection board. It doesn't happen often, but the occasional fault does get through our lab."

At that juncture my friend pointed out that he had a small workbench in his garage, where the serviceman could check the board in detail under a good light. He jumped at the chance — and struck the jackpot! To his touch, a transistor felt suspiciously "loose" and, when he nudged it a little harder, it fell right off. At least one of its three leads must have been broken but still making erratic contact, while the other two were probably fatigued.

Fortunately, he was able to supply a suitable replacement from his kit and to repair and re-install the panel on the spot. The receiver hasn't faltered since.

But you can see why I was happy not to be involved: four separate calls to find and correct a fault in a module that wasn't even in the set the first time the set failed!

I wonder what was wrong with the original faulty module, and how much the exercise cost the service company?

8-legged conductor

So much for "dogs". But just to continue this month's animal theme, here's an intriguing little take of the havoc caused by a rather different kind of beast — one with eight legs, all of them hairy!

I called on a colleague recently and found him in a small degree of trouble. He asked if I had my picture tube tester with me, and could he use it to test the tube in a set he had on his bench. As it happened, I did have the tester in the van, so I set about evaluating the tube for him. While I worked he told me the history of the fault before us.

Miss Muffett should be so lucky — she only lost a bowl of whey!

The story goes that the owner was watching the set one evening when there was a loud "splat" from inside the cabinet, and then nothing. The set went completely dead. It was a fairly late model Sanyo, and as my friend is the local Sanyo agent, the owner brought it straight to him.

When Frank took the back off, the cause (though not the extent) of the trouble was immediately apparent. Spreadeagled on the picture tube base board was the biggest Huntsman spider we've ever seen. It was quite dead, of course, but it was the nature of the killing that had done the dastardly deed to the television set.

By this time I had got a reading of the tube's emission, and had to report that the red gun was down to about 10% of normal efficiency. With the other two guns at near normal emission, there was no way this tube could ever give a balanced picture.

Frank continued with the tale of woe. The first fault he found was that the main fuse had blown. This was because the line output transistor was shorted. Then he found the EHT tripler was ruined.

After putting right all of these troubles, he could only get a bluey-green picture. There was almost no red content at all. He tried all the screen and drive controls, and checked the chroma output stage, but he couldn't get any more than a pale red image that was flaring badly. He thought it must have been the tube, and of course we now know that he was right. But why?

It seems that the extinct arachnid must have been warming itself on the tube baseboard, when its body made contact between the tracks to the Screen (G2), at some 670 volts, and the red cathode. Even after the corpse was removed from the board there was still a strip of baked spider between the two points. This had to be scraped away quite vigorously before the board was safe to use again.

We think that the short has in some way stripped the cathode of its emissive coating, although the mechanism by which this occurred is quite obscure. This sort of technique is used sometimes to rejuvenate old tubes, except that for this purpose the potentials are reversed, negative to cathode.

But whatever the mechanism, one crawly spider has ruined a fuse, a line output transistor, a tripler and picture tube. Miss Muffett should be so lucky — she only lost a bowl of whey!

Vintage radio faults

Finally this month, I have three little "mini stories" concerning old valve radios, sent to me by regular reader Mr J. Emery, of Bullcreek, WA. I thought you'd like to read them, in view of the current interest in restoring vintage radios. Who knows — you might come across the same faults as Mr Emery!

Here are his stories:

"Story number 1: At one stage during World War II, I was servicing part-time with the local agent for a well known manufacturer, when I came across one of their radios whose converter oscillator cut out at frequencies below 800kHz (on the dial). When I told my story to the full time serviceman, he put on a knowing look and told me to bring him the set and a large screwdriver."

"With the air of a magician, he took the screwdriver and tightened the screws at the top of the tuning gang which held its fixed plates in position. To my amazement the problem disappeared!"

"On the broadcast band the output of the converter oscillator tends to fall off at the low frequency end. Apparently the screws had become loose or corroded, increasing the resistance between the tuning capacitor and the oscillator coil to a point where it cut out at the lower tuning frequencies."

"Story number 2: When listening to a friend's console model valve radio one evening many years ago, the programme was interrupted by a loud burst of Morse code, which she said happened quite often."

"The next time I visited, I came armed with a signal generator and as I had suspected, the IF was tuned to around 500kHz. This was right in the middle of the maritime calling and distress frequency band — and she lived about a mile from the main transmitters for the Port of Fremantle! Re-tuning the IF transformers to 465kHz solved the problem."

"And finally, story number 3: A customer came to me with a valve mantel radio and a sheepish look on his face, saying, 'You're not going to believe me, but this set always seems to go off about the time for the evening news service.'"

"Whilst puzzling over what objection the radio could possibly have to presenting the news, I suddenly realised that the peak demand on the electricity supply would occur at this time, so I tried it on reduced voltage. Sure enough the oscillator cut out at 230 volts. With a new converter valve it continued to work down to 200 volts, and his problem was solved."

Thanks for those little journeys back along memory lane, Mr Emery. I only wish some of my faults in modern solid state equipment could be solved as easily!

TETIA Fault of the Month

Rank C2230

Symptom: Intermittent darkening of picture, together with noticeable worsening of already obvious side pin-cushion distortion. The 18.5V rail varies from high, to very high.

Cure: D555, D559 or D560 intermittent open circuit. One or more of these diodes will also have a higher than normal forward voltage drop. Replacing all three diodes will bring the rail back to 18.5V, correcting both the brightness problem and the SPC distortion.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, Tas 7015.

How to beat the high cost of cheap meters.

You get what you pay for.
So get the Fluke 70 Series.

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

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

That's because they're built to last, inside and out. So they're tough to break. They don't blow fuses all the time. You don't even have to replace batteries as often.

And they're backed by a 3-year warranty. Not the usual 1-year.

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

You may not care that they have a lower overall cost of ownership than all the other "bargain" meters out there.

But just in case, now you know.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE®

FLUKE 73	FLUKE 75	FLUKE 77
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000 + hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000 + hour battery life	0.3% basic dc accuracy
	3-year warranty	2000 + hour battery life
		3-year warranty

ELMEASCO
Instruments Pty. Ltd.

Talk to your local Elmeasco distributor about Fluke

A.C.T. John Pope Electrical (062) 80 6576 • J Blackwood & Sons (062) 80 5235 • George Brown (062) 80 4355
N.S.W. Ames Agency 699 4524 • J Blackwood & Sons • George Brown 519 5855 Newcastle 69 6399 • Auto-Catt Industries 526 2222 • D.G.E. Systems (049) 69 1625 • W.F.Dixon (049) 69 5177 • Ebson 707 2111 • Macelec (042) 29 1455 • Novacastrian Electronic Supply (049) 62 1358 • Obiat Pty Ltd 698 4776 • Petro-Ject 569 9655 • David Reid 267 1385 • Selectroparts 708 3244 • Geoff Wood 427 1676
N.TERRITORY J Blackwood & Son (089) 84 4255, 52 1788 • Thew & McCann (089) 84 4999
QUEENSLAND Auslec (07) 854 1661 • G.Brown Group (07) 252 3876 • Petro-Ject (075) 91 4199 • St Lucia Electronics 52 7466 • Cliff Electronics 341 4655 • Nortek (Townsville) (077)79 8600 • L.E.Boughen 369 1277 • Fred Hoe & Sons 277 4311 • The Electronics Shop (075) 32 3632 • Thompson Instruments (Cairns) (070)51 2404
S.AUSTRALIA Protronics 212 3111 • Trio Electrix 212 6235 • Industrial Pyrometers 352 3688 • J Blackwood & Sons 46 0391 • Petro-Ject 363 1353
TASMANIA George Harvey (003) 31 6533 (002) 34 2233
VICTORIA Radio Parts 329 7888 • George Brown Electronics Group 878 8111 • G.B. Telespares 328 4301 • A.W.M. Electrical Wholesalers • Petro-Ject 419 9377 • J Blackwood & Sons 542 4321 • Factory Controls (052) 78 8222 • Mektronics Co 690 4593 • Truscott Electronics 723 3094
W AUSTRALIA Atkins Carlyle 481 1233 • Dobbie Instruments 276 8888 • Protronics 362 1044

News Highlights

Hi-tech co-operation made possible Bicentennial Antarctic link

Apart from providing an example of the technology needed to present such a television feat, the live cross to Antarctica showed the extraordinary cooperation involved in "Australia Live — A Celebration Of A Nation", broadcast on January 1.

A Sony CCD camera, microphones and monitors captured the Antarctic pictures. The signals were then fed into a GEC Marconi Codec, recently bought by OTC. Here analog was coded to digital and passed to an NEC modem on loan from Telecom.

From there the 2Mbit/s stream was fed into a 7m dish, installed within a radome to protect it from the Antarctic elements. Here it was uplinked via Intelsat's Vista System and downlinked by the Ceduna Earth Station in South Australia.

Still as 2Mbit/s, it was then sent to OTC centre at Paddington, OTC engineer Peter Burgess, who helped train the two Antarctic engineers who recorded the pictures and sound, was at Ceduna to ensure safe carriage of the signal.

At Paddington, a matching codec converted the digital information back to analog and passed it onto the central Control Centre at TCN Channel Nine in Sydney.

Peter Sjoquist (L), Peter Faiman (R)

From there the picture went live to homes throughout Australia on Nine Network, ABC, SBS and regional commercial stations. They were also seen, via satellite, in Europe, America and Asia. The programme was also fed back the reverse pathway to Davis, giving the Antarctic base its first live television.

China to make Philips colour tubes

Philips and Jiangsu Province, in P.R. China, have signed the final contract for establishing a joint venture to manufacture colour TV tubes and deflection units. The signing of this contract, and preliminary agreements for the future manufacture of video cassette recorders in Dailan and of bipolar ICs in Shanghai, took place in Beijing's Great Hall of the People, in the presence of Mr C.J. van der Klugt, president of Philips and chairman of the Board of Management and Group Management Committee.

During his six day visit to China, Mr van der Klugt had a meeting with premier Zhao Zi Yan, while a reception was held in his honour by vice premier Tian Ji Yun.

Partners in the new joint venture are the China National Huadong electronic tube factory in Nanjing, 45% Philips 30%; and surprisingly the Hong Kong Investment and Trading Company, 25%. Total investment amounts to $US180 million, of which some 100 million are for equipment and know-how to be delivered by Philips.

The factory will be built at the premises of the Huadong Company and will have a capacity of 1.6 million tubes per year. Manufacturing will be based on the latest Philips technology for flat square colour TV picture tubes. Some 1,600 people in total will ultimately be employed.

It is expected that building work will start this year. Manufacturing will begin in mid-1990 and full production will be reached in mid-1994.

Design award to Australian POS terminal

An electronic point of sale terminal designed in Sydney has won a Design Council award. The award went to Cashmaster and a quantity of Cashmaster terminals have already been ordered by the Southern Pacific Hotel Corporation for use in the Boulevard Hotel in Sydney, in what is seen as a pilot trial.

The Cashmaster was designed to replace the cash register and differs from most electronic terminals in that it can use a variety of host computers. It can also be adapted to various retail systems through application software.

The terminal has a unique book-style keyboard which provides single keystroke rather than multi-keystroke access to stock items, product groups or customers.

Largest Australian SMT installation

Australia's largest Surface Mounted Component (SMC) technology installation has been implemented by STC, as part of its continuing effort to streamline production of the Commander BN Telephone Systems it manufactures for Telecom Australia and overseas markets. For a one-time investment of $1 million, the company expects to trim product manufacturing costs by the same amount each year.

The specific item to be manufactured is the miniaturised PCB that functions as the control panel of the complex Commander communications system. Previously, STC purchased these boards in a pre-assembled state.

The SMC installation is STC's second move to automate major aspects of the production of the Commander Telephone Systems. Earlier last year — and to generate projected savings of $100,000 per annum — a sophisticated robot with a unique, Australian-designed vision system was developed to handle the final key placement phase of the telephone's assembly.

SBS now available via DBS

Close to three million Australians in regional areas of South Eastern Australia now have the potential to receive SBS television via the Aussat satellite, following the Government's decision to end the encoding of the SBS signal.

The decision will provide immediate access to SBS programs to the 1000 or so owners of small domestic B-MAC satellite receivers in the South Eastern zone who are outside the areas already served by SBS. These people already receive ABC programs under the Homestead and Community Broadcasting Satellite Service (HACBSS).

The SBS has been using an Aussat satellite to distribute programs to its terrestrial transmitters in South Eastern Australia and Perth. This distribution signal is not actually designed for reception by small domestic satellite receivers, and when it was commenced in March 1986 it was decided to encode the signal because it was thought not to provide a suitable quality for regional reception.

The B-MAC transmission system has, however, performed even better than originally anticipated, paving the way for the signal also to be received by small domestic receivers.

TI Technology Award winners

Winners of the Texas Instruments' inaugural Technology Awards were Tiong Lee Ng from the University of NSW, Earl Chew from Monash University and John Reekie from the NSW Institute of Technology. Each was presented with a TI Personal Computer and praised for their initiative.

The awards were divided into three categories, LAN (Local Area Networking), DSP (Digital Signal Processing) and Parallel Processing (Fifth Generation Computing).

In the Parallel Processing Category, Reekie developed a performance-oriented expansion of the capabilities of a digital music synthesiser, which was written for the Texas Instruments' TMS320C25 DSP chip.

Winner of the LAN category, Ng, presented a protocol devised to implement an efficient integration of voice and data communications in the Token-Ring.

To win the DSP category, Chew developed a Digital Baseband Echo Cancellation Test set using a Texas Instruments' TMS32020 card which plugged into a PC.

Managing Director of Texas Instruments Stuart McNair said the winning projects graphically demonstrated the high level of technological talent in this country.

"It is clear that we have many young technologists in Australia whose expertise will provide the basis for an expansion of Australian technology in the near future.

"This is the very reason for the Technology Awards being created — to provide the encouragement for more students to look to electrical engineering as a career."

The awards were presented by Mr Larry Adler, Chairman of FAI Insurance, Mr Mel Ward, Managing Director of Telecom, and Mr Brian McKay, President of the Australian Electronic Industry Association.

New Sydney satellite terminal

Australia's international communications network has received a boost with the opening of OTC's $26 million Sydney Satellite Earth Station at Oxford Falls.

Located 17 kilometres north of Sydney's central business district, the station carries telephone, television, text and data traffic between Australia and New Zealand, Papua New Guinea, Asia, Japan and North America.

The OTC Sydney Satellite Earth Station currently operates three dishes — an 18-metre Standard A working to one Intelsat satellite; an 8-metre Standard A for testing; and a 7-metre for digital business service demonstrations. OTC's 32-metre antenna, previously at the Moree satellite centre in central NSW, will be relocated to Sydney this year and will work to a second Intelsat satellite.

It is expected that the satellite earth station will then carry almost one third of Australia's total international communications traffic.

News Highlights

Electric vehicle endurance run

Canon Australia is sponsoring the Australian Electric Vehicle Association's 1988 Electrathon, to be held at Melbourne's VFL Park on Sunday 1st May.

There will a total of three events, for various kinds of vehicle with 2, 3 and 4 wheels, different battery weight limits and other qualifiers. Prizes totalling over $5000 will be awarded for the three events.

Further details are available from Gabby Jenes, AEVA Melbourne Branch, PO Box 273, Mitcham 3132 or phone (03) 758 6871.

Transistor turns 40

The transistor, the invention which opened the way to the modern electronic age, celebrated its 40th anniversary late last year.

The transistor was invented at AT&T Bell Laboratories in Murray Hill, New Jersey on Dec 23, 1947, by a research team charged with finding a replacement for the bulky, fragile and energy-hungry vacuum tube.

For their achievement, three physicists — John Bardeen, Walter Brattain, and William Shockley — received the 1956 Nobel Prize in Physics, one of four Nobel Prizes awarded to Bell Laboratories scientists over the company's 62-year history.

Sometimes called Bell Labs' "Christmas gift to the world", the device was born when the team first demonstrated the "transistor effect" — the amplification of a voice signal by a semiconductor crystal in an electrical circuit.

The "transistor" was not named by one of its inventors, but by a colleague, John Pierce, who coined the term from the device's ability to *trans*fer res*istance* from one wire contact to another.

Sadly co-inventor Walter Brattain died in Seattle on October 13, just two months before the 40th anniversary. He was 85.

Video communications for Expo 88

Texas-based Datapoint Corporation has become Expo 88's official supplier of Integrated Video/Voice Intercommunication Systems, which will be used to help parents find their lost children at the Exposition.

Expo 88 is to take delivery of five MINX workstations from Datapoint and establish a communications system throughout the Expo site using some three kilometres of video cable. Each workstation consists of a colour monitor with built-in full-motion colour video camera and speaker microphone.

Communications between workstations are serviced through a cluster controller and there will be one workstation in each of four Information Centres. The Duty Operations office will also have a workstation.

In the video communications mode, which will be used at Expo 88, the MINX workstation operates on a hands-free basis. The video image is switched by voice activation to show the current speaker in a multi-way conference.

News Briefs

- Former ***Bell & Howell Australia*** executives Barry Edmonds and Barry Smith have bought the company's audio visual division. The new operation will be known as ***B & H (Aust.)***, and will be based in Ultimo, NSW.
- John Stankovich has been appointed national sales manager for Adelaide-based ***Titan Electronics***. Mr Stankovich was formerly assistant chief engineer of SAS-10.
- ***Olex Cables*** has been awarded a $A10 million contract to supply optical fibre cable to Televerket, the Swedish telecommunications authority. First delivery is in April, with the rest during 1988-89.
- International power supply maker Computer Products Inc. has appointed ***Amtex Electronics*** as its sole Australian distributor. Products in the CP range include Boschert switchers and Stevens-Arnold DC/DC converters.
- A PCB technology consultancy has been established in Sydney by Robert Perrin, formerly with Printronics and an internationally recognised expert in this area. Mr Perrin can be contacted on (02) 81 3299.
- ***Intertan Australia***, which trades as Tandy Electronics, has appointed David Beveridge to the position of agricultural, educational and vertical computer marketing co-ordinator.
- Peter Avis, formerly with GEC and George Brown Group, has been appointed sales manager for ***Computer Switching Systems & Cables***. CSSC has now added design and manufacture of cable looms, to its existing services to the industry.
- Japanese electronics giant ***Fujitsu*** is to build a $30 million telecommunications factory at Dandenong, in Victoria. The new plant will create about 200 new jobs, and is expected to begin production of telephones and related equipment in late 1988.

Hi-tech office building

Central Plaza, Brisbane's newest office twin towers, can give a very dedicated executive access to his office facilities, any time of the night, seven days a week. It can also be remotely programmed with air conditioning requirements, right down to the hours of operation and temperature.

This is all possible through a revolutionary telephone command system (TCS), which is linked to the building automation computers controlling the 48 level Central Plaza One tower and the 30 level Central Plaza Two tower.

The system, recently developed by Digital Equipment Corporation in the United States, can be accessed from any push button telephone in the world.

According to mechanical engineer on the project, Mr Kris Kistiansen of Norman, Disney and Young, Central Plaza offers tenants the opportunity to choose their own working hours without having to rely on building engineers or security guards.

When the computer is contacted by a tenant it responds with the words, "Hello, this is your Central Plaza computer", by virtue of a voice synthesised computer chip which is programmed to respond to certain basic words. The tenant can then enter his identification number to proceed.

The system, which has a spoken menu, asks specific questions relating to the time a tenant wants the air conditioning plant to run outside normal hours. It can also increase or decrease the temperature, add more air or command a cost statement.

"It's technology that is new to Australia, and it puts Central Plaza right up with the most sophisticated buildings in the world", said Mr Kistiansen, who has specified the system for Central Plaza.

The TCS can also be used to enter Central Plaza without a card key, using a vandal proof telephone at the entrance to the building's car park.

Efficient power for remote areas

BP Solar has released what is believed to be the most complete and economical package for isolated power supply yet produced. The RAPS (Remote Area Power Supply) system can provide the electrical needs of most outback homesteads.

It claims to bring easily obtainable 24 hour-a-day power to many remote areas for the first time.

RAPS makes optimum use of power produced either by a diesel generator, solar panels — or a combination of both. Power is stored in specially developed long life batteries.

An Australian designed control panel is at the heart of the system. It can be programmed to users' requirements to provide priority power to chosen house circuits.

The controller automatically shuts down the generator to avoid wastage when the batteries are fully charged.

Systems development engineer of BP Solar, David Bartley said RAPS could be individually tailored to suit the requirements of each user.

Amateur radio "field day"

All amateur radio operators, their families, friends and those interested in amateur radio are invited to attend the 1988 Central Coast (NSW) Amateur Radio Field Day, to be held on Sunday 21st February at the Gosford Showground. Gates will open at 8am wet or dry, as all displays are under cover.

The registration fee will be $4 for gents, $2 for ladies and $1 for children, with a pensioner concession of 50% on production of pension card. A special group concession will also be available.

Field day attractions include a home brew contest, home brew antennae evaluation (70cm), trade displays and displays of amateur television and packet radio.

Sydney and Newcastle trains will be met by a courtesy bus which will run between Gosford Railway Station and the Showground between 8.30am and 10.30am. Plenty of off street parking will be available at the Showground.

HP claims first with LaserRom service

Hewlett-Packard Australia claims to have beaten its competitors to the punch in announcing HP LaserRom, a new support service that places HP product and technical information on compact discs.

Subscribers to the new service will be able to access up-to-date reference manual information, application notes, solutions to problems and information about HP products and services; up-to-date because they will receive a new disc each month. The old disc is simply thrown away.

Information stored on the disc can be accessed instantly through a keywork and retrieval file management system. Customers specify words, phrases, words in proximity to each other, and LaserRom, finds the required information. The system even has a built-in thesaurus which further assists.

THE GREAT 15% OFF SALE CONTINUES

Due to the unbelievable response in January we are extending our pre-catalogue sale for one more month. Sale definitely ends last day in February - no exceptions.

That's right! **No Exceptions. Every single item** in your local Jaycar Store is **Discounted** for a strictly limited time. We have to remove **hundreds** of old lines for our brand new March '88 Catalogue so that we can fit many great new products in. Rather than just discount the old lines the Boss told us - **Discount everything!**

But you must hurry. Any regular line that is in stock at the time of purchase qualifies for the 15% discount. We **will not** back order goods that are out of stock during the sale at the discount price. If any out of stock item comes back into stock **during** the sale, you will get it at the discount price!

(Please do not ask for the discount price after the sale).

So now is the time to make a significant saving on that big kit, and other major purchases.

NEW KITS FOR FEBRUARY

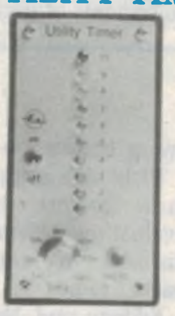
LOW COST UTILITY TIMER

Ref: EA Feb 1988

Whether you wish your egg soft, but not too soft, or whether you want to add the time factor to a game of Trivial Pursuit, this utility timer is ideal.

Complete kit Cat. KA-1697

$21.95



TRANSISTOR, FET AND ZENER TESTER

Ref: EA Feb 1988

Revamped version of an oldie. Checks transistors, fets and zeners as well as checking transistor breakdown voltages. Great for the workbench, and also for showing how semiconductor devices operate. Complete kit includes box, meter, transformer and all parts.

Cat. KA-1698

$55.00

LOW DISTORTION AUDIO OSCILLATOR **$165**

Ref: EA Dec 1986

At last it's available, the metered version of our auudio oscillator. Compares with the very best laboratory standard sine wave equipment available.

Cat. KA-1677

SUPER SIMPLE MODEM **$85.00**

Ref: AEM Sept 1986

Due to customer demand, we have decided to introduce this into our range. It's very cheap and it works well. Kit is supplied with RS232 female connector and all other parts except power pack which is extra $13.95 (Cat. MP-3020)

Cat. KM-3046

LOW OHMS ADAPTOR FOR DMM's **$29.95**

Ref: Silicon Chip Feb 1988

Another handy kit from SC which utilises your digital multimeter.

Cat. KC-5023

MODEM END OF FILE INDICATOR **$9.95**

Ref: Silicon Chip Feb 1988

PC board and all parts supplied including switch.

Cat. KC-5024

DOOR MINDER **$37.50**

Ref: Silicon Chip Feb '88

New generation door opener alarm.

Cat. KC-5020

9V power supply Cat. MP-3010 $18.50

LESS 15% OFF ALL PRICES

TELEPHONE INTERCOM

Ref: ETI Feb 1988

Use 2 old telephones to make an intercom. Kit includes power supply, filter capacitors, box and all parts.

Cat. KE-4731

$59.95

ULTIMATE CAR BURGLAR ALARM

Ref: Silcon Chip Feb '88

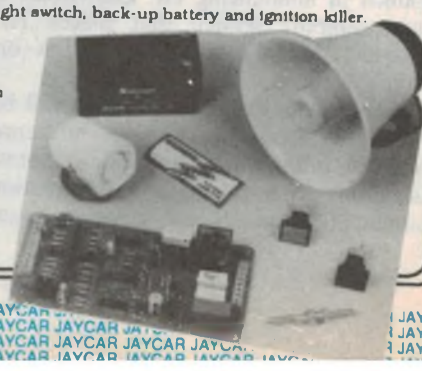
Includes flashing light switch, back-up battery and ignition killer.

Cat. KC-5021

$79.50

Extras - Siren Horn Cat. LA-5700 **$26.50**

Screamer Piezo Cat. LA-5255 **$17.95**



15% off these kits

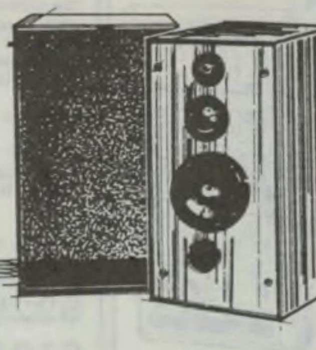
Cat		WAS	SALE PRICE
Electronics Australia Kits			
KA-1010	Musicolor 4	$125.00	$106.25
KA-1109	Electric Fence	$23.50	$19.97
KA-1115	300W amp module	$119.95	$101.96
KA-1116	300W power supply	$99.50	$84.58
KA-1117	300W speaker protector	$23.50	$19.97
KA-1119	Transistor tester	$21.50	$18.28
KA-1220	Signal tracer	$27.95	$23.76
KA-1390	Frequency Counter 50MHz	$169.50	$144.08
KA-1428	Function Generator	$129.50	$110.08
KA-1430	Vocal Canceller	$24.95	$21.21
KA-1505	TAI Hall Effect	$44.95	$38.20
KA-1506	Transistor Assisted Ignition	$42.50	$36.13
KA-1508	Touch Light Dimmer	$29.95	$25.46
KA-1522	Guitar Effects BBD	$115.00	$97.75
KA-1535	Ignition Killer	$23.50	$19.98
KA-1550	Deluxe Car Alarm	$89.50	$76.08
KA-1555	CQAM Stereo Decoder	$26.50	$22.53
KA-1556	Ultra Sonic Movement Det.	$34.95	$29.70
KA-1560	Railmaster Controller	$109.95	$93.46
KA-1574	30V 1A Power Supply	$89.50	$76.08
KA-1582	House Alarm	$169.00	$143.65
KA-1595	Digital Capacitance Meter	$85.00	$72.25
KA-1598	40W Inverter 12/230V	$99.95	$84.96
KA-1610	300W Inverter 12/230V	$249.00	$211.65
KA-1635	AM/FM Stereo Tuner	$599.00	$509.15
KA-1636	AM/FM Remote Control	$99.50	$84.58
KA-1650	Playmaster 60/60	$299.00	$254.15
KA-1652	Blueprint 60/60	$349.00	$296.65
KA-1660	Electric Fence	$59.50	$50.58
KA-1674	Digital Photo Timer	$89.95	$76.46
KA-1675	Screacher Car Alarm	$34.95	$29.70
KA-1677	Audio Oscillator (metered)	$165.00	$140.25
KA-1679	Turbo Timer	$29.95	$25.46
KA-1681	3 Band Short Wave Radio	$79.50	$67.58
KA-1682	Dual Tracking Power Supply	$129.95	$110.46
KA-1683	Battery Monitor	$14.95	$12.71
KA-1684	8 Channel I/R Transmitter	$45.00	$38.25
KA-1685	IR Receiver (Std)	$127.95	$108.76
KA-1686	IR Receiver (add-on)	$55.00	$46.75
KA-1687	Electronic Rain Guage	$49.95	$42.46
KA-1690	DI Box	$39.95	$33.96
KA-1691	TV Colour Bar/Pettern Gen	$159.00	$135.15
AUSTRALIAN ELECTRONICS MONTHLY KITS			
KM-3010	60W Mosfet amp	$59.50	$50.58
KM-3012	120W Mosfet amp	$79.50	$67.58
KM-3015	Listening Post	$39.95	$33.96
KM-3016	RTTY Encoder	$29.95	$25.46
KM-3020	6000 Power Amp	$998.00	$848.30
KM-3030	Ultrafidelity Preamp	$359.00	$305.15
KM-3040	Dual Speed Modem	$169.00	$143.65
KM-3042	Speech Synthesiser	$43.50	$36.98
KM-3050	Workhorse Amp	$35.00	$29.75
KM-3058	64 Pkt Radio	$59.95	$50.96
KM-3060	Balanced Line Driver	$99.50	$84.58
KM-3061	Microphone Preamp	$36.95	$31.41
KM-3062	RS True 232 Interface	$24.95	$21.21
KM-3063	Uo Satellite Decoder	$55.00	$46.75
ETI KITS			
KE-4013	Microwave Leak Detector	$17.95	$15.26
KE-4014	Mixer Preamp	$39.50	$33.58
KE-4023	Signal Spk Manfacturer	$22.50	$19.13
KE-4029	NiCad Battery Charger	$16.95	$14.41
KE-4033	Temperature Probe	$32.95	$28.00
KE-4050	ETI480 50W amp module	$27.50	$23.38
KE-4052	ETI480 100W amp module	$34.50	$29.33
KE-4048	ETI480 power supply	$29.50	$25.08
KE-4200	5000 Power Amp	$499.00	$381.65
KE-4202	5000 Preamp	$399.00	$339.15
KE-4204	5000 1/3 Octave Eq.	$219.00	$186.15
KE-4220	ETI499 150W Mosfet amp	$109.50	$93.08
KE-4666	RS232 Centronics Interface	$32.50	$27.63
KE-4678	ETI340 Car Alarm	$79.50	$67.58
KE-4690	ETI342 CDI Kit	$79.50	$67.58
KE-4698	4 Sector House Alarm	$29.95	$25.48
KE-4708	DI Box	$42.50	$36.13
KE-4711	Mini FM Transmitter	$9.95	$8.46
KE-4720	Digital Sampler	$119.00	$101.15
KE-4722	RS232 Commodore	$16.95	$14.41
KE-4724	Parametric Equaliser	$23.50	$19.98
KE-4725	Solder Iron Temp Control	$39.50	$33.58
SILICON CHIP KITS			
KC-5010	Capacitance Meter/DMM	$27.95	$23.76
KC-5011	Off Hook Indicator	$12.95	$11.00
KC-5012	Car Radio Power Supply	$28.95	$24.60
JAYCAR KITS			
KJ-6502	Syntom Drum Synth	$42.50	$36.13
KJ-6504	8 Channel Mixer	$595.00	$505.75
KJ-6505	Console P/supply above	$119.00	$101.15
KJ-6531	2801 1/3 Octave Eq.	$239.00	$203.15
KJ-6535	2010 10 Band Stereo Eq.	$169.00	$143.65
KJ-7000	Red Light Flasher	$19.95	$16.96

VIFA SPEAKER KITS - LESS 15%

EA 60/60 KIT
60W rms 8" 2 way with boxes
$449 LESS 15%
$381.65

AEM6102 KIT
100W rms 8" 2 way with boxes
$799 LESS 15%
$679.15

AEM6103 KIT
150W rms 10" 3 way with boxes
$1199 LESS 15%
$1,019.15



CONCORD OPEN SATURDAY 9am - 12pm

NOW OPEN IN SPRINGVALE MELBOURNE

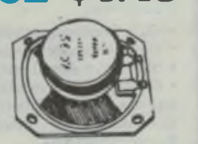
TAX FREE PRICES AVAILABLE

SPEAKER BARGAIN

We have purchased a surplus job lot of HIGH QUALITY 5" 8 ohm speakers with a huge magnet. These are made in New Zealand and at the sale price represent a bargain.
Power handling is 10 watts.
Don't miss this bargain.

NORMALLY $8.95 each

FEB 1/2 PRICE $4.48
LESS 15%
$3.80
10 up $3.50 each
Cat. AS-3010



DIRT CHEAP!!

12" GUITAR SPEAKER
NEW MODEL

Finally available, our updated guitar speaker with extended frequency response. Especially suited for not only Bass guitar buy Rythm & Lead as well.

Specifications

Resonant Frequency	60Hz (was 80Hz)
Impedance	8 ohms
Freq. Response	60 - 5000Hz (was 80 - 4000)
Power Handling	100 watts
Magnet Weight	40 oz
Net Weight	3610 grams (was 3520g)
Sensitivity	102dB

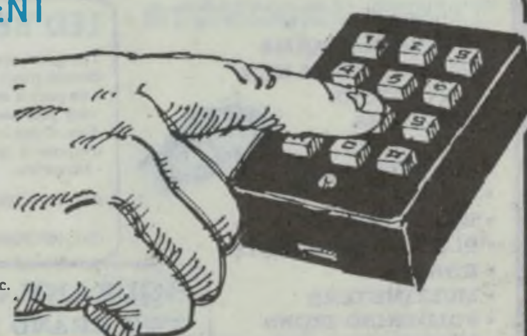
But the best news is the price - NO INCREASE
Cat. CG-2380

STILL ONLY $89.50 - LESS 15% $76.07

5 or more $79.50
LESS 15% $67.58

CAR THEFT DETERRENT

Save your car for less than $20
It's a black box with 12 digits on the top (like a calculator) and a flashing LED.
It looks very similar to the controller on a very expensive car alarm (the one that guarantees your car won't be stolen).
So with this sitting on your dash, would be thieves will think you have a high quality alarm, and move on.
Can be used on its own, or to complement any existing alarm system.
Use on cars, around the home, on boats, etc.
Easy to install, size 70 x 50mm, sticky tape already supplied on back.
Includes alarm stickers. Requires 2 x AAA batteries (not supplied).
Cat. SB-2375 $1.95 for 2.
Cat. LA-5090



NEW '88

$19.95 LESS 15% $16.96

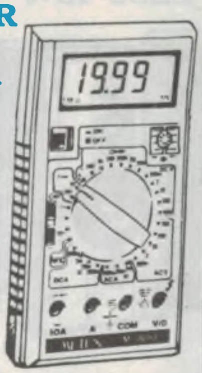
SAVE AN AMAZING $229.20 BELOW 1/2 PRICE
INTELLIGENT MODEM KIT - (BELOW COST)

ETI684 Intelligent modem at a silly price. It appeared in ETI December 85, Feb/March/June/July & August 1986.

NORMAL PRICE	$379.00
Power Supply	$ 49.95
TOTAL	$428.95

SALE PRICE $235
LESS 15%
$199.75 including power supply below cost!!

DIGITAL MULTIMETER WITH FREQUENCY COUNTER



- Capacitance tester
- Transistor tester
- 20 amp current
- High impact case

Cat. QM-1555

$159
LESS 15%
$135.15

AC MILLIVOLT METER

The model QT-2310 is a sideband Millivolt meter for measuring AC voltages from 0.3mV to 100V in 12 ranges with bandwidth of 5Hz to 1MHz. Each range shares 10 dB. The effective sensitivity at 0.3mV range is 30uV. Equipped with 3 colour scales, volt, dB and dBm.

Specifications:

Voltage Range:	0.3 1 3 10 30 100 100V 0.3 1 3 10 30 100, in 12 ranges
dB Range:	-70 -60 -50 -40 -30 -20 -10 0 +10 +20 +30 +40dB. dB (0dB=1V rms. OdBm=0.775V)
Accuracy:	±3% of full scale to 1kHz or 400Hz
Input Impedance:	10Mohm for each range. 40pF or less
Bandwidth:	±3% 20Hz - 200kHz ±5% 10Hz - 500kHz ±10% 5Hz - 1000kHz
Amplifier Output:	1 Vrms at full scale 600 ohm impedance

240V operated
Cat. QT-2320

$225 LESS 15%
$191.25

NEW'88

AUDIO GENERATOR

Features:

- High frequency stability: within ±2Hz
- Output voltage floating: within ±1dB
- Sine wave signal output: more than 8Vrms
- Equipped with synchronised input terminal of signals, thus enables the high power output signals to be accurately controlled by small signals.

Specifications:

Frequency Range:	10Hz - 1MHz 5 decade bands
Accuracy:	±3% +2Hz
Output Impedance:	600 ohms unbalanced
Output Control:	High, Low (-40dB) and fine adjuster

Sine Wave Output

Range:	10Hz - 1MHz
Output Voltage:	8Vrms max.
Output Distortion:	Less than 0.05% 400Hz - 20kHz Less than 0.3% 20Hz - 200kHz Less than 0.05% 500Hz - 50kHz Less than 0.5% 50Hz - 500kHz
Output Flatness:	±1dB (1kHz)

Square Wave Output

Range:	20Hz - 20kHz
Output Voltage:	15V p-p max
Rise Time:	0.5uS

Cat. QT-2310

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

$239
LESS 15%
$203.15

NEW'88

15% OFF ALL PRODUCTS

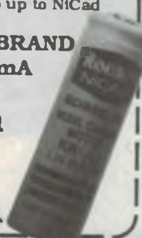
PENLIGHT NiCads

Don't keep wasting money buying throw-away batteries. Step up to NiCad rechargeables.

SUPERB ROCKET BRAND AA PENLIGHT 450mA

Cat. SB-2452

$4.25 each
LESS 15%
$3.61 each



HEATSHRINK TUBING

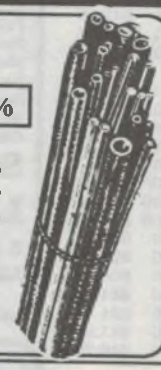
SHRINKS WITH A MATCH

- 2 colours - red and black
- remains flexible after shrinking
- all supplied in 1 metre lengths

LESS 15%

Size	Red	Black	Price
1.3mm	WH-5540	WH5530	$1.75
2.5mm	WH-5541	WH-5531	$1.75
3.5mm	WH-5542	WH-5532	$1.85
5mm	WH-5543	WH-5533	$1.95
7mm	WH-5544	WH-5534	$2.10
10mm	WH-5545	WH-5535	$2.25
16mm	WH-5547	WH-5537	$3.25

Shrinks to 1/2 the size listed.



NEW'88

Schools, Technical Colleges, Universities

- Are you happy with your present electronics supplier?
- Do you get instant credit?
- If not, try Jaycar - we offer
- SPEEDY SERVICE
- INSTANT ACCOUNTS
- REASONABLE PRICES
- GREAT RANGE OF COMPONENTS

SAVE 15% ON ALL THESE PRODUCTS

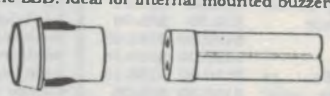
- BURGLAR ALARMS
- PASSIVE INFRA RED DETECTORS
- SPEAKERS
- RESISTORS
- TRANSISTORS
- CAPACITORS
- WIRE • BOOKS
- PLUGS AND SOCKETS
- ROBOTS
- MULTIMETERS
- SOLDERING IRONS
- TOOLS
- MODEMS • FANS
- TV ANTENNAS
- HEADPHONES
- SOLDER
- BISHOP GRAPHICS
- LEDS
- SWITCHES
- BOXES
- CROSSOVERS
- RACK BOXES
- TRANSFORMERS
- KITS

DIRT CHEAP!!

LED BEZELS

The great new LED bezels are made of black plastic, and are supplied in two parts. Simply push part A into the panel (you will need a 10mm hole), then put the LED into part B and insert part B (with LED) into part A for a tight fit. You end up with a very professional LED bezel at about 1/4 the price of chrome ones.
Also, if you have the need for a hole in a panel up until now its been extremely hard to disguise it. Simply mount one of these without the LED. Ideal for internal mounted buzzers - lamps etc.

Cat. HP-1105 Pkt of 10 **$2.99**
Cat. HP-1106 Pkt of 100 **$26.95**



Jaycar will not be knowingly undersold on any item of the same quality

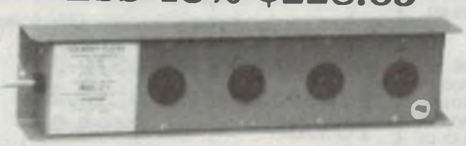
SQUEAKY CLEAN MAINS FILTERS

TWO BRAND NEW MODELS, BOTH FULLY APPROVED BY THE ELECTRICITY AUTHORITY

4 OUTLET

The MS-4020 will supply up to 4 appliances. Each 240V socket is independently filtered. The filter will suppress interference from RF sources, spikes, transients and lighting, and supply up to 4 outlets with a total load of 10 amps.
Cat. MS-4020

$269.00 LESS 15% $228.65



DIRT CHEAP!!

2 OUTLET

The two outlet will handle up to 7.5 amps.
The two sockets are not independently filtered although.
Cat. MS-4025

$99.00
LESS 15%
$84.15

BEWARE! There are many mains filters on the market. One sample we evaluated had only one capacitor in it!

Restoring a vintage "American Midget" receiver

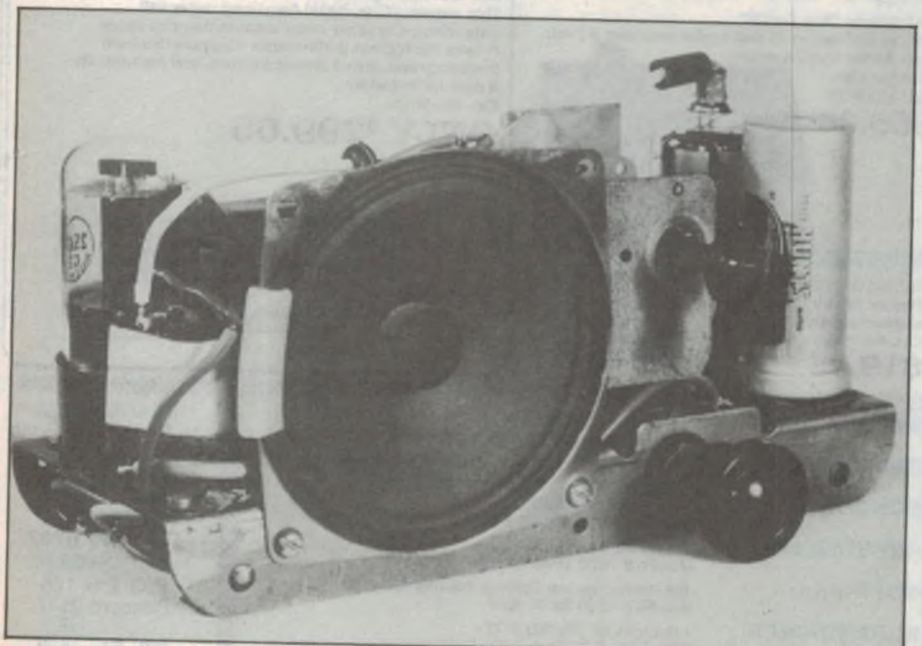
Restoring old valve radios and other equipment is a popular activity, judging by the very warm response we received last year when we published a couple of articles on the topic. Here's another very interesting restoration story, from a reader in Northern Ireland . . .

by WILLIAM JAMES

There was a special reason why this particular receiver had attracted my attention. A friend had acquired it from a village shop in County Tyrone, Northern Ireland, a few years after the end of World War II. During the War years an American soldier had left it in to be repaired but had never returned to enquire about it. My friend got the set for nothing because it had no commercial value. In fact, he saved it from the scrap heap. He kept it for a period and then offered it to me, to see if I could get it going.

At first sight the midget did not present an encouraging spectacle. It was covered with dust, while tubes, speaker and cabinet were all missing. The octal socket for one of the tubes was quite badly damaged. Tied to the chassis was a faded, tattered label which read: "Needs 12B8GT and 25A7GT." I was to find out in due course that this was not an understatement of the position! But my memory was stirred.

I recalled that a radio enthusiast in my family circle had built an American-type midget when stationed in Cheshire during the War, using the aforesaid tubes but following a design published in the British press in 1944. I have not been able to trace this design. The set, which was transformer-coupled, was working up to about 1955, but I do not know what eventually became of it. Some relevant documentation still exists. There are details of a 12B8GT tube. There is just the single note, "25A7GT", and there is a drawing showing how to wire up a Bulgin LF 33 transformer for a 1:4 step-up ratio, parallel feed. And there the record ends.



Front view of the restored chassis, taken from the speaker end. Above opposite is another view, very close to actual size.

Suffice to say that I was sufficiently interested to take possession of the American midget.

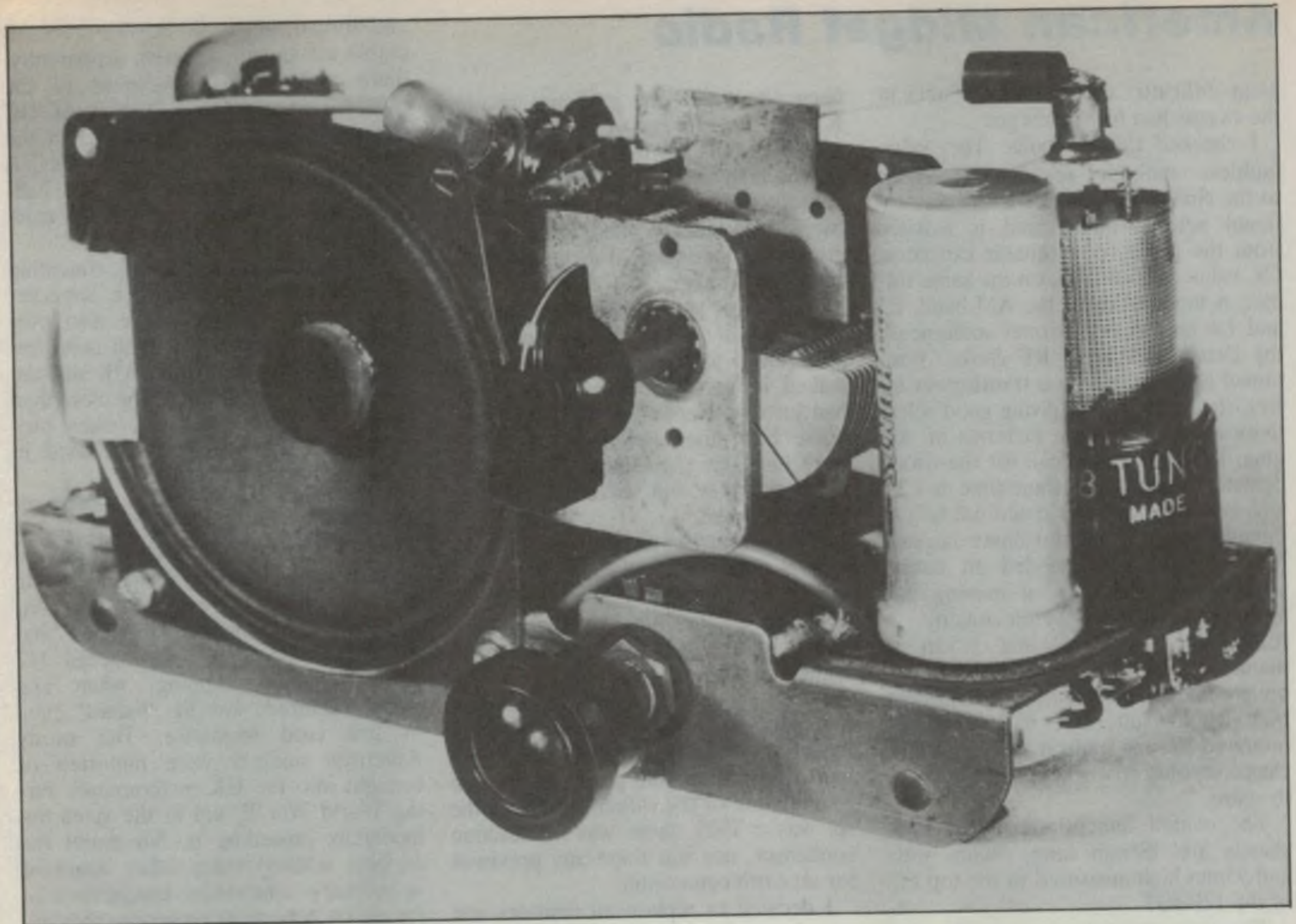
The 12B8GT is a triode/pentode, used as RF amplifier plus triode detector, while the 25A7GT is an output pentode plus half-wave rectifier.

Some years elapsed before I recently decided to commence any serious work. My first step was to clean the chassis thoroughly using a compressor and then a proprietary fluid. A blast of air at 100psi is mighty effective treatment for the dusty vanes of a tuning capacitor!

No identification could be found on the chassis, which is of stout steel with a plated surface. There had been, I was told, a plastic cabinet, white or cream, but this had been cracked and was then scrapped. The original speaker, reported to be of the reed type, had been removed for another application, but the cone had been damaged and the speaker, too, had been scrapped. Connected to the chassis was a line cord resistance cable about 2.8 metres in length, which had been tapped close to the centre to supply HT. The work on the tapping was not of factory standard, so I concluded that the line cord had either been altered or was a replacement.

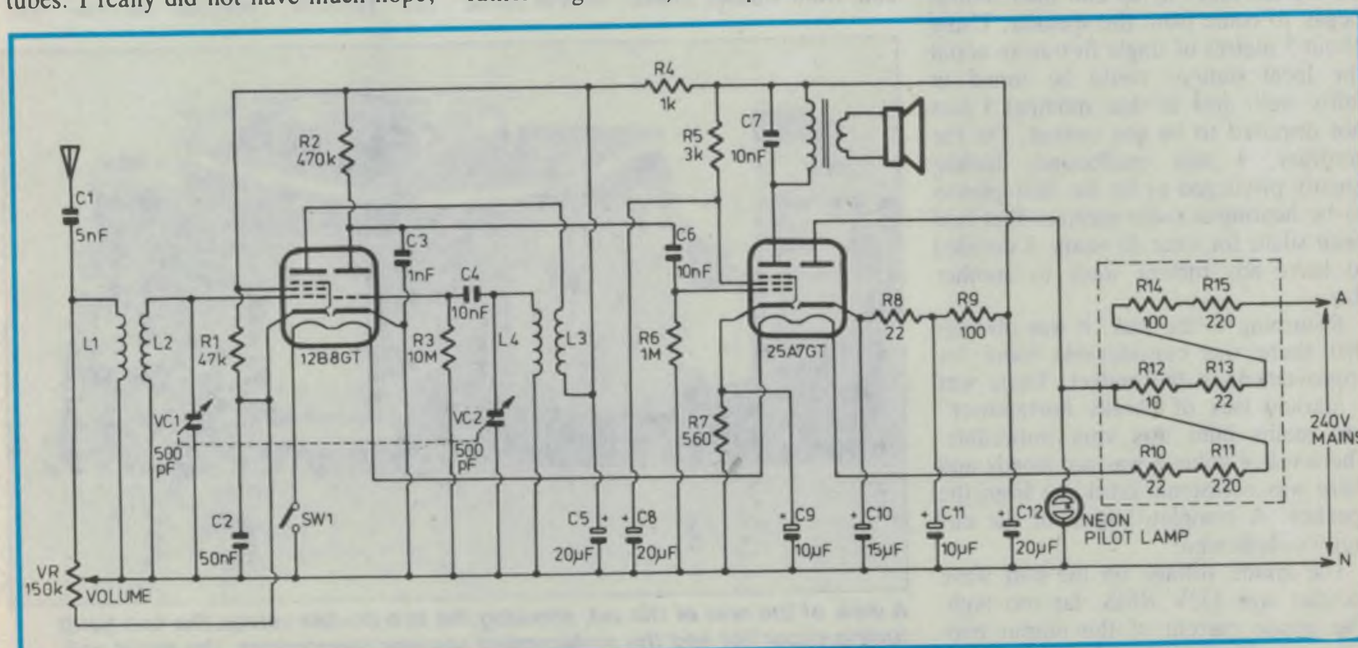
This particular set would always have required a line cord resistance of a certain value, even when used in the USA, in order to drop the mains voltage of 117V in that country to the figure represented by the sum total of the heater voltages of the two valves plus the voltage of any conventional pilot lamp. In the UK or Australia an additional 100 to 120 volts would have to be dissipated). I expected the line cord to be burnt out, but it did in fact show continuity on the vital resistance section.

Examination of the circuit showed it to be relatively simple in appearance,



but with one or two strange-looking features. Unlike the British design, the triode and the output pentode are resistance capacity coupled. The first thing to do was to try to obtain the tubes. I really did not have much hope, but after diligent searching I was able to get both of them, brand new, the 25A7GT proving to be the harder. (A 25A7, which has the same characteristics, is more readily obtainable, but is a rather larger tube). Complete data on both tubes was also found.

The socket for the 25A7GT had to be replaced, the damage looking as though someone had been trying with a screwdriver to prise out a seized up tube. This task was accomplished with no



The circuit for the receiver, as restored. It may bring back memories for some older readers . . .

great difficulty, except that the hole in the chassis had to be enlarged.

I checked the RF coils. They gave faultless continuity readings. Referring to the circuit diagram, L1 is the conventional aerial winding and is isolated from the aerial by a tubular capacitor, C1, value 0.005uF. L2, on the same former, is tuned to cover the AM band. L3 and L4 are on one former underneath the chassis. L3 is an RF choke. Positioned as it is, there is a transformer effect, the arrangement giving good selectivity at some expense in terms of volume. L4 is the tuned coil for the triode detector, tuned at the same time as L2.

A reed type speaker could not be obtained, which was unfortunate because it would not have needed an output transformer. However, a moving coil speaker would give better quality. A round one, 4 ohms, and 8.5cm in diameter could just be fitted in. I bought the smallest output transformer that would suit, but it had to be mounted on one end on the top of the chassis because there was so little space to spare.

The overall dimensions of the little chassis are 185mm long, 70mm wide and 95mm high measured to the top cap of the 12B8GT.

The time came to try out the set. First, a general check was made to ensure that damage would not be caused by some erroneous connection. The set was switched on and I waited, holding my breath, to see what would happen. Slowly the tubes lit up and then sounds began to come from the speaker. Using about 5 metres of single flex as an aerial the local stations could be tuned in fairly well. Just at that moment I was not disposed to be too critical. On the contrary, I was spellbound, feeling greatly privileged to be the first person to be hearing a radio receiver that had been silent for over 40 years. I decided to leave any further work to another day.

Returning to the task, it was obvious that there was considerable room for improvement in the midget. There was a marked lack of "brake horsepower" and mains hum was very noticeable. The level of volume was not steady and there was occasional crackling from the speaker. A complete check of the circuit was indicated.

The anode voltage on the half wave rectifier was 132V RMS, far too high. The anode current of the output pentode was 35mA, when it should have been about 20. The grid bias resistor, R7, did not appear to be original and measured only 300 ohms, partly explaining the high anode current of the output pentode. All other resistors were about twice their colour coded value, e.g., a grid leak, nominally 10 meg., was actually over 21 meg.

As regards to the capacitors, with the exception of C1, none was within its prescribed tolerance and every one leaked in varying degrees. The circuit had just two electrolytic smoothing condensers in one aluminium can. Both were in better shape than I had anticipated but they still leaked to an unacceptable extent.

The current flowing through the heaters was actually only 0.25 amps, when it should have been 0.3 amps. So it was obvious that the total resistance of the line cord was too high for the mains voltage in my area.

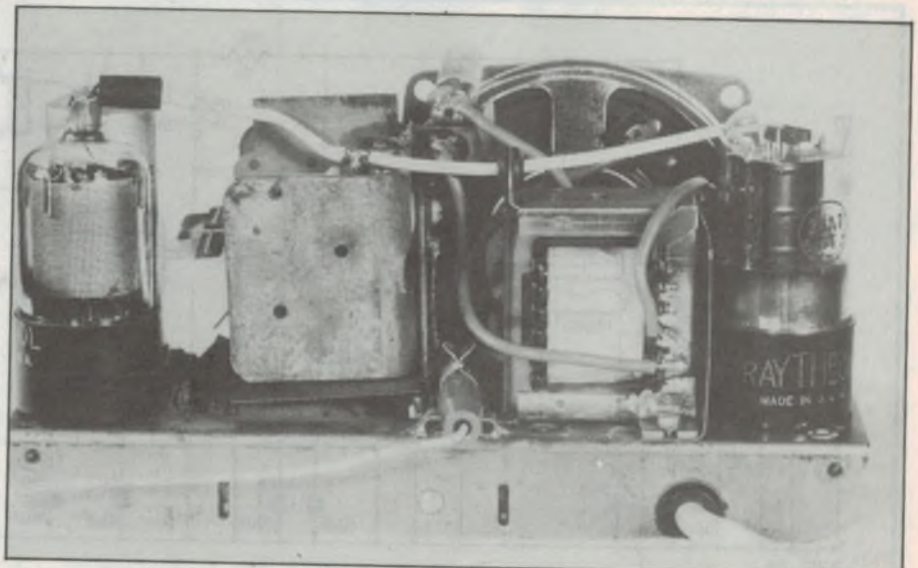
I was somewhat puzzled as to how the volume control actually worked, having no circuit diagram and finding it hard to think out the principle from an examination of the wiring. Although the set was a TRF, there was no reaction condenser, nor was there any provision for an earth connection.

I decided to replace all resistors and capacitors excepting the volume control, VR, and the aerial series capacitor, C1. I also decided to obtain all the information I could get on vintage American midgets. As it turned out, a surprising amount of such information was available from various sources both at home and abroad, but it did involve a considerable amount of research. Apparently, there were different versions of the classical "Midget", but all were AC/DC operated and were very compact by the standards of their time. A few models had full-wave rectification, but half-wave rectifiers were much more common.

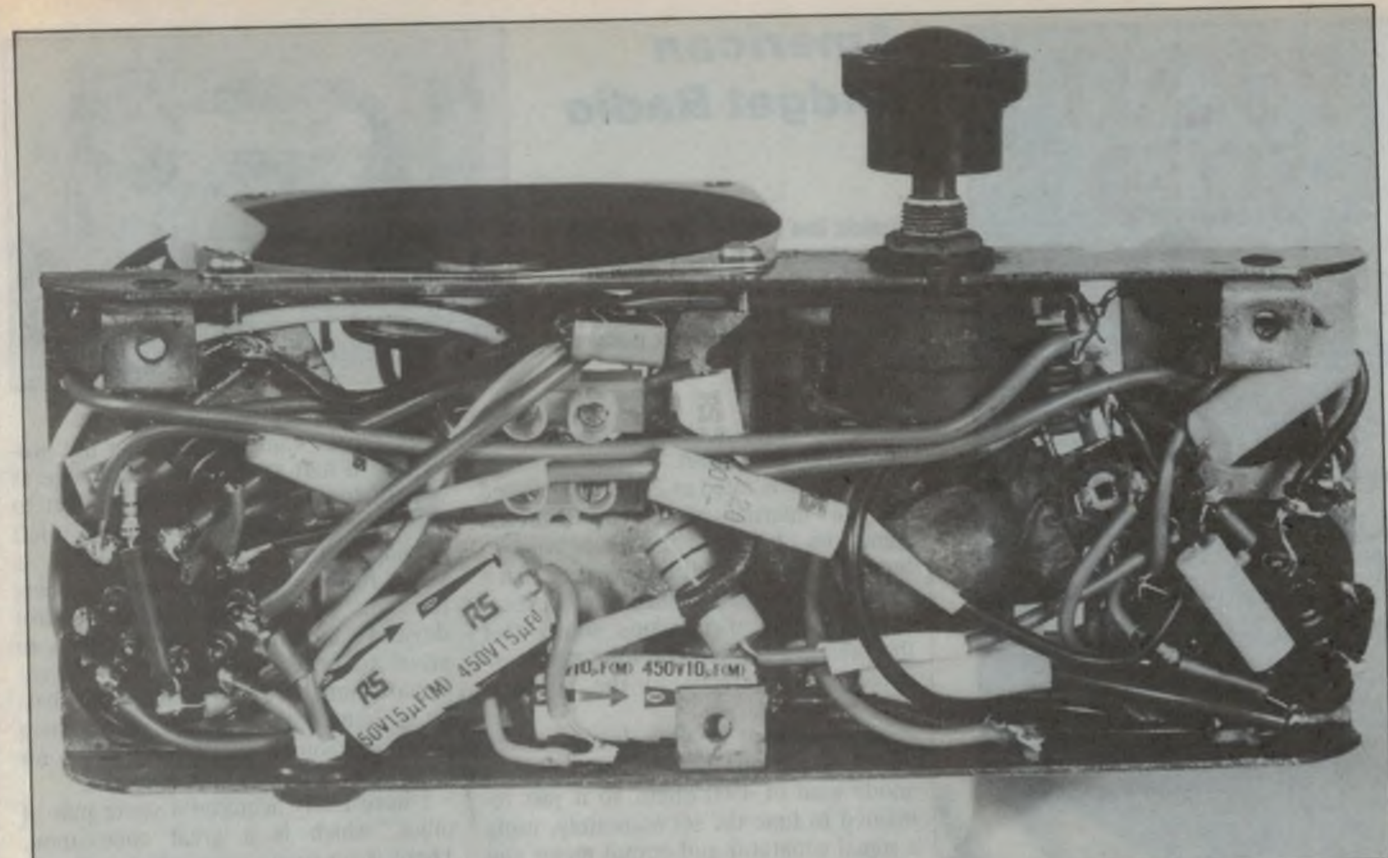
TRF designs predominated, consisting of 3 single tubes plus rectifier. Superhet versions with 5 tubes were also produced. But the type of circuit most frequently encountered in the UK was the multiple-tube set of the type described in this article. Such a set, when produced, could have been purchased in the USA for about $12.

Tube heaters in the midgets were either 0.3 amp or, later, 0.15 amp. In the latter case heater voltages could all add up to a figure sufficiently high to enable a voltage dropping resistance to be dispensed with altogether, provided that the mains supply did not exceed 117 volts. Voltage dropping, when and where required, was by "ballast" tube or line cord resistance. The sturdy American midgets were imported or brought into the UK in thousands during World War II and in the years immediately preceding it. No doubt the midgets reached many other countries in ordinary commercial transactions or for use by Americans on service abroad.

From my research, I found out how the volume control worked. Potentiometer VR (measured by me at 150k) has one end connected to the input terminal of the aerial coil L1, while the other end is connected to the cathode of the 12B8GT, pentode section. The



A view of the rear of the set, showing the two double valves, the two-gang tuning capacitor and the replacement speaker transformer. The aerial coil L1/L2 is obscured here by the 25A7 valve at right.



Underneath the chassis things are pretty tight, and something of a "rat's nest" — not exactly unusual with compact valve equipment!

slider of the potentiometer is connected directly to the chassis, so that the aerial circuit will be damped by a reducing shunt resistance as the grid bias of the pentode is raised, reducing its gain. Conversely, tuning the volume control "up" reduces the coil shunting, and at the same time reduces the valve's grid bias to increase its gain. (Please refer to theoretical diagram. The principle is much easier to illustrate than to describe).

I also found out how to do something about the mains hum. The two electrolytics in the original design are shown as C8 and C12. Taking inspiration from, but not slavishly copying, the resistance smoothing of the Firestone "Air Chief", an American midget of the same vintage but of different design, I have added three other electrolytics plus three resistors. These capacitors are C5, C10 and C11, while the resistors are R4, R8 and R9. Surprisingly, there was no by-pass capacitor for the output valve's self-bias resistor, R7. I raised the value of R7 to 560 ohms, which seems to be about right for my particular tube, and later also added C9 to provide more gain.

I now had to face up to getting rid of the line cord, which apart from the nowadays unacceptable asbestos covering on the resistance cable, was obviously responsible for much of the trouble in the set, giving HT voltage that was too high and heater voltage that was too low.

By calculation, and also using the well established principle of trial and error, I decided that the voltage drop for the rectifier anode could be obtained with a resistance of about 350 ohms, while a heater current of 0.3 amp should be provided by a further resistance of 245 ohms, making 595 ohms altogether. There would be quite a bit of heat to be dissipated, so 50W resistors would be required.

The nearest commercial values worked out at 352 and 242 ohms, total 594 ohms. Six resistors were needed, and these were mounted in a standard diecast metal box in which ventilation holes were drilled and to which rubber feet were fitted. If the set were to be used outside the workshop the box, which gets quite hot, would need to be protected by a suitable wire cage. The actual value of the six resistors in series is 597 ohms, cold, rising to 604 ohms at full working temperature.

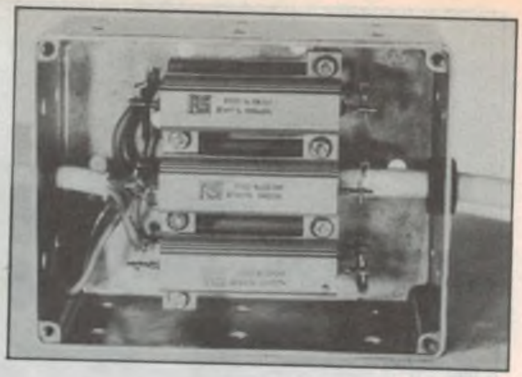
As regards the values chosen for the power pack, let me say that my mains voltage is nominally 230V, but may be varied by the supply authority up to 6% either way, so that at any particular time the voltage may be as high as 244V or as low as 216V. Usually, it is too low rather than too high.

Thus there is no absolute figure to govern these calculations and one has to settle for a compromise. Quite large voltage swings occur on a daily basis and I find them very frustrating. I am aware that some of the 50W resistors are working hard in their present application, but I am satisfied to have the set operating, and I demonstrate it for short periods only.

The power pack, which is earthed, is connected to the set by a non-reversible 3-pin plug and socket. I have another power pack, using a mains transformer with the single output of 115V, but it cannot be packaged so neatly and two voltage dropping resistors are still required.

The original set was wired in such a way that the last component in the heater chain was a 0.3 amp, 6 volt pilot lamp MES ("medium Edison screw" base). Presumably this was intended as a "set-on" indicator, there being no panel or dial to light up. I have read that the positioning of such a resistance between the last valve and the chassis is a likely cause of hum, so I have substituted a neon tube of the same MES

American Midget Radio



Inside the voltage-dropping resistance box, used to replace the original resistance-type mains cord. The diecast metal box gets quite hot!

type, connected as shown between rectifier anode and chassis.

This tube is rated at 240 volts AC and has an internal resistance. There is some loss of light at the lower voltage, but the tube gives all the warning that I require. Some slight flickering is seen. However, the oscilloscope shows that the presence of the neon tube makes no detectable difference to the performance of the set.

The speaker had already been matched to suit the output pentode's anode load of 4500 ohms, so it just remained to tune the set accurately, using a signal generator and output meter and confirming the setting with the 'scope.

The midget had now been transformed. Connected to a conventional "L"-shaped outdoor aerial, the set has more power than the small speaker can usefully handle. Selectivity is exceptionally good for a TRF. All my usual AM stations are readily available and easily separated. Even quite distant stations can be heard at reasonable strength on an indoor aerial about 1 metre long.

I had thought that the volume control potentiometer might have to go, but the crackling disappeared with the re-wiring — maybe a dry joint or a faulty resistor. The set is very tolerant of the positioning of the various components, which I would not myself regard as an ideal arrangement. The circuit is in fact completely stable.

There was still some slight hum from the speaker, so it was now that I tried a by-pass capacitor across R7. A value of 10uF proved to be sufficient, less than I had expected. The set is now virtually silent when the volume control is turned down. One has to put an ear close to the speaker to hear any hum at all and there is no modulation hum.

There may well be some readers who have never even heard a valve or "tubed" set of the TRF type in action. If so, they have missed a different quality of sound, because a TRF does not cut-off the sidebands in the same way as a superhet.

When the midget came into my possession it had a length of aerial wire as a permanent fixture, soldered direct to the aerial capacitor, C1, and just left trailing behind the chassis. What is more, it had all the appearance of being the work of the manufacturer. I have devised a modification which enables an aerial to be connected in the conventional manner. At the moment the chassis is housed in a simple, close-fitting plywood cabinet, but I have plans for something better and more stylish.

I have lately acquired a spare pair of tubes, which is a great consolation. There is no single valve which will substitute for a 12B8GT. As regards the 25A7GT, which is the one more likely to fail, a 32L7GT can be used with appropriate modifications to the power pack, the self-bias resistor R7 and the output transformer.

I was able to buy a 32L7GT and have found that it works successfully, giving even greater power output than a 25A7GT.

If it ever became necessary, the set could readily be modified to run on 0.15amp tubes, namely 25B8GT and 70L7GT. I should perhaps make it clear that the set has had its circuit significantly changed only in the matter of additional smoothing. All the components which have been replaced have the same values as those marked on the original. (R7 was not original).

So the task has been completed. It has provided me not merely with weeks but months of intensely interesting research, experimentation and problems to be solved. Now I can start restoring my late father's 1939 4-tube battery superhet, a Bush model BA61. In this case I am fortunate in having the manufacturer's full service literature.

Sometimes when I look at the American midget, I think about the original owner and wonder what became of him. I was told that his Army unit had disappeared overnight from its local training camp not long before the Allied invasion of Normandy in June, 1944. EA

MONITORS ONLY $129

SAMSUNG 12" 20MHz COMPOSITE MONITOR ONLY $129

FEATURES...
- High contrast, non-glare screen
- High resolution, 80 or 40 character display

SPECIFICATIONS...
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green (P39) or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0.5V-2.0Vp-p
Scanning frequency:
Horizontal: 15.734 KHz + − 0.1%
Vertical: 60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 307(H) x 297(L)mm
Weight: 7.3 Kg
Shipping weight: 8.3 Kg

Cat No	Description	Price
X14514	(GREEN)	$129
X14516	(AMBER)	$129

10 OR MORE ONLY $119.00

SAMSUNG 12" TTL/COMPOSITE MONITOR ONLY $179

FEATURES....
- At last a monitor with both TTL and Composite modes!
- High contrast, non-glare screen
- High resolution, 80 or 40 character display
- Swivel/Tilt base

SPECIFICATIONS....
Picture tube: 12" diagonal and 90° deflection
Phosphor: Green (P42)
Video input signal: Composite/TTL Switchable
Polarity: Negative/Positive
Level: 0.5 - 2.0Vp-p/4.0 + − 1.5Vp-p
Impedance: 75ohm, more than 6.8K ohm
Scanning frequency:
Horizontal: 15.75 KHz + − 0.1%/18.432KHz + − 0.1%
Vertical: 47-63Hz
Video bandwidth: 20MHz
Active display area: Composite 206(H) x 160(V)mm, TTL 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: Phono Pin Jack, 9 pin D-Sub Connector
Controls:
Outside: Power Switch, Contrast, Brightness, Signal Select, V-Hold, V-Size
Inside: H-Width, H/V linearity, Focus, H/V-Shift
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7.3 Kg
Shipping weight: 8.3 Kg

Cat No	Description	Price
X14509	(GREEN)	$179

SAMSUNG 12" FLAT SCREEN COMPOSITE MONITOR ONLY $149

FEATURES....
- Flat, high contrast, non-glare screen
- High resolution, 80 or 40 character display
- Tilt/swivel base
- Compatible with Apple* and IBM* colour composite signal

SPECIFICATIONS....
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0.5-2.0Vp-p
Impedance: 75ohm
Scanning frequency:
Horizontal: 15.734 KHz + − 0.1%
Vertical: 50-60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 character x 24 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 310(W) x 307(H) x 300(L)mm
Weight: 8.1 Kg
Shipping weight: 9.6 Kg

Cat No	Description	Price
X14510	GREEN	only $149
X14512	AMBER	only $149

SAMSUNG TTL 12" MONITOR

- High contrast, non-glare screen
- Excellent value for money!

SPECIFICATIONS:
Picture tube: 12" diagonal 90° deflection
Mode: TTL
TTL input signal:
Polarity: TTL Positive
Level: 4V p-p + − 1.5V
Impedance: 75ohm
Video bandwidth: 16MHz (− 3dB)
Scanning frequency:
Horizontal: 18.432 + − 0.1KHz
Vertical: 50HZ + − 0.5%
Active display area: 216(H) x 160(V)mm
Display characters: 80 characters x 25 lines
Input connector: 9 pin connector
Controls:
Front: Power ON/OFF, Contrast
Rear: V-Hold, V-Size, Brightness
Internal: Vertical Linearity, Horizontal Linearity, Horizontal Width, Focus
Power supply: 110/120V 60Hz, 220/240V 50 Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7.3Kg
Shipping weight: 8.3Kg

Cat No	Description	Price
X14500	(GREEN)	$189
X14502	(AMBER)	$189

IBM* XT* COMPATIBLE COMPUTERS $795*

Check these features and our prices. We're sure you'll agree they're exceptional value for money!

- Assembled in Australia!
- Tested by us for 24 hours prior to delivery!
- 150W power supply
- AT* style keyboard
- 8 Slot motherboard
- 6 months warranty!

(Switchable 4.77/8MHz Turbo versions available for an extra $50)

* $795 COMPATIBLE COMPUTER
256K RAM Single Drive, Graphics and Disk Controller Card. $795

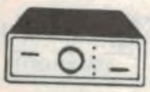
256K RAM COMPATIBLE COMPUTER
2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Parallel Port. (Includes Timer Disk) $945

640K RAM COMPATIBLE COMPUTER
2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Serial, 1 Parallel Port. (Includes Timer Disk). $995

WITH 20 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive .... only $1,595
& Dual 360K Floppy Disk Drives .... only $1,795

WITH 40 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive .... only $2,295
& Dual 360K Floppy Disk Drives .... only $2,495

WITH 80 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive .... only $3,795
& Dual 360K Floppy Disk Drives .... only $3,995



2 & 4 WAY RS232 DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY Cat X19120 **only $59**
4 WAY Cat X19125 **only $79**

2 & 4 WAY CENTRONICS DATA TRANSFER SWITCHES

Save time and hassles of constantly changing cables and leads around with these inexpensive data transfer switches. These data switches support the 36 pin centronic interface used by Centronics, Printronics, Data Products, Epson, Micronics, Star, and many other printer manufacturers.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector
- Bale locks are standard

2 WAY (X19130) ...... **only $59**
4 WAY (X19135) ...... **only $79**

COMPUTER PAPER

Quality paper at a low price! 2,000 sheets of 70 gsm bond paper
Cat. C21003 11 x 9½" **$39.95**
Cat. C21005 15 x 11" **$67.95**

THOMSON EGA MONITOR

Top quality high resolution EGA monitors with a space-age design
SPECIFICATIONS:
CRT: 14 inch (360mm) diagonal, 90 degree deflection
Display Size: 245(H) x 180(V)mm
Phosphor: P22, non glare, tinted screen
Dot Pitch: 0.31mm
Video Bandwidth: 18 MHz
Resolution: 15.75KHz - 640 x 200, 21.85KHz 640 x 350
Input Signals:
1. RGBI - positive, H(+), V(+)
2. RrGgBbI - positive, H(+), V(−)
Input Impedance: TTL Level (330 ohms)
Dual Scanning Frequency:
Horizontal: 15.75 KHz or 21.85 KHz + − 10Hz
Vertical: 50 - 60 Hz
Connector: 9 pin, D-type
Size: 312(H) x 363(L) x 380(W)mm
Weight: 10.8 Kg (Net)
X14525 .... **$895**

RITRON 2 MONITORS

Stylish monitors available in green or amber displays and featuring swivel base that tilts forward and back 30 degrees and swivels right to left 60 degrees!
SPECIFICATIONS:
CRT DISPLAY SIZE: 12 inches non-glare 90 degree deflection
INPUT SIGNAL: 1.0 - 2.5V p-p composite video signal
INPUT INPEDANCE: Normal 75 ohm, high approx. 50K ohm
INPUT TERMINALS: RCA phone jack
RISE AND FALL TIME: Less than 25 us
VIDEO BANDWIDTH: 20MHz
Corner; 800 lines
Geometric distortion; 2% or less
Linearity; less than 2%
CONTROLS: **Front**; Power On/Off, brightness, contrast
Rear; Vertical hold, Horizontal hold, Vertical line, Vertical size

Green Cat. X14506 **Normally $235**
Amber Cat. X14508 **Normally $239**
NOW ONLY $169

SAKATA 13" RGB COLOUR MONITOR

High quality IBM* compatible monitors, great with VCR's too!
SPECIFICATIONS:
CRT: 13", 90° deflection colour
Input Signal:
Video Signal: Separate video signal
Video: Positive
Sync: Positive
Input Level: TTL Level
Scanning Frequency:
Horizontal: 15.7KHz
Vertical: 60Hz
Display Size: 245(H) x 182(V)mm
Resolution:
Horizontal: 640 dots
Vertical: 200 lines
Size: 343(H) x 362(W) x 421(D)mm
Weight: 11.6kg
Cat. X14530 .... **$695**

IBM* AT* COMPATIBLE $2,795

Assembled & Tested in Australia!
- 1 M/Byte Main Board
- 1.2 M/Byte Floppy Disk Drive
- Colour Graphics Display Card
- Floppy & Hard Disk Controller
- Printer Card and RS232
- 200W Power Supply
- 6 MHz
- 80286 CPU
- 8 Slots
- 20 M/Byte Hard Disk
- Keyboard
- 6 Months Warranty

IBM* BABY AT* COMPATIBLE .. $2,495

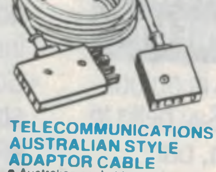
- 1 M/Byte Main Board
- 1.2 M/Byte Floppy Disk Drive
- Colour Graphics Display Card
- Floppy & Hard Disk Controller
- Printer Card and RS232
- 200W Power Supply
- Switchable 8/10/12 MHz
- 80286 CPU
- 8 Slots
- 20 M/Byte Hard Disk
- Keyboard
- 6 Months Warranty

Dimensions: 360(W) x 175(H) x 405(D)mm

DELUXE PRINTER STAND

- Restores order to your work area without occupying extra space
- Feeds and refolds paper under the printer automatically
- Adjustable paper deflectors ensure smooth flow of paper
- Made of moulded plastic
- Suitable for most printers

C21058 (80 column) **$69.95**



TELECOMMUNICATIONS AUSTRALIAN STYLE ADAPTOR CABLE

- Australian socket to plug/socket
- Length 10 metres

Cat. Y16015 .... **$14.95**

RS232 DATA SWITCH WITH TESTER

- No power required
- Ideal for 1 computer to 2 peripherals or 2 computers to one peripheral
- 25 pin RS232 "D" connectors
- Six dual coloured LED indicators showing certain flow status:

T.D. Transmit Data
R.D. Receive Data
R.T.S. Request To Send
C.T.S. Slear To Send
D.S.R. Data Set Ready
D.T.R. Data Terminal Ready
- Size: 200(W) x 68(H) x 150(D)mm

Cat. X19110 .... R.R.P. $169
Our Price $149

CANON A-50 PRINTER

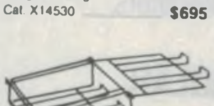
- Serial Impact Dot Matrix
- 180 C.P.S.
- Near Letter Quality Mode
- 1.4K Buffer

Cat. C20045 .... **$595**

PANASONIC KX-P1081 DOT MATRIX PRINTER

- 120 C.P.S.
- Pica or Elite character set
- Print Modes: NLQ, Dot Graphics, Proportional Font, Draft
- Proportional Printing
- Reliable and Compact
- Proportional Printing
- Logic Seeking
- 1K Printer Buffer

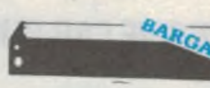
Cat. C20035 .... **only $595**



PRINTER STANDS

- Restores order to your work area
- Conveniently stacks paper printout in document tray automatically
- Made of black plastic coated steel
- Suitable for most printers
- Excellent value at these prices!

C21054 (80 column) **$26.95**
C21056 (132 column) **$36.95**



PRINTER RIBBONS

CP80, BX80, DP80, BX100, MB100
ALL A CRAZY LOW $9.95

PRINTER RIBBONS TO SUIT EPSON MODELS...

MX100, FX100, RX100 (Cat. C22002) $19.95
MX70/80, FX70/80, RX70/80 (Cat. C22031) $10.95

COPY HOLDER (YU-H32)

- Adjustable arms allows easy positioning
- Copy area 9½" x 11"
- Sliding line guide
- Clamp mounting

C21062 .... **$39.95**

COPY HOLDER (YU-H33)

- Copy area 9½" x 11"
- Sliding line guide
- Flat metal base

C21060 .... **$39.95**

008 335757 TOLL FREE MAILORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS & INQUIRIES CALL (03) 543 7877

SENDATA DIRECT CONNECT MODEM

- CCITT V21 300 baud full duplex
- CCITT V23 1200/75
- Bell 103 300 Full duplex
- Bell 202 1200 Half duplex
- Auto answer
- LED display for Power, TX, RX, CD
- AC power adaptor included
- DB25 pin connector
- Telecom Approval N° C83/37/1045

Cat. X19120 .... $295

(SOFTWARE FOR VIATEL ... $95)

HEAD CLEANER DISKS

It only takes a minute amount of dust, dirt or magnetic oxide particles on your drive heads to cause problems errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.

CAT.No.	SIZE	PRICE
C12560	3½"	$6.95
C12555	5¼"	$6.95
C12851	8"	$14.95

VERBATIM DISK SPECIALS!

All prices 10 disk boxes!

Description	1-9 boxes	10+boxes
3½" 1S/2D	$44.95	$42.95
3½" 2S/2D	$46.95	$43.95
5¼" 1S/2D	$22.00	$21.00
5¼" 2S/2D	$26.00	$24.00
5¼" 2S/4D	$75.00	$70.00
5¼" 2S/HD	$42.95	$41.00

"NO BRAND" DISKS!!

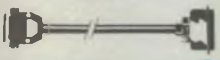
Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a 5 year guarantee, which indicates the quality of these disks. So why pay 2-3 times the price for the same quality?

Packs of 10, D/S D/D without boxes, or brand name, just their white paper jacket, and index labels. (5¼" disks includes write protects).

5¼" D/S "NO BRAND" DISKS FROM $0.85 EACH!!

10+DISKS	100+DISKS	1,000+DISKS
$9·50ea	$9ea	$8.50ea

(ALL PRICES PER 10 DISKS. TAX EXEMPT PRICES LESS $1)

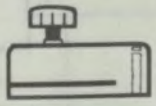


PRINTER LEAD FOR IBM*

- Suits IBM* PC XT and compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug

Cat P19029 1.8 metres $17.95

Cat P19030 3 metres $22.95



DISK NOTCHER

Converts 5¼" single sided floppy disks to double sided by placing an appropiate notch in the floppy disk jacket.

C21070 .... $9.95

MICRODOT 5¼" DISKS!

DESCRIPTION	1-9 BOXES	10+ BOXES
5¼" S/S D/D	$12.95	$11.95
5¼" D/S D/D	$13.95	$12.95

(SEND $2 FOR SAMPLE DISK!)

3½" "NO BRAND" DISKS!

10+DISKS	100+DISKS	1,000+DISKS
$29	$28	$27

(ALL PRICES PER 10 DISKS. TAX EXEMPT PRICES LESS $4)

Get more for your dollar with Rod Irving Electronics!

APPLE* COMPATIBLE CARDS

STOCK RUN OUT! BE QUICK TO CATCH THESE BARGAINS!

PRINTER CARD
Cat. X17029 .... ONLY $49

DRIVE CARD
Cat. X17019 .... ONLY $55

80 COLUMN CARD
Cat. X17025 .... ONLY $69

SUPER SERIAL CARD
Cat. X17035 .... ONLY $79

Z80 C/M CARD
Cat. X17041 .... ONLY $59

80 COLUMN/64K CARD
Cat. X $99

3¼" EXTERNAL DRIVE

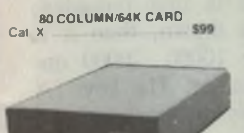
- 720K formatted capacity
- 37 way D type connector fits directly onto drive controller card
- Compatible with IBM* PC/XT
- Requires DOS 3.2 or greater
- Size: 266(D) x 104(W) x 75(H)mm

.... only $395

SEMICONDUCTORS!

Always check our prices before you buy!

	1-9	10+	100+
MX232	$11.50	$10.50	
V-20 8MHz	$14.95	$13.95	
V-30	$39.95	$34.95	
TEA2000	$11.95	$10.95	$9.95
ZN429	$9.95	$8.95	$7.95
ZNA234	$39.50	$37.50	$36.50
SAB6456	P.O.A.		
2114	$2.95	$2.75	$2.50
2716	$9.95	$9.50	$8.95
2732	$8.95	$8.50	$7.95
2764	$7.95	$7.50	$6.95
27128	$9.95	$8.95	$7.95
27256	$11.50	$10.50	$10.00
27512	$19.50	$18.50	$17.50
4116	$3.95	$3.50	$2.95
4164	$1.95	$1.85	$1.75
41256-150	$5.95	$5.50	$5.25
41256-100	$9.95	$9.75	$9.50
555 8 pin	$0.50	$0.40	$0.35
6116	$3.95	$3.75	$3.50
6264	$7.95	$6.95	$6.50
6802	$5.00	$4.00	$3.75
6821	$2.00	$1.80	$1.70
6845	$5.00	$4.00	$3.75
7406	$0.40	$0.30	$0.25
INS8250	$29.95	$27.95	
NE5534AN	$1.95	$1.85	$1.75
AM/EF7910	$19.95	$18.95	
MEL9501	$29.95	$27.95	
SC141D	$1.75	$1.50	
SC151D	$2.50	$2.25	
555	$0.40	$0.38	
741	$0.50	$0.45	



APPLE* COMPATIBLE SLIMLINE DISK DRIVE

Compatible with Apple 2+

Cat. X19901 .... Normally $225

SPECIAL $179

APPLE* IIC COMPATIBLE DISK DRIVE

(including cable .... only $199

JOYSTICK FOR IBM

Features Selectable "Spring centering" or "free floating". Electrical trim adjustments on both axis. 360 degree cursor control.

Cat. C14205 .... $39.95

8087

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

8087-3 (4.77MHz)	$269
8087-2 (8MHz)	$385
8087-1 (10MHz)	$585
80287-6 (6MHz)	$475
80287-7 (8MHz)	$679

5¼" DISK STORAGE (DD50-L)

Efficient and practical. Protect your disks from being damaged or lost!

Features...

- 50 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- Contemporary Design

Cat. C16025 .... **only $14.95**

3½" DISK STORAGE (DD80-L)

- Holds up to 80 x 3½" diskettes
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base
- Contemporary design

Cat. C16038 .... **only $24.95**

5¼" DISK STORAGE (DD100-L)

Efficient and practical. Protect your disks from being damaged or lost!

Features...

- 100 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact ABS plastic base
- Contemporary design

C16020 .... **only $19.95**

IBM* FLOPPY DISK DRIVE EXTENSION CABLE

- DB37 Male to 34 way edge connector
- Length 0.5 metres

P19045 .... $95

JUMBO 5¼" DISK STORAGE (DD120-L)

If you have lots of disks, you'll appreciate the extra capacity of this disk storage unit when it comes to locating a particular disk.

Features...

- 120 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base

C16028 .... **only $24.95**

RS232 WIRING ADAPTOR BOX

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

Cat. X15665 .... Normally $49.95

Only $44.95

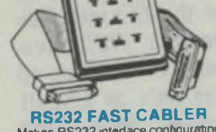
RS232 BREAK OUT BOX

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

SPECIFICATIONS:

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

X15700 .... $94.95



RS232 FAST CABLER

Makes RS232 interface configurating fast and simple. 3 slide switches enable line swapping functions, positive and negative voltages are displayed on 6 tricolour LED's.

SPECIFICATIONS:

Connector: DB25 plug on 100mm cable and DB25 socket on 100mm cable
Indicators: Tricolour LED's for pins 2(TD), 3(RD), 4(RTS), 5(CTS), 6(DSR), 20(DTR)
Switches: 3 Slide switches to swap leads
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm

X15710 .... $145

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
Fax: (03) 543 2648

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

008 335757 TOLL FREE MAILORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS & INQUIRIES CALL (03) 543 7877

Circuit & Design Ideas

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

Low cost light chaser/controller

This circuit was designed to decorate the house during the festive season but was adapted as a light show for any occasion.

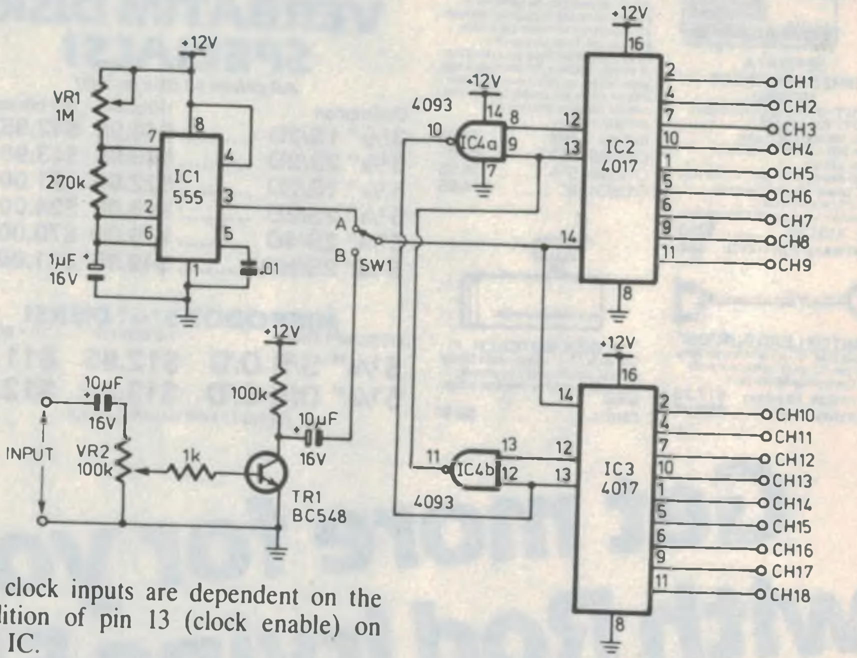
The circuit can be divided into three major parts. These are discussed in detail as follows.

1. Clocking system
2. Counting section
3. Final output configuration.

Firstly, the clocking system for the light chaser can either be digital or analog, depending on the setting of switch SW1. Assuming the switch is in position A, this connects IC2 and IC3 to the digital clock oscillator provided by IC1 (555) and associated components. IC1 is wired in the astable mode with operating frequency between 1Hz — 3Hz approximately, depending on the setting of potentiometer VR1 (1M).

With the switch in position B, an audio signal from an amplifier can be used to trigger the chaser. The analog signal is converted into a square wave by transistor TR1. The sensitivity of the unit can be adjusted using VR2, a 100k potentiometer.

The series of pulses selected by SW1 are fed directly into the clock inputs of IC2 and IC3 (4017 decade counters).



The clock inputs are dependent on the condition of pin 13 (clock enable) on each IC.

Assuming that pin 13 of IC2 is grounded, the clock input (pin 14) will permit the counter to increment until the count of 9. When this occurs, a carry-over output is available at pin 12, which is allowed to enter IC4a via pin 8.

IC4a and IC4b form a flipflop, which will change state when a high is on pin 8 of IC4a. The output (pin 10) will be high, hence initially disabling IC3. However pin 12 of IC4b is high simultaneously, giving rise to a high at pin 11. This disables IC2 and causes IC4a to change state, enabling IC3. The cycle repeats after this.

Finally, there are many combinations for connecting the output channels to produce variety of light patterns.

The simplest and easiest to construct is to construct a number of LED drivers, as shown in Fig.1. This option

Simple D-A & A-D converters for Apple II

These simple D-to-A and A-to-D converters for the Apple II+ computer are designed to operate with the I/O interface published in Circuit and Design Ideas of November 1987.

I constructed circuit 2, the D-to-A converter, on a small board, using uniform lengths of tinned copper wire soldered into the board as a "plug", to fit into the DIL socket of the I/O interface described in the November 1987 interface. The circuit consists of a "back to basics" converter, using only an LM301 op-amp and some resistors, diodes and miscellaneous components. At about $3.30, it is surely the cheapest D-to-A converter around. I connected the output to the tape input of my stereo amplifier.

Circuit 1 consists mainly of the Analog Devices AD670 A-to-D converter IC, which may be obtained fairly cheaply from Parameters. The IC is ideally suited for use with the Apple I/O and so connects straight to the slot (the I/O interface is not used here). There is only one other component, the 8-pin DIL socket, which I used as a cheap switch between bipolar and unipolar operation, and format.

This circuit has a conversion time of about 10 microseconds, so is suitable for audio applications, whereas most converters for the Apple rely on the primitive paddle inputs, which are too slow for audio. I found that a dynamic microphone has sufficient output to drive the converter without amplification.

Listing 1 is a primitive low frequency storage CRO. Press the space bar to halt the display and the arrow keys to vary the delay D which is printed at the bottom of the screen.

1 screen = 1252D + 36301 microseconds

Listing 2A is a voice special effects program. The voice is first recorded, then an envelope is drawn, then it is played back at line 10000. 20000 onwards is a voice repeater. The keys (A Z , .) are used to vary the start and end of the repeated section. Listing 2B is its machine code subroutine.

I also have available listings for a 2-channel music program using a conventional music score on the low-res screen. The commands are single letters based on assembler commands. Tunes are stored in text files.

Ross Donnelly,
Lindfield, NSW

$30

For listings 1 and 2 please see page 80.

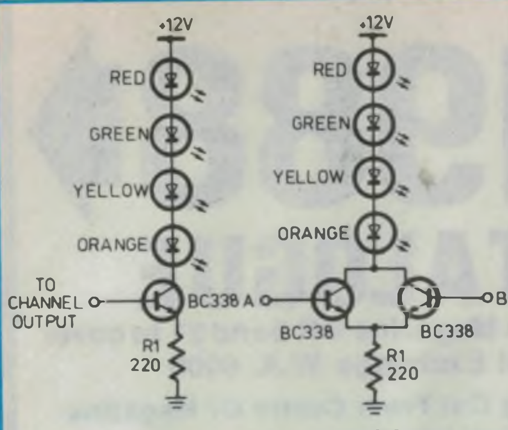


FIG 1 FIG 2

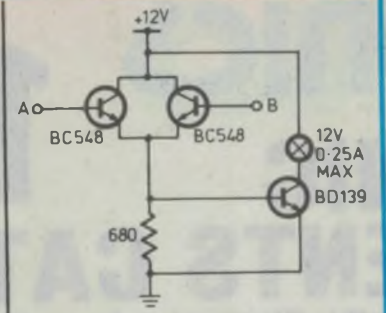


FIG 4

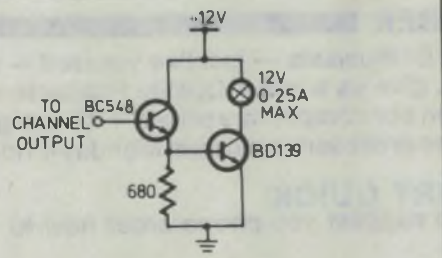


FIG 3

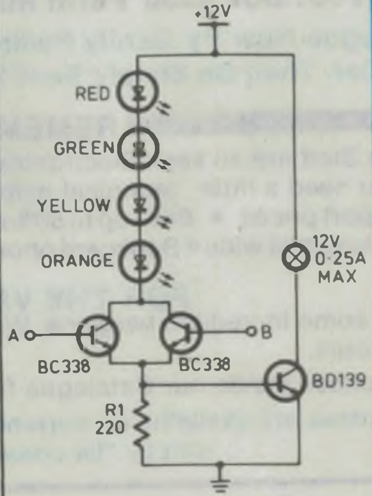


FIG 5

Pin Connections

A	B
Ch 1	Ch 18
Ch 2	Ch 17
Ch 3	Ch 16
Ch 4	Ch 15
Ch 5	Ch 14
Ch 6	Ch 13
Ch 7	Ch 12
Ch 8	Ch 11
Ch 9	Ch 10

All LEDs are 5mm

only involves a series of different colour LEDs. Each transistor's base is connected to an individual channel. When in operation, the outputs from either IC2 or IC3 are turned on in sequence hence switching the transistors on, giving a display involving 72 LEDs. The transistors should be able to handle more LEDs per string, although R1 may have to be lowered.

However the design shown in Fig.1 only permits unidirectional motion. The circuit shown in Fig.2 overcomes this problem. This involves the use of two transistors, connected in parallel; hence each can turn on the series of LEDs. Using the pin connections shown in Table 1, the LEDs will light sequentially, then reverse (count backwards). With random connections of the two inputs to the controller outputs this will give interesting effects. The circuits shown in Fig.1 and 2 can be used to decorate windows or Christmas trees.

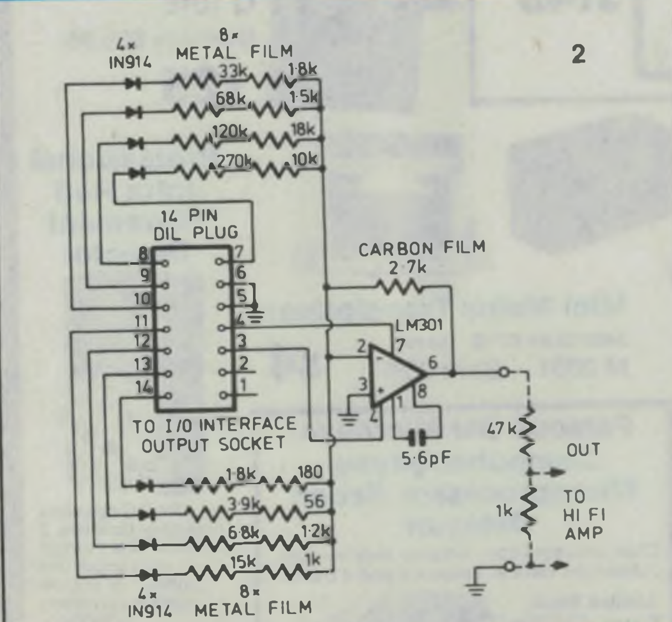
For decoration of a room. LEDs are a bit small; the design in Fig.3 solves this problem. The simple option shows a BC548 connected as a Darlington pair with a BD139. The latter transistor is used to control a standard Christmas tree light globe, thus many colours could be used. The total number of lights to be used is 18 however if the BD139 was substituted with a 2N3055 with suitable heatsinking, more globes per string can be used. Once again, this only operates unidirectionally.

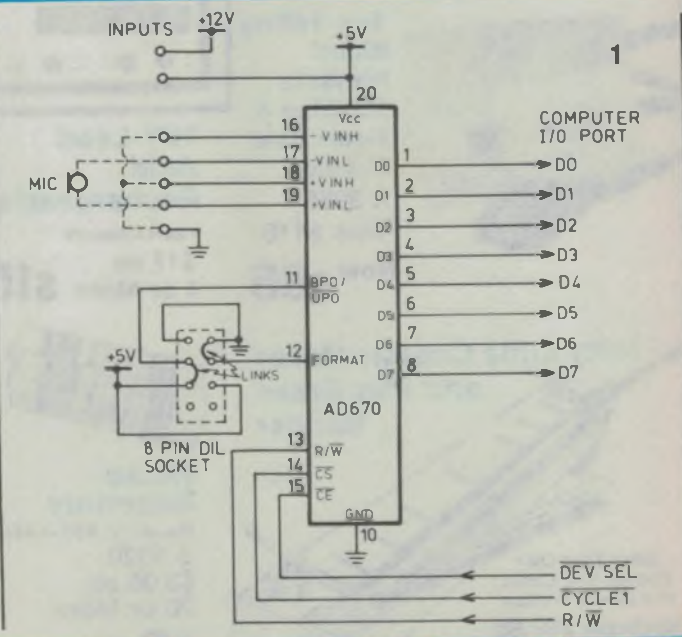
For bidirectional operation, Fig.4 can be used. The operation of this option is very similar to Fig.2 except for the use of light globes.

Finally, all of the above designs are combined to produce a "light show" which can involve LEDs and lights. This is shown in Fig. 5, although any number of combinations are possible.

Alfred Fong,
Carlingford, NSW.

$30





Improved mains voltage stabiliser

Magnetic voltage stabilisers consisting essentially of a transformer and a capacitor have been used in industry for some time, in areas such as electronic process control. A recent improvement in the so-called ferro-resonator technique, developed in Germany from traditional stabilisers, has made it possible to apply stabilisers to computers without having to resort to the costlier uninterruptible power supplies.

A new development of the ferro-resonator technique in voltage stabilisers is said to have made them suitable for use in power supplies for computers.

It consists essentially of an air gap in the transformer core and a supplementary secondary winding which is magnetically coupled to the air gap. This new arrangement is said to reduce core losses, to improve the load factor and to cause the secondary winding to be more independent of loading.

In order to use an ordinary transformer for voltage stabilisation the secondary winding is kept at saturation level, so that a large change in the primary voltage causes only a very small change in the secondary voltage.

However, in a normal transformer kept at saturation the primary current quickly attains the short-circuit condition, with consequently large power losses.

This led to the development of the ferro-resonant transformer, which has a nearly constant output voltage. In its first versions the ferro-resonant technique involved an ordinary transformer with a capacitor in series with the primary winding. This produced an extremely bad load factor. For a secondary loading of 1kVA, the primary side had to be designed for about 50A.

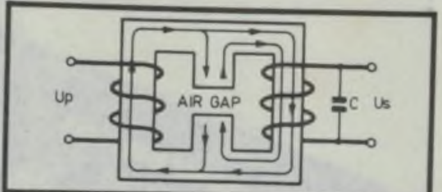
All these problems are said to have been overcome in a new design from Germany. This involves redesigning the iron core with an air gap between the primary and secondary circuits, providing a magnetic shunt, and including a capacitor in parallel to the secondary winding.

If the air gap is properly designed, part of the primary flux will be short-circuited and will not be coupled to the secondary circuit. Conversely, part of the secondary flux cannot reach the primary side.

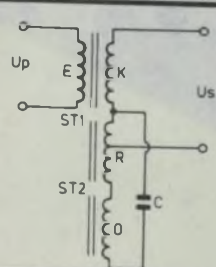
The secondary voltage produces a capacitive current which itself produces a magnetic flux. The arrangement is designed so that this flux is in phase with the flux produced by the primary voltage. Thus the secondary flux can drive the secondary core at saturation even while the primary core remains in the linear domain.

With this arrangement the secondary voltage is fairly nearly sinusoidal, but still load-dependent. Here a trick is employed, consisting of a harmonic-compensation winding which is magnetically coupled over the air gap.

Further information can be obtained from Mwb Messwandlerbau AG, of Bamberg, West Germany.



Basic idea of the improved ferro-resonant transformer.



Up	=	input voltage
Us	=	output voltage
E	=	input winding
K	=	compensation winding
R	=	Resonant and output winding
O	=	harmonic compensation winding
ST 1,2	=	air gap
C	=	resonance capacitor

Complete new mains voltage stabiliser, using improved ferro resonance.

Construction project:

Universal Midi Interface

Enter the exciting world of Midi music with this low cost interface. It's easy to build, and is simply interfaced to almost any standard PC via the Centronics-type parallel printer port.

by ROB EVANS

Buy a new electronic musical instrument these days, and chances are it will be equipped with sockets labelled "MIDI". MIDI is an acronym for Musical Instrument Digital Interface, which is a hardware and software specification for the transfer of data between electronic musical instruments. The nature of this standard allows remote access to almost every control aspect of a MIDI equipped instrument, via the MIDI sockets.

A complete discussion of the MIDI standard appeared in the January issue of EA, including typical codes and applications. One of the most versatile applications mentioned is MIDI control from a personal computer (PC). This is usually achieved via an interface unit, designed to provide the correct word format and baud rate, as defined by the MIDI specification.

Most MIDI interface units are designed for a specific computer, and are accessed via the expansion bus or user port. Naturally, they will not work on other computers without some (or considerable) modification. In the event of a computer upgrade for example, your expensive MIDI interface is ready for its gold watch! The essence of this problem is not the actual design of an interface, but the lack of a common computer connection system. If a universal high speed port was available, the specialized MIDI interface would be quickly replaced by a generally available, low cost unit.

The closest thing to a universal computer port is the "Centronics"-type parallel printer socket found on virtually all machines, due to a printer being the most popular peripheral. The data and handshaking lines of this port tend to have a common format and pinout, which is ideal for conversion to the MIDI standard. The parallel data can easily be processed by a parallel to serial device (for example, a UART), which may be configured to produce the correct MIDI serial word format.

This method has the advantage of complete compatibility to most computers, and ease of programming — since the interface is addressed as if it were a printer. The disadvantage is that the printer port will only *transmit* information, preventing the interface from receiving MIDI data.

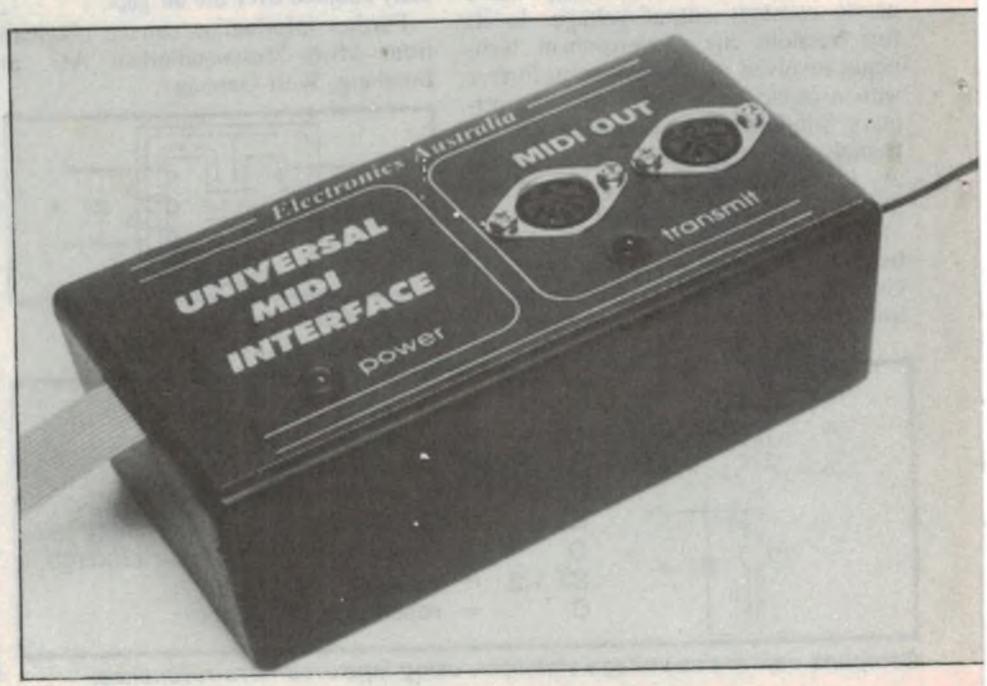
The lack of a MIDI input is not too serious, considering that most sequencing and control applications only involve transmitted data. Many hours of machine code programming are required if a computer is to cope with the speed of incoming MIDI data bytes. In fact, the idea of a universal interface is compromised if the software is difficult to write, and will not readily transfer to another computer.

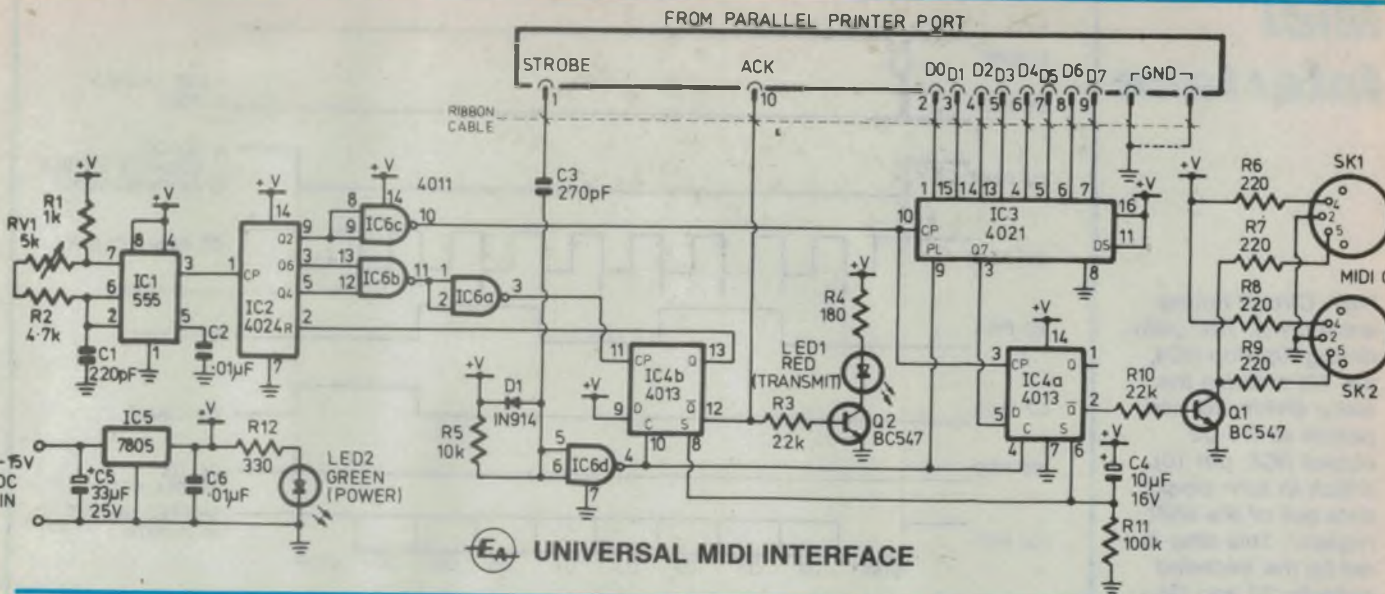
The design

The initial prototype for the EA MIDI Interface was put together in a matter of hours, then connected to the lab PC and a synthesizer. With a few lines of BASIC programming, the EA corridors reverberated with some very dubious music! Clearly, the unit was easy to install and responded to very simple programming.

This initial design was based on a UART handling the parallel to serial conversion, and raised a few questions regarding cost and availability of these specialised 40-pin chips. The last thing a universal interface needs is a chip that is not universally available! Also, only half the chip was being used (effectively a UAT rather than a UART).

After some research it appeared that a "discrete" design using common





The circuit is based around a standard shift register (IC3), while the remaining logic controls the timing.

CMOS chips was not only lower in cost and smaller, it was far more interesting than an LSI "black box".

The final result is a interface for anyone who wants to talk MIDI via their computer. Perhaps it should be named "The People's Interface" or maybe the "Volksmidi"!

The circuit

The circuit of the Universal MIDI Interface can be divided into two main sections, the parallel to serial conversion and the timing circuits. When a Strobe pulse is received from the printer port, the timing circuitry allows the parallel data to be shifted to the serial output for the correct number of clock cycles. The Acknowledge line is then pulsed to indicate that the interface is ready to process another parallel byte.

The master clock for the timing process is based around a simple 555 timer (IC1) running in astable mode at 250kHz. According to the MIDI specification, the serial data must be clocked out with an accuracy of +/- 1%. The 555 clock has this level of stability in our prototype, which avoids the expense of a crystal locked oscillator. In practice, we found that a clock error of more than 3% was required before the MIDI data was rejected by the receiving instrument.

A 7-stage binary counter (IC2) divides the clock by 16, to produce the 31.25kHz MIDI clock at its Q2 output. This is inverted by IC6c to provide the appropriate edge (see Fig.1) to clock the shift register formed by IC3 and IC4a.

The clock divider (IC2) is normally held in a reset state by the set condition of IC4b, a D-type flipflop. IC4b is then cleared by a narrow pulse version of the Strobe pulse from IC6d, thereby enabling IC2 and clock pulses to the shift register.

A logical AND is then performed by IC6b on the Q4 and Q6 outputs of the clock divider IC2; this decodes the 10th clock pulse. The result is inverted by

```
00010                                    REM. ALL NOTES OFF * *
00020 LPRINT CHR$(144);
00030 FOR A=36 TO 96
00040 LPRINT CHR$(A);CHR$(0);
00050 NEXT A
00060 INPUT A1$
00100                                    REM. NOTE TEST * *
00110 LPRINT CHR$(144);                 :REM. SEND "NOTE ON" STATUS
00120 FOR X=36 TO 96                    :REM. SET NOTE RANGE
00130 LPRINT CHR$(X);CHR$(64);          :REM. SEND NOTE, VEL 64
00140 FOR Y=0 TO 200: NEXT Y            :REM. NOTE ON TIME
00150 LPRINT CHR$(X);CHR$(0);           :REM. SEND NOTE, VEL 0 (OFF)
00160 NEXT X                            :REM. NEXT NOTE
00170 INPUT A1$
00190                                    REM. PROGRAM CHANGE DEMO * *
00200 FOR X=0 TO 31                     :REM. SET RANGE
00210 RESTORE
00220 LPRINT CHR$(192);CHR$(X);         :REM. SEND PROGRAM CHANGE
00230 READ Z                            :REM. READ NOTE DATA
00240 IF Z=-1 THEN NEXT X
00250 IF Z=-2 THEN GOTO 270
00260 LPRINT CHR$(Z);:GOTO 230          :REM. SEND NOTE DATA
00270 FOR B=0 TO 100:NEXT B             :REM. DELAY LOOP
00280 IF X=31 THEN END
00290 GOTO 230
00300 DATA -2,144,48,64,-2,48,0,-2,60,64,-2,60,0,-1
```

These simple BASIC programs will help in getting the system up and running, and provide a starting point for more serious programming.

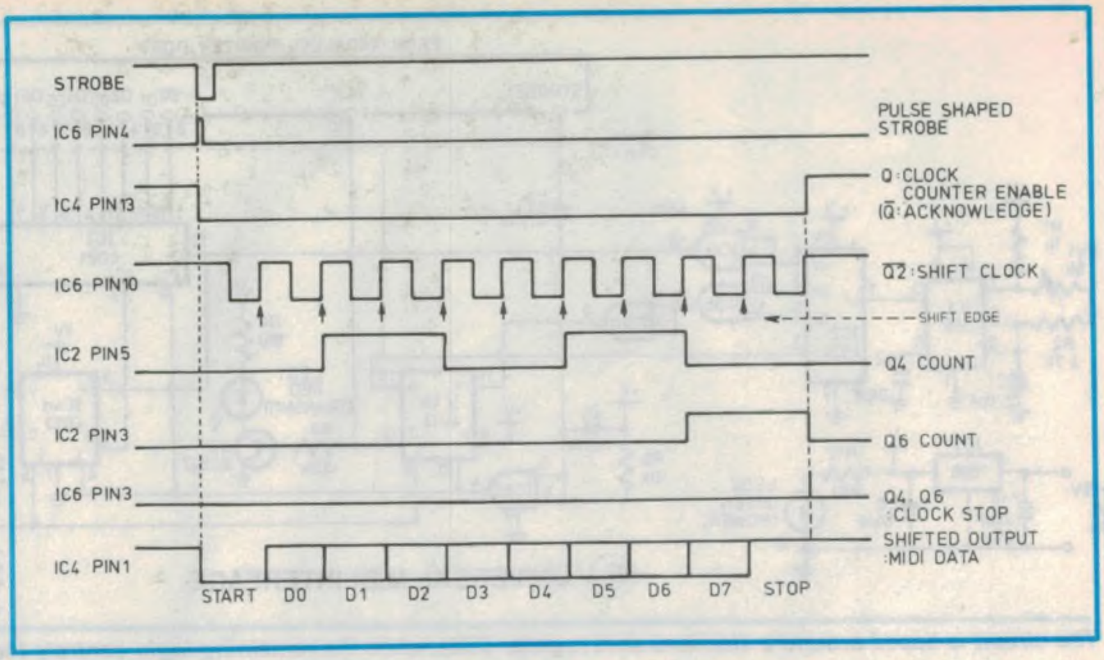


Fig1. Circuit timing waveforms: The main timing flip-flop (IC4, pin 13) enables the clock divider for ten pulses at the Q2 output (IC6, pin 10), which in turn clocks data out of the shift register. This time is set by the decoded outputs Q4 and Q6 (IC6, pin3).

IC6a and applied to the clock input of the timing flipflop IC4b. The rising edge of this pulse clocks a hardwired HIGH at the D input of IC4b to its Q output. This high level resets the clock divider IC2, halting clock pulses to the shift register; thus ending the transmission.

The above explanation is most easily followed by referring to Fig.1, which shows the timing waveforms. In summary, the timing is controlled by the action of the flipflop IC4b, which is reset by the Strobe pulse, and finally set after the appropriate number of clock cycles as decoded by IC2.

Internally, the main shift register IC3 is simply a string of D-type flipflops with assorted logic, allowing each output to be set or cleared in response to the parallel inputs. These inputs will "jam" each shift register stage to a logic level matching each bit of the data word (D0 to D7). This action is enabled by a high level pulse on the Parallel Load input (PL), which in our case is derived from the Strobe signal.

When each rising edge of the clock pulse is detected, the loaded data will be serially shifted out of the register (at Q7) as the MIDI word, minus the start bit.

IC4a is effectively another stage of the shift register, tacked on the end. Its function is to produce the MIDI Start bit, which is always a low logic level, and to ensure a nominal HIGH output when the interface is not transmitting.

Again, the shaped Strobe pulse instigates the timing, in this case by clearing IC4a. The start bit is then terminated by the arrival of the next clock pulse and data from IC3. The last bit of this data will always be a HIGH, due to the Serial Data input (DS) of IC3 being tied to the +5 volt rail. Therefore, we automatically have a Stop bit (logic high), and the correct logic during the rest period between transmitted bytes.

The MIDI data stream appears with the correct logic polarity at the Q output of IC4a, however the Q-bar output is used due to the inverting nature of the output buffer Q1. This buffer provides the current sourcing for two standard 5mA MIDI loops.

An Acknowledge signal is sent to the printer port from the Q-bar output of IC4b. This line will return to a low logic level when the timing sequence is completed. The computer then knows that the MIDI word has been transmitted (or "printed"!), and will apply another Strobe pulse if it has the next byte ready on the parallel data lines. A transmit indication is provided from the Acknowledge line via the action of Q2, which illuminates LED1 during the cleared state of IC4b.

A power-on reset (or in this case; set) pulse is delivered to IC4a and IC4b by the charging action of C4 via R11, as the supply rail rises to its full value. The 5 volt regulator IC5 and associated circuitry have been included to allow the interface to be run from a plugpack or any convenient voltage source. Therefore the unit has the independence of a printer, although it's not nearly as heavy! Naturally, this regulated supply (IC5 etc.) may be omitted in favour of an accessible 5-volt source from the computer.

Software

Programming the Universal MIDI Interface is extremely simple. This is due to the printer driver program which is inherent in most computers supporting a

When BASIC isn't!

There is a trap when using some of the more recent forms of BASIC (Microsoft GW Basic etc.). If ASCII code 13 is sent via the printer port, the program interprets this as a printer Carriage Return and immediately sends a Line Feed code (10). We can hardly blame the software for this, as it believes that a *printer* is connected to the parallel port, rather than a Midi interface!

This problem may be tackled in a couple of ways. The first (and preferable) solution is to consult the computer's software manuals for a method of suppressing this automatic Line Feed. The second method is to use an offset when a data code of 13 is required. For example, a synthesizer with 32 selectable voices (programs) can be tricked into selecting program 13 by sending code 45 (an offset of 32), or code 77 (an offset of 64). A 64 voice capability may be treated in a similar way; that is, sending an offset of 64 (code 77 for voice 13).

printer port. The BASIC instructions "PRINT" or "LPRINT" will automatically address the printer port (in this case, the MIDI interface), and activate the Strobe and Acknowledge lines. The character (CHR$) statement should be used so as to avoid ASCII codes, and a semi-colon (;) added to prevent carriage returns. For example, the MIDI status byte for "Note On" is sent as:

LPRINT CHR$ (144);

If a *large* MIDI system is to be implemented, the program may need to be written in machine code. This is because the execution time of a BASIC program may become significant when transmitting intense MIDI data. The interface itself is capable of transmitting a continuous stream of data bytes, without timing delays.

For the majority of applications, a BASIC program will offer more than adequate performance from the MIDI interface. As a starting point, a couple of simple examples can be found at the end of this article.

Construction

The Universal Interface is quite easy to construct, for all of the components except the MIDI output sockets and indicator LEDs are contained on one PCB measuring only 45x110mm (code: 88ms1).

Before any construction actually begins, the PCB should be checked for any bridged tracks due to incomplete etching. Quite a thorough check is worthwhile at this point, for this may prevent the infamous "frazzled constructor syndrome" when a PCB fault is encountered in final testing! Also, the corners of the PCB may need to be trimmed to clear the lid mounting posts.

The easiest way to begin construction is to tackle the lower profile components first. This allows the PCB to lie evenly with the copper side facing upwards while the component legs are being soldered. The overlay guide should be carefully followed for the correct component orientation, and the usual static and earthing precautions taken for the CMOS logic chips.

After mounting the larger components, short lengths of wire may be soldered to the appropriate PCB pads for later connection to the front panel sockets and LEDs. The 12-way ribbon cable may also be soldered to the appropriate pads, although the order of the wires will depend on the terminating connector arrangement.

Many PCs use a DB25-type socket for the parallel printer port, the most likely connector required to terminate the 12-way ribbon cable is a DB25-type line plug. When such a PC is interfaced to a printer with a Centronics-type connector, a DB25 to Centronics adaptor cable is used. Therefore, if the interface is required to connect *directly* at the point where a Centronics equipped printer would be, a Centronics-type (or a 36-way Amphenol 57N series!) socket is necessary.

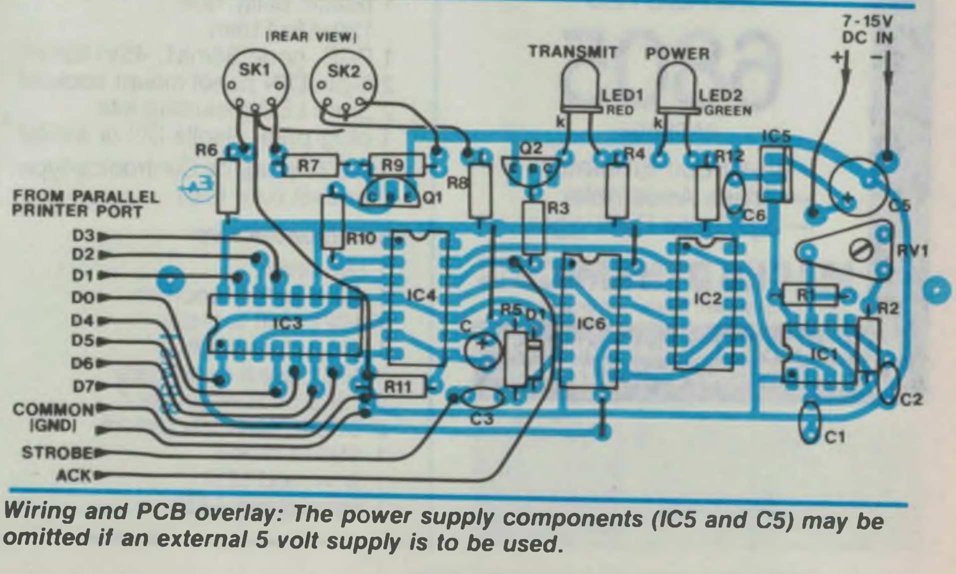
It's worth bearing in mind the relative cost when choosing between the two connectors, for the Centronics socket tends to be around four times the price of a suitable DB25 plug. In fact, a Centronics socket costs around the same as the parts required for the entire MIDI Interface.

The order of the Strobe, Acknowledge, and Data bit lines are the same for both styles of connectors. The Strobe is pin 1, Acknowledge is pin 10, and Data bits 0-7 are pins 2-9 respectively. The difference is simply the ground connections, which are 18-25 for the DB25, and 19-30 for the Centronics connector.

Some computers (e.g. IBM PCs and compatibles), may check the Busy and Paper End lines during their print routine. In this case, the Paper End line (pin 12) should be grounded and the Busy line (pin 11) tied to the Acknowledge (pin 10). The most convenient position to connect these links is at the DB25 or Centronics connector.

The final stage of construction is to prepare the box for the mounting of the PCB and other components. The Dynamark front panel may be attached, and holes drilled for the LEDs and DIN sockets. Care should be taken at this point, for drill bits have a nasty habit of destroying front panels.

Holes are then drilled for the power supply lead (if applicable) and the PCB mounting screws. The ribbon cable enters under the lid via a slot filed in the top of the box body. Finally, all of the parts are mounted in the box, and inter-



Wiring and PCB overlay: The power supply components (IC5 and C5) may be omitted if an external 5 volt supply is to be used.

wired according to the overlay diagram.

Testing and programming

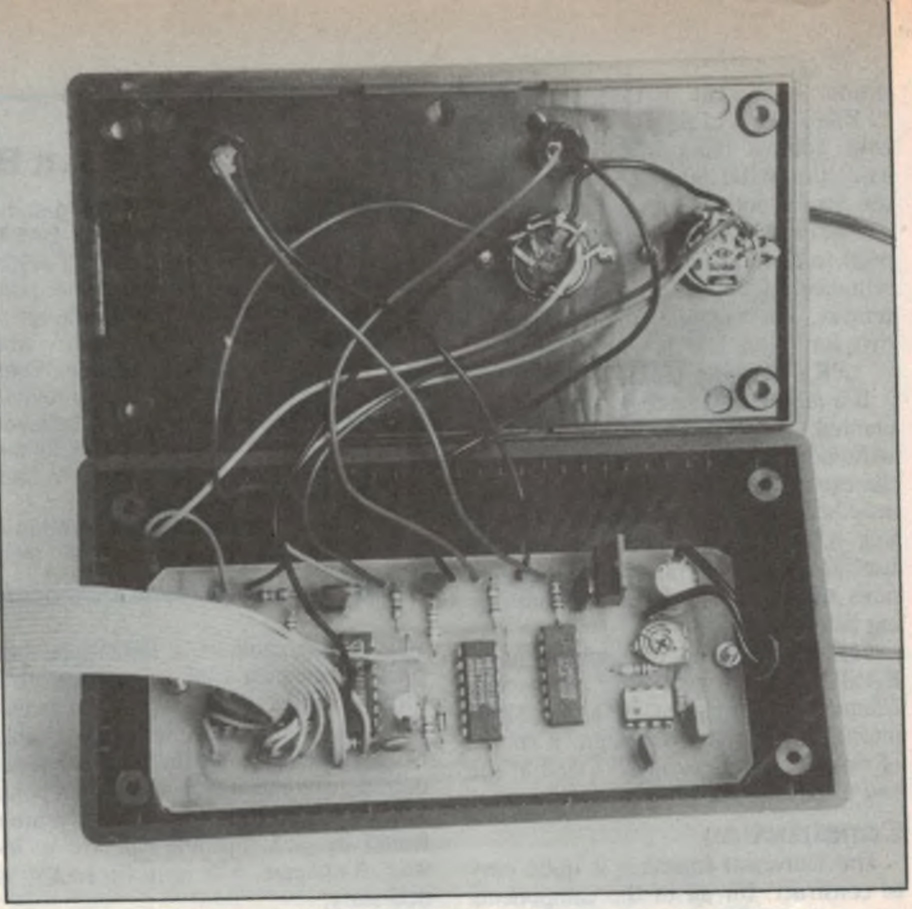
The initial tests on the MIDI Interface should be completed with only the power supply connected. Use a multimeter or CRO to check the 5 volt supply and the "power-on set" condition of IC4a (pin 1 HIGH). The master clock may be set to 250kHz by adjusting RV1, while monitoring the output with a CRO or (preferably) a frequency counter.

If the above mentioned test instruments are not available, the clock frequency can be adjusted on a trial and error basis. Assuming the circuit is working correctly, the Interface should be connected to suitable MIDI instrument and the printer port of a PC. Then run a simple, repetitive program (such as the supplied listing) while adjusting the clock frequency trimpot RV1 for reliable operation. Note that the MIDI channel number of the instrument must match the MIDI channel number encoded in the program.

The asynchronous nature of MIDI information means that if the transmission of note data is interrupted, the instrument will effectively "hang" until it receives further instructions. Therefore, when the instrument rejects data arriving at an incorrect rate (wrong setting of RV1), notes will continue to sound until matching "note off" bytes are received.

This can be quite confusing when the selected sound on a synthesizer has a natural decay; the notes will fade away despite the lack of "note off" messages. If the instrument is 8-voice polyphonic (8 separate oscillators) for example, each oscillator may eventually be assigned to a note that is not sounding. Now, *some* synthesizers may not respond to the 9th "note on" data, leaving the instrument effectively "dead".

Despite this complicated sequence of events, the solution is very easy. Simply turn the instrument off, and turning it on again will reset the oscillators. Another solution is provided by lines 20 to 60 of the program in this article, which



PARTS LIST

- 1 plastic utility box, 130x68x41mm
- 1 PCB, code 88ms1, 45x110mm
- 2 5-pin DIN panel mount sockets
- 2 5mm LED mounting kits
- 1 plug pack, 9volts DC or similar
- 1 DB25 plug, or Centronics-type socket (see text)

Semiconductors

- 1 555 timer
- 1 4024 binary counter
- 1 4021 shift register
- 1 4013 dual flip flop
- 1 4011 quad nand gate
- 1 7805 5volt regulator *
- 2 BC547 NPN transistors
- 1 1N914 diode
- 1 5mm red LED
- 1 5mm green LED

Capacitors

- 1 220pF ceramic
- 1 270pF ceramic
- 2 10nF metallised polyester
- 1 10uF 16VW electrolytic (PC mount)
- 1 33uF 25VW electrolytic * (PC mount)

Resistors (all 0.25W, 5%)

1 x 180Ω, 4 x 220Ω, 1 x 330Ω, 1 x 1kΩ, 1 x 4.7kΩ, 1 x 10kΩ, 2 x 22kΩ, 1 x 100kΩ 1 x 5kΩ horizontal trimpot

Miscellaneous

12-way ribbon cable, nuts and bolts, hookup wire, Dynamark front panel.

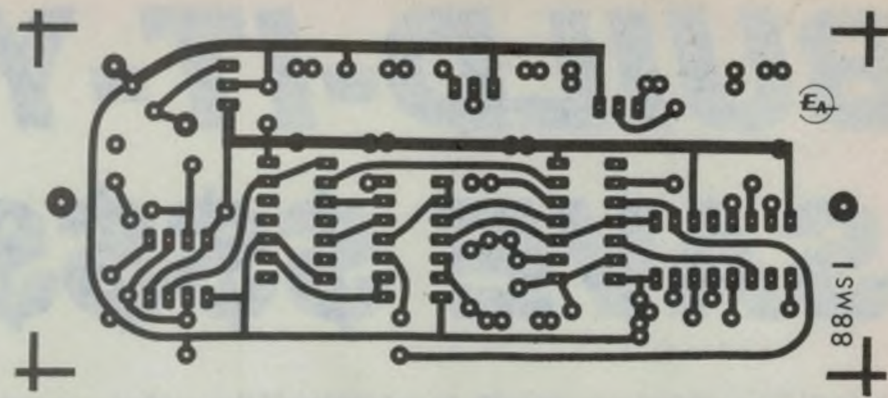
* Note: parts for optional power supply.NN

sequentially sends a "note off" message to each possible note position. This is a little more convenient, and should be run at the beginning of each sequence when there is a danger of data rejection.

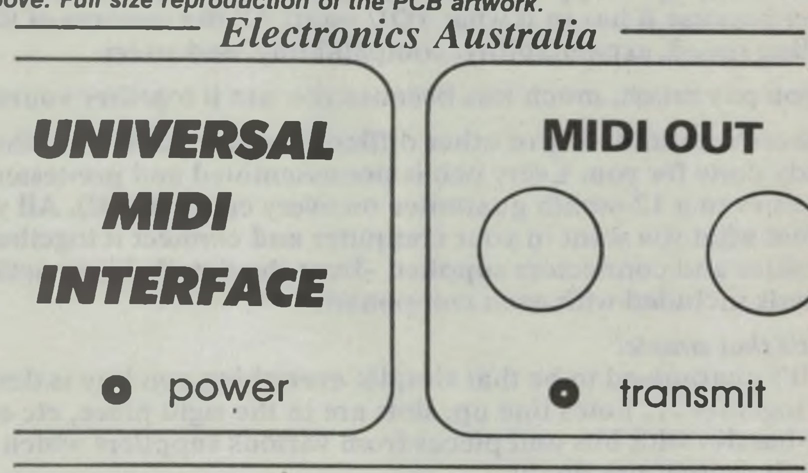
The next section of the program (lines 110 to 170) sounds each note in turn for a period as set by line 140. This will complete a cycle of the possible notes of an average synthesizer (as set by line 120), and is ideal for setting the clock frequency without test instruments.

The last program (lines 200 to 300) demonstrates the MIDI program change capability. This will "play" a couple of notes then change to the next program (or sound), working its way through 32 possibilities (maximum range 127: see line 200). The "INPUT A1$" line is included between programs so the next section will run after a Carriage Return key.

These programs have been included as a starting point for more adventurous programming, which is only limited by your imagination and software skills. However, simple tasks such as a defined series of program changes, or a repetitive bass melody only require a few quick lines of BASIC programming.



Above: Full size reproduction of the PCB artwork.



The front panel artwork for the Universal MIDI Interface, shown full size.

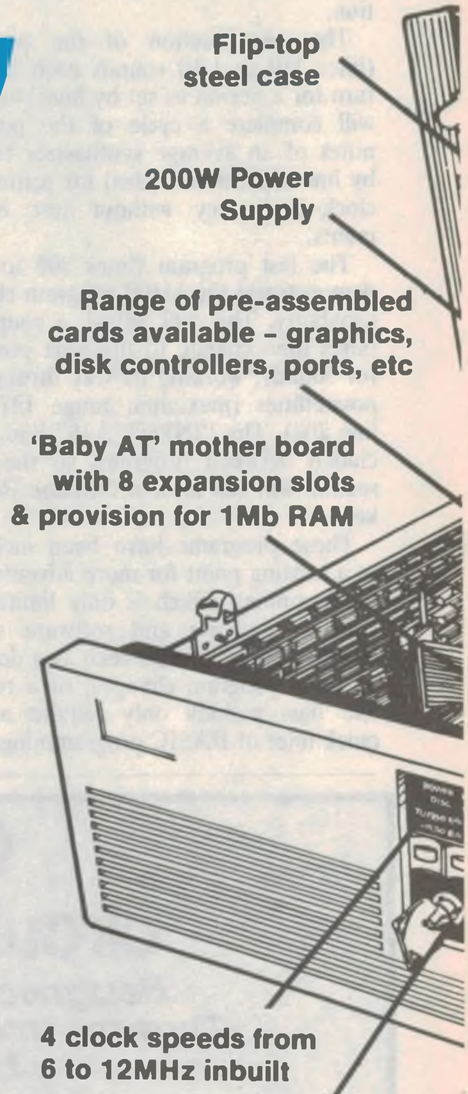
BUILD-IT-YOURS SAVE $$$$!

At last! The *perfect* opportunity to get yourself the *perfect* computer . . . *perfect* because it has in it what *YOU* want! All the features of the'AT': blinding speed, expandability, compatability, and so on.

But you pay much, much less because you put it together yourself!

No, there's no soldering or other difficult work required. All that's already done for you. Every pcb is pre-assembled and pre-tested (there's even a 12 month guarantee on every component!). All you do is select what *you* want in your computer and connect it together, using the cables and connectors supplied -from the detailed instruction manuals included with each component!

Yes, it's that simple!
And it's guaranteed to be that simple: everything you buy is designed to fit together . . . holes line up, slots are in the right place, etc etc. No more hassles with bits and pieces from various suppliers which sometimes fit, sometimes don't!



WHY BUILD YOUR OWN COMPUTER?

Apart from the reasons above (ie, you get what you want and you pay less – two of the best reasons ever invented!!!) there are a few other big reasons to 'do it yourself':

(1) You'll learn as you go!

Nothing teaches you more about how something functions than constructing it yourself. It's the best way for anyone to gain an understanding of the fundamentals of computer operation – even if you've never looked inside one before! Suddenly all those 'buzz words' you've often wondered about will start taking on meaning . . .

(2) Imagine being able to say 'I built it myself!'

Yes, just imagine. It must be one of the ultimate projects!
School & Tech students – think of how this will shape up as your major project: and think of how much value it will be to you in the future!
Business People: now the computer you've always wanted at work can be the one you have. And with the money you'll save, there'll be enough left over for another one at home!
Hobbyists: how long is it since you've really been able to get your teeth into a 'real' project?

(3) We've made it so affordable!

You don't have to outlay a large amount in one hit: this computer has been deliberately kept in 'modular' form so you can buy the individual bits and pieces when you want them – and when the pocket will allow them!

BRIEF

Mother Board:
- 80286 CPU
- 6, 8, 10 & 12MHz speed (selectable)
- Provision for 256K, 512K, 640K or 1024K RAM on board
- CHIPSet technology & IC's
- 7 Channel DMA
- 16 Level Interrupt
- Award BIOS (fully licensed)
- Real time clock on board (battery b/u)
- 8 Input/Output Slots (6 with 62 and 36 pin connector, 2 with 62 only)
- CMOS Memory to Maintain System Configuration
- IBM PC/AT compatible

All LSI & RAM IC's fully socketed
80287 Co-processor socket provided

ELF 'AT' —

YES! AN '80286' COMPUTER FOR UNDER $2000!

Buy what you want, as you want it . . .

'Baby AT' Motherboard:
Complete with 8 expansion slots, back-up battery, speaker, manual and all IC's except RAM. Cat X-1000 — **$799**

Hinged Steel Case
Footprint just 430mm square, case covered in quality bone crinkle finish. Pre-drilled, slotted, etc as required, complete with front panel. Cat X-1005 — **$175**

200W Power Supply With enough capacity for full expansion, complete with whisper quiet fan, on/off switch and input/ output connectors. Cat X-1010 — **$275**

DISK CONTROLLERS:
Floppy Controller:– Up to 4 360K or 1.2Mb drives. Cat X-2014 — **$129**
Hard/Floppy Controller: Handles 2 of each hard/floppy. Cat X-2008 — **$399**

DISK DRIVES:
1.2Mb Floppy Disk Drive Complete with cables Cat X-2200 — **$269**
20Mb Hard Disk Complete with cables Cat X-2203 — **$795**

PLUG-IN CARDS:
CGA & Parallel Printer: Cat X-2010 — **$129**
MGA & Parallel Printer: Cat X-8141 — **$149**
EGA card with Hercules Compatability: Cat X-2013 — **$399**
Serial/Parallel/Game Port Card: Cat X-2012 — **$139**

KEYBOARDS
84 Key 'IBM' Format Cat X-3820 — **$129**
101 Key Expanded Style: (direction keys and extra function keys) Cat X-3821 — **$149**

MEMORY
Fast (120ns) top quality 41256 RAM chips. 9 required per 256K bank. Cat Z-9313 — (each): **$10.95**
Special price for 18 or more: (each): **$9.95**

SPECIFICATIONS

Hard/Floppy Disk Controller:
- Controls 1 or 2 hard disks
- Ind. standard ST-506/ST-412 Interface
- Up to 2048 cylinders
- Up to 16 read/write heads
- Data Transfer rate 5Mb/s

- Controls 1 or 2 floppy disk drives
- Interface similar to FD-55F minifloppy
- Double density 320/360Kb or 160/180kb
- High density 1.2Mb
- Rated to work up to 12MHz

Graphics Cards:
- MGA, CGA & EGA available

Ports:
- Keyboard port on motherboard
- Parallel, serial & game ports on interface
- Monitor port on appropriate graphics card

EXCLUSIVE TO

DICK SMITH ELECTRONICS
PTY LTD

DSEB465/RT1087

A project for newcomers:

Earwig: a bug in a matchbox

This easy to build and low cost baby FM transmitter fits in a matchbox. It transmits to any standard FM radio and can be used around the home, on a hiking trip or as a baby minder. Its sensitivity and clarity are very impressive — even the ticking of a clock is clearly transmitted.

by COLIN MITCHELL

Almost every electronics hobbyist has the ambition to use the airwaves. Whether it be for a remote control car or Dxing halfway around the world, the desire to transmit is in us all.

This project will get you on the air with the least fuss, the least cost, and you can transmit 300 metres or so to an ordinary FM radio. You can therefore use it to monitor a baby's room, swimming pool, gate, driveway or as a night security device. We've called the circuit EARWIG because an earwig is a small bug and this design fits perfectly into that category.

The concept of FM transmission is superb. It produces an extremely high quality signal that is noise-free and is relatively easy to get a good range with very low power.

The Earwig produces no more than 5-8 milliwatts of radiated signal and yet the range can be up to 300 metres in a built-up area.

Buildings and high-voltage transmission lines have an effect on the range and they can sometimes kill the signal just 100 metres from the source. But most of the time the signal finds its way around and through the obstructions and you can get a range that will be most impressive.

The most challenging part of this project is to achieve the best range using a 3V supply and 1/2 wave antenna.

By constructing the Earwig, you will learn a lot about FM transmission and see just how effective it is.

The first question everyone asks is: "How can I increase the range?" The answer is not as simple as it seems. A lot of complications creep in when the voltage and power are increased and we must warn you that serious interference will occur to the surrounding airwaves once you start pumping high levels of energy into it.

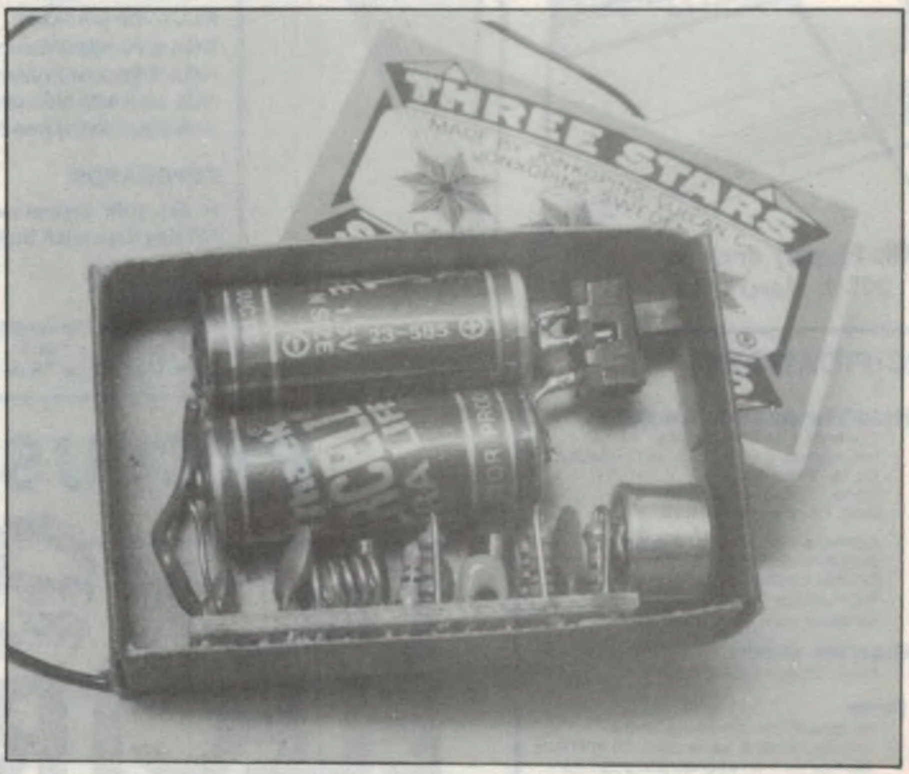
Everything is quite safe when you are down at 10 milliwatts and although you can achieve 300 metres, the signal strength at this distance is only a few microvolts and you are almost down to snow level.

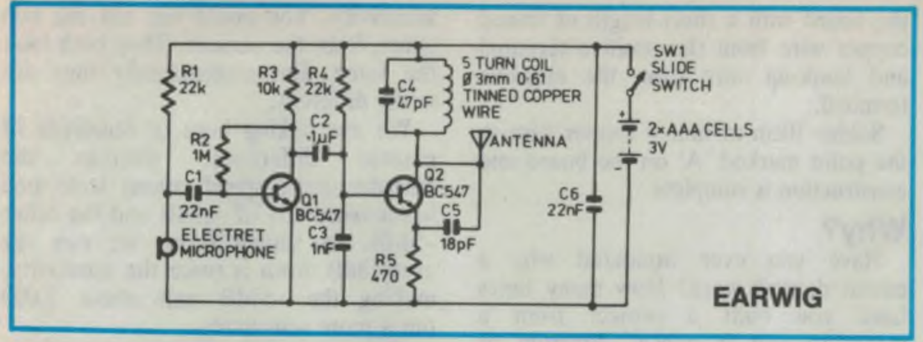
These projects are for interest and educational purposes only and they have a magnetic draw about them. They certainly have us hooked!

You can spend hundreds of hours experimenting and improving the design and sometimes you come right back to square one.

We have done all the experimenting for you and come up with the simplest and best FM transmitter possible. It is small enough to fit inside a match box and comes with a 10cm antenna for inter-room communication.

We have had a unit running for nearly 12 months. It sits on top of the TV during news and similar programs





Complete circuit for the Earwig. It's very easy to build . . .

and the writer has an FM receiver next to his typewriter. He can monitor the TV while typing and if an important item comes up, he can go and watch it.

Mind you, most programs need very little viewing and when the adverts come on, you can turn the radio down for up to two minutes. It's amazing what you can achieve in two minutes!

The Earwig can also be used as a baby monitor for those times when you are next door. It is left in the children's bedroom and if they wake up, you can be on the scene in seconds.

The unit looks a bit like a video transmitter and you can use any one of a number of small plastic boxes to house the circuit: or, as we have suggested, you can use the humble match box.

The current consumption is less than 5 milliamps and you should get between 80 and 100 hours of operation on two 'N' cells.

The circuit has been designed for maximum output rather than immunity to stray capacitance and although it has a very low drift factor, it is not possible to touch the circuit without it drifting off frequency. A 'tight' circuit will be described in another project as considerable output has to be sacrificed if you require the frequency to be stable when the circuit is handled.

Although the output is not crystal locked, the frequency drifts very little in normal operation and our tests showed a receiver did not need re-tuning after an 8 hour test. The only thing that will influence the output frequency is the condition of the batteries. As they age, the frequency changes slightly.

A reduction in the transmitting range will indicate the voltage has fallen to below the minimum allowed and the cells should be replaced. They are soldered together to fit inside the matchbox and provided they are soldered quickly, the seal on top of each cell will not be damaged and they will not leak.

All the components are easy to obtain and if you know what you are doing, you can use parts from your own sources. If you have any hesitation about wire size, coil diameter, identifying a monoblock capacitor, reading 10p or 1n on a ceramic, or the type of electret microphone to use, you should buy a kit.

Kits are available from the supplier shown at the end of the article and the complete kit of parts include a pre-wound coil and PC board with overlay. The only item you need to supply is the matchbox and perhaps a few fake matches.

How it works

The circuit consists of two stages, an audio amplifier and an RF oscillator.

The electret microphone actually contains a FET transistor and this can be counted as a stage, if you wish. The FET amplifies the change in capacitance of the diaphragm at the front of the microphone, and this is why electret microphones are so sensitive.

The audio amplifier stage around Q1 has a gain of about 20 to 50 and amplifies the signal for injection to the base of the oscillator stage.

The oscillator stage around Q2 is designed to operate at about 88MHz and this frequency is set by the inductance of the 5-turn coil, together with the 47pF capacitor. The frequency is also determined by the transistor, the 18pF feedback capacitor and also to a lesser extent by the biasing components such as the 470-ohm emitter resistor and 22k base resistor.

When the power is applied, the 1nF base capacitor will gradually charge via the 22k resistor. But the 18pF will charge much faster, via the oscillator coil and the 470-ohm resistor. The 47pF will also charge (although only a small voltage will appear across it) and the coil will produce a magnetic flux.

As the base voltage gradually rises, the transistor will turn ON and effectively put a resistance across the 18pF.

A few messy cycles will now occur while the 1nF capacitor charges to the operating voltage of the stage, so we will resume our discussion when the operating voltage has nearly been reached.

The base voltage will continue to rise and the 18pF will have the effect of trying to prevent the emitter from moving. A point in time is reached when the energy from the capacitor is exhausted and it can no longer resist the movement of the emitter. The base-emitter voltage decreases and turns the transistor off. The current flow in the coil then ceases and the magnetic flux collapses.

This collapsing magnetic field produces a voltage in the opposite direction and whereas the collector voltage may have been 2.9V, it will now rise to over 3V, and charge the 47pF in the opposite direction. This voltage will have the effect of charging the 18pF and the voltage drop across the 470-ohm emitter resistor will be such that the transistor will be turned more firmly OFF.

As the 18pF charges, the emitter voltage will drop to a point where the transistor will begin to turn ON and the current flow through the coil will oppose the collapsing magnetic field.

The voltage across the coil will reverse and the collector voltage will drop. This change will be passed on to the emitter via the 18pF and the result will be that the transistor will turn ON very hard and short out the 18pF, to begin the cycle again.

So what we have in the Q2 stage is an oscillator circuit, which produces AC energy at 88MHz. The amplified audio signal fed to Q2's base via the 0.1uF capacitor varies the frequency of this oscillation, to produce the desired FM signals.

Construction

Before commencing construction it's a very wise idea to place the two cells and PC board in the tray of a matchbox and see exactly how much room you have.

The headroom is the most critical as you need to leave space for a single row of matches on a thin sheet of card. In fact, you can glue a few dead matches on the card to add more reality.

Lay all the components on the work bench and identify each of them. There is nothing more annoying than incorrectly swapping two components and having to remove them later. To avoid this, place the parts on the bench so that they match the positions on the board. This will allow you to concentrate on soldering.

The solder we recommend is superfine 0.61mm resin core type, as the thin solder makes a much better job. As one salesman also told us "It goes twice as far!"

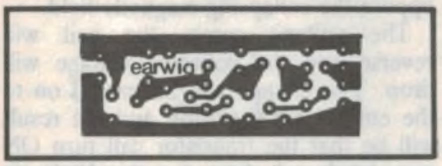
A small 15 to 20 watt soldering iron is needed and provided the tip is cleaned on a wet sponge before use, you will have no trouble in producing a first class job.

The only item that needs fabricating is the coil. It can be would with 22 B&S (0.5mm) or 24 B&S (0.71mm) enamelled or tinned copper wire.

Although the wire diameter is important, it is not as critical as the number of turns, the diameter of the coil or the length of the coil.

Wind five turns on a 3mm diameter shaft, such as a medium Phillips screwdriver and space the turns as shown in the photos, over about 5.5mm.

Final setting of the frequency will be done by stretching the turns apart or squashing them together, and at this stage the coil is ready for fitting. If you have made the coil from enamelled wire, the ends should be tinned up to



The PCB pattern, actual size, for those who make their own.

the point where they enter the PC board. This tinning is done while the coil is on the screwdriver to act as a heatsink, and any surplus solder should be removed so that the ends will fit down through the holes in the board.

Now you can wire up the PCB (printed circuit board). Start at the microphone end of the board, but leave the microphone to last to prevent the leads being damaged when fitting the rest of the parts.

The resistors stand on end and fit firmly up to the board, to keep the height to a minimum.

Continue across the board, mounting each part as you come to it. The transistors should be pushed down so that they are only as high as the other components. Add everything, including the microphone and you only have to fit the batteries, switch and antenna.

The batteries are soldered together by using the switch and some tinned copper wire at one end, and soldered to the board with a short length of tinned copper wire from the positive terminal and hook-up wire from the negative terminal.

Solder 10cm of tinned copper wire to the point marked 'A' on the board and construction is complete.

Why?

Have you ever wondered why a circuit doesn't work? How many times have you built a project from a magazine and it doesn't function as described?

Don't blame yourself or blame the magazine. Most of the time it's due to a factor called *tolerance*.

As made by the manufacturer, all components have a value falling inside a "spread range", rather than the "nominal" value marked on them. The width of this spread range is known as the tolerance. So if the tolerance is said to be 5%, this means that the value of a particular part will be anywhere between 5% below its marked value, and 5% above.

Tolerance applies to resistors, capacitors, transistors and such things as electret microphones, coils and integrated circuits.

Then we have another factor, called *limits*. For each component in a circuit, there will be a range of allowable values for that part. Providing the value remains inside that range, or inside those limits, the circuit will work properly. Normally each component's value is chosen so that it falls in the middle of this range.

Most circuits are not very critical, and for any particular component they will generally work equally well if we select the next higher or lower value, from that designated. If not, the circuit is either very critical or the chosen value is not the most appropriate.

When you place a circuit on the open market, such as in a magazine project, you have an enormous range of potential builders, drawing their supplies from many different sources. Sometimes they use the designated values, sometimes they select the next value. Also some components have a tolerance of +/-5%, while others are up to +50% of the marked value. When these parameter spreads and limits are combined in a random manner, you can quite often come up with a circuit that doesn't want to work!

Take the electret microphone, for example. On a 3V supply, some microphones are super-sensitive with a 100k load resistor (R1). Others may require 4.7k to get a barely acceptable sensitivity. You could not tell the two apart, from the outside. They both look the same. But electronically they are vastly different.

We are talking here of hundreds of percent difference, whereas the manufacturer's specifications state one has a sensitivity of –22dB and the other –54dB. In simple terms we can say every 3dB down is twice the sensitivity, making the –54dB unit about 2,000 times more sensitive!

The same can apply to transistors. The specification sheets may show two devices to be nearly the same and yet when they are connected to a circuit, one will work perfectly while the other will fail to operate.

This is one of the reasons why the kit market has flourished. Kits are generally put together from batches of parts that have been tried in the circuit and for this reason we are advocating first-time constructors invest in a kit.

You have the greatest potential for success, and nothing is more encouraging than success.

Setting up

Once all the components have been soldered in position, the project can be set up and tested for performance. The test procedure is to add a short antenna (5-10cm long) to the antenna point on the board and tune an FM radio across the band, looking for the signal.

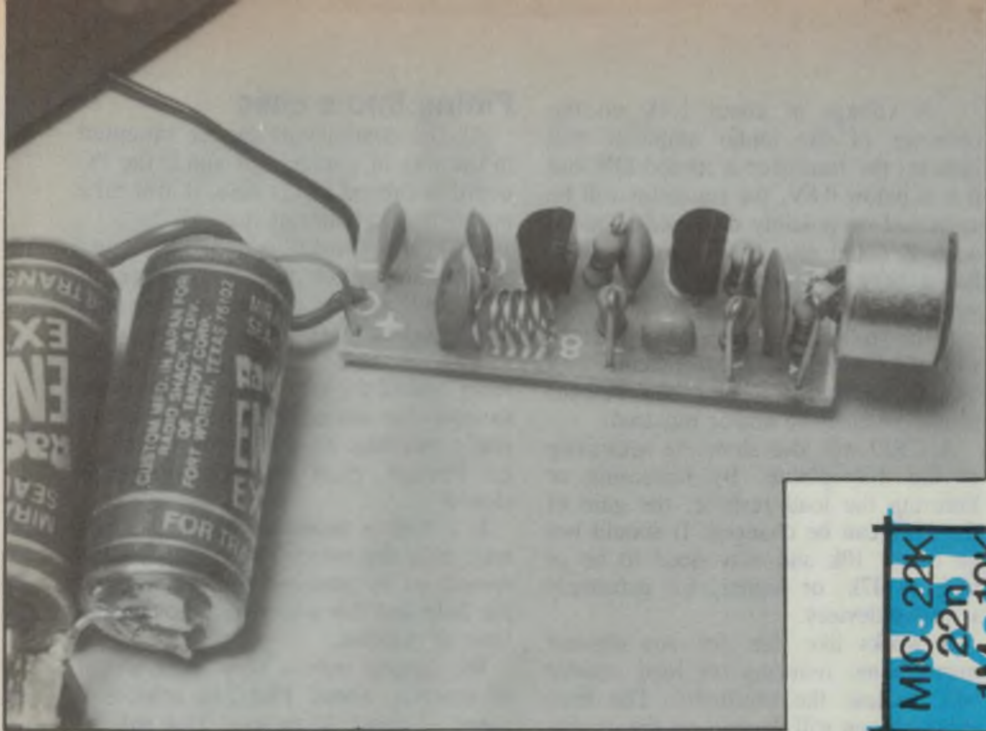
It is best to keep the transmitter some distance from the radio, to prevent any of the harmonics or side tones from being picked up.

If you cannot detect the carrier, it may mean the frequency is below the band. Move the turns of the oscillator coil apart a little, and try again. If you are using tinned copper wire, make sure none of the turns are touching. If you are using enamelled wire, make sure the coil has continuity by either measuring it with a multimeter set to low ohms, or measuring the current taken by the circuit, which should be about 4-6mA.

Once the carrier is detected, you can check the sensitivity of the front end by placing the Earwig near a clock. The ticking should come through loud and clear, and the circuit should be more sensitive than your ear.

The load resistor for the electret microphone (R1) will determine the sensitivity and it may have to be lowered to 10k or raised to 47k, depending on the sensitivity required.

Make sure the frequency of transmission is well away from any of your local FM radio stations, as the signal from a station will swamp the



Left: A larger than life view of the assembled PCB and battery assembly, to guide you in putting it together.

Below: The PCB overlay diagram, showing exactly where everything goes. Be careful with the orientation of the two transistors.

Earwig when you are testing for range.

By moving the turns of the coil together, the frequency will be lowered and if the turns are spread apart, the frequency will increase. This saves using a trimming capacitor and keeps the cost down, but you can use a trimmer if you wish.

A word of assistance here. If you use a 5-65pF air trimmer, for example, it will be very difficult to tune the circuit to a specific frequency as a few puff (picofarads) will change the frequency by 1MHz or more. It is much better to use a 39pF ceramic for C4, and put a 10pF or 22pF trimmer across it. This way you are fine tuning the circuit and you have much more lee-way with the adjustment.

Theoretically the inductor should also be adjusted to maintain the L/C ratio of the tuned circuit, but over the small range we require, this is not critical.

The output power of the Earwig can be determined by using an FM radio with a tuning indicator. You really need to have a comparison, as four units on the indicator of our tuner indicates a very good output. We tested the output of our prototype with a 10cm length of antenna laying horizontally and about 10 metres from the tuner. With a 4 unit reading, we know the transmitter will be capable of transmitting about 300 metres with a halfwave antenna (170cm long).

If it doesn't work

Hopefully the Earwig will work first go for you, but if it doesn't, you have a challenge in store.

If you cannot pick up the carrier on an FM receiver, you should firstly assume the frequency is below the normal 88-108MHz FM band. This is the most probable reason.

Measure the current flow. If it is about 4-6mA, the circuit will be operating. Move the turns of the coil apart and sweep the band. When touching any of the parts on the board, make sure you use a non-metallic screwdriver and also keep away from the batteries etc.

The capacitance effect of your hand will detune the circuit appreciably and it may drop out completely. It all depends on how critical the tolerance values are, in your case. It is also important to keep to the 3V supply and place the batteries close to the board, as shown in the photos.

The whole layout must be exactly as shown to maintain the same circuit capacitances. Once you get the circuit working, you can change the arrangement but during the initial test procedure, everything must be as shown.

The oscillator is operating at about 88MHz and unless you have a 100MHz CRO, you cannot detect the waveform. If you are fortunate enough to have a frequency counter, the antenna can be connected directly to the 75ohm input on the counter.

Otherwise it will be necessary to make some DC voltage readings see if the oscillator transistor Q2 is biased correctly.

Measure the base voltage and also the emitter voltage. An ordinary multimeter will indicate about 2V in both cases, due to the loading of the meter. Only a high impedance meter such as a FET meter will indicate 2V on the emitter and 2.5V on the base.

If a voltage is present in both cases, you can assume the transistor is

Parts List

Resistors (1/4W)

1 470Ω
1 10k
2 22k
1 1M

Capacitors

1 18pF ceramic
1 47pF ceramic
1 1nF ceramic
2 22nF ceramic
1 0.1uF monoblock

Semiconductors

2 BC457 transistors

Miscellaneous

1 Earwig PC board, 36 x 12mm
1 mini slide switch SPDT
1 electret mic insert
2 'N' cells
15cm tinned copper wire
17cm antenna wire

Kits

Kits of components for this project are available from Talking Electronics, 35 Rosewarne Ave., Cheltenham, Vic. 3192. Tel: (03) 584 2386. The complete kit costs $8.55 and comes with a pre-wound coil and printed circuit board. Extra PC boards cost $1.70 each and the parts are $7.00, if bought separately. Pack and post on any order is $2.00.

Earwig

operating, but it may be transmitting at the wrong frequency.

The 18pF feedback capacitor suits a BC547 transistor. If you intend to use another type, the value can be decreased to 10pF or 5.6pF. Try changing this capacitor first and then the transistor.

Simple things such as shorts on the PC board, broken tracks, poorly soldered joints, or unmarked components are always a possibility. Especially components with poor markings. If you are unsure about the value of a component, replace it immediately. It could be ten times out, and the circuit will never work!

If you are detecting a carrier but no audio, the fault will lie in the audio stage and/or the microphone.

These two sections can be tested with a CRO and you can measure the audio signal to see what is being presented to the oscillator stage.

Without a CRO you will be stuck. Even though the voltage on the electret can be between 0.7V and 1.5V, this will not indicate the sensitivity of the microphone or if it is working at all.

A voltage of about 1.4V on the collector of the audio amplifier will indicate the transistor is turned ON and if it is below 0.8V, the transistor will be saturated or possibly damaged in some way. It could also mean the transistor has a very high gain and will not be suitable.

If the voltage is above 2.5V, the stage will not be turned ON sufficiently and again, the transistor and bias resistor should be checked and/or replaced.

A CRO will also show the sensitivity of the microphone. By increasing or lowering the load resistor, the gain of the FET can be changed. It should not go below 10k and may need to be as high as 47k, or higher, for extremely sensitive devices.

It works like this: for any electret microphone, reducing the load resistor will increase the sensitivity. The final value chosen will depend on the quality of the microphone.

This is about as far as you can go with simple test equipment. If all fails, start again with a new kit. Sometimes something stupid has occurred such as swapping two components over or reading the value of a resistor incorrectly, and this will be extremely difficult to find.

Fitting into a case

All the components can be mounted in the tray of a matchbox and if the PC board is turned on its side, it will take up the least amount of space.

Cover the "works" with a single layer of matches, stuck to a thin piece of card, and take the antenna out one end of the tray or up through the roof.

A small hole can be made in the other end of the tray to allow the sound to enter the microphone but this is not really essential as the sound seems to get through, even when the drawer is closed.

If a hole is made in the side of the tray, near the switch, the circuit can be turned on by pushing a match through the hole and this will save removing the layer of matches.

We suggest only a very short length of antenna, about 10cm, to achieve a range of about 30 metres. This will be sufficient for inter-room communication and will be ample for even a large house.

The complete project also looks very nice painted black, with the short antenna mounted upright to look like a video amplifier.

I hope your unit works as well as ours. EA

Circuit & Design Ideas

Continued from page 65

Below are Mr Donnelly's listings for the D-A and A-D converters for the Apple II as referred to on page 68.

```
*8000.810D

8000- 20 E2 F3 A2 00 8A 48 A9
8008- 00 9D 00 7C 68 C9 80 30
8010- 09 48 A9 50 9D 00 7C 68
8018- 29 7F C9 40 30 09 48 A9
8020- 28 9D 00 7C 68 29 3F 48
8028- 4A 4A 4A 4A 9D 00 7D 68
8030- 29 0F C9 08 30 0C 48 BD
8038- 00 7C 09 80 9D 00 7C 68
8040- 29 07 0A 0A 18 7D 00 7D
8048- 9D 00 7D A9 20 18 7D 00
8050- 7D 9D 00 7D E8 E0 C0 D0
8058- AC A9 00 AA A8 9D 00 7E
8060- 48 98 9D 00 7F 68 C8 C0
8068- C7 D0 05 A0 00 18 69 01
8070- E8 D0 EA 86 02 E8 86 03
8078- A4 02 A9 80 99 00 40 20
8080- ED 80 E6 02 D0 F2 4C DA
8088- 80 A6 03 CA D0 FD A4 02
8090- B9 00 40 20 ED 80 A4 02
8098- A9 FF 38 ED A0 C0 BD A0
80A0- C0 4A 99 00 40 20 ED 80
80A8- E6 02 D0 DD AD 00 C0 10
80B0- D8 2C 10 C0 C9 A0 D0 0B
80B8- 2C 00 C0 10 FB 2C 10 C0
80C0- 4C 89 80 C9 88 D0 09 C6
80C8- 03 D0 0F C6 03 4C DA 80
80D0- C9 95 D0 B5 E6 03 D0 02
80D8- E6 03 A9 00 85 24 A9 15
80E0- 85 25 20 22 FC A5 03 20
80E8- DA FD 4C 89 80 AA BD 00
80F0- 7C 85 00 BD 00 7D 85 01
80F8- BE 00 7F B9 00 7E A8 B1
8100- 00 5D 07 81 91 00 60 01
8108- 02 04 08 10 20 40
```

Listing 1

```
]LIST

0  POKE 896,3
1  CALL 804
10  HGR : HCOLOR= 3
20  HPLOT 0,0 TO 255,0: HPLOT 0,128 TO 255,128
30  HPLOT 0,64
40  FOR A = 0 TO 255
50 Q = 16384
60 N = 50
65 V = 10
70  FOR QQ = 1 TO V
72  HPLOT A,64 TO A, PEEK (Q + A * N + QQ * N / V) / 2

75  NEXT
80  NEXT
10000  CALL 768: GOTO 10000
20000 S = 64
20005 N = 1
20010  POKE 773,S
20020  PRINT S,N
20030 QQ =  PEEK (S * 256 + 256 * N)
20040  POKE S * 256 + 256 * N,0
20050  FOR A = 1 TO 5
20060  CALL 768
20065  NEXT A
20070  POKE S * 256 + 256 * N,QQ
20080  CALL 768
20090  GET Z$
20100  IF Z$ = "A" THEN S = S + 1
20105  IF Z$ = "." T
HEN N = N + 1
20110  IF Z$ = "Z" THEN S = S - 1
20115  IF Z$ = "," THEN N = N - 1
20120  GOTO 20010
```

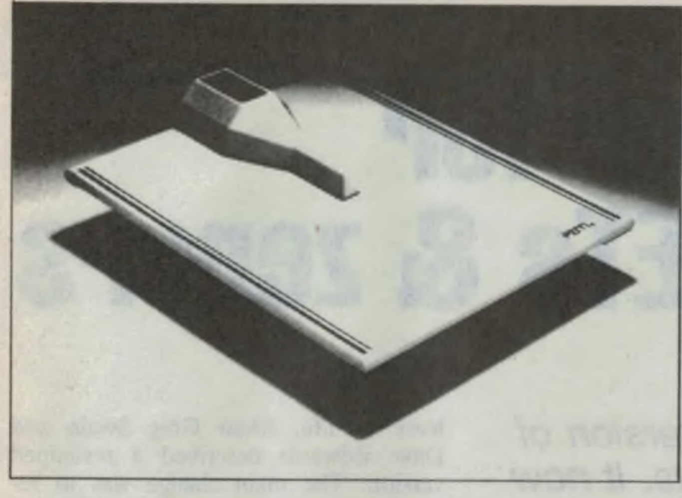
Listing 2a

```
*300.34F

0300- A0 00 84 00 A9 44 85 01
0308- B1 00 F0 17 8D 90 C0 84
0310- 1F AD 80 03 20 A8 FC A4
0318- 1F EA EA C8 D0 EA E6 01
0320- 4C 08 03 60 A0 00 84 00
0328- A9 40 85 01 AD A0 C0 8D
0330- A0 C0 91 00 84 1F AD 80
0338- 03 20 A8 FC A4 1F EA C8
0340- D0 EA E6 01 A5 01 C9 7F
0348- D0 E2 A9 00 8D 00 7F 60
```

Listing 2b

Editor's Note: Unfortunately lack of space prevents us publishing the full music programs listing provided by Mr Donnelly. We can provide copies of these via the Reader Service for $2.00 for interested readers.



PZM® -30FS

PRESSURE ZONE MICROPHONE®

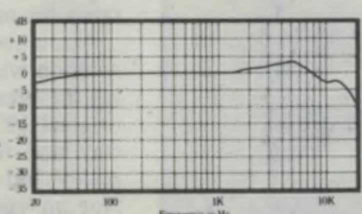
The PZM® -30 series microphones are workhorse versions of the PZM line, designed for exacting professional use, and built to take the normal abuse associated with professional applications. Miniaturized electronics built into the microphone cantilever allow the 30 series to be powered directly by simplex phantom powering.

The PZM-30FS (silver finish) provides a smooth, flat high frequency response for the most accurate and natural pickup.

Type: Pressure Zone Microphone
Frequency Response: 20 Hz to 15 kHz
Polar Pattern: Hemispherical
Impedance: 240 ohms, balanced
Sensitivity: —67 dB re 1V/microbar or —47 dB re 1 mW/10 dynes/cm²
Maximum SPL: 150 dB SPL
Operating Voltage: 12 to 48 volts simplex phantom powering
Finish: Silver
Net Weight: 6.5 oz (184 grams)
Accessories Supplied: Windscreen, carrying/storage pouch
Optional accessories: PH-1, battery phantom power supply; PH-4, 4-channel AC phantom power supply

Horizontal-Plane Polar Response
source 30⁰ above infinite surface

Frequency Response
source 30⁰ above infinite surface



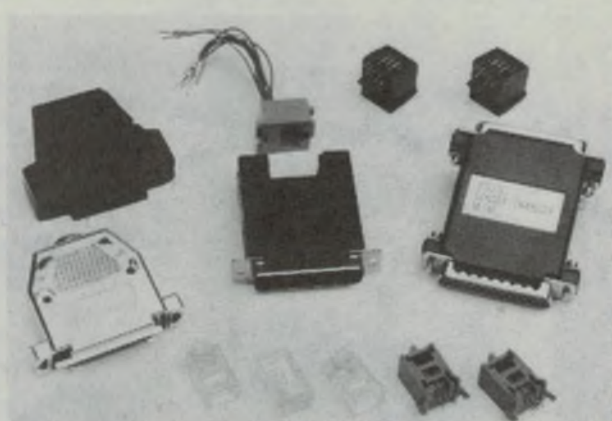
crown®

Australian Distributor:- Bose Australia Inc.
11 Muriel Avenue, Rydalmere, NSW 2116.
(02) 684 1255 — 684 1022. Telex: AA127168

Adaptor cables? Call ACD Itronics, we've got the right connections.

When you pick up the phone and call ACD Itronics (Capital City phone numbers listed below), you've made the right connection between quality products and top service. All IBM adaptor cables — and many others — in stock, plus the connectors you need. Yes, Centronics, D, and IDC, to name a few.

When you talk to ACD Itronics,, you're talking to the experts in telecommunications. The right connection . . .



ACD ITRONICS

MELBOURNE: *4-27 Lexton Rd, Box Hill Vic 3128. Ph* ***898 9458,*** *Fax 899 0373*
SYDNEY: *106 Belmore Rd, Riverwood NSW 2210. Ph* ***534 6200,*** *Fax 534 4910*
BRISBANE: *55 Noreen St, Chapel Hill Qld 4069. Ph* ***878 1488,*** *Fax 878 1490*

COLBAR

Construction project:

Low cost tester for transistors, FETs & zeners

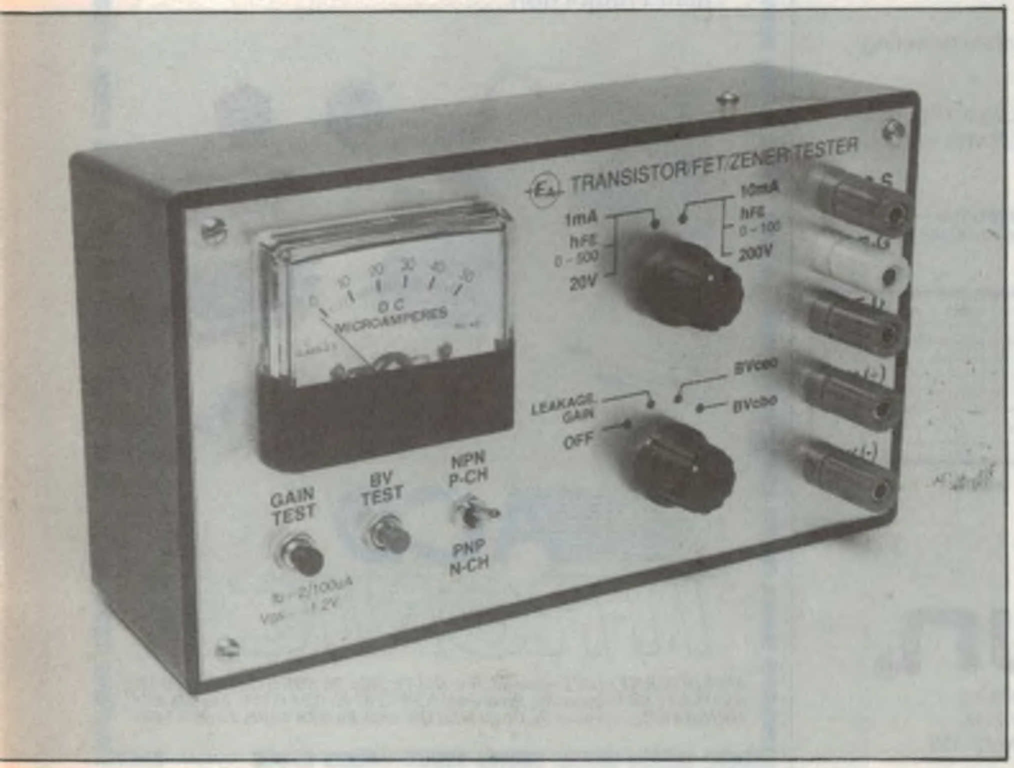
Here's a revamped and enhanced version of one of our most popular-ever projects. It now checks zener diodes as well as transistors and FETs, and also lets you check transistor breakdown voltages. Great for the workbench, and also for showing how semiconductor devices operate.

by JIM ROWE

Way back in August 1971, I described a simple little transistor tester project. It started off as a design challenge: to come up with the simplest, cheapest tester that would check FETs as well as bipolar transistors. I guess I can't have done too badly, because it ended up with only 17 low-cost parts (including the box).

I'm rather proud of that little tester, because it became very popular. Literally thousands of that first version were built, and like my original unit they've probably been in use ever since on workbenches all around the country. I hope their owners have found them as useful as I have the original.

In July 1978 the design had a new lease of life, when Greg Swain and Dave Edwards described a revamped version. The main change was to rebuild it in a low-cost plastic jiffy box, replacing the original die-cast aluminium case which had by then become rather expensive. They also substituted the newer miniature toggle switches for the original sliders, to make construction easier.



Even larger numbers of this 1978 version of the tester were built than of the first, and the kit suppliers tell me that they've been selling kits for it steadily ever since. So all in all, it's been a pretty successful little design — certainly one of our most successful test instrument designs ever.

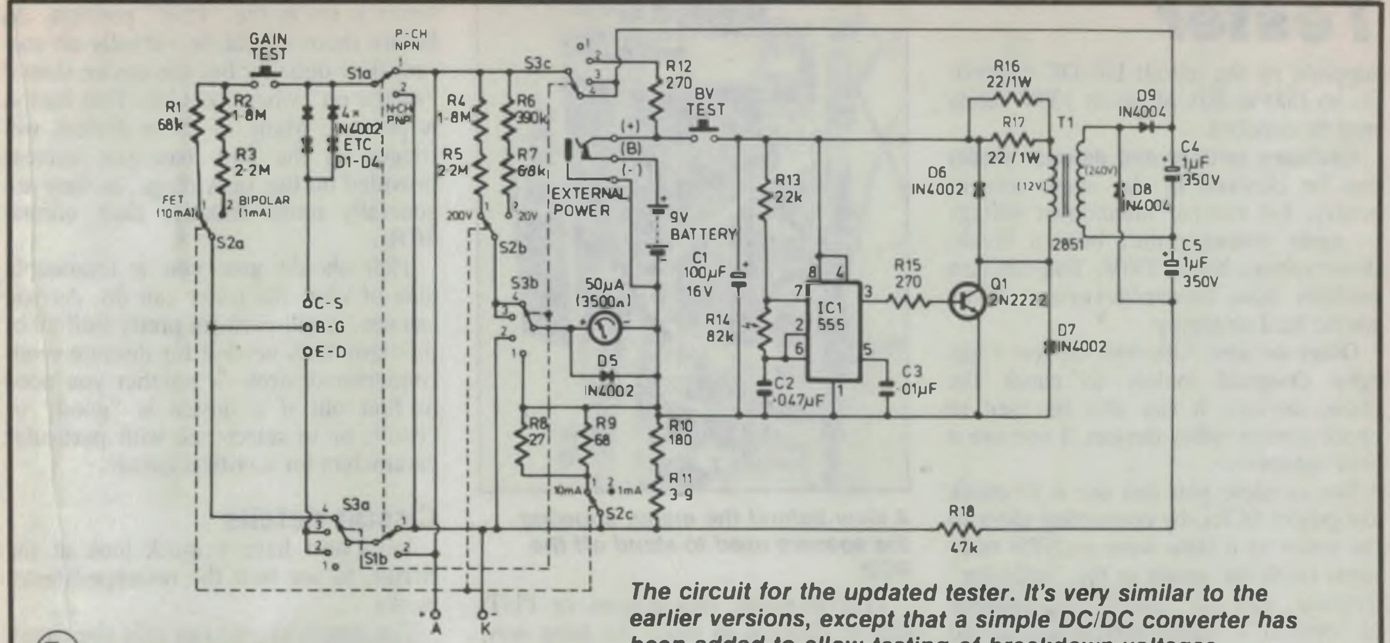
Why fiddle around with it now, and risk spoiling a good success story? Well, over the years that I've been using the original, I've really only missed one facility: the ability to check breakdown voltage, for both transistors and zener diodes.

I know we've described separate zener diode checkers over the years, but these were dedicated units either with their own meter or designed to go with a separate multimeter. I myself also described a fancier "Transistor Test Set," which included breakdown voltage testing (August 1968), but this was too fancy for most people.

No, it seemed to me the most elegant solution was to work out a way of adding the breakdown voltage facility to the original 1978 tester design — in such a way that the original concepts of simplicity and low cost were still retained. Not an easy trick, perhaps, but I felt sure it could be done.

So a few weeks ago I finally decided to bite the bullet, and here's the result. I'll leave it to you to decide if I've been successful or not . . .

Although the new circuit might look a little more complex than before, there's still not much in it. The main thing that has been added is a simple DC/DC converter, to step up the 9V from the bat-



TRANSISTOR/FET TESTER

The circuit for the updated tester. It's very similar to the earlier versions, except that a simple DC/DC converter has been added to allow testing of breakdown voltages.

tery for the breakdown tests. Apart from that the switching has been expanded a little, to provide the additional ranges. The meter movement has also been changed to a more sensitive 50uA type, for the same reason. Otherwise, the circuit is almost identical.

From the catalogs, my calculations are that the parts for this new design should cost you less than $47 — not all that much more than the 1978 version, for which kits have been selling for just on $30.

What it tests

The new tester lets you do all of the tests performed by the previous version, plus more. Here's a quick rundown:

For bipolar transistors, it lets you measure the collector-emitter leakage current Iceo, using either a 1mA range (for low power devices) or a 10mA range (for power transistors). You can also measure the collector-base leakage current Icbo, by temporarily swapping the base and emitter leads.

Then you can measure the common-emitter current gain hFE (also known as β), again on two scales: 0-500 for low power devices, and 0-100 for power transistors.

And finally, you can measure either BVceo, the collector-emitter breakdown voltage, or BVcbo, the collector-base breakdown voltage. You can even measure the base-emitter breakdown voltage BVebo, if you wish, by temporary lead swapping. There are two ranges to measure breakdown voltage, 0-20V and 0-200V, although measurements cannot be made beyond about 130V as that is the voltage produced by the inbuilt DC/DC converter. Devices with breakdown voltages above this figure will therefore not break down, and the meter will read the converter output voltage.

The BVceo test will also let you check those "sneaky" transistors that show up as normal on the low voltage tests, but develop a short (or high leakage) at higher voltages.

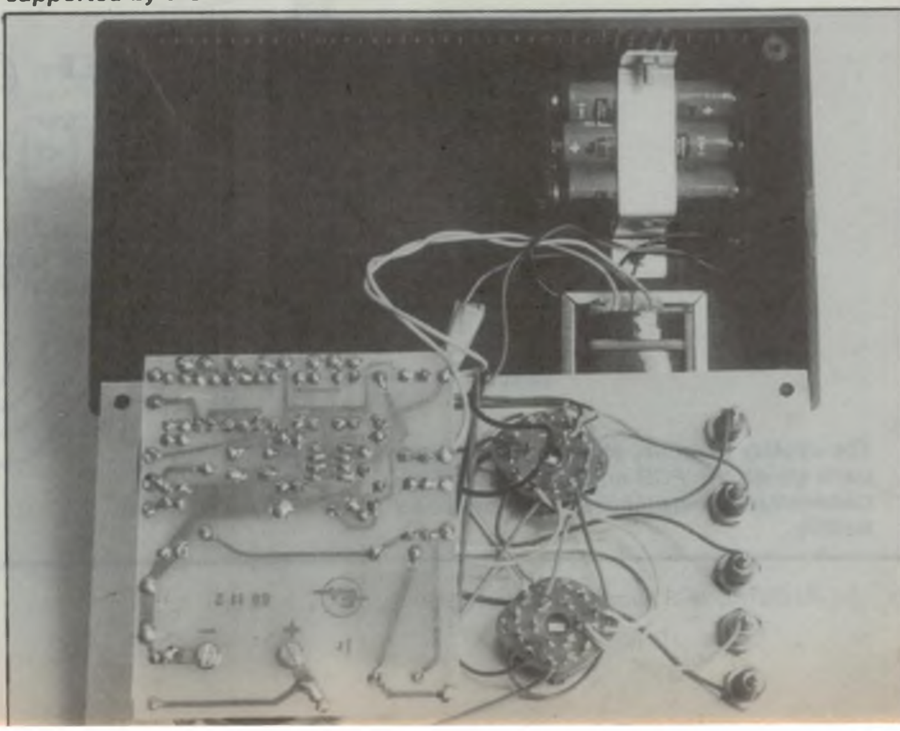
All of these bipolar transistor tests can be performed on either NPN or PNP devices, of course.

For junction FETs, the tester lets you first measure Idss, the drain-source current with zero bias on the gate. This can be measured again on either of two ranges: 0-1mA or 0-10mA. Then you can do a test to determine the transconductance (gm), by applying a reverse gate bias of 1.2V, and observing the resulting drop in drain current. Although the gm is not indicated directly, it can easily be calculated by dividing the observed drop in drain current by 1.2.

Both P-channel and N-channel junction FETs can be tested. With care the tester can also be used to test depletion-mode MOSFETs.

For zener diodes, the tester lets you check the main parameter: their breakdown or "sustaining" voltage. This can again be measured on either of two ranges, 0-20V or 0-200V. As with transistors, zeners are checked using current

Inside the case. Most of the components mount on a small PCB, which is supported by the meter terminals.



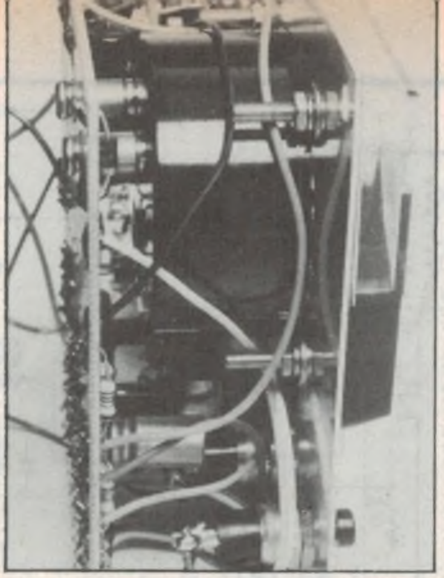
Tester

supplied by the inbuilt DC/DC converter, so that zeners of up to 130V rating may be checked.

Ordinary rectifier and detector diodes can be checked in the same way as zeners, for reverse breakdown voltage — again assuming they have a breakdown voltage below 130V. You can also perform basic forward/reverse tests by simple lead swapping.

Other devices: Although the tester has been designed mainly to check the above devices, it can also be used to check various other devices if you use a little ingenuity.

For example you can use it to check low-power SCRs, by connecting them to the tester as if they were an NPN transistor (with the anode to the "collector" terminal, gate to "base", and cathode to "emitter"). There should first be no current drawn, but the device should trigger into conduction when the Gain Test button is pressed. The 10mA range will be most appropriate to use here, because this applies a 100uA base/gate current for the gain test instead of the 2uA used for the 1mA range. Most low-power SCRs should trigger into conduction with 100uA applied to the base, but with devices of low gate sensitivity you might need to apply higher current by using an external resistor between anode and gate.



A view behind the meter, showing the spacers used to stand off the PCB.

Programmable unijunctions or PUTs can be checked in much the same way. These are really just low-power anode-gate SCRs. The easiest way to check them is to connect them "upside down", with anode to the emitter terminal and cathode to the collector terminal. The gate is connected to the base terminal as before, and this time the tester is set in the "PNP" position. As before there should be virtually no current flow initially, but the device should "switch on" when the Gain Test button is pressed. Many of these devices will trigger on the 2uA base/gate current provided on the 1mA range, as they are generally more sensitive than normal SCRs.

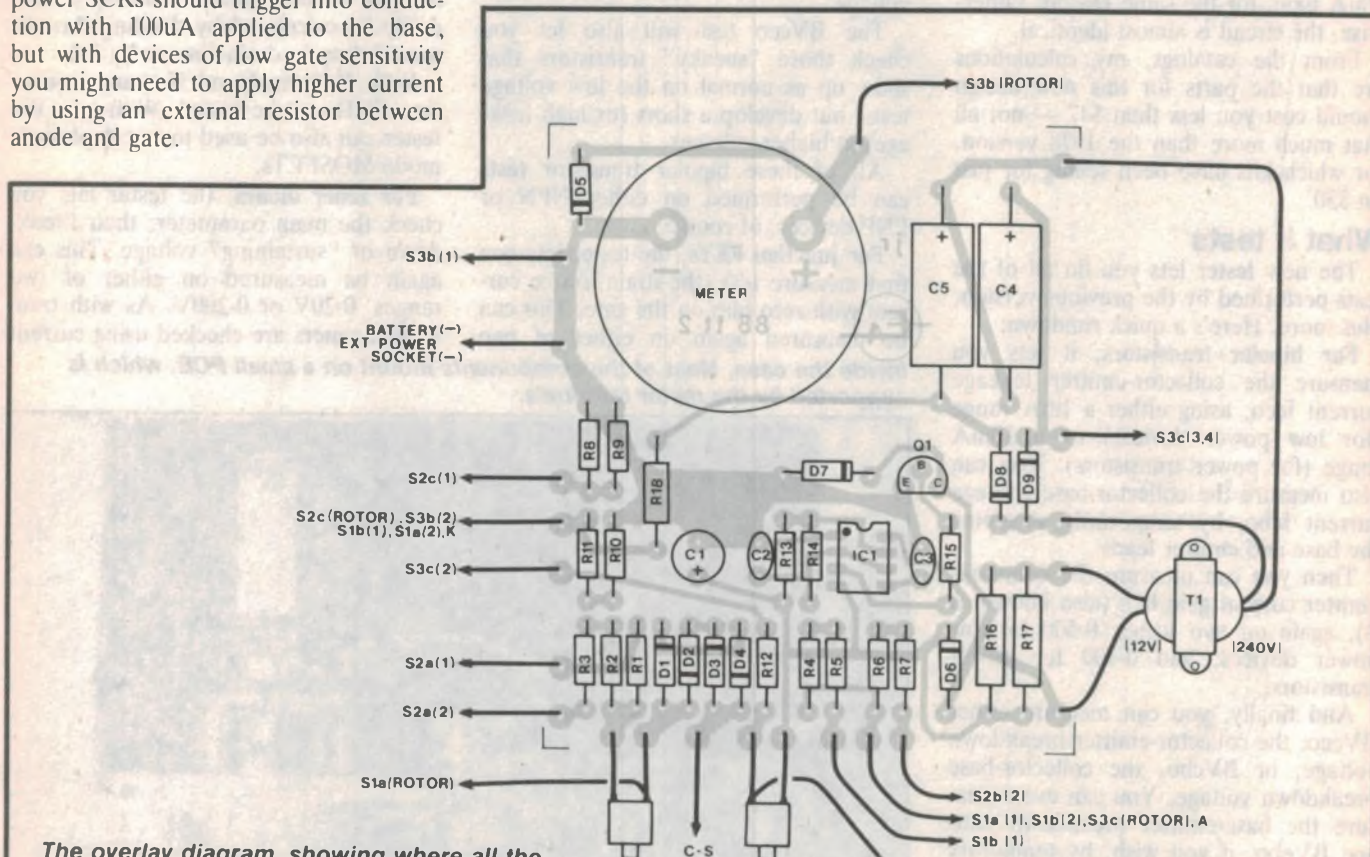
That should give you a reasonable idea of what the tester can do. As you can see, it will perform pretty well all of the basic tests needed for discrete semiconductor devices — whether you need to find out if a device is "good" or "bad", or to select one with particular parameters for a critical circuit.

Circuit details

Let's now have a quick look at the circuit, to see how the revamped tester works.

For simplicity, we can split the circuit neatly down the centre, by visualising a vertical line just to the right of the 9V battery. To the left of this line is the basic testing circuit, very little changed from before, while to the right is the additional DC/DC converter.

Switch S3 is the main testing mode



The overlay diagram, showing where all the parts go on the PCB and also most of the connections to switches, transformer and battery.

selector, which replaces the power switch in the original design. In this case it provides four positions: Off, Leakage/Gain, BVceo and BVcbo. There are now three poles, with S3c effectively switching the power, S3b the meter and S3a the device under test.

Switch S2 is the 10mA/1mA, 200V/20V, FET/Bipolar range selector. This again has three poles, with S2a to select base resistors (and hence base current), S2b to select meter multiplier resistors for voltage measurement, and S2c to select shunts for current measurement.

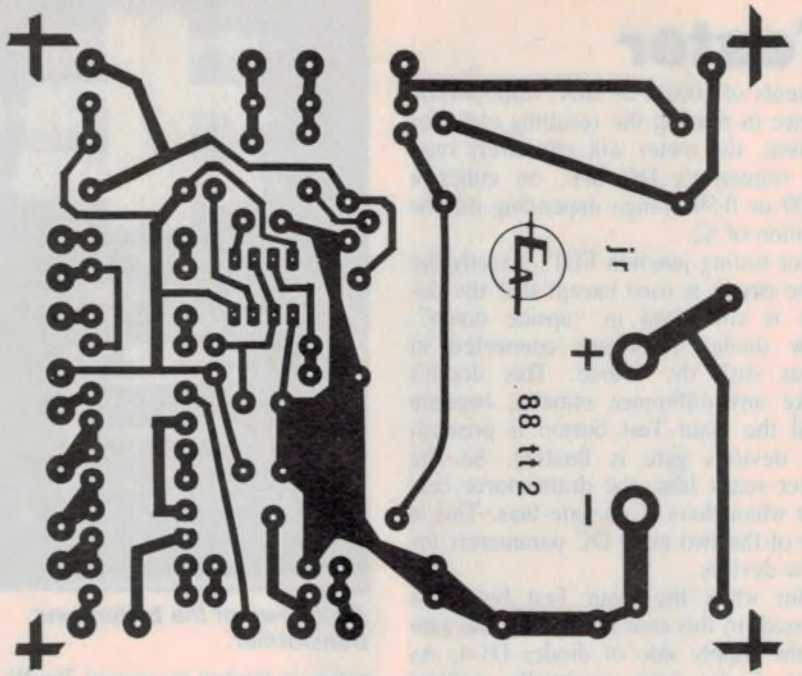
S1 is the NPN-P channel/PNP-N channel selector, which simply reverses the polarity of connections to the device under test.

In position 2 of S3, the meter is basically connected as a current meter in series with the 9V battery, the four diodes D1-4, protective resistor R12 and the device under test. The meter will effectively read either a 0-1mA or 0-10mA, depending on the position of S2c. R10 and R11 in series form the 1mA meter shunt, while R8 and R9 are connected in parallel with these to form the 10mA shunt.

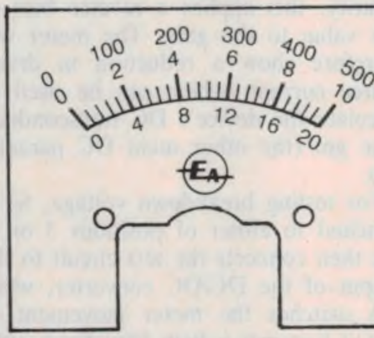
Diodes D1-4 are in series with the C-S terminal, so for bipolar transistors they are simply in series with the collector. This means that they simply reduce the applied collector voltage by about 1.2V, which has negligible effect as the performance of a bipolar transistor is largely independent of collector voltage.

The B-G terminal is normally open circuit. So initially the meter will read Iceo, the collector-emitter leakage current with the base open circuited. This is a very useful test, because there are few bipolar transistor faults which do not show up in terms of increased Iceo. And the few that don't, like an open-circuited base, will soon show up in the gain test.

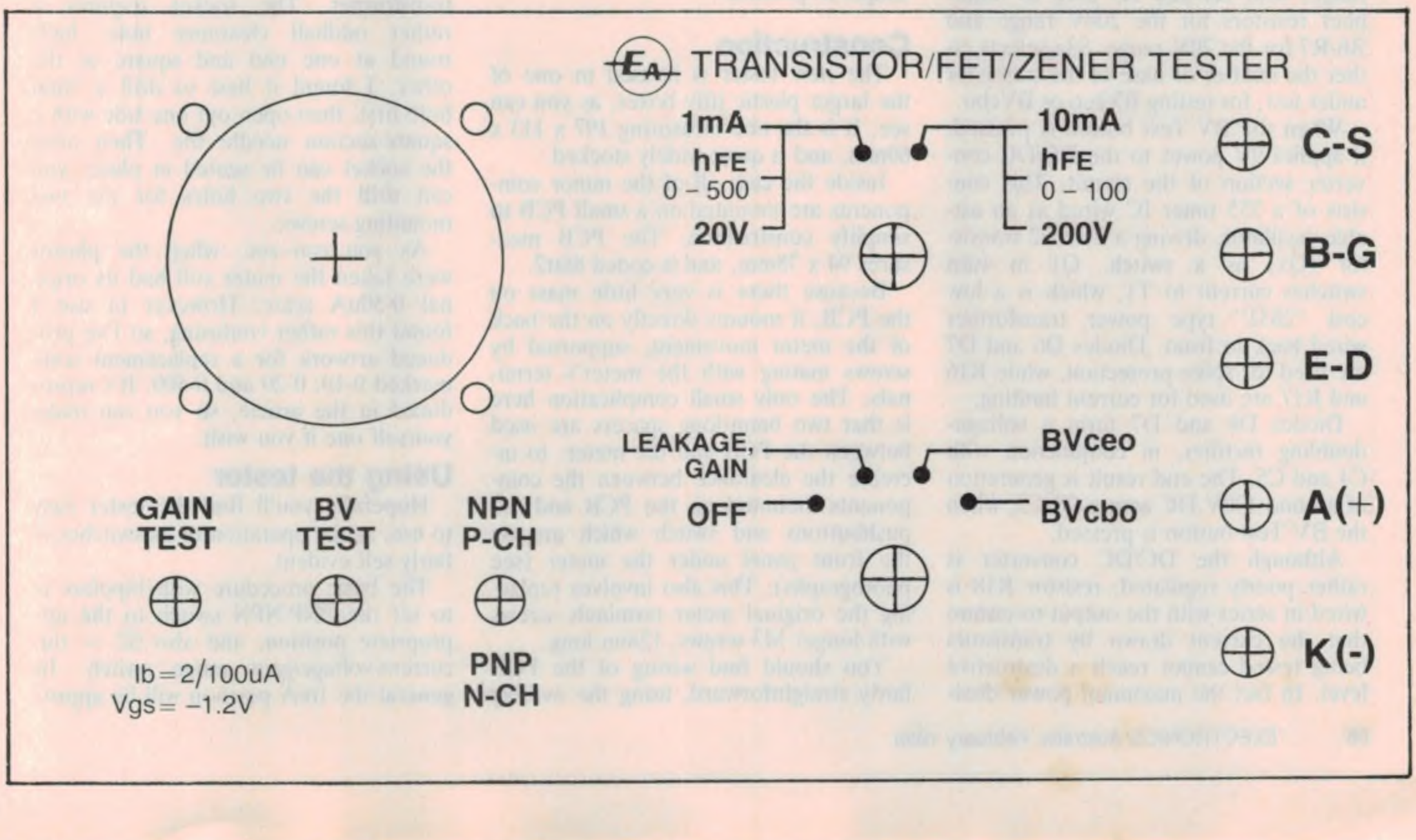
To test gain, the Gain Test button simply connects the B-G terminal to the collector supply from S1a, via either R1 or the R2-R3 series combination. These are selected to give approximate base



Above: The PCB pattern, actual size for those who make their own.



Above: The replacement meter scale art. Below: The front panel art.



Tester

currents of 100uA or 2uA, respectively. Hence in reading the resulting collector current, the meter will effectively read the transistor's DC hFE, on either a 0-100 or 0-500 range depending on the position of S2.

For testing junction FETs, exactly the same circuit is used except that the device is connected in "upside down". Now diodes D1-4 are connected in series with the source. This doesn't make any difference initially, because until the Gain Test button is pressed, the device's gate is floating. So the meter reads Idss, the drain-source current when there is no gate bias. This is one of the two main DC parameters for these devices.

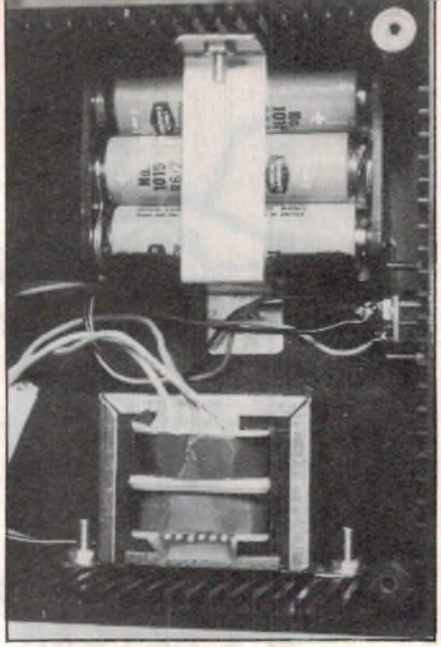
But when the Gain Test button is pressed, in this case it connects the gate to the supply side of diodes D1-4. As these diodes have essentially a fixed voltage drop of 1.2V, independent of polarity, this applies a reverse bias of this value to the gate. The meter will therefore show a reduction in drain-source current, which can be used to calculate the device's DC transconductance gm (the other main DC parameter).

For testing breakdown voltage, S3 is switched to either of positions 3 or 4. S3c then connects the test circuit to the output of the DC/DC converter, while S3b switches the meter movement so that it becomes a high impedance voltmeter. S2b is used to select the actual range, with R4 and R5 used as multiplier resistors for the 200V range and R6-R7 for the 20V range. S3a selects either the emitter or base of the transistor under test, for testing BVceo or BVcbo.

When the BV Test button is pressed, it applies 9V power to the DC/DC converter section of the circuit. This consists of a 555 timer IC wired as an astable oscillator, driving a 2N2222 transistor (Q1) as a switch. Q1 in turn switches current to T1, which is a low cost "2851" type power transformer wired back to front. Diodes D6 and D7 are used for spike protection, while R16 and R17 are used for current limiting.

Diodes D8 and D7 form a voltage-doubling rectifier, in conjunction with C4 and C5. The end result is generation of around 130V DC across C4-C5, when the BV Test button is pressed.

Although the DC/DC converter is rather poorly regulated, resistor R18 is wired in series with the output to ensure that the current drawn by transistors being tested cannot reach a destructive level. In fact the maximum power dissipation is limited to around 75mW, quite a safe figure.



A close-up of the battery and transformer.

To allow more convenient testing of zener diodes, separate A and K terminals have been provided as you can see. These are connected before S1, to remove any ambiguity. They're also marked "+" and "-", for the same reason. Note that for a zener, it's the N-type end that is the anode (because this is the end designed to be connected to the more positive voltage).

Perhaps the only other comment to be made about the circuit is that its slightly "strange" look is the result of my striving to keep the switching as simple as possible.

Construction

The new tester is housed in one of the larger plastic jiffy boxes, as you can see. It is the one measuring 197 x 113 x 60mm, and is quite widely stocked.

Inside the case all of the minor components are mounted on a small PCB to simplify construction. The PCB measures 94 x 78mm, and is coded 88tt2.

Because there is very little mass on the PCB, it mounts directly on the back of the meter movement, supported by screws mating with the meter's terminals. The only small complication here is that two 6mm-long spacers are used between the PCB and the meter, to increase the clearance between the components mounted on the PCB and the pushbuttons and switch which are on the front panel under the meter (see photographs). This also involves replacing the original meter terminals screws with longer M3 screws, 12mm long.

You should find wiring of the PCB fairly straightforward, using the overlay diagram as a guide. This also shows the connections from the PCB pads to the switches and the converter transformer. As usual, it's a good idea to wire the low-profile resistors and diodes on the PCB first; then add the capacitors, the transistor and the IC. Don't forget to watch the polarity of the electrolytics and diodes, and the orientation of the 555 and 2N2222.

The remainder of the wiring between switches S1, S2 and S3 is a bit fiddly, but easily done if you use the circuit schematic as a guide. There really isn't much to do.

The converter transformer is mounted in the bottom right-hand corner of the case, using two 1/8" or 3mm screws and nuts. Its leads then run to the appropriate pads on the PCB. The transformer I used had it own leads, that were just the right length. However it had a fifth lead, connecting to the centre-tap of the low voltage winding. I cut this back and taped it up, to prevent any risk of it touching anything.

Similarly the holder for the six "AA" size cells is mounted in the top right-hand corner, using a small clamp bracket bent up from a strip of scrap aluminium sheet. This measured 100 x 16mm before being bent up, with a 4mm hole near each end for the mounting screws. As before, the battery clamp is attached to the case using two 1/8" or 3mm screws and nuts.

The external power socket is mounted on the right-hand end of the case, between the battery and the converter transformer. The socket requires a rather oddball clearance hole, half-round at one end and square at the other. I found it best to drill a 7mm hole first, then open out one side with a square-section needle file. Then after the socket can be seated in place, you can drill the two holes for the two mounting screws.

As you can see, when the photos were taken the meter still had its original 0-50uA scale. However in use I found this rather confusing, so I've produced artwork for a replacement scale marked 0-10, 0-20 and 0-500. It's reproduced in the article, so you can make yourself one if you wish.

Using the tester

Hopefully you'll find the tester easy to use, as the operation of its switches is fairly self evident.

The basic procedure with bipolars is to set the PNP/NPN switch to the appropriate position, and also S2 — the current/voltage/gain range switch. In general the 1mA position will be appropriate for low power transistors, and the 10mA position for the others. Then connect the transistor to the C-B-E terminals, and turn S3 the function switch to the Leakage/Gain position, for the first test: leakage current (Iceo).

For a modern silicon transistor, the meter should give virtually no reading. If it does, the transistor is probably faulty and dirt-tin material. The other exception is a power transistor, and/or one that is quite hot. But if this is the case, it would be wise to let it cool down — to check if the leakage drops sharply (as it should).

With one of the older germanium transistors, you'll probably get a noticeable reading for Iceo (also called Ico'), as these devices do have somewhat higher leakage even at normal temperatures. Higher gain devices will also tend to give higher readings, so a significant reading for these transistors can still mean that the transistor is OK.

Naturally enough if the meter flies over to a full scale reading as soon as you turn S3 to the Leakage/Gain position, the transistor is shorted.

If the transistor passes the leakage test, now you can check for current gain hFE, by pressing the Gain Test button. Now the meter should give a healthy reading if the device is good, and you'll be able to read its gain. A zero reading indicates an open-circuit base, while a poor reading means that the transistor is either sick, or has very low gain.

For low-gain devices, you may need to switch S2 to the 10mA position, to read the gain on a 0-100 range. Note that because this range checks the transistor at a higher current level, you may get a different reading on this range. Most silicon transistors have a current gain that's roughly proportional to collector current, at these current levels.

What if you don't know the correct connections for the transistor, or whether it's NPN or PNP? Well, the tester is arranged so that wrong connections shouldn't damage either the tester or the device you're testing. So take a punt, and see what happens.

If you've guessed the basic polarity wrong, the meter will usually give a high reading for leakage. So if this happens, try switching to the other polarity. If the leakage current immediately drops, chances are you now have at least that bit right.

Similarly with the gain test. If you get very low or zero gain, try swapping the leads; you may have the collector and emitter leads swapped, or the base and emitter.

In general, it's best with an unknown device to keep lead swapping until you get (a) the lowest leakage current reading, combined with (b) the highest gain reading. This will correspond to the correct connections!

For FETs, having the wrong polarity setting generally won't show up in the first Idss test, as most of these devices have a symmetrical channel which conducts equally either way. But the clue here is when you press the Gain Test button: if the current *increases* instead of going down, you have the wrong polarity. So if this happens, switch to the other polarity.

Actually if you aren't sure of the FET's connections either, it's a good idea to try flicking the polarity switch to the other position, before you try pressing the Gain Test button. If you've got the connections right, the reading for Idss shouldn't alter. If it does, you have the gate swapped with the drain or source — so try lead swapping until you get the same Idss reading for both polarity settings. Then it'll just be a matter of finding the polarity setting that gives you a current *drop* when you press the gain button.

These basic tests are all you normally need for checking whether a transistor or FET is "good" or "bad", or for selecting and matching devices for a particular circuit.

However in some cases you'll also want to switch to the breakdown voltage ranges, to check if a transistor is shorting only when higher voltage is applied, or to select one capable of coping with the voltages present in a particular circuit.

Note that many transistors of a given type often have a breakdown voltage considerably higher than the rating for that type, so using these tests you can quite often select a "low voltage" transistor that will work at higher voltages. Great for emergencies!

Basically the BVceo test measures collector-emitter voltage rating, while the BVcbo test measures collector-base rating. As the transistor amplifies its own internal base leakage current when the base is left open, the BVceo test will always give lower readings than BVcbo. And generally, this makes the BVceo reading the safer one to use in selecting a transistor for a circuit. But if it's going to be working in a circuit where the base will be tied firmly to the emitter via a low impedance, you may be able to use the higher BVcbo reading as a guide.

For testing zeners, it's simply a matter of hooking them up correctly to the A and K terminals, switching S2 to the 200V range (to start with, at least), and turning S3 to either of the BV positions. Then press the BV Test button, and the meter will give you a reading very close to the nominal zener voltage. You may have to turn down to the 20V range, for low voltage types.

As mentioned earlier, a reading of 160V or thereabouts probably means that the zener is either open circuit, or that it's a high voltage type with a breakdown voltage higher than the tester's DC/DC converter output.

If the reading is nearly zero, you just might have the zener hooked up to the terminals backwards. So before throwing it in the rubbish bin, try it around the other way. Those connections can be a bit confusing, can't they?

Parts List

1 Plastic jiffy box, 188 x 113 x 60mm
1 PCB, 94 x 79mm, code 88tt2
1 3-pole 4 pos rotary switch
1 6-pole 2 pos rotary switch
1 DPDT miniature toggle switch
2 momentary contact min. pushbuttons
1 50uA/3500Ω meter movement
5 Screw terminals (2 red, 1 yellow, 2 black)
1 Power transformer, 240V to 12V/150mA (2851 type)
1 Battery holder, 6 x AA cells
1 Battery cliplead, to suit
1 External power socket, switching type
2 Small control knobs

Semiconductors

1 555 timer IC
1 2N2222 or similar NPN
7 1N4002 or similar
2 1N4004 or similar

Resistors

All 1/4W: 1 x 3.9Ωs, 1 x 27Ω 1 x 68Ωs, 1 x 180Ωs, 2 x 270Ωs, 1 x 6.8k, 1 x 22k, 1 x 47k, 1 x 68k, 1 x 82k, 1 x 390k, 2 x 1.8M, 2 x 2.2M.
2 x 22Ωs, 1W

Capacitors

1 .01uF metallised polyester
1 .047uF metallised polyester
2 1uF 350VW electrolytic
1 100uF 16VW electrolytic

Miscellaneous

Strip of scrap aluminium for battery clamp; screws and nuts; 2 x 6mm long spacers for PCB mounting on meter; insulated hookup wire; solder, etc.

10MHz TURBO PLUS MOTHERBOARD

This 10MHz, no-wait-state board is a drop-in replacement for the sluggish 4.7MHz PC motherboard.

- 8088-3 running at 10MHz/no wait states
- Turbo/normal selectable
- 4 channel DMA
- 8 expansion slots
- Keyboard port
- 640K RAM fitted

$475

8MHz Turbo Motherboard still available at new low price. Was $450.00.

NOW ONLY $425

1.2MB/360KB FLOPPY CONTROLLER

The perfect answer for backing up hard disks, archiving etc.

- Supports both 1.2MB and 360KB drives
- Fully PC/XT, PC/AT compatible
- For suitable drive see below

$125

150W SWITCHING POWER SUPPLY

Drop-in replacement for IBM PC's puny 63W supply.

- Boosts PC to PC/XT specs. Essential to run hard discs and other ad-ons on PC.
- Outputs +5V/15A, –5V/1A, +12V/5A, –12V/1A.
- All cables to disk drives, mother-board etc.

$148

AUSTRALIA'S BEST SPEEDUP CARD

Speed up your PC over 7 times with our superb new speed-up card.

- 80286 CPU *plus* 8088 for complete software compatibility
- Clock rate 6/8MHz (selectable)
- RAM on-board for disk cache
- DMA support
- Socket for 80287 co-processor

$545 Limited Stock

You'll always get a better deal at Electronic Solutions

1. Everything we sell comes with our 14 day money-back guarantee.

2. We only sell top quality products. Brands like NEC and Mitsubishi. With Electronic Solutions you know you're getting the best!

3. Massive buying power means our prices are the lowest in Australia for the same quality goods.

4. Our buying team get the latest products sooner. Whether you want an 80386 card, a turbo graphics card or the latest EGA card, we've often got it in stock when our competitors are just thinking about it.

FLOPPY DISK CONTROLLER

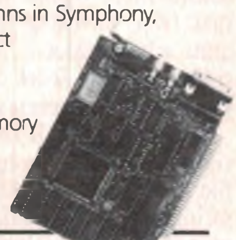
Controls up to 4 DS/DD 360K drives.

$65

PEGA EGA card – unmatched resolution

Get all the standards with this superb short slot EGA card.

- Supports Monochrome, Hercules, CGA, EGA and Plantronics modes. Fully Auto switchable.
- Supports 132 columns in Symphony, Lotus and WordPerfect
- Automatic monitor detection
- 256K of video memory standard
- Flicker free scrolling



$495

DISK DRIVES

40 Track Mitsubishi.

Very fast track-to-track. 360KB DSDD. Lowest price in Australia. **$245**

1.2MB NEC

Super high density. Superb construction and reliability. Works with 1.2MB floppy controller. **$275**

20MB NEC Hard Disk.

Very fast and super reliable. Best price in town. **$695**

Complete with controller. **$895**

XT Style Case with Hinged Lid

Perfect for building your own PC.

$95

MEMORY

512K Ram Card – Short Slot

- 512K RAM installed (41256 chips)
- DIP switches to start address

$195

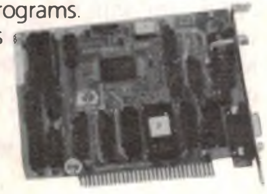
640K Ram Card – Short Slot

- 640K memory installed
- User selectable from 64K to 640K
- DIP switches to start address

$225

Colour Graphics/Mono – Short Slot

This amazing new card drives RGB colour, composite colour or a TTL monochrome monitor. And it fits in a short slot. Full CGA support. Can be used as a colour graphics card with a monochrome display and still run all the colour programs. The card even cures the dread colour graphics "flicker and snow".



$195

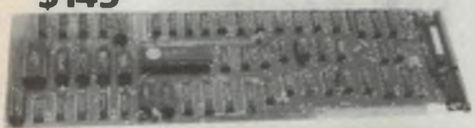
Colour Graphics Video Card

■ Suits RGB and composite colour monitors
■ Light pen interface
■ Fully CGA compatible
■ 40 x 25 & 80 x 25 (text), 640 x 200 (mono) and 320 x 200 (colour) **$115**

Colour Graphics/ Printer Adaptor

Attaches to IBM-compatible RGB monitor; provides complete compatibility with IBM Colour Graphics Adaptor. Equivalent to the IBM colour/graphics adaptor with additional printer port to replace the video port originally supplied by IBM.

$145



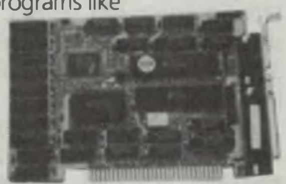
Parallel Printer Card

■ Standard TTL level ■ Centronics printer port, full IBM, EPSON compatible **$44**

Turbo Mono Graphics/ Printer – Short Slot

If you want fast, flicker free scrolling and full Hercules compatability, this is it! Perfect enhancement for slow scrolling programs like Microsoft Word etc. The ultimate monochrome graphics card.

$175



Serial RS-232 Card

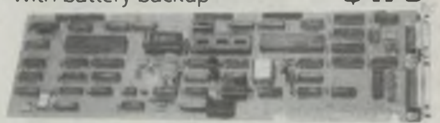
■ Independent receive clock input
■ 2nd serial port option
■ Full buffering eliminates need for precise synchronisation **$55**

2MB EMS Memory Card for PC/XT or AT

An affordable "Above Board" memory card. Fit up to 2MB of high speed RAM (0K fitted). At a low introductory price: **$495**

Multi I/O Card

■ Floppy disk adaptor, 2 drives DS/DD
■ 1 serial port, 1 parallel port, 1 joystick port ■ Clock/calendar with battery backup **$175**

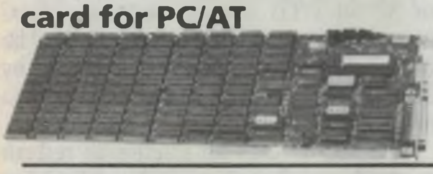


I/O Plus Card

■ Clock calendar with battery backup
■ 1 serial port, 1 parallel port, 1 joystick port **$136**

NEW PC/XT PRODUCTS
the power you're searching for!

2.5MB Multifunction card for PC/AT



Give your AT a big boost with this superb quality, low cost expansion card.
■ One RS232C serial port
■ One parallel printer port
■ Memory expansion to 2.5MB (0K fitted)
■ Fully PC/AT compatible

$495.00

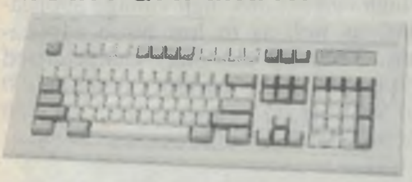
180W AT Power Supply

Suits all IBM PC/AT compatibles.
■ User selectable 115/230V AC input
■ Outputs: +5V/17A, –5V/0.5A, +12V/7A, –12V/0.5A
Overload protection
■ Short circuit protection

$195.00

■ Cooling fan stops when voltage output falls to zero
■ Top quality components used throughout

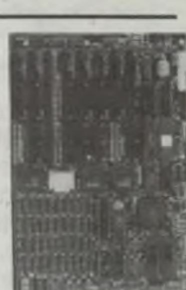
Enhanced Keyboard suit both PC/AT and XT



The finest keyboard on the market.
■ Suits both IBM PC/XT and AT (switchable)
■ Full 101 keys with separate cursor and numeric pad
■ Superb key action
■ Lights for caps, num and scroll lock

$145

10MHz Baby AT Motherboard



Ultra high performance PC/AT motherboard outperforms all the others. Drop it into your existing PC/XT! Up to 1MByte of RAM on-board (640K fitted)
■ 80286-8 running at 6/10MHz switchable.
■ Speed test 11.7 on Norton Utilities
■ 7 channel DMA for disk and special I/O
■ 8 expansions slots (6 full AT standard)
■ On-board battery backup, real time clock
■ Phoenix ROM BIOS

$945

Baby AT Case

$135.00

Suits "Baby AT" motherboard or 10MHz PC/XT motherboard.
■ Hinged cover for easy access
■ Keyswitch, reset/turbo buttons, indicators

SUPER SPECIALS

V20 chips	$29.00
V30 chips	$49.00
NEC Multisync monitor	$1150.00
TTL Amber Monitor	$275.00
TTL Green Monitor	$280.00
256K RAM chips	$7.00

ELECTRONIC SOLUTIONS

Electronic Solutions

PO Box 426 Gladesville 2111
Phone (02) 427 4422
We accept Bankcard, Mastercard and VISA. Mail orders our specialty. All prices include sales tax.

- All products carry a 14 day money back guarantee
- All products carry a full 3 months warranty
- All cards come with full documentation
- Ring for quantity discounts and tax free prices.
- Freight $7.50 for first item, then $2.50 for each extra item.

New Products

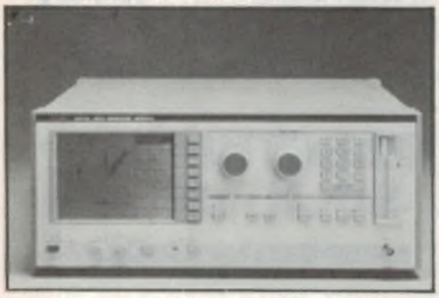
Pyropen junior

Demand has forced the George Brown Group to purchase Weller's entire allocation, for Australia, on the "Pyropen Junior" out to June 1988.

Refilled in seconds, this easy-to-handle butane gas operated soldering/-brazing pen requires no power cord or batteries and is electrically completely neutral (no peaks). "Longlife" soldering tips deliver quick heat-up time. Features include:

- Temperature Control:
Soldering iron 200°C — 450°,
Hotblow feature 430°C maximum;
Torch feature 1300°C maximum.
- Light-weight/portable — carry it in your pocket; length 170mm.
- Quick refills with Weller BR200 Butane aerosol.
- Functional aluminium body, cap stays cool and won't melt.

Introductory price of the tool is $71.82, plus sales tax if applicable. For further information contact your local George Brown Group office or the George Brown Group Marketing Division, 456 Spencer Street, West Melbourne 3003.



Digital video generator

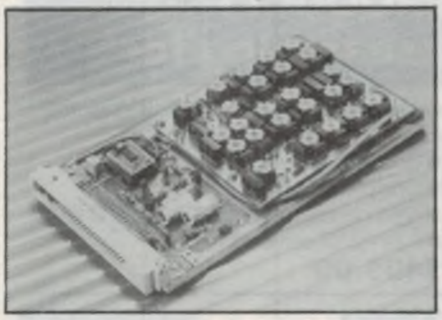
The MG6301 series of digital video generators from Anritsu can generate more than 100 test waveforms and pattern signals, including those specified by CCIR, FCC, NTC-7, IEEE, EIA, EBU, BBC and IBA.

Models are available that are switchable between PAL and NTSC systems, and there are models which are dedicated to either system.

Ultra-high precision signals are obtained by separating the waveform data into luminance, chrominance and sync data and combining them using 3 D/A converters. Arbitrary waveforms can be generated by front panel programming, or by remote control, either full field or ITS (insertion test signal), allowing new standards to be easily catered for. A 3.5" floppy disc drive is fitted for storing waveform data.

An ID code can be inserted in the vertical blanking interval to enable far-end and near-end automatic measurements to be made, in conjunction with the MS6301 video signal analyser and without the use of an external controller.

For further information contact STC/Anritsu, 58 Queensbridge Street, South Melbourne 3205.



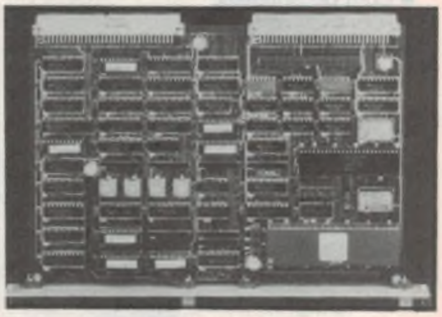
Video filters

For digital TV equipment a range of low cost video filters has been introduced by Matthey Electronics, under the "LC 422" part number. The LC indicates low cost; the 422 indicates compatibility with the general requirements of CCIR 601. The LC 422 pre A/D and post D/A filters are supplied in small DIL modules with sin x/x correction included for Y, U and V channels.

For analog TV the Matthey "VERY SMALL — VS" range of video filters has been extended to meet market requirements and now totals six different performance ranges (VS, VSA, VSB, VSC, VSD, VSE).

A Matthey video amplifier can now be used to return signal strength on any of the filter range to zero. This has been done in a new zero loss filter on a Eurocard, which features the versatility of a "plug in" facility for any of the Matthey range of filters: VS, microfilters, Brickwall, etc.

Full details of these and other Matthey products are available from Johnson Matthey, 8th floor, 500 George Street, Sydney 2000.



2Mb VMEbus RAM module

The Compcontrol CC-87 VMEbus module contains 2Mb of dynamic RAM, based on high density 256K bit dynamic memory devices.

The module supports the full 32 bit capability of the VMEbus and may perform byte, word, long word and unaligned data transfers with a byte wide parity check. It can be used with 8, 16 or 32 bit DTB masters and has selectable Address Modifier decoding. The base address can be installed on any 2Mb boundary within the 4 Gigabyte address space.

The CC-87 uses an intelligent refresh method and has a typical read access time of 290ns and a typical write access time of 22ns. Minimum cycle time is 320ns. Power consumption is 1.6A typical at 5V DC.

For further information contact Philips Scientific & Industrial, 25-27 Paul Street North, North Ryde 2113.

High-Q VHF/UHF chip capacitors

Stewart Electronic Components has released a range of High-Q VHF/UHF multilayer chip capacitors.

The capacitors are specifically designed for use in the VHF/UHF region in high current and high voltage applications, as well as in low noise applications. They are also fully characterised with graphs of AC current ratings at 100 and 500MHz, Q figures at 100, 200, 400 and 800MHz and self-resonant frequency.

Values normally stocked range from 1pF to 1000pF, but other values are available on indent in quantities of 100 minimum.

Further information from Stewart Electronic Components, 44 Stafford Street, Huntingdale 3166.

Stepping motor controllers

The new stepping motor controllers C-530 and C-560 allow a simultaneous operation of three 5-phase motors. With a resolution of 1000 steps per revolution, these motors are well suited for high-resolution positioning systems.

Working on the constant current principle, the new stepping motor controllers can be adapted to motors of different phase currents.

Both models — the C-530 and the C-560 — are equipped with an IEEE-488 or RS-232 interface as standard. They are available in a 19" rack mount casing which can also be used as table top model. While the devices of the C-530 series can be operated by the computer only, the C-560 series has various manual operating controls and display elements.

A microcomputer installed in the controller provides an extensive set of commands e.g., to position the motors, to set the parameters or to read the positions. Thus a high grade of flexibility is achieved allowing the operation of different mechanical systems.

Further information is available from Warsash, PO Box 217, Double Bay 2028.

Hydroponics meter

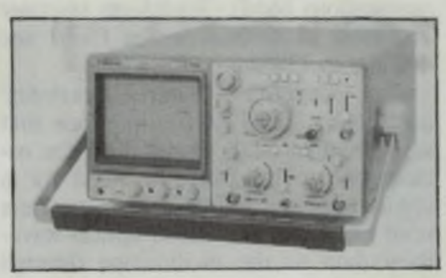
TPS has just released a new Australian-made instrument for hydroponics, or for soil pH and salinity. The New Model HP81 is a combined pH and conductivity meter in one unit. It has digital readout for improved accuracy.

The pH electrode has a plastic body, and is fitted with a protection cover for the tip. The conductivity probe is made from high-impact plastic, and includes the temperature sensor.

Compensation for changes in temperature of the sample is fully automatic. Simple methods for pH and conductivity measurements of soils and hydroponics solutions are included in the handbook.

The HP-81 features extremely low battery drain with an easy to read, precise liquid crystal display. It is fitted with screwdriver controls for calibration, and has separate input connectors for each electrode. This means that both probes can be in the soluton at the same time, for ease of measurement.

For further information contact TPS, 4 Jamberoo Street, Springwood 4127.



Low-cost 100MHz oscilloscope

A new high performance, low cost, three channel 8-trace 100MHz oscilloscope, Model COS 5100, has been released by Kikusui.

The oscilloscope has a frequency range of DC to 100MHz (-3dB) and maximum sensitivities of 5mV/div (full bandwidth) and 1mV/div (20MHz). Novel temperature compensated DC amplifier circuits ensure a very low drift and low baseline noise. Single channel, dual channel, Ch1, Ch2 and Ch3 (trigger view), add or subtract channels (differential), and X-Y operation modes are switch selectable. A low impedance channel 1 output is provided for connecting a frequency counter or a voltmeter — using the Ch1 amplifier as a buffer.

Delay line and dual sweep are provided (A, A delayed by B, B). 23 sweep speeds can be selected for both the main (A) and delay (B) sweeps between 0.5sec/div and 20nsec/div. At x10 magnification, a maximum sweep speed of 2ns/div is reached. Push-button selection of continuous or delayed triggering ensures low-jitter viewing. A ten-turn delay time multiplier knob allows accurate measurement of time intervals and time relations of waveforms.

"Alternate sweep" displays simultaneously both the main and the delayed sweep, providing high resolution 8 trace viewing of waveforms. (Ch1, Ch2, Ch3, Ch1+Ch2, each displayed both main and delayed.)

The oscilloscope uses and 18kV high acceleration voltage 6" rectangular CRT, with internal graticule, providing a bright trace and parallax-free measurement of waveform characteristics even at the highest sweep speeds. Made of aluminium diecast, the oscilloscope is very compact and light but sturdy, being suitable for both laboratory and field service use.

Further details are available from Emona Instruments, 86 Parramatta Road, Camperdown 2050.

120MHz/1.1GHz counter

Advanced LSI technology helps provide economic performance to 120MHz — 1.1GHz optionally — in the latest compact timer/counter from Philips Test & Measurement. The PM 6665 features a special MTCXO (mathematically temperature-compensated crystal oscillator) option, providing oven-oscillator stability at much lower cost. Other options include GPIB (IEEE 488/IEC 625) instrument bus interfacing for systems applications, and a battery unit for field operation.

Reciprocal counting guarantees high resolution at all frequencies and avoids the +/- 1 input cycle error inevitable in conventional direct counting. At least seven digits are provided per second of measuring time over the whole frequency range. A full nine digit readout is provided, using an integrated LCD delay.

A microprocessor combined with an in-house designed 'counter on a chip' provides all counting and timing logic. Use of high speed CMOS integrated circuitry and SMD — surface mounted device — technology keeps component count to a minimum, reduces power consumption and makes the instrument particularly compact.

For further information contact Philips Scientific and Industrial, 25-27 Paul Street North, North Ryde 2113.

Products...

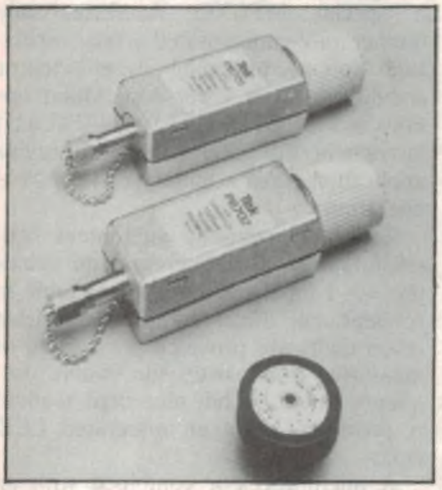
CMOS CPU board for Multibus

Intel has introduced a CMOS technology CPU board for the Multibus I architecture, based on an 8MHz 80C86 microprocessor. The iSBC 86C/38 board is intended for customers needing a low-power CPU board that will operate under harsh environmental conditions, such as industrial automation or robotics. It is fully application code compatible with the existing Intel iSBC 86/35 CPU board.

The iSBC 86C/38 draws less than 8 watts when running at 8MHz. It boasts 1Mbyte of on-board, zero-wait-state, parity checking, dynamic random-access-memory (DRAM). It has a real-time clock/calendar with on-board battery back up that will maintain the time and date for more than 10,000 hours.

For customers with extreme low-power-consumption requirements, the board features a "slow-mode" which draws less than 4 watts and operates at 1MHz. This feature is especially useful during temporary or emergency conditions when continued operation must rely on a battery-based power source.

Further information from Intel Australia, Level 6, 200 Pacific Highway, Crows Nest 2065.



Opto converters for scopes

Tektronix has introduced a pair of probe-sized optical/electrical converters that permit analysis of light signals on its 11000 Series oscilloscopes in research, product development, and manufacturing applications.

The P6701 and P6702 converters enable Tektronix' 11000 Series instruments to act as high-frequency optical oscilloscopes, by combining the functions of optical power meters with extensive waveform acquisition, display and analysis capabilities.

Both the P6701 with a bandwidth of DC to 700MHz and the P6702 with a bandwidth of DC to 500MHz can be used for high speed analog optical waveform analysis. Together, the converters offer a waveform response ranging from 450nm to 1700nm, making them useful for research and development projects involving from near ultraviolet to near infrared light. These waveform response capabilities enable the converters to cover the 850nm, 1300nm and 1550nm fibre optic communications bands. Waveform response is 450nm to 1050nm on the P6701 and 1000nm to 1700nm on the P6702.

The converters feature Tektronix' proprietary TEKPROBE interface that supplies them with power from the oscilloscope, eliminating the need for a separate power source. The converters send calibrated and scaled optical waveform data to the oscilloscope through the interface.

For further information contact Tektronix offices in each state or at 80 Waterloo Road, North Ryde 2113.

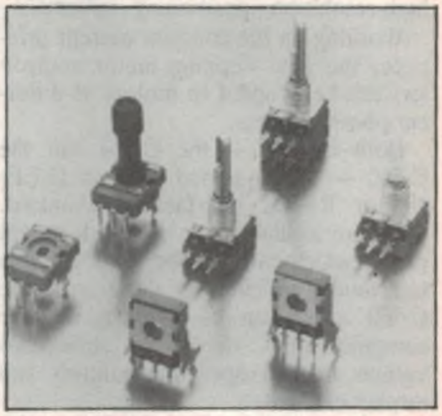
LED backlight LCD display

Optrex Corpn. of Japan has extended its range of LCD dot matrix character and graphic displays to incorporate a series of LCD character displays with built-in LED backlight.

The series is available in a choice of 16 character x 1 line, 16 character x 2 line and 40 characters x 2 lines. The LCD incorporates a single +5V supply (no external power supply for backlight required). Inbuilt ROM and RAM, operating temperature of 0-50°C, storage temperature −20 to +70°C and low power consumption are built into the range of Optrex LCDs, although they remain very slim with a maximum thickness of 15mm.

Amtex Electronics stocks an extensive range of Optrex LCD displays including a range of high contrast character displays with electroluminescence backlight available in a basic model or extended temperature range of −20°C to +70°C, and semi-custom displays with 12 o'clock viewing with or without EL backlight. For large scale display, Amtex stocks the Optrex DMF Series which feature high contrast and wide viewing angle. They incorporate the new super twisted type LCD with or without EL and a 640x200 dot display using a cold cathode backlight, claimed to be one of the most visible (in both full sun and low light condition) LCD display ever developed.

For further information contact Amtex Electronics, PO Box 10, Villawood 2163.



Carbon, cermet mini pots

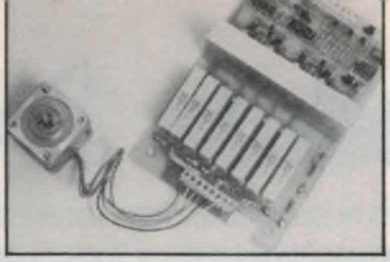
The new PP12 range of customised, miniature potentiometers from Philips comprises carbon types with logarithmic resistance ranges and cermet types with linear resistance ranges. A variety of accessories is available to support the potentiometers, which can be customised to suit specific requirements. The carbon types are aimed at consumer applications — for example audio — and the cermet types at high-quality professional applications such as telecommunications and measuring equipment.

The carbon types in the range have logarithmic resistance characteristics and high mechanical endurance of between 10,000 and 25,000 cycles for consumer applications. The cermet potentiometers are linear, and withstand 50,000 operational cycles in professional applications.

The devices suit vertical or horizontal mounting, and can have single or tandem drives. They may be supplied as complete units with integral metal or plastic shafts, or as modules (with an optional snap-in shaft).

The maximum power dissipation is up to 0.2W (carbon) or 1W (cermet), and the maximum resistance goes up to 4.7 meg ohm, + or — 10 or 20%. The maximum dimensions depend on type: for a single-shaft unit, they are 13 by 19 by 8.5 mm.

Further details are available from Philips Elcoma, 11 Waltham Street, Artarmon 2064.



Stepper motors, driver kit

Tronics 2000 is the Australian distributor for the Sanyo Denki range of Japanese manufactured stepper motors. The company has now released a matching stepping motor driver module, in kit form.

The L/R-01 is a PCB module which drives a stepping motor in response to external logic signal commands. It provides an internal clock signal, but this may be replaced with an external signal if desired.

The driver can deliver up to 5 amps per phase, when connected to a suitable 15-30V DC supply. Internal jumpers allow selection of full/half stepping (200/400 steps per revolution), normally high or low external clock pulse, internal/external clock and internal/external speed control for the internal clock. The driver has an 18-turn on-board speed control pot, allowing adjustment from 15-900 pulses per second.

Price of the driver module kit is $350 plus tax if applicable. Price of the compatible 103-540-36 stepper motor shown is $127, again exclusive of tax.

For further information contact Tronics 2000, 18-20 Syme Street, Brunswick 3056.

Australian made smart modems

Totally designed and built in Australia, the new Avtek Megamodems are compact, fully Hayes compatible and available in either V21/V22 or V21/22/23 configurations. An internal "in-modem" is also available as a half-card unit, suitable for IBM PCs and compatibles.

Unlike competing modems, the Megamodems are upward compatible. They also carry a 12-month extended warranty and access to Avtek's technical support line. Priced at $375 and $449 including tax, both "Megas" are claimed to be priced well under equivalent products, local or imported.

For further information contact Avtek Electronics, 21 Bibby Street, Chiswick 2046.

Shielded LAN cable

Belden 89901 is a four-pair shielded plenum transceiver cable which meets IEEE 802.3 requirements for compatible local area networks.

This 78-ohm transceiver cable has three 20 AWG (stranded) 0.037" tinned copper twisted data pairs that are foam FEP Teflon insulated. The power pair is insulated with solid FEP Teflon. The pair shields are electrically isolated from the outer shielding with an overall polyester isolation tape and Duofoil shield; the overall tinned copper braid shielding provides 95% shield coverage. This shielding construction significantly reduces EMI/RFI interference. Jacket is gray FEP Teflon.

The cable has a nominal capacitance of 17.5pF/ft and a velocity of propagation of 78%. It is NEC 725 (b) Class 2 classified for use in air plenums without conduit.

For additional information, contact Belden Electronics, PO Box 322, Clayton 3168.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Quad UART

Standard Microsystems has announced the COM78804 Quad Universal Asynchronous Receiver Transmitter or Quad UART. This provides four UARTs on one chip to reduce parts count, simplify multiplexing, and lower the cost of multiport communication systems.

In addition to the four UARTs mentioned above, the COM78804 incorporates four independent baud rate generators, as well as a flag scanner that assumes functions usually handled by a host computer or external control logic.

The COM78804 is software and architecture compatible with the COM78808 Octal UART, also offered by Standard Microsystems and second-sourced by Digital Equipment Corporation and Texas Instruments Corporation. The COM78808 provides more flexibility in configuring the number of available input/output ports on a piece of communication equipment.

For further information contact Total Electronics, 8 Harker Street, Burwood 3125.

100V/us precision op amp

Precision Monolithics has released the OP-44, a high-speed, precision operational amplifier. Boasting a slew rate of 100V/us minimum and minimum gain-bandwidth product of 15MHz, the OP44 has AC characteristics similar to high-speed amplifiers such as the HA-2520, but with significant improvements in DC precision. The OP-44 is internally compensated for use in circuits with a closed-loop gain of three or more.

Input precision of the OP-44 is outstanding for a fast opamp. Bias current is 200pA at 25°C, and increases to only 20nA at 125°C. Offset voltage is internally trimmed to below 750uV, eliminating the need for external offset nulling in most applications. Twelve-bit accuracy is ensured with 86dB minimum common-mode rejection and an open-loop gain of over 500,000.

Available in 8-pin metal cans and ceramic and plastic mini-dips, the OP-44 conforms to the industry-standard 741 pinout.

For further details contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064.

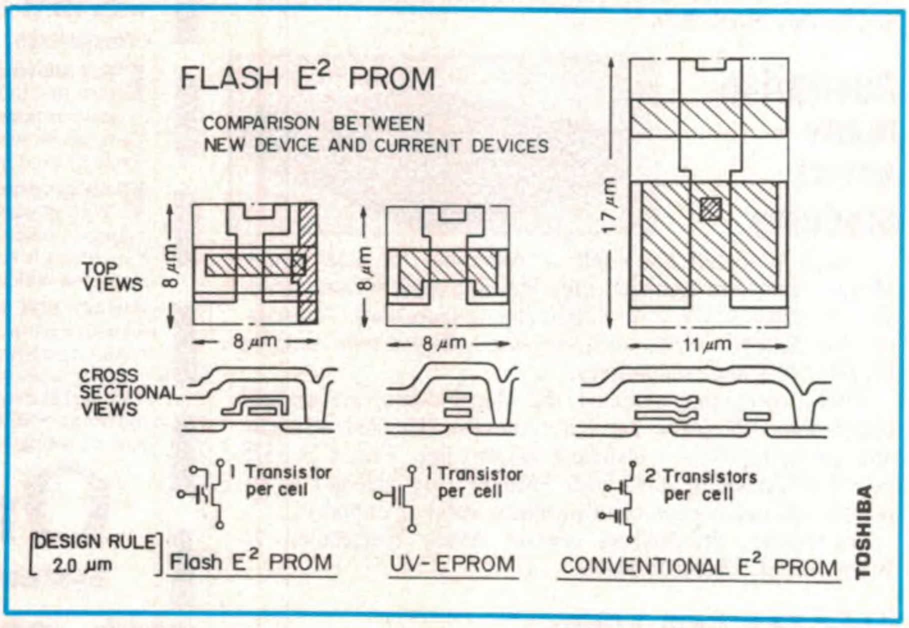
Oki develops superfast Ga-As chip

Oki Semiconductor has announced the development of an ultra-high-speed gallium-arsenide multiplexer/demultiplexer chip, capable of operating at speeds of up to 2 gigabits per second in an optical transmission system.

According to Oki, AT&T is currently developing such an optical transmission system built around the chips, which have 80 and 200 gates.

Oki says the chips represent "a major breakthrough in GaAs technology and a solution to former practical limitations in the use of this material". The company was able to overcome traditional GaAs problems like high power consumption and insufficient drive capacity with a proprietary "self-aligning" fabrication process developed in 1983. The process uses a tungsten-aluminum alloy as gate metal. This alloy is both stable and has low resistivity, and can withstand temperatures of up to 900°C.

In addition, to keep power consumption low, Oki has adopted a "super-buffer" field-effect transistor logic (SBFL) circuit. And by using this circuit on the same chip with a direct-coupled field-effect transistor logic circuit (DCFL), Oki was able to overcome the low drive capability issue as well.



256K "flash" EEPROM

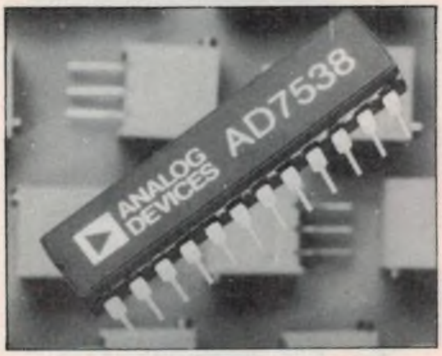
Toshiba has announced a new type of VLSI memory chip, a 256-kilobit "flash" EEPROM, named because it can electrically erase all stored data simultaneously and instantly.

The new device is developed from conventional UV-EPROM cell structure. The new chips are also designed to be fully compatible with 256K UV-EPROMs.

A conventional UV-EPROM cell consists of a double-layer transistor; the first layer stores electrons, and the second gate is for programming and reading. These cells must be exposed to ultraviolet beams to erase contents.

Toshiba engineers have added another layer, an "erase gate", to devise a triple-layer structure. All the information stored in the memory chip is erased in a flash by applying high voltage to this erase gate.

The new product, TMM 28257P, has a memory organisation of 32K word by 8 bit, and is packed in a 28 pin plastic DIP (dual inline package). It is based on the JEDEC pin placement standard common in the US and other countries, and is pin-compatible with JEDEC-based 256K EPROMs. Access time is 200ns with 250ns and 300ns versions also available.



High accuracy 14-bit DAC

A new CMOS multiplying digital-to-analog converter (DAC) from Analog Devices provides 14-bit resolution and 14-bit accuracy over its full specified operating temperature range. This eliminates the need for external trims for gain and offset, important in military and avionic applications.

Accuracy specifications are claimed to be the best in the industry for CMOS multiplying DACs, featuring integral and differential nonlinearity of ±2LSB and ±1LSB respectively. Packaging in a small 24-pin skinny DIP ensures that designers do not have to pay a space or cost penalty for added resolution and accuracy.

Microprocessor compatibility and double-buffered data latches allow simultaneous update in systems using multiple DACs. Applications for the DAC include digital audio, microprocessor-based control systems, precision servo control and measurement and control in high temperature environments.

For further information contact Parameters, 25-27 Paul Street North, North Ryde 2113.

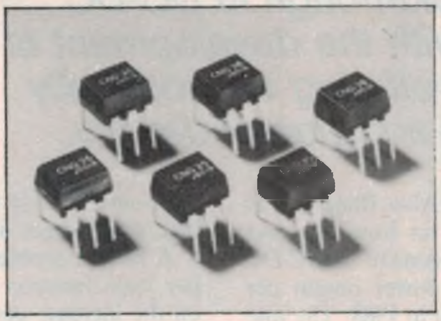
1200bps full duplex modem chip

The uAV22 1200bps full duplex modem IC is fabricated in Fairchild's advanced double polysilicon-gate CMOS process. The monolithic device performs all the signal processing functions required of a CCITT V.22 alternative B compatible modem. Handshaking protocols, dialling control and mode control functions can be handled by a general purpose, single chip microcomputer. The uAV22, uC and several components to perform the telephone line interface and control provide a high performance, cost effective and ultra low power solution for V.22-compatible modem designs.

The modem chip performs the modulation, demodulation, filtering and certain control and self-test functions required for a CCITT V.22-compatible modem, as well as additional enhancements. Both 550Hz and 1800Hz guard tones and notch filters and DTMF tone generator are on-chip. Switched-capacitor filters provide channel isolation, spectral shaping and fixed compromise equalisation. A novel switched-capacitor modulator and a digital coherent demodulator provide 1200 DPSK operation.

The receive filter and energy detector may be configured for call progress tone detection (dial tone, busy, ringback, voice) providing the front end for a smart dialler.

For further information contact the George Brown Group Marketing Division, 456 Spencer Street, West Melbourne 3003.



Long-life optocouplers

Several new optocouplers from Philips featuring emitters implemented in the new single heterojunction GaAlAs infra-red technology, offer long-life operation for applications like telephony and data processing.

The optocouplers exhibit a current transfer ratio (CTR) drop of only 5% after 10,000 hours operation — compared with the 40% drop found in GaAs infra-red optocouplers.

Type numbers of these devices, each consisting of an infra-red light emitting diode and a silicon receiver chip, are: CN35, CN36, PO40/44A, CNR36, 6N135 and 6N136.

One important result of the new technology is that the optocouplers boast a higher current transfer ratio at lower input currents, for example typically 0.5 in the case of the CNG35 driven at 500uA. This is about five times higher than for equivalent GaAs devices, making the optocouplers suitable for low-current CMOS circuit drive. It also ensures better linearity over a range of drive currents — an important factor in the transmission of analog signals.

For further information contact Philips Elcoma, 11 Waltham Street, Artarmon 2064.

68030 unveiled

Motorola has unveiled its newest 32-bit microprocessor, the 68030. After six months of evaluation sampling with key customers, the company is now accepting orders for the 030 at a top speed of 20MHz.

The new chip follows in the footsteps of the 68020, and is claimed to set the highest performance standards for general-purpose microprocessors.

The 030 (nicknamed "oh thirty") retains all essential features of the 020, and includes a number of enhancements that increase the processor's "parallelism" — the number of functions it can perform simultaneously — and its "bandwidth" — the rate at which it can feed information to its central execution unit.

One result of these innovations is the 030's performance, up to twice that of the 020. The second benefit is reduced system cost. Because the 030 provides high system performance without the need for extra components such as graphics coprocessors, memory management hardware and expensive static random access memory (SRAM), overall system cost can be reduced while providing the highest performance available. Motorola predicts the price of some 030-based system will be as low as $US2000 — a fraction of the cost of current 32-bit systems.

The 030 is the first general-purpose microprocessor with on-chip "cache" memory for computer instructions and data (the 020 was the first with an instruction cache). By storing this essential information on the chip itself, the 030 avoids the delays associated with external memory devices. The 030 is also the first with a Harvard-style architecture traditionally restricted to mainframe computers, supercomputers and reduced instruction set computers (RISC). This architecture provides multiple, parallel data paths on the chip, speeding information flow.

A 25MHz version of the 68030 is under development.

Local breakthrough in DC-DC converter technology

Australian power supply maker Statronics has made an important breakthrough in DC-DC converter technology, with the development of a totally new technique offering exceptionally high levels of efficiency and power density.

Statronics certainly hasn't the resources Alan Bond had at his disposal to win the America's Cup — far from it — but the global contest for the greatest power density in DC-DC converters (power density meaning total power output per unit volume) looks set to come to Australia in 1988. The title was briefly with Sweden, and at present three American companies are the leaders. It's unlikely there'll be the same scale of celebration or media coverage, but we do have a "winged keel" going for us in the Statronics camp.

The 100kHz current-mode controlled switchers and converters released by the company early last year are of high power density, particularly for small output powers of 10W to 70W — up to 4.5W per cubic inch.

Despite some problems with some early runs caused by the wrong ferrite material being supplied — resulting in higher losses, lower efficiency and hence excessive temperature rises at full power, these teething problems have now been solved and the range is rapidly gaining acceptance. Higher production volumes have enabled some substantial cost reductions, making them very attractive where efficiency and size are important. One factor not promoted by Statronics in the past is that it has the capacity and flexibility to produce "specials" based around these existing designs. Engineering costs, while moderate, generally dictate minimums for "specials" of around a few hundred.

The constant striving for ever greater compactness, which implies even higher operating frequencies and (more importantly) even greater efficiencies, is spurred on by the rapid advances in packing density of computing equipment — for example by the growing use of surface-mount techniques and VLSI chips. We all regularly hear of exceptional computing power in rapidly shrinking boxes.

Too much heat

This continual reduction in size means that more logic loads are fitted in smaller spaces, so extracting the heat generated by the logic and the power conversion devices feeding them becomes a significant problem. In "super-computers" and some military equipment, liquid coolants are ducted past heat pipes to get rid of the heat.

A further problem is that the total current, while dropping per logic function as MOS technology advances, is actually on the increase per unit volume of the computer, because so many more chips are loaded in a given volume.

In a very large computer system, each board may be larger than a square foot in area, and consume 10A or more from the 5V rail. Now imagine a seven foot rack with six rows of 15 such boards — a powerful system indeed! But this system is not only high powered in terms of computing: consider the 5V current.

Each row of boards will require 150A or more, and the whole rack a hefty 1000A. Now remember the voltage drops that can be tolerated. Let's say a really well designed board will have in-board drops of less than 100mV, another 50mV through the connector to the back plane — leaving just 100mV for the bus-bars, let alone power supply regulation!

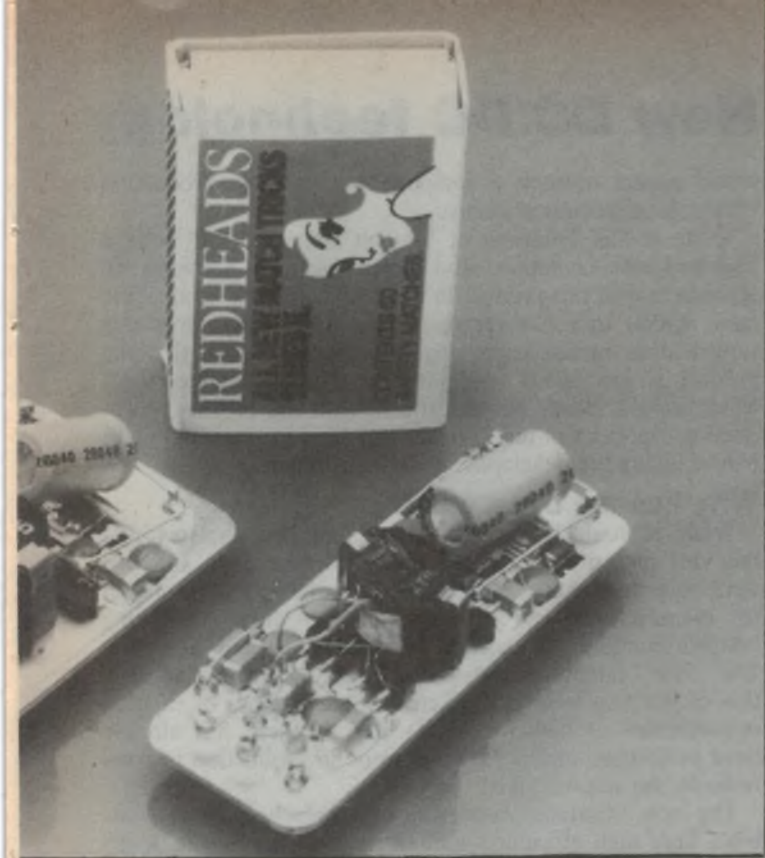
We are talking here of resistances in the order of 100 micro-ohms — the rack is going to be full of enormous copper bus-bars! The power lost in copper alone will be 250 watts.

Using a bunch of 150A power supplies may sound OK, but think of the risk in ducting all that mains voltage around. Then add the complexity of "redundancy" (spare power supplies which will pick up the load if the main one fails), or even battery back-up for line power outages. The problems will send chills down any power supply engineer's spine.

On-board DC-DC

This is why the search has been on in earnest for super-efficient high density DC-DC converters — for "distributed power systems" — so that the main power can be distributed at the maximum "extra-low voltage" level of 41V. The distributed current is then down by about a factor of 7 to 8 times. Ground loops, voltage drop problems and huge bus-bars disappear.

The main power supply from the power line is also greatly



Internal view of Statronics' new 20W and 10W hybrid converters, with a box of matches to indicate size.

simplified, made more reliable, and is less costly. Above about 3kW it is very much easier to provide an excellent single output switcher than a multiple output one, and redundancy and battery backup also become quite straightforward. Efficiencies at 41V output, even with power factor correction, low distortion to the input waveform and parallel operation can be expected to be above 85%, without stretching present technology.

Consider the example above, which would require 90 converters. The conversion losses will be about 400 watts — only a small increase, but the copper losses will be almost eliminated and the saving in real estate, ground loop problems and main power supply costs will be very worthwhile.

The breakthrough

For this important requirement for on-board converters, Statronics has applied for a patent on a totally new DC-DC converter topology. The first, but by no means the only application of this is for very high frequency, high efficiency, high power density applications. The experimental results already obtained actually surpass research results just published by no less an institution than the Massachussetts Institute of Technology!

Although MIT has researched operating frequencies to around 10MHz (!), they are a long way from the objective of power densities of 50W per cubic inch (heatsinked), and even further from the desired efficiency.

A prototype converter providing isolation and good load regulation has been built by Statronics. This operates at around 2MHz , and converts 41V to 5.0V DC at 10A output, with an efficiency of 90 to 92%. Statronics' managing director Rod Tuson says that even higher efficiency will be obtained for 12V and 15V output versions, since the major part of the 4.5 watts dissipation is rectification losses.

This exceptional power conversion efficiency is achieved through the use of a new zero-voltage switching technique, zero-current switching for the rectification and recently released very low forward drop Schottky rectifiers.

Using surface-mount techniques (one of the devices used will only be available in this package style in mid-1988), on a tiny eight-layer printed board, it is quite easy to squeeze 50W converter into less than a cubic inch — including heatsinking for 40°C! The parts count includes only five semiconductors, two resistors, four NPO ceramic capacitors, the multilayer board, and three ferrite cores. MTBF has not yet been calculated, but is expected to be remarkable, as one

Outside views of the 10W, 20W, 30W and 70W converters, again with a matchbox for size comparison. They're very small!

New DC/DC technology

would expect of such a components. Also the production cost looks extremely attractive.

While in San Francisco at Wescon launching the Voltage Standard with Guildline, Rod Tuson discussed licensing the manufacture of this product in the USA, which is seen as the main market area. Not surprisingly, considerable interest was shown, even at this early stage. Tuson points out that the product is just about ready for "production engineering", which should ideally be undertaken with the licensee's production capacities in mind, hence the need to establish intent before taking the development too much farther.

Why license overseas?

While it would be desirable to manufacture in Australia, the vast majority of the manufactured cost is in the five semiconductors, so the ideal licensee would be a semiconductor manufacturer who makes all five — thus eliminating "double margins". No such manufacturer exists in Australia. The "50W" family for distributed power is just one application of the new technique, there being a number of exciting opportunities at higher powers. One of these has already been prototyped and is expected to be in production in Australia by the second quarter of 1988.

The new Statronics converter topology, because it combines very high efficiency with small size and weight, lends itself to aerospace applications. Added benefits are that there are no electrolytic capacitors, and negligible switching transients to complicate noise filtering. The output ripple is low, approximately sinusoidal and twice the operating frequency (i.e., 4MHz). The zero voltage switching arrangement eliminates the need for snubber networks.

The converter provides good load regulation, of the order of 200mV from 1% load to full load. The efficiency is constant through the load range, except for the small power used by the MOSFET driver.

All this sounds too good to be true, but working prototypes prove the results. The "downside" is that line regulation cannot be provided for anything but very tiny input changes — so small as to be not worth implementing. In a distributed power system such as has been discussed, this is not a problem. However, for applications where the input voltage changes substantially, a conventional PWM converter would have to be used.

Higher power

Apart from the 50W example already discussed, at higher powers Statronics would like to see as many Australian-made applications of this technique in production as soon as possible, and will provide design help and applications engineering to licensees. Statronics simply doesn't have the capacity to implement all the numerous practical applications. Wherever DC output of low noise is required, line input regulation is not necessary, but low cost, very high efficiency, and small size are important, this technique is in its element.

Possible unconventional application up to several hundred watts include: Projector lamp power sources, uninterruptable power supplies with DC output, quartz halogen sources, DC isolators, battery or automotive powered equipment. These applications can be implemented now with power densities from 20 to 35 watts per cubic inch, efficiencies above 90%, and costs as low as tens of cents per watt.

Expressions of interest are invited. Further information is available from Statronics at 103 Hunter Street, Hornsby 2077. Telephone: (02) 476 5714.

Basics of Switchers

There have been a lot of developments in the areas of switching power supplies in the last few years. If you've found it hard to keep up, here's an easy to follow explanation of the various kinds of circuit, how they work and the things that need to be considered when choosing one.

While linear power supplies have many desirable characteristics such as simplicity, low output ripple and noise, excellent line and load regulation, and fast recovery time, they are not particularly noted for high efficiency.

Switching power supplies, on the other hand, are becoming popular due to high efficiency and high power density. Table 1 compares some of the salient features of both linear and switching power supplies.

Line and load regulation are usually better with linear supplies, sometimes by as much as an order of magnitude, but switching power supplies frequently use linear post-regulators to improve output regulation.

The output voltage ripple of a switcher, generally in the range of 25 to 100mV peak-to-peak, is higher than that of a linear supply. While the RMS value of this ripple is much lower, it is the peak-to-peak value that is more significant with switchers. Switchers also have slower transient recovery times than linears, but have much longer hold-up times, a characteristic which is important in computer applications. Transient recovery time and hold-up time are both defined in the "Power Conversion Glossary".

Finally, the switching supply has the advantage of wider input voltage range than its linear counterpart. The linear supply input range is usually ±10% and has a direct effect on the efficiency of the supply. With a switcher, however, there is little or no effect of input voltage range on efficiency, and the input range is usually ±20%, making the supply useful under brown-out conditions.

TABLE 1 LINEAR VS. SWITCHING SUPPLIES

SPECIFICATION	LINEAR	SWITCHER
Line Regulation	.02 – .05%	.05 – 0.1%
Load Regulation	.02 – 0.1%	0.1 – 1.0%
Output Ripple	0.5 – 2 mV RMS	25 – 100mV P-P
Input Voltage Range	±10%	±20%
Efficiency	40 – 55%	60 – 80%
Power Density	0.5W/in³	2.3W/in³
Transient Recovery	50 μsec.	300 μsec.
Hold-Up Time	2 msec.	32 msec.

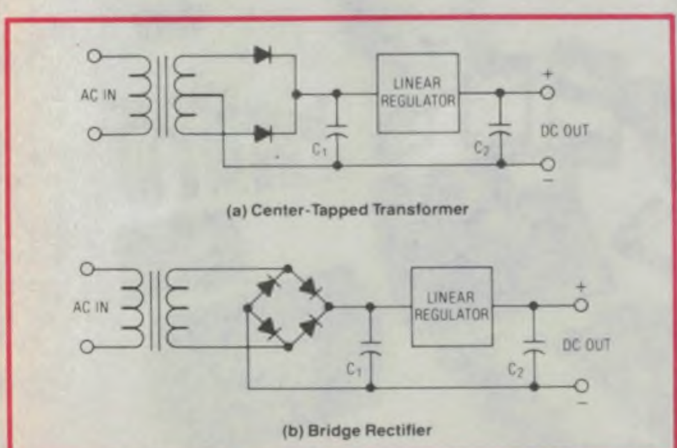


Fig.1: Typical linear power supply circuits.

Switching power supplies are not new. They were developed in the 1960's and used primarily in military and aerospace systems. However, in recent years switching technology has improved and the cost of switching components has come down significantly, leading to practical industrial and consumer grade switching power supplies.

Switchers began replacing the large linear supplies in which both size and heat dissipation were problems, and have been gradually working their way down to lower power levels.

Efficiency

There are many losses in a conventional linear power supply, using circuitry as shown in Figs.1 and 2. First the 50 or 60Hz transformer is far from 100% efficient; it has both core losses and winding losses. Next, the rectifier diodes have a significant instantaneous voltage drop across them while they are conducting the capacitor charging current pulses.

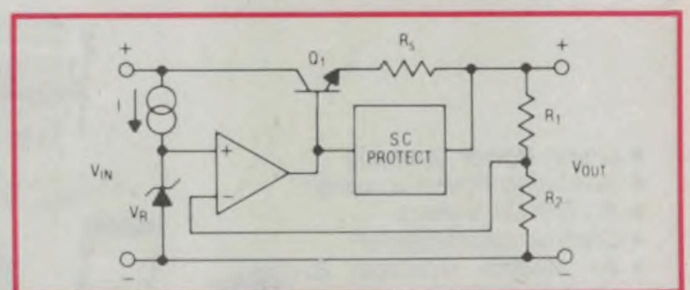


Fig.2: A linear (dissipative) voltage regulator.

The linear regulator is a dissipative circuit which has a minimum permissible voltage drop across the series pass transistors. This drop is determined at minimum line voltage and therefore is higher at nominal or high line voltage.

All of these losses result in an output efficiency of about 45% for a typical linear power supply with a 5V output. The switching supply, on the other hand, has fewer dissipative components because it employs a switching regulator.

The flyback regulator

The basic circuit upon which many lower power switchers operate is the flyback regulator, shown in Fig.3. This circuit converts one DC voltage into another, regulating the output voltage by means of pulse-width modulation (PMW).

Pulse-width modulation is a method of controlling the ratio of on-time to off-time of a switch. In a flyback type switching supply, the longer the on-time compared to the off-time, the more energy is stored in the transformer and transferred to the load. Fig.4 illustrates pulse-width modulation.

The flyback regulator operates as follows. The switching transistor Q_1, is controlled by the pulse-width modulator circuit. When Q_1 is on, the current increases linearly in the primary of the transformer. This transformer is actually an inductor with a secondary winding and, unlike a normal transformer, stores substantial energy in its flux.

When Q_1 turns off, the flux in the transformer core begins to decrease and therefore causes I_2 to flow in the secondary. I_2 charges capacitor C also flows into the load. Fig.5 illus-

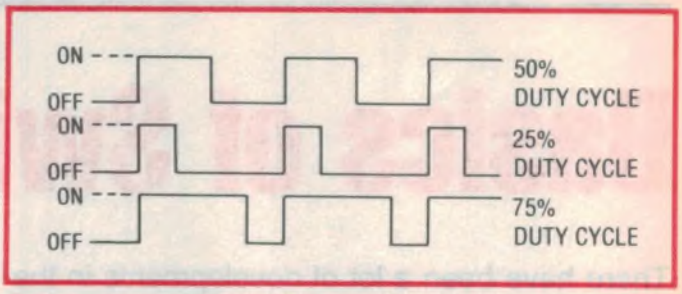


Fig.4: Pulse width modulation. The switching duty cycle is varied to control stored energy.

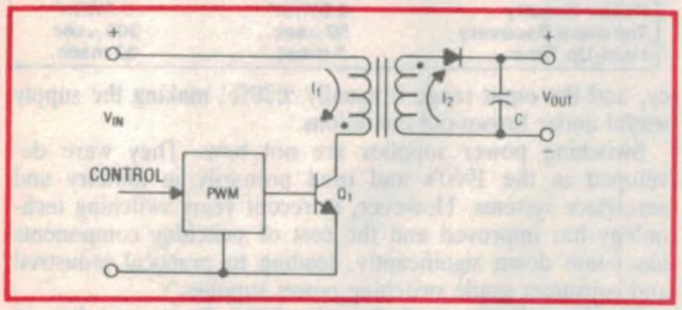


Fig.3: The basic circuit for a flyback switching regulator.

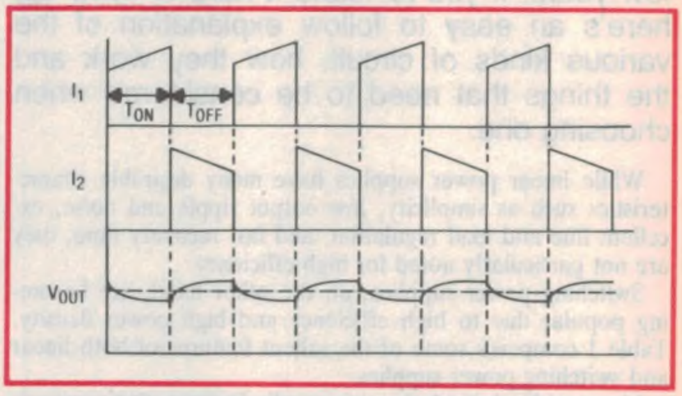


Fig.5: Waveforms for the flyback regulator.

trates the current pulses I_1 and I_2 during the on-time and off-time of the switching transistor. While I_1 builds up during the on-time, I_2 decays during the off-time and maintains the voltage across capacitor C.

If the output load increases, it is only necessary to increase the on-time of Q_1 during which I_2 builds up to a higher value, and as a result a higher I_2 flows in the secondary during the off-time. The reverse occurs for a lighter output load, with I_2 decreasing in value.

If the output voltage is compared with a reference voltage and the difference used to control the pulse-width modulator, the loop is closed and the circuit automatically keeps the output voltage at a constant value.

The ideal flyback regulator circuit is lossless, since at any time the switching element has either zero voltage or zero current. In practice, however, there are some switching and conduction loses in Q_1 and also losses in the transformer, diode and capacitors. But these losses are generally small compared with those in a linear regulator circuit.

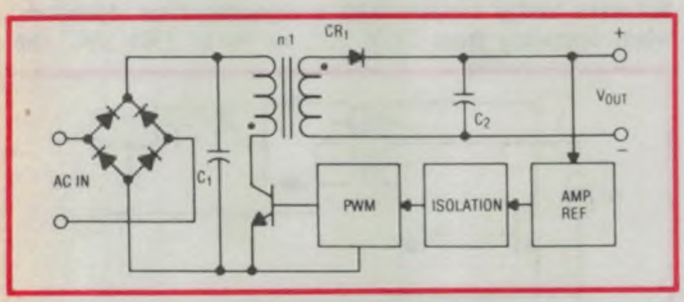


Fig.6: A complete flyback switching supply.

Off-line switching supply

Based on the flyback regulator circuit, a complete off-line switching supply is shown in Fig.6. The switcher is called "off-line" because the DC voltage to the switch is developed right from the AC power line without first going through a 50 or 60Hz transformer. This is accomplished by means of a bridge rectifier circuit, which charges filter capacitor C1.

This circuit also shows the feedback loop completed from the output back to the switching transistor. This feedback loop must have isolation in order for the DC output to be isolated from the AC line, and this is normally accomplished by a small transformer or an opto-isolator.

The forward converter

Another popular switching configuration is known as the forward converter circuit and is illustrated in Fig.7. Although this circuit looks much like the flyback circuit, there are some fundamental differences. The forward converter does not store significant energy in the transformer but, rather, in the output series inductor.

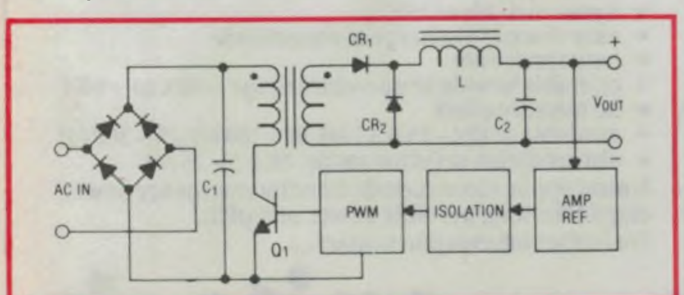


Fig.7: A forward converter switching supply.

The direction of the dots on the transformer shows that when the transistor switch is on, an output voltage is generated at the secondary and current flows through diode CR_1 into the inductor. The longer the on-time of the switch relative to the off-time, the higher the average secondary voltage and the higher the output load current.

When Q_1 is off, the current in the inductor cannot change instanteously and continues to flow through CR_2. Thus, unlike the flyback circuit, current flows from the energy storage element during both halves of the switching cycle. The forward converter therefore has lower output ripple voltage than the flyback circuit for the same output power.

Multi-output switchers

Most switching power supplies have more than one output. Typically, in addition to a 5V logic output, there may be +12V, −12V, +24V and −5V outputs. These outputs are used in systems to power other devices such as floppy and

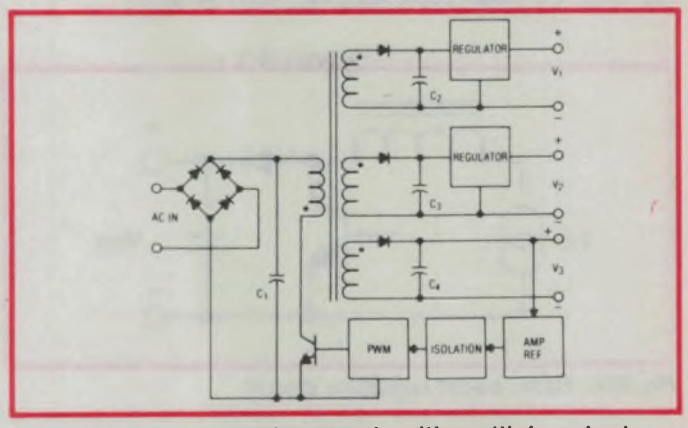


Fig.8: A flyback switching supply with multiple outputs.

hard disk drives, printers, CRT terminals, RS-232 circuits, and analog interface circuits.

Fig.8 shows a multiple output flyback switcher. The main 5V output is fed back to the pulse-width modulator to regulate the entire circuit. This means that the auxiliary outputs are not as well regulated as the main output. In some applications such as disk drives this is not critical. In other more critical applications the auxiliary outputs have linear post-regulators to provide better regulation, as shown in the diagram.

Standard switching power supplies are usually available with up to five different outputs.

Other topologies

For simplicity the front-end rectifier and filter are not shown in these circuits. There are a number of other topologies for switching supplies, which are shown in simplified form in Fig.8.

Buck Regulator: The first of these is the "buck regulator". The buck regulator operates like the forward converter, except that a transformer is not used and there is no input to output isolation for the circuit. The input DC voltage is regulated to a lower value by pulse-width modulation of the switch. This circuit is frequently employed as a three-terminal high efficiency regulator.

Boost Regulator: A similar circuit is the "boost regulator", in Fig.9(b), which operates like the buck regulator except that the output voltage is higher than the input voltage. In fact the output voltage is equal to the input voltage plus the voltage determined by the switching of the transistor.

Push-Pull Converter: Fig.9(c) shows a push-pull converter

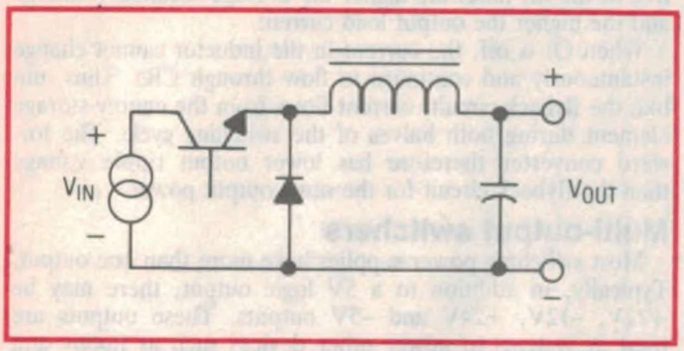


Fig.9(a): The basic buck regulator configuration.

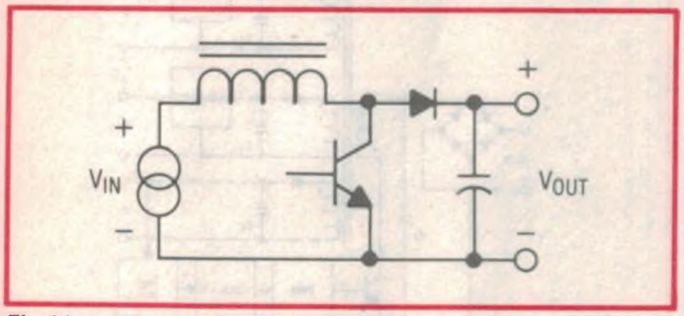


Fig.9(b): Basic boost regulator circuit.

which is another variation of the forward converter except that two switches are used on the primary side of the transformer.

Full and Half Bridge Converters: Fig.15(d) and (e) show two more variations on the forward converter, call "full-bridge and half-bridge" converters respectively. The only differences from the previous circuit are the manner in which the transformer primary is driven.

Input voltage selection

Switching power supplies generally have selectable AC input voltage ranges of 115 or 230V AC nominal. Fig.10 shows how this is accomplished simply for many switchers.

When operating from 230V AC, or the range of 180 to 260V AC, the jumper is removed and the input circuit is a full-wave bridge rectifier with a capacitor filter. However, when operating from 115V AC, or 90 to 130V AC, the

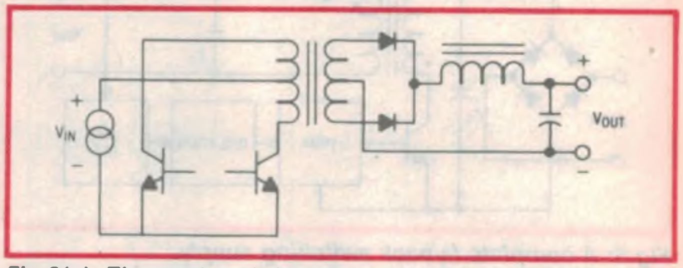


Fig.9(c): The push-pull forward converter.

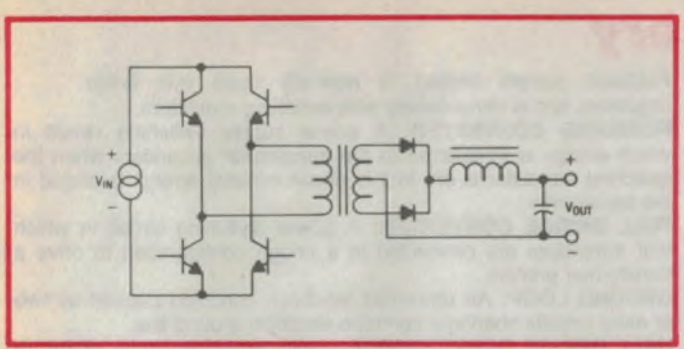


Fig.9(d): The full bridge forward converter.

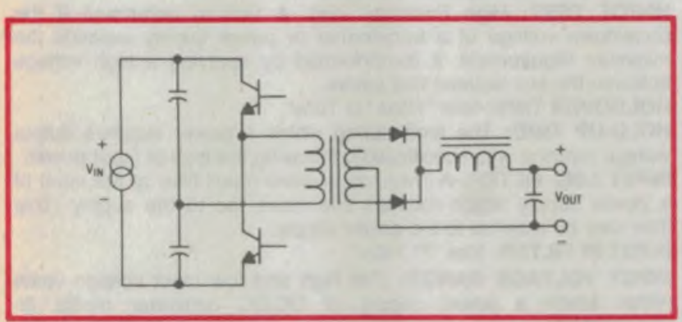


Fig.9(e): The half-bridge forward converter.

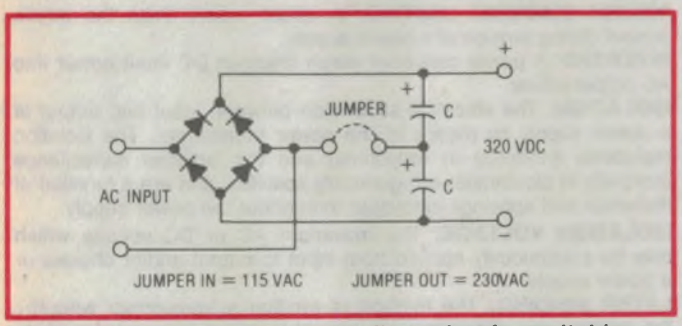


Fig.10: Single jumper input configuration for switching between 115V and 230V input.

jumper is in place and the two capacitors in series are alternately charged on each half cycle, producing a doubled output voltage.

The obvious advantage of this type of input circuit is that it permits a single jumper selection for either US or European/Australian input voltage ranges and permits the systems designer to handle this problem in the simplest way for his world-wide equipment designs.

Switcher efficiency and size

One of the great advantages of switchers, in addition to high efficiency, is the high power density, or power-to-volume ratio. This of course is the result of the reduction in size of various components, for 20kHz and higher operation, compared with 50/60Hz operation. Mainly, the large 50/60Hz power transformer is replaced with a miniature ferrite core transformer and the filter capacitors are likewise much smaller. The only exception to this is the input filter capacitor which must filter a full-wave rectified 50/60Hz sine wave.

Another important component used with switchers is either a fast-recovery or Schottky diode, for rectifying or controlling the direction of the output current. These fast diodes are required to prevent significant power losses due to the stored charge of conventional rectifier diodes.

In addition, Schottky diodes have a much lower forward voltage drop than conventional diodes, further boosting efficiency.

EMI and RFI

Switching power supplies, unlike linear supplies, can be a source of electromagnetic and radio frequency interference. There are two basic types of interference: conducted and radiated.

The source of this interference is a short burst of high frequency-content energy caused by the rapid switching voltage and current transients in a switcher. These bursts of energy are repeated at the switching frequency of the supply.

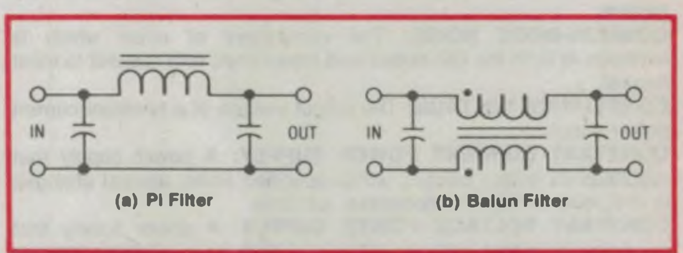


Fig.11: Input filters for switching power supplies.

Conducted EMI/RFI is noise fed back from the power supply onto the AC power line. This noise can be effectively suppressed using a pi input filter for differential mode noise and a balun and capacitor filter for common mode noise. These filters are illustrated in Fig.11, and must use components which are effective at RFI frequencies. Fig.12 shows the definition of differential mode noise and common mode noise.

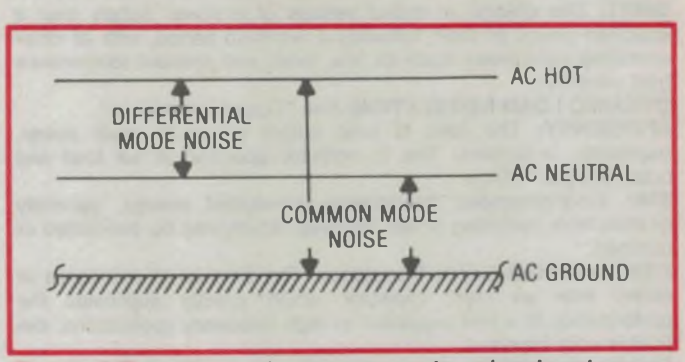


Fig.12: Differential and common mode noise. Input filtering is needed to prevent switcher noise from causing RFI.

While many switching supplies have an internal input filter to suppress the conducted EMI/RFI, for those that don't, an external filter can be employed for this purpose.

Radiated EMI/RFI is noise that is directly transmitted from the circuitry and leads themselves. This can be effectively suppressed by means of a metal enclosure around the power supply. Some switching power supplies have inherently low radiation due to the special switching techniques employed.

The material in this article has been extracted from the Computer Products "Power Supply Engineering Handbook", by arrangement with Computer Products, Inc. and its Australian distributor Amtex Electronics, of 36 Lisbon Street, Fairfield. Our thanks to both companies for their co-operation.

Power Supplies — Glossary

AMBIENT TEMPERATURE: The still-air temperature in the immediate vicinity of a power supply, measured a minimum of 4 inches (100mm) from the supply.
BACK RIPPLE CURRENT: See "Reflected Ripple Current".
BALUN: A transformer which presents a high impedance to common-mode signals and a low impedance to differential-mode signals. It is commonly used on the input of switching power supplies to suppress common-mode noise.
BREAKDOWN VOLTAGE: The maximum AC or DC voltage which may be applied from input to output and/or chassis of a power supply.
BROWN-OUT: A planned voltage reduction by a utility company to counter excessive demand on their generation and distribution system.
COMMON-MODE NOISE: The component of noise which is common to both the DC output and return lines with respect to input neutral.
COMPLIANCE VOLTAGE: The output voltage of a constant current power supply.
CONSTANT CURRENT POWER SUPPLY: A power supply that regulates its output current, within specified limits, against changes in line, load, ambient temperature, and time.
CONSTANT VOLTAGE POWER SUPPLY: A power supply that regulates its output voltage, within specified limits, against changes in line, load, ambient temperature, and time.
CROSS-REGULATION: In a multiple output power supply, the percent voltage change at one output caused by the load change on another output.
CROWBAR: An overvoltage protection circuit which rapidly places a low resistance shunt across the power supply output terminals if a predetermined voltage is exceeded.
CURRENT LIMITING: See "Output Current Limiting".
DERATING: The specified reduction in an operating parameter to improve reliability. Generally for power supplies, it is the reduction in output power at elevated temperatures.
DIFFERENTIAL MODE NOISE: The component of noise measured between the DC output and output return. See "Ripple and Noise".
DRIFT: The change in output voltage of a power supply over a specified period of time, following a warm-up period, with all other operating parameters such as line, load, and ambient temperature held constant.
DYNAMIC LOAD REGULATION: See "Output Impedance".
EFFICIENCY: The ratio of total output power to input power, expressed in percent. This is normally specified at full load and nominal input voltage.
EMI: Electromagnetic Interference. Unwanted energy, generally emitted from switching power supplies, which may be conducted or radiated.
ESR: Equivalent Series Resistance. The amount of resistance in series with an ideal capacitor which exactly duplicates the performance of a real capacitor. In high frequency applications, low ESR is very important.
FARADAY SHIELD: An electrostatic shield between input and output windings of a transformer. This can be used to reduce coupling capacitance, which in turn reduces output common mode noise.
FAULT-MODE INPUT CURRENT: The input current to a power supply or DC/DC converter, with the output short circuited.
FEED FORWARD: A control technique whereby the line regulation of a power supply is improved by directly sensing the input voltage.
FERRORESONANT POWER SUPPLY: An open-loop voltage stabilised power supply in which a portion of the transformer core is driven into saturation by a resonant tank circuit. The output is derived from the saturated portion of the transformer and is relatively independent of input voltage.
FLYBACK CONVERTER: A power supply switching circuit which normally uses a single transistor. During the first half of the switching period the transistor is on and energy is stored in a transformer primary; during the second half period this energy is transferred to the transformer secondary and the load.
FOLDBACK CURRENT LIMITING: A power supply output protection circuit whereby the output current decreases with increasing overload, reaching a minimum at short circuit. This minimises internal power dissipation under overload conditions. Foldback current limiting is normally used with linear regulators and is unnecessary with switching regulators.
FORWARD CONVERTER: A power supply switching circuit in which energy is transferred to the transformer secondary when the switching transistor is on. In this circuit minimal energy is stored in the transformer.
FULL BRIDGE CONVERTER: A power switching circuit in which four transistors are connected in a bridge configuration to drive a transformer primary.
GROUND LOOP: An unwanted feedback condition caused by two or more circuits sharing a common electrical ground line.
HALF BRIDGE CONVERTER: A power switching circuit similar to the full bridge converter except that only two transistors are used, with the other two replaced by capacitors.
HI-POT TEST: High Potential Test. A test to determine if the breakdown voltage of a transformer or power supply exceeds the minimum requirement. It is performed by applying a high voltage between the two isolated test points.
HOLDOVER TIME: See "Hold-Up Time".
HOLD-UP TIME: The time during which a power supply's output voltage remains with specification, following the loss of input power.
INPUT LINE FILTER: A low-pass or band-reject filter at the input of a power supply which reduces line noise fed to the supply. This filter may be external to the power supply.
INPUT PI FILTER: See "Pi Filter".
INPUT VOLTAGE RANGE: The high and low input voltage limits within which a power supply or DC/DC converter meets its specifications.
INRUSH CURRENT: The peak instantaneous input current drawn by a power supply at turn-on.
INRUSH CURRENT LIMITING: A circuit which limits the inrush current during turn-on of a power supply.
INVERTER: A power converter which changes DC input power into AC output power.
ISOLATION: The electrical separation between input and output of a power supply by means of the power transformer. The isolation resistance (normally in megohms) and the isolation capacitance (normally in picofarads) are generally specified and are a function of materials and spacings employed throughout the power supply.
ISOLATION VOLTAGE: The maximum AC or DC voltage which may be continuously applied from input to output and/or chassis or a power supply.
LAYER WINDING: The method of winding a transformer whereby the primary and secondary are wound in layers over one another, separated by an insulation layer.
LEAKAGE CURRENT: The AC or DC current flowing from input to output and/or chassis of an isolated power supply at a specified voltage.
LINE REGULATION: The change in output voltage in percent as the input voltage is varied over its specified limits, with load and temperature constant.
LINEAR REGULATOR: A popular stabilisation circuit in which a control device is placed in series (or parallel) with the load to give a constant voltage across the load. The control device is always conducting, and the difference between input and output power is dissipated by the control device.
LOAD REGULATION: The percent change in output voltage as the load is changed from minimum to maximum, at constant line and constant temperature. The load change may be specified for other than no load to full load, such as 20% load to full load.
LOCAL SENSING: Using the power supply output voltage terminals as the sense points to provide feedback to the voltage regulator.
MTBF: Mean Time Between Failure. The failure rate of a power supply, expressed in hours, established by the actual operation or calculation from a known standard.
NOMINAL VALUE: The stated or objective value for a quantity, such as output voltage, which may not be the actual value measured.
OFF-LINE POWER SUPPLY: A power supply which operates off the AC line directly, without using a power transformer prior to rectification and filtering.
OPERATING TEMPERATURE RANGE: See "Temperature Range, Operating".

OPERATIONAL POWER SUPPLY: A power supply with a high open loop gain regulator which acts like an operational amplifier and can be programmed with passive components.
OUTPUT CURRENT LIMITING: An output protection feature which limits the output current to a predetermined value in order to prevent damage to the power supply or the load under overload conditions. The supply is automatically restored to normal operation following removal of the overload.
OUTPUT IMPEDANCE: The ratio of change in output voltage to change in load current.
OUTPUT VOLTAGE: The nominal value of the DC voltage at the output terminals of a power supply.
OUTPUT VOLTAGE ACCURACY: For a fixed output supply, the tolerance in percent of the output voltage with respect to its nominal value under all minimum or maximum conditions.
OVERLOAD PROTECTION: An output protection feature which limits the output current of a power supply under overload conditions, so that it will not be damaged.
OVERSHOOT: A transient change in output voltage, in excess of specified output accuracy limits, which can occur when a power supply is turned on or off, or when there is a step change in line or load.
OVERVOLTAGE PROTECTION: A power supply feature which shuts down the supply, or crowbar or clamps the output, when its voltage exceeds a preset level.
PARALLEL OPERATION: The connection of the outputs of two or more power supplies of the same output voltage to obtain a higher output current than from either supply alone. This requires power supplies specifically designed to share the load.
PARD: Periodic and Random Deviation. A term used for the sum of all ripple and noise components measured over a specified band width and stated in either peak-to-peak or RMS values.
PI FILTER: A commonly used filter at the input of a switching supply or DC/DC converter to reduce reflected ripple current. The filter usually consists of two parallel capacitors and a series inductance and is generally built into the supply.
POST REGULATION: A linear regulator used on the output of a switching power supply to improve line and load regulation and reduce output ripple voltage.
POWER FAIL DETECTION: A power supply option which monitors the input voltage and provides an isolated logic output signal when there is loss of line voltage.
POWER FOLDBACK: A power supply feature whereby the input power is reduced to a low value under output overload conditions.
PREREGULATION: The regulation at the front-end of a power supply, generally by a type of switching regulator; this is followed by output regulation, usually by a linear type regulator.
PROGRAMMABLE POWER SUPPLY: A power supply with an output controlled by an external resistor, voltage, or digital code.
PULSE-WIDTH MODULATION: A method of voltage regulation used in switching supplies whereby the output is controlled by varying the width, but not the height, of a train of pulses which drive a power switch.
PUSH-PULL CONVERTER: A power switching circuit which uses a centre-tapped transformer and two power switches which are driven on and off alternately. This circuit does not provide regulation by itself.
RATED OUTPUT CURRENT: The maximum load current which a power supply was designed to provide at a specified ambient temperature.
REFERENCE: The stable voltage, generally a Zener diode, from which the output voltage of a regulated supply is controlled.
REFLECTED RIPPLE CURRENT: The AC current generated at the input of a power supply or DC/DC converter by the switching operation of the converter, stated as peak-to-peak or RMS.
REMOTE SENSING: A technique of regulating the output voltage of a power supply at the load by means of sensing leads which go from the load back to the regulator. This compensates for voltage drops in the load leads.
RESOLUTION: For an adjustable supply, the smallest change in output voltage that can be realised by the adjustment.
RETURN: The name for the common terminal of the output of a power supply; it carries the return current for the outputs.

Power Supplies — Glossary *(continued)*

REVERSE VOLTAGE PROTECTION: A feature which protects a power supply against a reverse voltage applied at the input or output terminals.

RIPPLE AND NOISE: The magnitude of AC voltage on the output of a power supply, expressed in millivolts peak-to-peak or RMS, at a specified band width. This is the result of feed through of the rectified line frequency, internal switching transients and other random noise.

SERIES REGULATION: The most popular method of linear regulation in which the control device is in series with the raw DC and the load to achieve constant voltage across the load.

SHORT-CIRCUIT PROTECTION: A feature which limits the output current of a power supply under short-circuit conditions, so that the supply will not be damaged.

SHUNT REGULATION: A method of linear regulation in which the control device is in parallel with the load to achieve constant voltage across the load.

SOFT START: A feature which limits the start-up switching currents of a switching supply and causes the output voltage to rise gradually to its final value.

SPLIT BOBBIN WINDING: The method of winding a transformer whereby the primary and secondary are wound side-by-side on a bobbin with an insulation barrier between the two windings.

STABILITY, LONG TERM: The output voltage change of a power supply, in percent, due to time only, with all other factors held constant. Long-term stability is a function of component ageing.

STANDBY CURRENT: The input current drawn by a power supply under no load or when shut down by a control input.

STEP CHANGE: A instantaneous change in a quantity from one value to another.

SWITCHING FREQUENCY: The rate at which the DC voltage is switched in a DC-DC converter or switching power supply.

SWITCHING REGULATOR: A high efficiency switching circuit which uses a closed loop system to regulate the output voltage, generally by means of a pulse-width modulator.

TEMPERATURE COEFFICIENT: The average percent change in ambient temperature over a specified temperature range.

TEMPERATURE RANGE, OPERATING: The range of ambient or case temperatures within which a power supply may be safely operated and meet is specifications.

TEMPERATURE RANGE, STORAGE: The range of ambient temperatures within which a power supply may be safely stored, non-operating, with no degradation in its subsequent operation.

THERMAL PROTECTION: An internal safeguard circuit in a power supply which shuts down the unit in the event of excess internal temperature.

TRACKING: A characteristic of a dual or other multiple output power supply whereby one or more outputs follow another output with changes in line, load, and temperature, so that each maintains the same proportional output voltage, within specified tracking tolerance, with respect to common.

TRANSIENT RECOVERY TIME: The time required for the output voltage of a power supply to settle within specified output accuracy limits, following a step change in output load current or a step change in input voltage.

UNDERSHOOT: A transient change in output voltage, below output accuracy limits, which can occur when a power supply is turned on or off, or when there is a step change in line or load.

UPS: Uninterruptible Power Supply. A power supply which continues to supply power during a loss of AC input power. This is accomplished by means of a backup battery and a DC/AC inverter or DC/DC converter.

VOLTAGE BALANCE: The difference in magnitude, in percent, between the two output voltages of a dual output power supply where the voltages have equal nominal values with opposite polarities.

WARM-UP DRIFT: The initial change in output voltage of a power supply from turn-on until it reaches thermal equilibrium at nominal line, full load, 25° ambient temperature.

WARM-UP TIME: The time required, after initial turn-on, for a power supply to meet its performance specifications.

Export success for Aussie supply maker

Local power supply manufacturer Statronics looks set to top its success in the local market with big sales in the US market, following a successful launch of its new products at Wescon 87 in San Francisco late last year.

The name Statronics has for more than a decade been associated with its line of linear modular power supplies, which are to be found in a wide range of enterprises throughout Australia. In 1985, a range of ferro-resonant DC power supplies (the technique used in most quality computer "Line Conditioners") was introduced and is now similarly scattered.

More recently, a family of very compact switching power supplies of novel design was added, completing the full spectrum of techniques for obtaining regulated DC power.

In contrast with these "work-horse" power supplies is the company's activities in high-precision measurement instrumentation. It is the first instrument in this family which has achieved a remarkable success in the world's most technologically advanced market — North America. The instrument is the Statronics VS4 Portable DC Voltage Standard.

This is a precision solid-state standard for DC voltage, designed to replace the traditional four-cell "Standard Cell" enclosure in calibration laboratories which must maintain traceability to the National Standard for Voltage, in Australia maintained by the CSIRO National Measurement Laboratory.

The VS4 was released in Australia two years ago and was an immediate success, in no small part due to collaboration with the National Measurement Laboratory in the development of the instrument.

No export activity was initiated until a good year's history was established and user feedback obtained. However the performance of the instrument rapidly became known abroad, and Statronics was approached for distribution rights by four of the world's best-known names in precision instrumentation.

After some agonising over this tough but delightful decision, Guildline Instruments was chosen to distribute under its own brand in North America and Europe. Any readers who have worked in a calibration laboratory will know this name, which appears on some of the most respected calibration equipment. The Guildline brand is so revered in this specialised field as to be just as important an association for the product in North America as the National Measurement Laboratory is in Australia.

Launched at Wescon

The product was launched in the USA at the "Wescon '87" exhibition in San Francisco in November. This is one of the biggest professional electronics shows anywhere, with over 60,000 visitors daily, hundreds of exhibitors, and filling an area about equal to two football fields. On the Guildline exhibit, branded "Guildline 4410", the Australian voltage standard attracted a great deal of interest. The measurement community in USA, as was the case here, has been waiting expectantly for a DC Voltage Standard with the stability of Standard Cells, combined with the robustness of solid-state electronics.

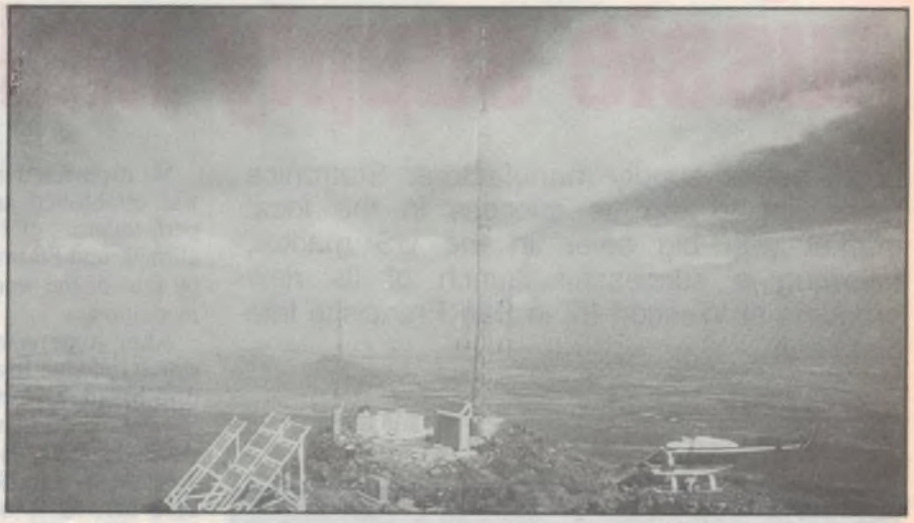
To put the VS4/4410 voltage standard in its technological context, it should be noted that there are only three competitors throughout the world in even a similar class, despite lengthy and expensive development programs by some of the world's largest instrumentation companies. The acceptance of the product by Guildline (with its 25-year history as the major supplier of standard cells and enclosures) as one worthy of its brandname will be in many cases sufficient product endorsement to assure acceptance.

According to Statronics managing director Ron Tuson, a paper produced by the American "National Bureau of Standards) (NBS) and published in September 1987, defining an "ideal" voltage standard, reads almost exactly like the VS4/4410 specifications.

It is pleasing that a product developed and manufactured in Australia, and which is obviously at the leading edge of precision electronic technology, should be succeeding in the world's most demanding market. Forget the "Technology Cringe"!

Several orders were received for the VS4/4410 just two working days after the release at Wescon, which is remarkable for this conservative field. This augers very well for the future. Exports worth over $A1.2 million of this one instrument are expected for the bicentennial year.

New Products



Solar power supply modules

Solarex provides a range of cost effective photovoltaic power supply modules, designed for telecommunications applications. Unlike other types of power supply, the modules provide clean RFI-free DC, obviating the risk of interference with transmission or reception.

Solarex can supply a wide selection of 11 different modules, with outputs from 1.5W to 45W. For unusual requirements, such as the Ford solar powered vehicle, the company will design and manufacture to suit the need.

The company can also integrate photovoltaic generators with existing energy sources, for enhanced reliablity or cost effectiveness. Solarex system controllers can be arranged to automatically select and activate the appropriate source in these hybrid systems. The controllers also have the ability to send an alarm signal to warn of system faults and permit correction before failure.

Further information from Solarex, 78 Biloela Street, Villawood 2163.

Low profile 15W DC/DC converter

Rifa Power Products has introduced a new series of 500V DC isolated DC/DC converters with single, dual or triple outputs (5, 12 and 15V in different output configurations for in all 14 versions).

The PKC series, also known as the In-Card converters, operate on a 2:1 input voltage range for 24V (18-36V) and 48/60V (36-72V) battery systems, with temperature range −45°C to +85°C. Housed in a 0.42" (10.7mm) high anodized aluminium enclosure, the converters can be mounted as conventional On-Card converters or recessed into a punched hole in the PCB. Overall dimensions are 80 x 55 x 10.7mm and the weight is 50 grams.

For further information contact Rifa, PO Box 95, Preston 3072.

Negative polarity DC/DC converter

Boschert's 3T5AN series are DC/DC converters which provide a single negative output voltage from a positive input. The open board units are three-terminal 25kHz switching regulators which accept raw positive DC inputs of 10 to 40V (3T5AN4030) or 20 to 60V (3T5AN6030). The regulated output is adjustable between –4.5V to –30V, rated at 5 amps.

The 3T modules are complete functional blocks; no complex electronic circuitry is necessary to make them operate. Also, 75% typical efficiency is an added advantage and since this efficiency is essentially independent of input voltage, output current need not be derated with increasing input voltage. Other features include short circuit protection, remote on/off (logic inhibit) parallelability and remote sensing.

For further information contact Amtex Electronics, 36 Lisbon Street, Fairfield 2165.

Conditioners, regulators UPS

Ferguson Transformers is now able to provide a broad range of power conditioning and supply solutions, from line conditions to an uninterruptible power supply (UPS).

Three different types of line conditioners are available, with ratings from 160VA to 10kVA. Rejection ratios are greater than 120dB for frequencies up to 1MHz.

The VR series of voltage regulators provide 1% output regulation for input variations of ±15%, with sinewave output (typically 5% harmonic content). Power ratings range from 160VA to 1kVA.

The Ferguson UPS combines a ferroresonant constant voltage transformer with electronic control circuitry and a synchronous inverter. When the mains input voltage drops below 85%, the mains is disconnected and the inverter takes over. Transfer is effected in less than 10 milliseconds. Three power ratings are available 250VA, 750VA an 1kVA.

Further information from Ferguson Transformers, 7 Moorebank Avenue, Moorebank 2170.

X-ray power supplies

X-ray systems are a typical application for Spellman's high voltage power supplies using series resonant technology. High peak power up to 100kW and continuous power up to 30kW are available using resonant frequencies of 60kHz and at repetition rates above 20kHz. Typical applications include CAT scanners, radiological equipment, X-ray lithography and industrial X-ray systems. For example, Spellmans' 30kW CAT scanner power system includes a floating filament supply, emission control and built-in diagnostics.

The outstanding performance of Spellman's X-ray supplies is shown by their fast rise times in the millisecond range, fast emission loop settling times of less that 50 milliseconds and very low line component ripple of less than 0.02% p-p.

Further information from Quentron Optics, Unit 22/23, 36-38 East Street, Five Dock 2046.

Electronic loads

Kikusui of Japan now offers a complete range of seven electronically controlled loads, for the testing and calibration of DC power supplies and batteries.

The PLZ-Series and PLZ-2 Series with dual load settings, allow you to safely preset and maintain constant RESISTANCE and preset and maintain constant CURRENT. Other features include the dynamic testing of the source by switching between 2 load settings, monitoring circuitry protects the device from overload and digital displays indicate power dissipation, input current, input voltage and resistance.

Dynamic loads can be varied using the in-built oscillator (10Hz-1kHz), thereby measuring the transient response and stability of DC power supplies.

The controlled testing of rechargeable batteries and solar cells is made easy with the PLZ-Series with the presettable constant hold mode.

Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050.

Battery range

Varta Batterie Ag in Germany manufactures all types of power cells, from large capacity submarine and aircraft cells to torch batteries and miniature button cells for watches, cameras, calculators and hearing aids.

Varta produces a complete line of sophisticated batteries utilising a variety of electrochemical systems. These can be designed specifically for particular applications or general purpose use, with regard to voltage capacity and internal resistance characteristics.

Varta were pioneers in the development of Nickel Cadmium Rechargeable Batteries and are acknowledged leaders in NiCad technology. In fact, the first batteries produced by Varta were this type. The Singapore production facility produces NiCad button cells 24 hours a day, seven days a week.

For further information on the Varta range contact Adeal, 150 Buckhurst Street, South Melbourne 3205.

Standby power supply

The new SinePro standby power system from Topaz is ideal for keeping computers, PABX, key systems, control and monitoring equipment on line during power failures.

Unlike similar off-line UPS's the SinePro offers unlimited backup time, sine wave output, electrical noise suppression and simple installation.

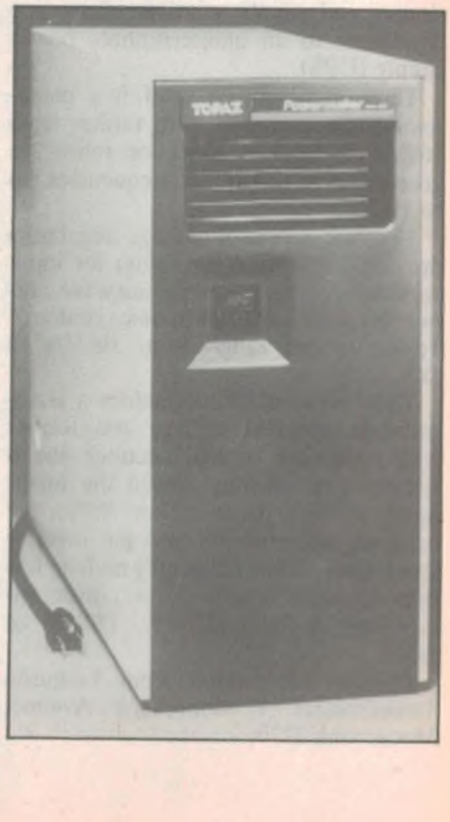
When commercial power is present the SinePro filters out electrical noise, spikes and surges. In the event of a blackout the unit instantly switches to battery and begins supplying standby sine wave power within 4 milliseconds.

Power ratings of 5000VA and 1kVA are available, with a 3 amp or 6 amp switch selectable battery charger for fast recharge of large battery packs.

The SinePro is designed to work from external batteries, a feature that allows backup time to be chosen to suit individual system needs.

Further information from Online Control, Unit 2, 7 Waltham Street, Artarmon 2064.

1.3KVA UPS



Switching power supplies

Melcher, an established producer of high quality power supplies, has complemented its product range with a small power Ibek power supplies. These comprise switching regulators and DC-DC converters for direct PCB-mounting, with an output power of 1 to 10 watts.

The wide Melcher product range, now starting at an output power of 1 watt, comprises switching regulators up to 300 watts, DC/DC converter and AC-DC converters up to 50 watts, single and multiple-output modules, with fixed or adjustable output voltage, made for extreme ambient temperatures or performance specifications, with different mounting and connecting possibilities.

For further information contact Jesec, 569 Hampton Road, Hampton 3188.

Data loss, equipment malfunction or even permanent hardware damage to mid-sized computer systems due to power failure can now be avoided economically with the just released 1.3kVA Micro uninterruptible power supply (MUPS) from Topaz.

In the event of power blackout or brownout, the Topaz 1.3kVA MUPS provides battery-backed AC sinewave power for eight minutes at full load, and 25 minutes at half load. This enables continuous operation through the majority of power interruptions and allows adequate time for orderly shutdown of equipment during longer power failures.

Power ratings of 400VA and 1kVA are also available, with full load battery back up of 35 minutes and 120 minutes respectively.

The units are attractively styled to complement the modern office, and are fitted with standard Australian GPO plug and sockets. Sealed batteries are built in.

Further information from Online Control, Unit 2, 7 Waltham Street, Artarmon 2064. EA

Supercom V3

Looking for an easy to use data communications package for your IBM PC or compatible? Australia's own award-winning package Supercom has just been upgraded into Version 3, making it even better than before. We've been trying it out . . .

Perhaps I'm a bit thick when it comes to communications software for personal computers, but frankly I've found some of them pretty hard to drive. Often they seem to be designed to do all sorts of fancy things, but nothing easily — unless you're an expert in both data comms protocols and assembly language programming.

If you just want to do simple things like grab a nominated word processing file off a disk and squirt it up the line, or vice-versa, things quite often seem to get difficult — especially if you're like me, and tend to prefer using an old-fashioned manual modem.

Whenever I tried to do this with the well-known Crosstalk package, for example, there always seemed to be some mysterious command code needed before its vast powers would be unleashed. And as usual, Murphy's Law would operate, so that very code would be the one I'd be unable to remember, not using the thing all that often. So it would sit there like a reproving kindergarten teacher, refusing to proceed until I'd wade into the manual to find the forgotten command.

All this changed sometime in 1986, when I came across a package called Supercom, developed locally by two young Aussies: Barry Hall and Steve Engel. Here at last, I found, was a comms package which was designed to be easy to drive — even if you *didn't* use it every day. It wasn't all that expensive, either, yet it offered features that packages from the US (like Crosstalk) didn't, like support for Telecom's *Viatel*.

Other people must have thought Supercom was pretty good too, including the experts. It won a coveted "Software Package of the Year" award from our sister magazine *Your Computer*, for example.

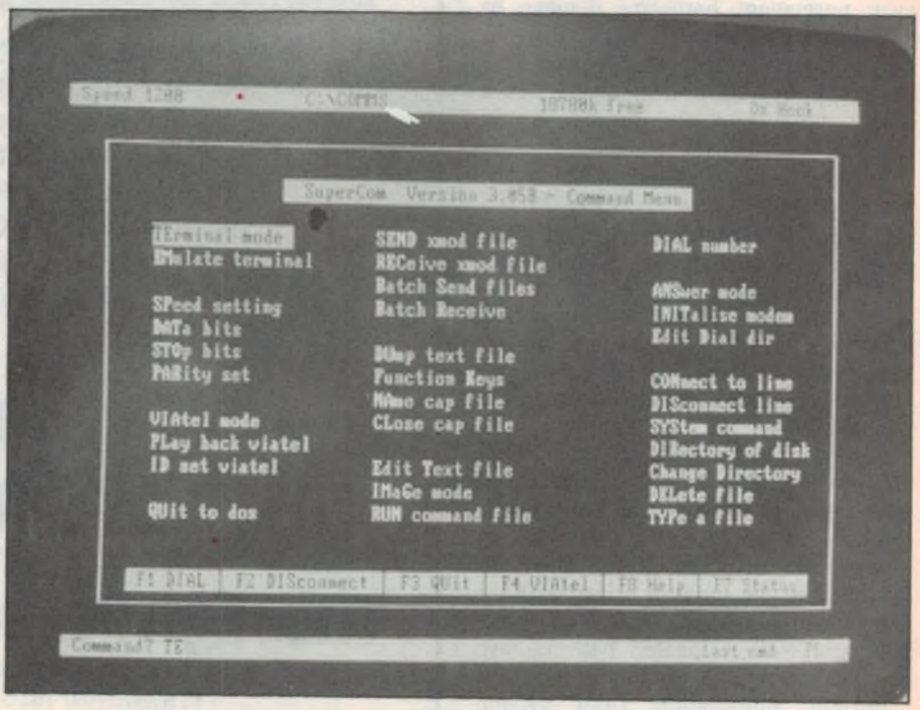
Since the launch of Supercom, Barry and Steve have apparently set up a small company in Sydney called Operating Systems Research. They've also managed to get some of the local computer makers and distributors to include Supercom in the bundled software supplied with their machines. It's good to see local enterprise getting some recognition, although I get the impression that the directors of OSR are not exactly riding around in Mercedes yet . . .

Despite this, they've been continuously improving Supercom itself. In fact Version 3 has just been released, and I've been able to try it out over the last few weeks.

It's still the basic Supercom package, but with even more emphasis on ease of use by the occasional and non-technical user. At the same time, there are even more fancy features for the experienced 'pro' user, lurking there behind Supercom 3's friendly facade.

What I like is the really easy to use Help facility, which you can call up either by hitting the F8 key, or by typing in the word HELP followed by the command you've half-forgotten. This doubles your chances, if like me you're saddled with a poor memory. I'm also delighted to see that you can now set it up to work properly with a CGA card and monochrome video monitor — one of the little hassles with earlier versions.

On the features side, Version 3 can now emulate over 40 different communications terminals. It also supports both XMODEM/MODEM7 and YMODEM (single file or batch mode) protocols for error-free transfer of files, so again you have two chances of success — apart from the even simpler approach of catching a dumped file using the "capture" facility. I use this when



Supercom's main command menu screen. From here it's easy to select a desired function, or view and modify status.

Front cover of the Supercom manual, which is well written and easy to follow.

I'm being sent files from people who don't have a computer/package with error-checking protocol, and it usually works quite well.

As before if you have a modem with autodialling (either Hayes-compatible or DTR line pulsing), it can support this very easily. I tried it out with the Bit Blitzer, for example. You can get it to set up a dialling directory, and also to "keep trying" if a number is engaged.

Basic transfer rates available are from a leisurely 75bps to a pretty blistering 38.4kbps, and Supercom also supports the Viatel 75/1200bps split baud rate (so you don't need a fancy modem that does rate conversion). It's quite easy and quick to set it up for different formats — data bits, stop bits, parity and so on.

Other features include a "Photostat" facility, to let you run MS-DOS software remotely; a script facility, for things like automatic accessing of services like Telememo; a built-in text editor; and the ability to locate Supercom itself virtually anywhere on a hard disk.

In short, it now seems to do almost everything, while still being surprisingly easy to drive. What more could you want?

Supercom 3 sells for a very reasonable RRP of $199, considerably cheaper than Crosstalk. You should be able to pick it up at most places selling PC software, or from the official distributors Logo Computer Centre, of Suite 303 Henry Lawson Business Centre, Birkenhead Point, Drummoyne 2047. Failing that, try contacting Barry or Steve of OSR, at 561 Blaxland Road, Eastwood 2122. Their phone number is (02) 85 0436. (J.R.)

Interested in joining the staff of EA?

Australia's leading electronics magazine requires a project designer/writer for its editorial staff. This position involves the design and development of hobby electronics projects, and then writing about them for the magazine.

You'll need a sound knowledge of electronics theory and practice, and lots of enthusiasm. You'll also need to be able to express yourself clearly, in writing. But apart from that, we have no preconceived ideas about your background. You might be a student, a technician, a fully qualified engineer or just a keen enthusiast.

If you believe you're the person we're looking for, ring Jim Rowe on (02) 693 6620, or send your resume to him at Electronics Australia, Federal Publishing Company, 180 Bourke Road, Alexandria 2015.

Principles of Logic Analysis — 3

This is the third of our short series of articles on the basic principles of logic analysis. Having introduced the logic analyser and the way it works, the author now discusses how it is used to acquire data from the circuit under test.

by WOLFGANG SCHUBERT

To begin the discussion this month, we will first look at the probes used to link the device under test to the logic analyser. These are of two basic kinds — universal and microprocessor specific.

Universal probes are used for general measurements in logic circuits. Four to eight channels can usually be connected via such a probe. The inputs have a high impedance (approx. 1M) and a low capacitance (approx. 2 to 5pF). The small input capacitance is particularly important for timing measurements with a high sampling rate, in order to prevent feedback to the measured signal.

In addition to the input buffers, these probes contain comparators with thresholds which can be programmed to the logic family used: a threshold range between –6V and +6V is sufficient for most measurements. The mechanical connection to the device-under-test is made using a small cable with spring-loaded sleeves which can be pushed onto wire-wrap pins or test pins, or via miniclips.

Microprocessor specific probes contain a circuit matched to a particular type of processor. This circuit converts the input signals in the same manner as the universal probe, and can also preprocess the data to be analysed. This preprocessing serves to relieve the logic analyser of some "housekeeping" functions — e.g., by demultiplexing multiplexed address and data buses. Read and write events then occupy only half the space (referred to the maximum memory size of the analyser) and a measurement can record more memory accesses of the processor.

In the case of modern microprocessors such as the Intel 8086, the preprocessing in the probe is carried out for a further reason. These processors possess internal instruction queues, in order to optimize the use of the bus. If the processor carries out a program jump, it may occur that it has already read instructions located after the jump and which are now no longer executed. With such a processor there is therefore no longer a fixed relationship between the instructions read and the actually executed program. In order to examine the program sequence using the logic analyser, the preprocessing facility in the microprocessor probe must simulate the queue in the processor and ensure that the superfluous instructions are not passed to the logic analyser.

There are also interface probes to analyse interfaces such as RS232, IEC-625/IEEE-488 bus or Ethernet. In this case the probe provides the analyser with additional signals, generated inside the probe, which provide information on how the passed-on data are to be interpreted (as data addresses etc.). In addition, the probe converts the data format of the interface into a bit-parallel representation which can be easily handled in the logic analyser.

Generation of analyser channel groups

State analysers often have a large number of channels: the 20MHz analyser of the Rohde & Schwarz LAS, for example, has 72 channels. It is clear that to simply handle these channels as 72 individual channels would not serve much of a purpose. The reasons are:

- Not all channels are required for every measurement. These channels should then be suppressed during data acquisition and evaluation in order to improve the clarity.

```
CONFIGURATION MENU
THRESHLD [ TTL]  [ TTL]  [ TTL]  [ TTL]  [ TTL]  [ TTL]
         PROBE F PROBE E PROBE D PROBE C PROBE B PROBE A
         7......07......07......07......07......07......0
LABEL CODE      |       |       |       |       |
ADR   H ........|.......|.......|.......|++++++++|++++++++
DATA  H ........|.......|.......|++++++++|.......|........
STAT  B ........|.......|++++++++|.......|.......|........
```

Fig.13: When an analyser is being configured, various lines can be defined as grouped together.

- It is meaningful to combine individual channels into groups - for example the lines of a bus.
- With the data pattern definition handled in Fig 13, just as in the state display, it is expedient to represent various channel groups in different notations such as hexadecimal, binary or ASCII.

The example in Fig.13 shows such a channel group definition for connection of a microprocessor: the 16 address lines are combined into group ADR and are displayed in hexadecimal form, the 8 lines of the data bus DATA are also displayed in hexadecimal form and the status lines STAT are displayed in binary form, because each individual line is important in this case.

Defining the clocks

The points in time at which the logic analyser accepts data from the probes are defined by a clock. There are two possibilities: an "internal clock" is where the signal for recording is obtained from a clock generator in the logic analyser. This clock generator is usually adjustable in steps of 1-2-5, which means that the sampling periods can be 100ns, 200ns, 500ns, 1us etc.

The recording produced using an internal clock is characterised by equidistant clocks, where the time between changes in signal can be determined by counting the clocks. The internal clock is therefore mainly used with timing analysers because such delay measurements are only

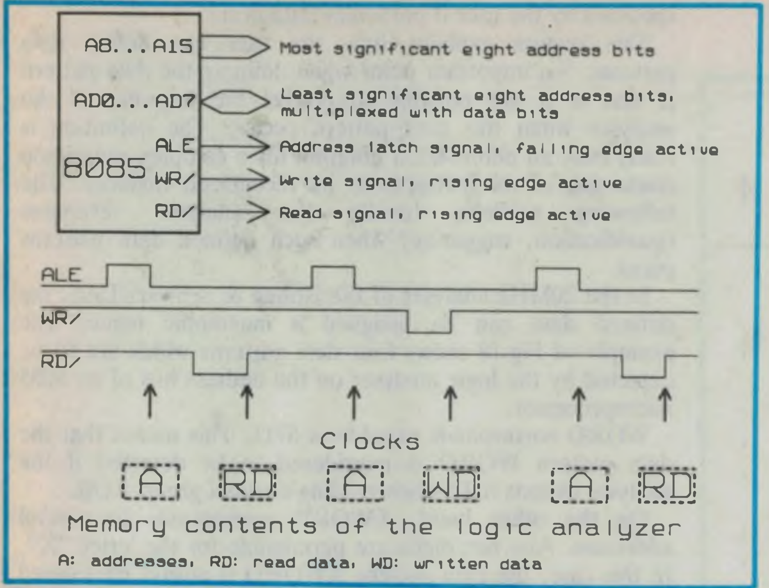


Fig.14: An example showing where multiple clocks must be used. The ALE signal must be used to clock addresses, WR/ to clock write data and RD/ to clock read data.

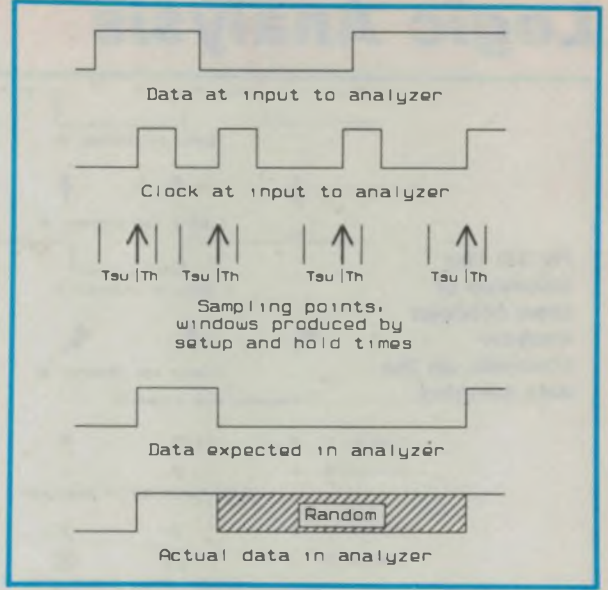


Fig.15: The influence of setup and hold times on the data sampled by the logic analyser. Both parameters can effect the actual data stored.

meaningful if the sampling rate is much higher than the frequency of the examined signals.

On the other hand, an external clock is normally used for state analysis and is directly obtained from the device-under-test using a special clock probe. It is possible to define whether the rising or falling edge is to activate the data transfer. A single external clock channel is often insufficient when analysing bus systems, because several different clocks may occur in the device-under-test which signal data transfer on the bus.

Multiple clock inputs are implemented on older analysers, in that all clock signals write the data inputs into intermediate memories, which are then read into the analyser when the so-called master clock signal occurs in parallel to the data present at this time. This method has two disadvantages:

- The analyser must have a large number of channels, because all the stored data in the intermediate memories must be transferred simultaneously when the master clock signal occurs.
- Data are lost when measuring systems where the sequence of occurrence of the various clocks is not defined if a clock occurs twice in sequence, without the master clock signal in between.

With modern analysers the data bus is scanned with each clock and the clock input responsible for storing is also recorded, in order to correctly assign the acquired data for subsequent evaluation. The above-mentioned disadvantages are then avoided.

Up to four external clocks can be connected to the 20-MHz analyser LAS from Rohde & Schwarz.

The example in Fig.14 uses a processor with multiplexed address and data buses (Intel 8085). The data probes of the analyser are connected to AD0 to AD7 and A8 to A15, and the clock probe to ALE, RD-bar and WR-bar.

Quality of data acquisition

An important measure of the quality of a logic analyser recording is the degree to which it reproduces the actual events on the analysed lines, despite the simplification of the analog input signals into level-discrete and time-discrete digital signals.

The following features are particularly important in conjunction with the clocks which transfer the data from the probe to the analyser:

Setup and Hold times: The input circuit of the logic analyser operates like a D flipflop, and therefore has setup and hold times just like a D flipflop. Within the window around the clock produced by the setup and hold times, each change in data at the inputs means that the stored logic level becomes unpredictable. It is therefore important for the setup and hold times to be as small as possible, or at least much smaller than the smallest sampling period.

The use of a small sampling period is nonsensical if this condition is not fulfilled. Changes in data are then frequently not correctly detected because they occur in the forbidden zone produced by the setup and hold times.

Setup and hold times are particularly important when using an external clock. The hold time should be zero if possible to prevent erroneous measurements resulting from a large analyser hold time when analysing fast circuits in which levels change rapidly as a reaction to the occurrence of the clock.

Skew: A further parameter is the skew between the channels which is produced by tolerances in the logic analyser components. These delay times between the channels mean that the relationships between the individual signals are no longer correctly determined. This is particularly inconvenient for measurements with an internal clock. The skew should also be much smaller than the smallest sampling period.

In the diagram of Fig.16, it has been assumed that channel B has a delay with respect to channel A, whereby a skew is produced. A small skew is important when measuring with an internal clock because it increases the setup and hold time of the individual channels, as can be seen in the example.

Detection of glitches

It is important with timing analysers to determine whether additional changes in signal have occurred between the clocks. Such changes are usually not visible in the display, because the status of the signal lines is only transferred at the clocks (sample mode).

Timing analysers therefore often contain circuits which are

Logic Analysis

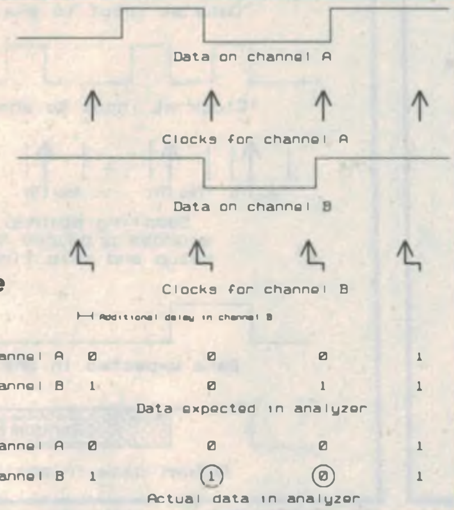


Fig.16: The influence of skew between analyser channels, on the data sampled.

able to magnify all brief changes in signal up to the next clock where they are detected (latch mode). Since this display mode cannot differentiate whether a change in signal only occurs briefly or is present for a longer period, a further operating mode (glitch mode) has been introduced for many analysers.

In glitch mode two analyser channels are connected in parallel to the same probe input. One channel is operated in latch mode, the other in sample mode. The data collected by the two channels are then compared and a marker inserted in the display at the positions where differences occur.

The disadvantages of this mode are the halving of the number of analyser channels available, and the fact that glitches occurring directly next to correct changes in level cannot be detected.

Definition of data patterns

The functions of the sequence controller will now be considered. Its contribution to data reduction during logic analysis is to permit only the data to enter the logic analyser memory which are required to provide go/nogo information.

In order to achieve this, the sequence controller must be able to differentiate between what is relevant and what is unimportant in the applied data, and to initiate actions

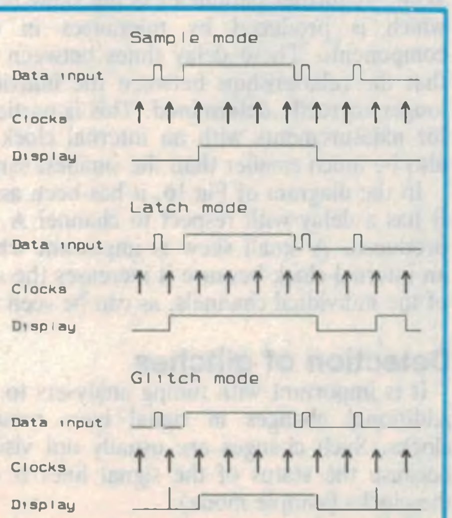


Fig.17: Display of the same data with the analyser in sample mode, latch mode and glitch mode.

specified by the user if particular data occur.

This section explains how the user can define data patterns. An important point when defining the data pattern is that it is not possible to predict the response of the analyser when this data pattern occurs. The definition is really only an abbreviated notation for a complex expression containing all bit patterns to be recognized together. The following sections handle the analyser responses (qualification, triggering) when such defined data patterns occur.

In the 20MHz analyser of the Rohde & Schwarz LAS, the defined data can be assigned a mnemonic name. The example of Fig.18 shows four data patterns which are to be detected by the logic analyser on the address bus of an 8085 microprocessor.

WORD corresponds to address 6711. This means that the data pattern WORD is considered to be detected if the analyser detects 6711 when reading channel group ADR.

On the other hand, XWORD corresponds to several addresses. Any hex digits are permissible for the letter "X". In this case, the data pattern XWORD is always considered to be detected if any address between 8000H and 8FFFH occurs.

The hexadecimal positions identified by "X" are designated as "Don't Cares" because they do not contribute towards the decision whether a data pattern has occurred or not. In the extreme case a data pattern could contain only Don't Cares; it is then always detected, irrespective of the data read in.

A further possibility of specifying a data pattern such that several different addresses satisfy it is shown by RANGE. In this case a range from 1000H to 2FFFH has been defined as the address range which satisfies the data pattern. This range definition requires a particular hardware circuit in the logic analyser which enables detection of ranges and this feature is therefore only seldom encountered.

There is one more possibility of specifying data, allowed for in the Rohde & Schwarz LAS: it is possible to define "data models", where any number of individual expressions as described above can be ORed together and result in a large number of data which all satisfy the corresponding data pattern.

In the example of Fig.18, MODEL is always detected if either an address between 1000H and 2FFFH, the address 6711H or an address between 8000H and 8FFFH occurs.

Qualification

Qualification is an aid to limit the volume of data read in. Conventional analysers have qualifier lines with a gate function for incoming data: a specific level defined by the user must be present before the data are connected to the analyser. Modern analysers can use data models, as described in the previous section for this function.

The example of Fig.20 demonstrates the effect of different qualification conditions on data recording. The device-under-test is a simple 8-bit counter. The three displays have been produced with an unqualified recording, recording with a qualifier word "8X" and recording with a qualifier word "X8".

These simple types of qualification are often no longer sufficient for measurements on processor systems. Modern analysers such as the 20MHz analyser of the LAS therefore have more extensive qualifier facilities, whose necessity will now be shown using practical examples.

In extensive program systems it often occurs that individual parts of the program exchange data via particular

```
DATAMODEL MENU
LABEL:     ADR
CODE:      H      EXT.
POL.:      ♦      CLOCK
-------------------------
WORD       ▮ 6711

XWORD        8XXX

RANGE        1000
             ::::
             2FFF

MODEL        6711
             8XXX
             1000
             ::::
             2FFF
```

Fig.18: Four sample data patterns, showing how they can be assigned names.

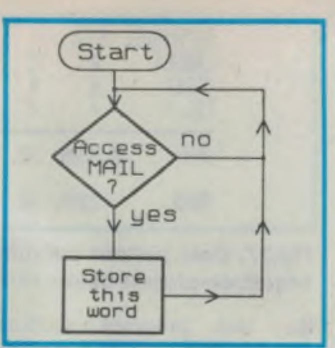


Fig.19: A typical qualification sequence, where data is stored only when MAIL is accessed.

LABEL CODE	COUNT H	CLOCK	TIME DIFF	S L	S Q
♦ 119	77	CLK0	_ 300ns	0	0
♦ 120	78	CLK0	_ 300ns	0	0
♦ 121	79	CLK0	_ 300ns	0	0
♦ 122	7A	CLK0	_ 300ns	0	0
♦ 123	7B	CLK0	_ 300ns	0	0
♦ 124	7C	CLK0	_ 300ns	0	0
♦ 125	7D	CLK0	_ 300ns	0	0
♦ 126	7E	CLK0	_ 300ns	0	0
♦ 127	7F	CLK0	_ 300ns	0	0
[illegible]	80	CLK0	_ 300ns	0	0
♦ 129	81	CLK0	_ 300ns	0	0
♦ 130	82	CLK0	_ 300ns	0	0
♦ 131	83	CLK0	_ 300ns	0	0
♦ 132	84	CLK0	_ 300ns	0	0
♦ 133	85	CLK0	_ 300ns	0	0
♦ 134	86	CLK0	_ 300ns	0	0
♦ 135	87	CLK0	_ 300ns	0	0
♦ 136	88	CLK0	_ 300ns	0	0

LABEL CODE	COUNT H	CLOCK	TIME DIFF	S L	S Q
♦ 120	87	CLK0	_ 400ns	0	1
♦ 121	88	CLK0	_ 300ns	0	1
♦ 122	89	CLK0	_ 300ns	0	1
♦ 123	8A	CLK0	_ 300ns	0	1
♦ 124	8B	CLK0	_ 300ns	0	1
♦ 125	8C	CLK0	_ 300ns	0	1
♦ 126	8D	CLK0	_ 300ns	0	1
♦ 127	8E	CLK0	_ 300ns	0	1
♦ 128	8F	CLK0	_ 300ns	0	1
[illegible]	80	CLK0	_ 72.5us	0	1
♦ 130	81	CLK0	_ 300ns	0	1
♦ 131	82	CLK0	_ 300ns	0	1
♦ 132	83	CLK0	_ 300ns	0	1
♦ 133	84	CLK0	_ 300ns	0	1
♦ 134	85	CLK0	_ 300ns	0	1
♦ 135	86	CLK0	_ 300ns	0	1
♦ 136	87	CLK0	_ 300ns	0	1
♦ 137	88	CLK0	_ 300ns	0	1

LABEL CODE	COUNT H	CLOCK	TIME DIFF	S L	S Q
♦ 128_	F8	CLK0	_ 4.8us	0	1
♦ 129_	08	CLK0	_ 4.8us	0	1
♦ 130_	18	CLK0	_ 4.8us	0	1
♦ 131_	28	CLK0	_ 4.9us	0	1
♦ 132_	38	CLK0	_ 4.8us	0	1
♦ 133_	48	CLK0	_ 4.8us	0	1
♦ 134_	58	CLK0	_ 4.8us	0	1
♦ 135_	68	CLK0	_ 4.8us	0	1
♦ 136_	78	CLK0	_ 4.8us	0	1
[illegible]	88	CLK0	_ 4.9us	0	1
♦ 138_	98	CLK0	_ 4.8us	0	1
♦ 139_	A8	CLK0	_ 4.8us	0	1
♦ 140_	B8	CLK0	_ 4.8us	0	1
♦ 141_	C8	CLK0	_ 4.8us	0	1
♦ 142_	D8	CLK0	_ 4.8us	0	1
♦ 143_	E8	CLK0	_ 4.9us	0	1
♦ 144_	F8	CLK0	_ 4.8us	0	1
♦ 145_	08	CLK0	_ 4.8us	0	1

Fig.20: An unqualified recording (left) compared with recordings using the qualifier words MAIL=8X (centre) and MAIL=X8 (right).

memory areas (mailboxes).

Assume that program PRO1 communicates with program PRO2 by writing a byte into the memory cell MAIL, which is to be subsequently read by PRO2. If this data transfer is to be monitored to establish whether PRO2 fetches every byte provided by PRO1, a qualification condition must be set such that only reads and writes are recorded from or to MAIL, although problems occur if other programs also require MAIL for other purposes in between: it would be necessary at the end of a measurement to laboriously examine the data stored by the analyser for memory accesses of interest.

In the case of sequential qualification, it is possible to constantly change qualification condition during the measurement and to thus eliminate unrequired data. In the previous case the qualification facility is programmed such that the write events to MAIL are only acquired between the start of PRO1 (BPRO1) and the end of PRO1 (EPRO1). The same applies in an analogous manner to the read events and PRO2.

In this manner all write events to MAIL outside the program PRO1 as well as all read events from MAIL outside the program PRO2 do not reach the memory of the logic analyser, and therefore do not need to be suppressed during evaluation. This is a good example of data reduction already during acquisition: effective reduction during data acquisition results in simplified reduction during data evaluation.

A further problem arises if it is necessary to establish the point from which a jump to the subroutine is made. Example: non-meaningful characters are sometimes output on a computer monitor. It is now necessary to extract all program points which jump to the monitor output routine. The problem is that the information to be extracted is present prior to the only known qualification feature, namely the entry into the output routine.

This problem can be solved using retroactive qualification. The PRESTORE instruction can be used to store data which actually already belong to the past. It is possible to subsequently store previous data because the analyser first stores the acquired data in an intermediate memory before transferring them to the main memory.

Triggering

The trigger is an event, defined by the user in the data stream to be analysed, which initiates the final phase of the measurement. The analyser has usually recorded continuously up to this point. The measurement is immediately stopped (or stopped after a presettable number of clocks) when the trigger occurs.

An immediate stop of the measurements is referred to as *pretrigger*, because all the data contained in the memory have been read in before the trigger occurred. If the user has specified the trigger delay (posttrigger counter) such that the complete memory is filled by data following the trigger, this is referred to as *posttrigger*, because only data following the trigger can be displayed.

The trigger can also be selected at any point between these two limits, by setting the posttrigger counter accordingly. Pretrigger is useful if a faulty condition is defined as the trigger, and the events leading up to this fault are to be examined. Posttrigger enables the response of the device-under-test to the trigger event to be examined.

Specific examples will now be used to show that simply triggering with one trigger word is insufficient for many measurements, and that more extensive possibilities are possible using advanced analysers.

It may be necessary to trigger if a signal changes polarity. This is not difficult if the signal has one polarity when the measurement is started, and assumes the other polarity for the first time at the point of triggering.

Difficulties exist if the signal at the beginning of the measurement already has the level which is to lead to triggering, because the analyser would already trigger in this case when the start key is pressed. This problem can no longer be solved using a simple trigger word; in a manner similar to the change of qualification condition for sequential qualification, the trigger condition must be changed during the measurement. This is an application for sequential triggering.

In the case of sequential triggering, the user can specify several trigger words which must occur in a specific sequence. The actual trigger (i.e., starting of the posttrigger counter which, having run down, stops the measurement) only takes place in this case with the last trigger word. The first word is referred to as the ARM word, in the case of sequential triggering with two words; the second word is the actual trigger word.

In the considered case, the ARM word has been defined such that it occurs when the line in question changes level for the first time. The actual trigger word only then becomes effective and triggering takes place correctly when the level changes for the second time. There are usually far more than two trigger levels in the case of state analysers (with the 20MHz analyser of the LAS, there are eight levels).

An additional trigger feature is the restart facility with sequential triggering. This facility can always be used if the sequential trigger is to be terminated and restarted. This can be explained using a simple example: in the example with

Logic Analysis

```
SELECTOR MENU

LEVEL  DELAY                IF CONDITION              COMMAND

0.01                        IF    MAIL                STORE WORD
END.
```

Fig.21: Qualifier setting in the LAS analyser's selector menu, with MAIL as the qualifier word.

```
SELECTOR MENU

LEVEL  DELAY              IF CONDITION                COMMAND

0.01                      IF    BPRO1                 GOTO 1
1.01                      IF    MAIL  &  WRITE        STORE WORD
                                                      GOTO 2
2.01                      IF    EPRO1                 GOTO 3
3.01                      IF    BPRO2                 GOTO 4
4.01                      IF    MAIL  &  READ         STORE WORD
                                                      GOTO 5
5.01                      IF    EPRO2                 GOTO 0
END.
```

Fig.22: Another example of setting various qualifiers and responses, again from the selector menu.

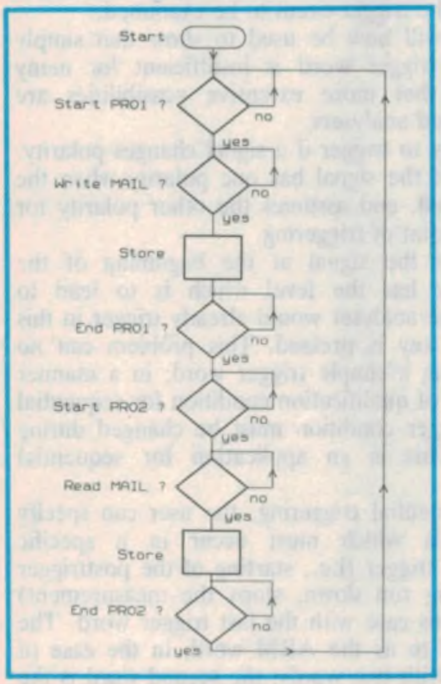


Fig.23: A flowchart showing sequential qualification and how it is used to control analyser action.

```
SEQUENCER  MENU
START CONDITION: TRACE ALL                 POST TRIGGER: 0500

LEVEL  DELAY          IF CONDITION         COMMAND

0.01                  IF     TRIG          TRIGGER
END.
```

Fig.24: Setting a simple triggering condition. When the data word TRIG occurs, the analyser is triggered.

```
DATAMODEL MENU
LABEL:     A      C    D    E    F
CODE:      H      H    H    H    B           EXT.
POL.:      +      +    +    +    +           CLOCK

ARM       XXXX   XX   XX   XX   XXXXXXX0

TRIG      XXXX   XX   XX   XX   XXXXXXX1
```

Fig.27: Data pattern definition for the ARM/trigger sequence shown below in Fig.26.

the two program sections PRO1 and PRO2 which communicate via the memory cell MAIL (see Fig.21), say that a fault occurs such that the memory cell is written more often than it is read and data are therefore lost. Because this takes place at irregular intervals, it is meaningful to trigger whenever the memory cell is written without previously having been read.

This is achieved in the following manner (Fig.29): if the cell is written, the trigger sequence branches to the second trigger sequence level designated 1.00, and waits for the second write event. Triggering takes place if this write event takes place. If a read event occurs first, however, the trigger is reset to the basic level and waits for the next write event.

In the last example the case occurred for the first time that several data words are present at one trigger level, which lead to different responses on part of the analyser. This is referred to as parallel monitoring. In the 20MHz analyzer of the LAS, almost unlimited parallel monitoring can take place in the trigger sequence (sequencer) as well as in the completely separate qualification sequence (selector).

An example is illustrated in Fig.31, where three different errors may occur in a computer system which are to be handled in different manners. Triggering is to take place immediately if ERR1 occurs. ERR2 is recoverable error; nothing is to take place if RSTRT occurs within 100 clocks,

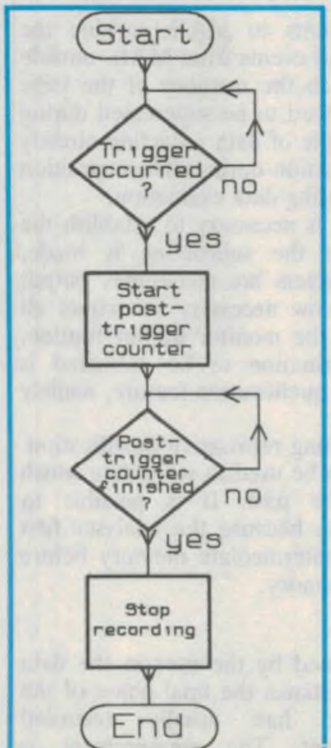


Fig.25: A trigger sequence with a post-trigger counter.

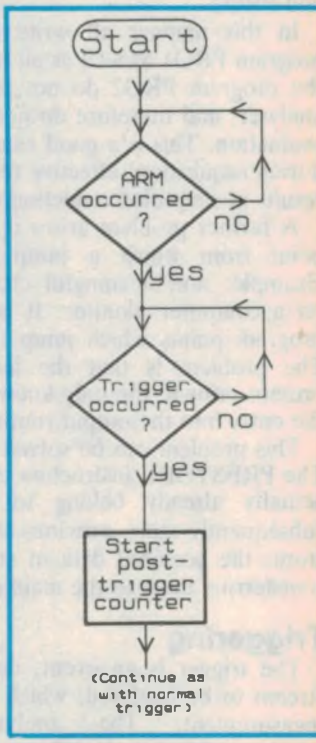


Fig.26: An ARM/trigger sequence, illustrated by a flowchart.

```
SEQUENCER  MENU

START CONDITION: TRACE ALL                              POST TRIGGER: 0500

LEVEL  DELAY                IF CONDITION                COMMAND

0.01                        IF    ARM                   GOTO 1

1.01                        IF    TRIG                  TRIGGER
END.
```

Fig.28: (Above) The sequencer settings for the ARM/trigger sequence of Figs. 26 and 27.

otherwise triggering must take place. ERR3 is to lead to triggering after 50 clocks. All three error conditions must be monitored simultaneously, since it is not known which error will occur first. This monitoring is effected at the first trigger level.

It is of course also possible to specify the data patterns with parallel monitoring, such that several of them occur simultaneously. To ensure that no contradictory instructions are produced in such a case, the parallel monitoring sequence also contains an "order of priority": the instruction assigned to the uppermost condition which has occurred is executed.

In the example of Fig.32, this would mean that the action specified for ERR1, i.e. immediate triggering, would be carried out if ERR1 and ERR3 occur simultaneously.

A further feature of intelligent state analysers, i.e. the free programmability of the trigger sequence, has been used in this case. This means that the trigger can no longer only jump from one trigger level to the next — or to the first level in the event of a restart — but can jump from any level to any other level. This feature is used if ERR3 occurs and with the subsequent jump from level 0 to level 2.

Start/stop recording

With many measurements it is disadvantageous that the previously explained qualification and trigger features can

```
SEQUENCER  MENU

START CONDITION: TRACE ALL                       POST TRIGGER: 0500

LEVEL  DELAY            IF CONDITION             COMMAND

0.01                    IF    MAIL  &  WRITE     GOTO 1

1.01                    IF    MAIL  &  WRITE     TRIGGER
1.02                    IF    MAIL  &  READ      GOTO 0
END.
```

Fig.29: (Above) A trigger sequence with restart (jump from 1.02 to 0.01)

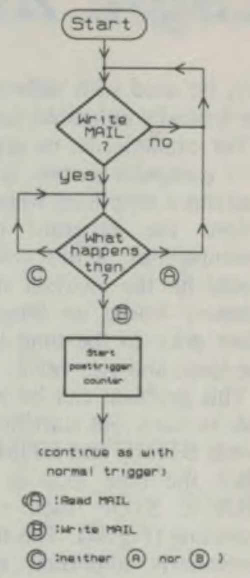


Fig.30: (Right) Flowchart of the trigger sequence with restart, as shown in Fig.29.

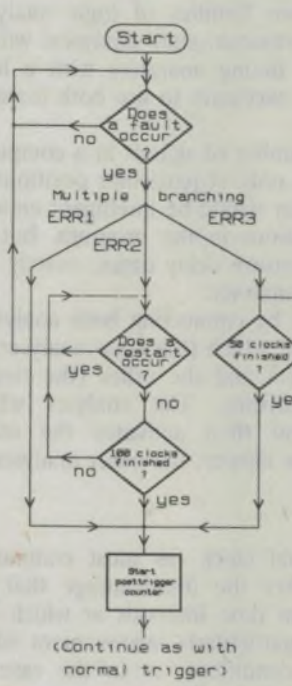


Fig.31: Multiple branching with parallel monitoring. Here three different kinds of error can occur in a computer system.

```
SEQUENCER  MENU

START CONDITION: TRACE ALL                       POST TRIGGER: 0500

LEVEL  DELAY                IF CONDITION         COMMAND

0.01                        IF    ERR1           TRIGGER
0.02                        IF    ERR2           GOTO 1
0.03                        IF    ERR3           GOTO 2

1.01                        IF    RSTRT          GOTO 0
1.02   AFTER 0100 CLOCKS                         TRIGGER

2.01   AFTER 0050 CLOCKS                         TRIGGER
END.
```

Fig.32: Programming of the sequencer for the parallel monitoring example shown in Fig.31, above right.

Logic Analysis

only be used with difficulty to suppress completely parts of the basically unlimited data stream.

For example, let us say that the execution of a subroutine in a computer system is to be monitored. This subroutine contains a time loop which is executed several hundred times before the program continues further. It would be advantageous in this case to not record this loop, since it would fill the analyser memory to such an extent that the memory would no longer contain the events which took place prior to the time loop, in the case of triggering after the loop, and vice versa.

This problem can be easily solved if the logic analyser is able to carry out start/stop recordings. Assume that the data words BTIME and ETIME are defined (Fig.33), which occur when the time loop is entered and left. The instruction TRACE STOP then stops and TRACE ALL restarts recording (Fig.34). The timing facilities described shortly are particularly important during start/stop mode to obtain information on the stop time.

Master/slave operation

As described previously, two families of logic analyser have been developed for cost reasons: state analysers with a high trigger intelligence, and timing analysers with a high sampling rate. It is sometimes necessary to use both features simultaneously.

Example: the timing of a number of signals in a computer system is to be examined, but only at particular positions in the sequence. The state analyser would be intelligent enough to trigger at the correct positions in the program, but its sampling rate is too low to measure delay times; exactly the opposite applies to the timing analyser.

This problem can be solved by connecting both analysers to the device-under-test, one of which (the state analyser) is responsible for trigger detection and the other (the timing analyser) for the actual recording. The analyser which detects the trigger point and then activates the other analyser(s) is referred to as the master, the other analyser(s) as slaves.

Timing facilities

Recordings using an external clock (as most commonly used with state analysers) have the disadvantage that no information is obtained on the time intervals at which the stored data occurred. This is particularly inconvenient when recording using qualification conditions, or in the case of start/stop recordings, because time differences may occur between individual items of data in the memory in such cases which may differ by many powers of ten.

Timing options — such as the LAS-B5 for the Logic Analysis System from Rohde & Schwarz — can be used to solve such problems. Such timing options contain nothing more than additional data channels to the analyser, in which the contents of a timer are stored in parallel to the data from the device-under-test stored by the analyser. This timing information for each stored data word can then be processed and displayed together with the evaluation. This is illustrated in Fig.36.

In the last of these articles we will look at the way data recorded by the logic analyser is evaluated.

(Published by courtesy Rohde & Schwarz, of Munich, West Germany, and Rohde & Schwarz Australia, 13 Wentworth Avenue, Darlinghurst NSW 2010.)

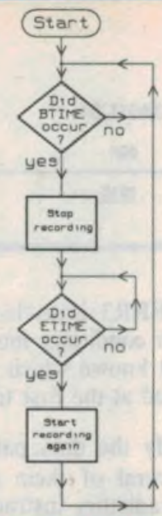


Fig.33: Flow chart showing a sequence of start/stop data recording, using the data words BTIME and ETIME to initiate starting and stopping respectively.

```
SEQUENCER  MENU

START CONDITION: TRACE ALL                     POST TRIGGER: 0500

LEVEL  DELAY              IF CONDITION          COMMAND

0.01                      IF   BTIME            TRACE STOP
                                                GOTO 1

1.01                      IF   ETIME            TRACE ALL
                                                GOTO 0
END.
```

Fig.34: (Above) Sequencer setting for the start/stop data recording example shown in Fig.33.

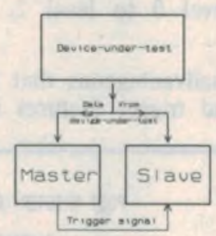


Fig.35: (Left) Master/slave operation of two logic analysers, with the master triggering the slave.

LABEL CODE	Z H	D B	CLOCK	TIME DIFF	S L	S Q
+ 6	7A	00101000	CLK0	_ 300ns	0	1
+ 7	88	01000010	CLK0	_ 4.2us	0	2
+ 8	89	01000001	CLK0	_ 300ns	0	1
+ 9	8A	00101000	CLK0	_ 300ns	0	1
+ 10	98	01000010	CLK0	_ 4.2us	0	2
+ 11	99	01000001	CLK0	_ 300ns	0	1
+ 12	9A	00101000	CLK0	_ 300ns	0	1
+ 13	A8	01000010	CLK0	_ 4.2us	0	2
+ 14	A9	01000001	CLK0	_ 300ns	0	1
+ 15	AA	00101000	CLK0	_ 300ns	0	1
+ 16	B8	01000010	CLK0	_ 4.3us	0	2
+ 17	B9	01000001	CLK0	_ 300ns	0	1
+ 18	BA	00101000	CLK0	_ 300ns	0	1
+ 19	C8	01000010	CLK0	_ 4.2us	0	2
+ 20	C9	01000001	CLK0	_ 300ns	0	1
+ 21	CA	00101000	CLK0	_ 300ns	0	1
+ 22	D8	01000010	CLK0	_ 4.2us	0	2
+ 23	D9	01000001	CLK0	_ 300ns	0	1

Fig.36: Timer information stored and displayed along with the captured data, in the TIME DIFF column.

Information centre

Tele-link modem

I am very interested in building the Tele-Link direct connect modem described in your October 1987 issue.

Can you give details where to find the parts, PCB etc., or can you advise a firm who is selling a full kit? Have you an approximate cost?

Thanks in anticipation. (R.J., Springwood Qld)

• ***The printed circuit board and front panel can be bought from RCS Radio, and the MAX-232 IC is available from Geoff Wood Electronics, both of whom advertise regularly. All the other parts are readily available from most electronics stores (e.g., Dick Smith Electronics or Jaycar).***

The cost of the unit will depend on the source of parts, but can be expected to lie somewhere in the vicinity of $120-$130.

Faulty readout

I constructed the Digital Readout for Shortwave Receivers (October 1982) and it worked perfectly except for one thing. One segment on the second last digit lights up when it shouldn't.

A "3" becomes a "9", a "0" becomes an "8", and a "2" becomes a backwards "9".

Can you suggest what is wrong, and how I can fix it? (P.S., Griffith NSW)

• ***From your description, it would appear that the "f" and "g" segments of the troublesome display have become shorted together at some point.***

We suggest that you check for solder bridges between pins 14 and 15 of IC10, pins 9 and 10 of the problematic 7-segment display, and also between the tracks where the two boards are soldered together. It may be useful to use a magnifier foi this, as even a very thin sliver of solder can carry enough current to cause problems.

Inverter problem

I would very much appreciate it if you could help me with a problem with the 12V to 230V Inverter project from EA September 1985. I built it up from scratch, which was a bit of a hassle.

The problem is that the current overload LED comes on, and the output voltage is low; also the TIP3055 drivers and the output transistors overheat. I have used 2N3772's instead of 2N3771's.

Also I would like to operate the inverter on a 24V supply. Could I change the way the transformer is wired, so that instead of connecting the low voltage taps in parallel to give a 10-0-10 volt configuration they are connected in series for 20-0-20 volt? In addition a 12V voltage regulator would be used for the PCB supply. Would that be a satisfactory way to convert to 24V?

Can you tell me of a source of kits for the Energy Monitor described in EA January 1984? I run my house lights from a wind generator, solar panel, battery bank and inverter system and I would like to measure how much power is obtained from natural energy.

I have been buying your magazine since 1981 and think it is great. In fact, I have a copy of nearly every issue since 1970. (J.W., Clare SA)

• ***It would appear that the 2N3772 transistors which you have used are not up to the job which they are being called upon to perform. Although both the '3771 and '3772 devices have the same power rating, the '3772 is not rated for as high a current as the '3771. Since the gain of any transistor falls with rising collector current, the '3772 is operating closer to its maximum than would the '3771. This means that the final transistors may not be fully turning on, resulting in the low voltage and overheating problems of which you speak.***

The current overload LED illuminating could indicate that the wire used for R1 was either too long or of the incorrect gauge. If this is the case, it may not be possible to compensate for the effect using VR2.

While it certainly seems feasible to connect each pair of windings in series for 24V applications, other

circuit modifications will almost certainly be required. Please note that we are not in a position to offer assistance with project modifications as we have not tested them in the lab.

We do not know of a source of kits for the Energy Monitor, however the printed circuit boards are available from RCS Radio, 651 Forest Road, Bexley NSW 2207.

Old radio design

From the brief detail following, could you possibly identify a short wave radio as published in Radio & Hobbies about the 1950's I believe.

It is an 8 valve set, with the following values: X61M (coated), 6G8G, 6J7G, 6V6G, 5Y3G, 6SN7GT, 6BY7 and one unknown. The set uses plug in coils for aerial, RF and oscillation.

As the set has been unused for some years I would like to see it back in service, so if identification is possible I would appreciate a photostat of the article describing the building of same.

Please let me know the costs involved in photostats and I will send my remittance. (B.G., Mentone, Vic)

• It's not easy to identify the design of your set. We can find circuits with similar valve lineups, but the plug-in coils have thrown us. It could be that your set is a custom-modified version of the Dual-Wave Super 8 as published in the June 1949 edition, but it's hard to be sure.

Photostat copies of articles are available from this office at $4.50 per project. For full details see the Reader Services section at the rear of the magazine.

100W amplifier

I have just completed building the 100 watt Playmaster amplifier first described in the January 1985 edition. This was not built from a kit, but all parts are as per instructions. All voltages seem to be OK, power supply and CMOS switches all OK as well. I have checked all component values, orientation PC board tracks several times.

My problem appears at the collectors of Q10 and Q11, as per the past two circuit diagrams. The voltage I get here is –9V. I am able to reduce this to –5V, with the 500 ohm trimpot at the collector of Q11. This indicates to me that the BF470 is not switching on. My bias voltage is 0.6V which corresponds with the circuit diagram and I have substituted for both Q11 and Q10 to no avail.

I wonder if there were any notes of errata, or errors in this design. If not, do you have any suggestions. These would be most appreciated. The problem lies in both channels. (G.B., Christchurch NZ)

• The problem you are experiencing with the output stage is most easily tracked down by measurement and analysis of all the voltages around the circuit.

A level of –9 volts at the collectors of Q10 and Q11 should be coupled to the output terminals by the power MOSFETs. This would then be applied via the 32k resistor as negative feedback to the base of Q7, thus turning it on and rebalancing the circuit. Obviously this loop is broken at some point, which will be indicated by the quiescent voltages around the circuit.

Transistor Q11 is arranged (basically) as a constant current source of around 10mA, which will show as a 1 volt drop across its emitter resistor. If this is not

occurring, re-check Q1 and its orientation in the PCB.

Also check for a short-circuit at the output terminals (perhaps RL1?), for this would damage the output MOSFETs and again break the feedback loop. In this condition the collectors of Q10 and Q11 would "drive" to plus or minus 9 volts, as limited by the zener diodes.

Rally Computer

I have built the Rally Computer, described in EA June/July 1985. I have a Hilux 4-wheel drive, with a pulse pickup of two magnets and a wheel code of 24340. The unit functions well, but has a fault.

When you approach the speed of 105kph the counter slows and as you reach 110kph the unit stops counting. When you slow down it resumes counting.

I have tried various methods of overcoming this, but to no avail. I have shifted the magnets, I have replaced the magnets. I have also altered various values of capacitor in the input side, to try to discharge the capacitor in case the counter was not counting the pulses. In fact the unit functions with the capacitor removed. The capacitor I am talking about is the .001uF in the RC network near the diode, on the sensor.

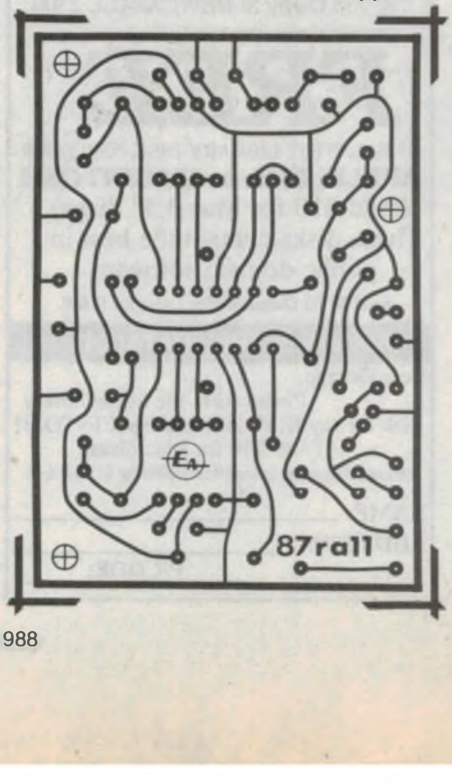
I am now at a loss to know what to do and would appreciate your help. (D.B., Armadale WA)

• The problem with your Rally Computer seems to be related to the time constants in the distance sensing input. Since you have tried altering the 0.001uF capacitor, we suggest that you try reducing the value of the 0.01uF capacitor connected to the collector of Q2. It would appear that this is the weak link in the chain, as its time constant (0.56ms) is longer than the RC network on the base (0.21ms). A value of 5.6nF or 6.8nF (5600pF or 6800pF) should remedy the problem.

Notes & Errata

AC/DC MILLIVOLTMETER (December 1987, File: 7/M/71): The transistor Q1 is shown on the circuit diagram as a BC557, while the parts list specifies a BC558. Either type is available, although we used a BC557.

UNIVERSAL VOICE OPERATED RELAY (November 1987, File: 1/RA/11): The values of resistors R10 and R12 have been interchanged on the circuit diagram, as have R9 and R11. Thus R9 is 82k, R10 is 68k, and R11 and R12 are both 100k. The resistor numbers on the PCB overlay correspond to these correct values. Also, a track disappeared from the PCB artwork between the making of the prototype and the printing of the magazine. The correct artwork is printed here.



TV COLOUR BAR GENERATOR (October 1987, File: 6/MS/21): Resistor R10 is 33k as shown in the circuit schematic, not 36k as implied by the parts list. Also the five ceramic bypass capacitors listed in the parts list as 0.01uF should be 0.02uF.

Also, D2 on the circuit diagram is around the wrong way. The orientation on the component overlay is correct.

JOGGER LOGGER (December 1987, File: 3/MS/133): The 74C926 counter IC has a maximum supply voltage rating of 6V. For maximum reliability and longest operational life, the supply voltage for this project should therefore be reduced to this figure. We suggest either replacing the 9V battery with say four type "AAA" cells in series, or retaining the 9V battery and wiring a 3.3V 400mW zener diode in series (with polarity such that it drops 3V).

THEVENIN-NORTON STORY (December 1987): On page 103, third column, in the fifth line from the bottom the word in italics should be *equivalent*. On page 105, first column and midway down, the expression given for impedance should read

Z=SQRT[r^2 + $(X_C - X_L)^2$]

Also the expressions given lower in the same column for Ohm's Law should read:

$v_R = i_R$ $v_L = -L\, di_L/dt$

$i_C = C\, dv_C/dt$ $v_C = (1/C)$. Integral (i_C)

PRE-PAK electronics – a major distributor for Arista products

• Catalogue numbers are in alphabetical and numerical order • Most items ex-stock! • 24 hour mail order service

CAT NO	PAGE	PRICE
828	88	$13.15
832	88	$6.30
256D	93	$424.85
3AG.BOX	18	$16.40
3AG.SBP	18	$2.10
3C2Y	22	$49.03
3S8.BOX	18	$67.41
3S8.SBP	18	$9.12
4LR44	20	$4.76
4SR44	20	$12.24
5C2Y	22	$71.29
5C2Y200	22	$14.75
5CAS	22	$61.42
A0144	33	$0.00
A2000	33	$0.00
A2155	33	$8.75
A2156	33	$14.90
A2840	33	$5.40
A2851	33	$6.10
A6672	33	$14.90
AA1	70	$39.40
AA10	70	$36.26
AA4	70	$78.50
AAR2	73	$123.55
AB1	61	$3.70
AB2	61	$4.25
AB3	61	$8.50
AB5	61	$19.45
AC26	12	$0.35
AC32	12	$0.40
AC34	12	$0.45
AC55	12	$0.80
AC65	12	$0.45
ACA1	38	$26.52
ACA2	38	$37.24
ACA3	38	$35.30
ACP2	65	$162.54
ACP3	65	$252.00
ACS1	62	$2.70
AL100	79	$4.65
AL100L	79	$7.05
AL101	79	$5.40
AL102	79	$5.70
AL102L	79	$6.30
AL103	79	$5.70
AL103L	79	$9.70
AL104	79	$5.65
AL105	79	$8.20
AL105A	79	$7.55
AL106	79	$4.45
AL107	79	$3.35
AL108	79	$2.30
AL111	79	$3.30
AL116	79	$2.45
AL116L	79	$3.30
AL118	80	$2.55
AL129	80	$3.30
AL130	80	$3.80
AL131	80	$3.80
AL132	80	$3.80
AL133	80	$3.35
AL134	80	$3.35
AL137	80	$3.60
AL141	80	$2.75
AL142	80	$3.75
AL142L	80	$4.70
AL148	80	$3.35
AL149	80	$3.45
AL150	80	$3.35
AL150L	80	$4.45
AL151	80	$2.60
AL152	80	$3.70
AL152L	80	$4.35
AL160	80	$3.60
AL161	80	$3.35
AL162	80	$5.45
AL163	80	$3.95
AL164	80	$3.10
ALK142	79	$36.30
AR30	40	$7.50
ARC1	87	$3.90
ASA1	70	$87.85
ASG839	87	$14.52
AST12	88	$2.30
AST25	88	$2.30
AST50	78	$2.40
ASW80	53	$63.82
AT12	67	$3.90
AT18	67	$3.90
AT20	67	$8.10
AT3	67	$3.90
AT6	67	$3.90
ATS1	62	$3.85
AVS11	74	$69.95
AW1	24	$35.07

CAT NO	PAGE	PRICE
AW2	24	$50.92
AW3	24	$91.77
AXR311	8	$5.25
AXR312	8	$4.80
AXR331	8	$6.40
AXR332	8	$4.20
AXR411	8	$11.45
AXR412	8	$5.40
AXR431	8	$10.90
AXR432	8	$4.50
AXRT5	8	$4.10
BA1	102	$22.50
BA125	60	$499.46
BA2	102	$20.95
BC120	64	$11.25
BC300	64	$11.85
BC450	64	$13.96
BC800	21	$9.90
BH21	15	$1.50
BH22	15	$1.20
BH23	15	$0.45
BH41	15	$1.55
BH41D	15	$4.55
BH41L	15	$1.90
BH42	15	$1.40
BH43	15	$0.75
BH43L	15	$0.75
BH63	15	$1.00
BH83	15	$1.50
BKS1	62	$7.95
BKS2	62	$8.50
BKS3	62	$11.45
BKS4	62	$9.65
BKS5	62	$8.30
BKS6	62	$5.35
BNC1	10	$1.95
BNC1ST	10	$2.35
BNC1TT	10	$2.80
BNC2	10	$1.75
BNC3	10	$5.60
BNC4	10	$3.75
BP2	12	$0.65
BP4	12	$0.60
BP4L	12	$0.80
BP4M	12	$1.75
BS2	12	$0.00
BS216	15	$0.25
BS216A	15	$0.35
BS216B	15	$0.25
BS216C	15	$0.40
BS4	12	$0.45
BS4A	12	$0.65
BS4M	12	$0.80
BSC2	23	$31.60
BSC3	23	$47.88
BT300	78	$11.80
BW2	25	$19.95
C25	5	$0.70
C35	5	$0.70
C65	5	$0.95
C65M	5	$2.20
CA1	38	$6.59
CA10	38	$10.95
CA11	39	$29.85
CA12	39	$34.50
CA1HC	38	$8.97
CA2	38	$13.35
CA20	37	$69.90
CA24	37	$13.55
CA28	40	$11.98
CA29	36	$25.40
CA3	38	$7.84
CA30	36	$18.28
CA31	37	$23.85
CA32	37	$25.90
CA4	38	$6.93
CA5	38	$12.44
CA6	38	$11.80
CA7	38	$8.52
CA9	38	$10.80
CAB1	39	$6.75
CAB2	39	$15.80
CAE144	39	$6.20
CAE24	39	$3.50
CAE48	39	$4.05
CAE6	39	$2.80
CAP1	12	$0.75
CAP12	16	$5.20
CAP1200	36	$19.35
CAP2	12	$1.80
CAP5	12	$1.90
CAP800	36	$12.60
CAP800P	36	$16.65
CAS1	91	$21.50
CAS10	92	$29.90

CAT NO	PAGE	PRICE
CAS11	92	$13.35
CAS13	53	$13.10
CAS15	93	$83.26
CAS16	93	$89.66
CAS18	92	$79.15
CAS19	92	$104.30
CAS4	91	$13.35
CAS5	91	$24.70
CAS6	91	$19.90
CAS7	91	$23.05
CAS8	92	$12.45
CAS9	92	$12.75
CBA1	53	$2.25
CBA12	41	$89.00
CBA14	41	$149.00
CBA2	41	$3.20
CBA20	41	$199.75
CBA4	41	$12.50
CBA6	41	$59.50
CBA8	41	$38.25
CC1	102	$2.50
CC103	18	$5.82
CC106	18	$6.84
CC107	18	$7.08
CC108	18	$10.20
CC3	18	$1.10
CC6	18	$1.80
CC7	18	$1.90
CC8	18	$2.30
CD10	86	$9.95
CD2	86	$15.40
CD20	86	$19.10
CD3	86	$5.45
CDA1	86	$58.35
CDA2	86	$7.60
CDA3	86	$18.89
CDS16	85	$33.60
CDS17	85	$55.75
CDS406	47	$247.55
CDS606	47	$450.55
CDS806	47	$588.90
CIC12	24	$200.97
CIC16	24	$233.20
CIC25	24	$103.95
CIC25L	24	$350.07
CIC6	24	$94.18
CIC9	24	$41.79
CIC9L	24	$128.10
CJ10	17	$2.20
CJ102	17	$19.33
CJ103	17	$0.00
CJ107	17	$26.46
CJ108	17	$26.46
CJ11	17	$2.30
CJ110	17	$12.84
CJ111	17	$13.56
CJ112	17	$14.28
CJ12	17	$2.40
CJ2	17	$2.70
CJ3	17	$0.00
CJ7	17	$3.75
CJ8	17	$3.75
CKP2	64	$78.00
CL10	90	$19.45
CL11	90	$23.10
CL12	90	$25.48
CL13	90	$24.57
CL2	90	$16.20
CL21	90	$30.35
CL22	90	$37.30
CL23	90	$40.65
CL25	90	$45.80
CL3	90	$18.36
CL31	90	$36.50
CL33	90	$32.44
CL35	90	$22.05
CL5	90	$18.82
CL6	90	$21.60
CL7	90	$23.95
CL8	90	$26.98
CL9	91	$49.95
CM1	59	$201.20
CM3	6	$4.75
CM4	6	$4.75
CNS1	40	$1.60
CNS2	40	$1.70
CP36L	11	$2.95
CP36PRA	11	$13.10
CP36PS	11	$4.95
CP36S	11	$6.00
CR2016	20	$2.90
CR2025	20	$2.90
CR2032	20	$2.90
CR2316	20	$8.64
CR2320	20	$8.64

CAT NO	PAGE	PRICE
CR2420	20	$8.64
CR2430	20	$8.64
CRS4	40	$7.75
CRS406	40	$9.90
CRS5	40	$8.45
CRS507	40	$11.50
CRS6	40	$10.30
CS100	31	$15.85
CS200	31	$8.90
CS300	31	$5.05
CS300A	31	$5.70
CS35	5	$1.10
CS4	12	$0.50
CS400	31	$7.50
CS65	5	$1.10
CS65M	5	$2.20
CT10	18	$1.10
CT110	18	$2.50
CT120	18	$2.50
CT130	18	$5.52
CT140	18	$7.92
CT20	18	$1.10
CT30	18	$1.50
CT40	18	$1.80
CTB1	18	$3.40
CTB101	18	$19.16
CTB102	18	$24.32
CTB2	18	$4.45
CTC15	89	$2.10
CTC20	89	$2.25
CW1	29	$0.00
CW2	29	$4.68
DA1	81	$4.70
DA2	81	$4.35
DA3	81	$4.00
DA4	81	$4.90
DA5	81	$3.80
DB15L	11	$1.70
DB15P	11	$2.15
DB15S	11	$2.30
DB25L	11	$1.70
DB25P	11	$2.25
DB25S	11	$2.50
DB25SW	91	$9.55
DB25SW2	91	$12.70
DB9L	11	$1.70
DB9P	11	$1.70
DB9S	11	$1.70
DB9SW	91	$8.12
DC10	6	$0.70
DC13	6	$0.70
DC16	6	$0.70
DC21	6	$0.60
DC25	6	$0.60
DC31	6	$0.90
DCA10	6	$2.00
DCA12	6	$2.00
DCA14	6	$2.00
DCA2	6	$2.00
DCA4	6	$2.00
DCA6	6	$2.00
DCA8	6	$2.00
DDF332	69	$4.96
DDF334	69	$6.95
DDF772	69	$5.96
DDF774	69	$7.90
DJ21	6	$0.75
DJ21P	6	$0.70
DJ25	6	$0.75
DJ25P	6	$0.75
DM1000	94	$476.40
DM18	96	$4.90
DM323	95	$13.90
DM626	95	$14.90
DM700	96	$11.30
DM702	95	$14.90
DM740D	96	$82.17
DM780	96	$67.50
DM800D	95	$33.75
DM802	95	$39.16
DM810	95	$24.78
DM902	94	$50.85
DM903	94	$81.90
DM904D	94	$86.94
DM905	94	$98.55
DS008	14	$9.50
DS1	102	$11.40
DS2	102	$24.70
DS3	102	$12.65
DSE20	11	$4.70
DSE34	11	$6.36
DSE50	11	$10.56
DT10	42	$10.50
DT20	43	$24.55
ECM101	37	$26.67

CAT NO	PAGE	PRICE
ECM104	97	$38.25
ECM130	97	$42.21
ECM141	97	$33.81
ECM1603	97	$26.25
ECM2110	96	$53.97
ECM300	97	$50.50
ECM450	99	$15.64
ECM502D	96	$50.29
ECM510	99	$20.80
ECM541	99	$28.17
ECM550	99	$29.50
EP1	108	$135.27
EP135	81	$1.05
EP2	108	$71.00
EP25	81	$2.10
EP25L	81	$3.40
EP3	108	$111.35
EP35	81	$2.10
EP35C	81	$3.30
EP35D	82	$6.45
EP35L	81	$3.40
EP4	108	$230.94
EP5	109	$71.00
EP6	109	$94.05
EP8	109	$139.15
EP9	109	$101.70
EPS100	84	$21.50
EPS50	82	$5.05
ES1	29	$1.85
ES2	29	$2.65
F11	9	$0.80
F56	9	$0.50
F59	9	$0.50
F59T	69	$1.60
F61	9	$0.80
F81	9	$0.80
FDC1	89	$5.46
FDC3	89	$5.46
FEP1	82	$2.52
FEP2	82	$2.52
FEP3	82	$2.76
FH001	13	$1.75
FH002	13	$1.15
FH003	13	$1.10
FH004	13	$0.70
FH005	13	$1.10
FH010	13	$0.40
FH240	13	$3.78
FH241	13	$2.00
FL1	68	$3.65
FL2	68	$3.65
FL21	68	$5.50
FL22	68	$7.10
FL23	68	$8.75
FL3	68	$5.33
FL4	68	$4.95
FL5	68	$4.95
FL6	68	$8.45
FL7	68	$8.45
FL8	68	$4.45
FL9	68	$5.98
FMA1	70	$2.95
FMA10	71	$63.40
FMA2	71	$20.15
FMA3	70	$7.75
FMA4	71	$46.40
FMA5	71	$35.75
FMA6	70	$19.65
FMA7	71	$38.30
FMA8	70	$11.30
FMA9	71	$31.20
FRC12	25	$108.57
FS1	102	$70.55
FS2	102	$64.00
FS4	103	$88.65
FSBA1	102	$94.60
GE220	106	$495.40
GL8	100	$7.80
GN15B	101	$6.85
GN15M	101	$6.15
GN33B	101	$8.20
GN33HB	101	$8.60
GN33HM	101	$7.85
GN33M	101	$7.45
GN53B	101	$10.45
GN53M	101	$9.60
GN81B	101	$4.10
GN81M	101	$5.55
GP15A	20	$3.00
GP1604A	20	$3.34
GP23S	20	$2.46
GP24A	20	$2.74
GP908S	20	$5.60
GP910A	20	$4.06
GR229	26	$5.98

CAT NO	PAGE	PRICE
GT10	57	$123.30
GT5	57	$81.25
GT8	57	$69.95
HCW40	44	$23.80
HCW60	44	$37.30
HCW80	44	$58.50
HD1	87	$11.55
HD1000	85	$43.45
HD82	83	$12.85
HD86V	83	$14.88
HP550	82	$4.50
HP660	83	$8.80
HR225	26	$5.98
HS10	81	$8.86
HS20	81	$0.00
HS30	81	$8.52
HST10	25	$12.10
HST14	25	$5.40
HT1	29	$12.95
HT10	30	$4.15
HT105	53	$35.60
HT11	30	$5.90
HT12	31	$6.25
HT13	31	$6.60
HT14	31	$5.85
HT15	31	$5.80
HT17	30	$15.45
HT18	30	$19.20
HT19	29	$8.75
HT1C	29	$2.44
HT1T	29	$2.64
HT23	32	$13.60
HT24	32	$10.20
HT25	32	$3.30
HT26	32	$5.50
HT3	29	$24.50
HT34	28	$24.90
HT35	28	$35.95
HT37	28	$56.20
HT37B	28	$21.12
HT37G	28	$0.65
HT37T	28	$8.88
HT3C	29	$56.22
HT4	28	$8.95
HT5	28	$24.90
HT6	30	$3.80
HT7	30	$5.15
HT8	30	$5.35
HT8A	43	$7.85
HT9	30	$5.15
HUW1	25	$5.88
HUW2	25	$12.07
HUW4	25	$17.22
ICS10	23	$136.60
IDC10	11	$2.56
IDC16	11	$3.12
IDC25P	11	$12.96
IDC25S	11	$12.96
IDC26	11	$4.56
IDC34	11	$5.76
IDC36CP	11	$11.04
IDC36CS	11	$11.40
IDC40	11	$7.32
IDC50	11	$9.00
IDC64	11	$12.36
IL2	13	$3.20
IL3	13	$1.60
IL4	13	$1.50
IL5	13	$1.50
IL6	13	$1.30
IL7	13	$2.20
IL8	13	$1.80
IPD1	19	$4.23
IPD2	19	$4.42
IPD3	19	$12.21
IPD4	19	$12.78
IT30	25	$8.50
J25	4	$0.75
J35	4	$0.65
J35C	4	$0.40
J35S	4	$1.00
J65	4	$1.10
JCB8	6	$17.50
JCL8	6	$5.90
JCP8	6	$8.95
JCS2	89	$14.24
JCS3	89	$21.40
JD2	7	$0.45
JD3	7	$0.95
JD4	7	$0.95
JD5	7	$0.95
JD5A	7	$0.95
JD5B	7	$0.95
JD6	7	$1.10
JD7	7	$1.20

CAT NO	PAGE	PRICE
JD8	7	$1.55
JD8A	7	$1.55
JK10	25	$4.70
JK5	25	$3.90
JL2	89	$8.82
JM3	6	$2.60
JM4	6	$2.60
JP3F	100	$8.97
JP3M	100	$7.20
JS25	4	$0.55
JS35	4	$1.40
JS65	4	$1.60
JS65C	4	$1.70
JS65I	4	$2.90
KE117	49	$29.98
KE630	49	$42.48
KE720	49	$56.80
KLT700	35	$0.00
L12	13	$0.40
L6	13	$0.40
LA1	45	$6.76
LA2	45	$6.76
LA3	45	$13.55
LA4	45	$23.30
LA5	45	$16.40
LA6	45	$12.20
LAB12	64	$23.20
LAB27	64	$37.45
LAB45	64	$51.20
LC223	26	$5.98
LMT1	56	$7.87
LMT10	56	$15.64
LMT11	56	$29.40
LMT12	56	$43.78
LMT2	56	$9.76
LMT3	56	$24.36
LMT4	56	$13.75
LMT6	56	$11.86
LMT7A	56	$16.59
LMT8A	56	$21.10
LNE11	8	$9.72
LNE12	8	$9.98
LNE31	8	$7.05
LNE32	8	$6.75
LR1120	20	$2.48
LR1130	20	$2.08
LR43	20	$2.30
LR44	20	$2.24
LTC20	89	$1.46
M205.BOX	18	$18.90
M205.SBP	18	$2.50
M358	9	$6.10
MB135	15	$2.30
MB136	15	$2.78
MBE1	89	$29.90
MD12	32	$12.50
MES2	61	$21.30
MES3	61	$13.86
MES4	61	$21.50
MES5	61	$0.00
MG1	32	$6.30
MG2	32	$9.65
MH1	101	$2.45
MH2	101	$3.75
MH3	101	$4.75
MH4	101	$0.00
MH5	101	$7.80
MH6	101	$9.80
MH7	101	$15.65
MHA3	72	$65.00
MHA4	72	$86.20
MHB2	72	$2.95
MHB4	72	$3.92
MHB6	72	$4.30
MHD12	85	$37.25
MHD3A	84	$16.55
MHD4	84	$19.95
MHD5	84	$20.35
MHM2	72	$14.25
MHM4	72	$14.40
MHM6	72	$16.80
MHM8	72	$22.50
MJ001	12	$0.80
MJ002	12	$0.70
MJ003	12	$1.20
MJ004	12	$2.40
ML10	100	$30.55
ML20	100	$44.10
ML5	100	$17.85
ML6	100	$25.50
ML8	100	$15.75
MM1	104	$38.95
MM3	104	$189.15
MM4	104	$335.90
MM5	104	$199.40

Prices include Sales Tax • Tax free deduct 16% where applicable • 30 Day credit accounts for Gov't depts etc (minimum order $50)

Add Pack/Post $3 plus 5% of order value • All prices subject to change without notice • Quantities 10 or more deduct 10% discount

Catalogue

FOR THE ARISTA™

1988 TRADE PRICE LIST

(02) 569 9797
Mon-Fri 9:00-5:30 Sat 9:00-1:00
BANKCARD MASTERCARD VISA AMEX

PRE-PAK electronics
1A West Street
LEWISHAM 2049

CUT THIS OUT

PRE-PAK electronics 1A West Street LEWISHAM 2049

(02) 569 9797 Mon-Fri 9:00-5:30 Sat 9:00-1:00 BANKCARD MASTERCARD VISA AMEX

1988 TRADE PRICE LIST FOR THE ARISTA™ Catalogue

PRE-PAK electronics – a major distributor for Arista products

• Catalogue numbers are in alphabetical and numerical order • Most items ex-stock! • 24 hour mail order service

CAT NO	PAGE	PRICE
MN40	15	$0.65
MR10	43	$11.80
MR44	20	$3.82
MR9	20	$4.62
MRS1	62	$4.20
MRS2	62	$4.95
MRS3	62	$4.40
MRS4	62	$8.75
MS102	14	$0.60
MS166	14	$3.57
MS168	14	$5.14
MS231	14	$8.38
MS313	14	$1.10
MS323	14	$6.06
MS501	46	$86.20
MS502	46	$131.70
MS505W	46	$171.60
MS506	46	$215.40
MSB BOX	18	$67.41
MSB SBP	18	$9.12
MT2	100	$24.15
MT4	100	$25.50
MT6	100	$15.75
MV1	32	$4.20
MX1	105	$189.50
MX2	105	$410.20
MX3	106	$634.45
N21	10	$5.30
N24	10	$3.90
N26	10	$5.30
NBC1	21	$29.50
NBC2	21	$19.80
NC3	21	$47.25
NC3FX	8	$5.85
NC3MX	8	$6.15
NCUM1	21	$21.45
NCUM1E	21	$12.23
NCUM2	21	$12.54
NCUM2E	21	$11.88
NCUM3	21	$8.74
NCUM4	21	$9.00
NCUM5	21	$9.00
NJ3FP	8	$8.75
NL222	26	$5.98
NM4	21	$5.56
NM5	21	$5.56
NP2C	8	$6.20
NP3C	8	$8.75
NS221	26	$5.98
P25	2	$0.45
P35	2	$0.45
P35M	4	$1.10
P35P	4	$0.60
P3F	8	$5.10
P3M	8	$4.60
P65	4	$0.75
P65M	4	$1.40
P65MA	4	$1.50
P65MP	4	$1.50
P65MRA	4	$1.10
P65MS	4	$8.50
P65P	4	$0.80
PA10	81	$1.74
PA100	81	$1.89
PA110	81	$2.03
PA120	81	$2.03
PA1202	107	$595.00
PA130	81	$1.74
PA140	81	$1.61
PA150	81	$1.74
PA160	81	$3.37
PA170	81	$3.65
PA1702	107	$0.00
PA20	81	$1.78
PA200	81	$2.59
PA200C	59	$649.75
PA21	76	$3.00
PA22	76	$4.95
PA23	76	$2.83
PA24	76	$4.95
PA26	76	$4.18
PA27	76	$3.59
PA28	76	$4.52
PA29	76	$4.52
PA30	81	$2.00
PA300C	59	$579.15
PA300T	59	$418.50
PA31	76	$3.34
PA32	76	$2.66
PA40	81	$2.14
PA50	81	$2.14
PA60	81	$1.68
PA70	81	$1.96
PA80	81	$1.96
PA90	81	$1.96

CAT NO	PAGE	PRICE
PA902	107	$424.85
PAA100	60	$592.75
PAA125	60	$643.35
PAA75	60	$538.00
PAC10	13	$2.20
PAC11	13	$3.00
PAC5	13	N/A
PAC9	13	$5.95
PACT2	59	$519.75
PAE12	57	$73.98
PAE15	57	$110.80
PBD1	52	$12.80
PC154	100	$8.76
PCL1	12	$0.90
PCL2	12	$4.65
PD2	7	$0.55
PD3	7	$0.70
PD4	7	$0.80
PD5	7	$0.80
PD5A	7	$0.80
PD5B	7	$0.80
PD5M	7	$4.40
PD6	7	$0.95
PD7	7	$1.05
PD8	7	$1.25
PD8A	7	$1.25
PDM3	7	$2.20
PDM4	7	$2.30
PDM5	7	$2.40
PDM6	7	$2.50
PDM7	7	$2.60
PDM8	7	$2.70
PDN11	8	$12.50
PDN12	8	$11.70
PDN31	8	$10.25
PDN32	8	$9.65
PER2	64	$118.10
PHS1	44	$12.70
PHS2	44	$12.90
PHS3	44	$11.20
PHS4	44	$32.10
PIR12	63	$107.20
PIR2	63	$135.90
PIR25	63	$107.20
PL1	16	$5.50
PL12	16	$4.55
PL13	16	$8.50
PL2	16	$5.50
PL258	9	$2.40
PL259	9	$2.40
PL259ST	9	$2.40
PL3	16	$5.50
PL4	16	$5.50
PL6	16	$9.95
PL7	16	$11.50
PL8	53	$10.20
PM3	6	$2.70
PM4	6	$2.90
PN38A	15	$1.35
PN38B	15	$0.98
PN38C	15	$0.86
PN38D	15	$0.75
PP1000	35	$33.25
PP1000MV	34	$27.75
PP10012	34	$9.90
PP1006	34	$9.90
PP1009	34	$9.90
PP2138	35	$39.50
PP300	34	$16.50
PP300MV	34	$17.95
PP312AC	33	$9.65
PP500MV	34	$19.90
PP9138	35	$21.35
PPDC10	34	$0.98
PPDC10T	34	$0.98
PPDC13	34	$0.98
PPDC21	34	$0.98
PPDC25	34	$0.98
PPP25	34	$0.98
PPP35	34	$0.98
PPW80	34	$44.85
PS25	4	$1.60
PS35	4	$0.80
PS35RA	4	$1.50
PS602	82	$9.95
PS65	4	$1.00
PS65M	4	$1.65
PS65P	4	$1.10
PSD2	64	$63.90
PT1	50	$2.95
PT10	51	$3.90
PT11	51	$3.90
PT12	51	$3.36
PT13	51	$4.34
PT14	52	$2.36

CAT NO	PAGE	PRICE
PT15	51	$17.72
PT16	52	$2.80
PT2	50	$3.60
PT20	50	$2.10
PT3	50	$3.60
PT44	52	$2.56
PT5	50	$5.52
PT64	52	$2.56
PT66	52	$2.96
PT8	51	$3.30
RC300	22	$37.69
RC300SB	22	$43.15
RCA1	5	$0.45
RCA1M	5	$0.95
RCA2	5	$0.45
RCA2G	5	$2.00
RCA2L	5	$2.70
RCA2M	5	$0.95
RCA2MS	5	$4.60
RCA2S	5	$0.75
RCA3	5	$0.60
RCA32	5	$0.70
RCA34	5	$1.25
RCA36	5	$1.80
RCA38	5	$2.75
RCA3G	5	$1.50
RCA3GB	5	$2.90
RCA3I	5	$0.80
RCA3L	5	$1.50
RCB1	87	$1.90
RCB2	87	$7.80
RCB3	87	$4.25
RCS1	29	$1.80
RCS2	29	$7.65
RCS3	29	$8.70
RG213	53	$272.97
RG58	22	$49.77
RG58CU	22	$66.67
RG59U	22	$55.23
RG8U	22	$340.41
RN115B	15	$0.80
RN99A	15	$2.10
RN99C	15	$1.25
RN99D	15	$1.00
RN99F	15	$0.80
RPP1000	35	$41.40
RPP2000	35	$56.60
RPP250	34	$24.20
RPP500	34	$30.80
RT1	28	$5.88
RT15	28	$5.88
RT3	28	$5.88
RX300	9	$1.20
RX310	9	$1.20
RZ10	9	$1.05
RZ11	9	$1.10
RZ12	9	$0.80
RZ14	9	$1.40
RZ15	9	$1.40
RZ16T	69	$1.41
RZ20	9	$0.80
RZ20M	9	$1.45
RZ20T	69	$1.85
RZ21	9	$0.90
RZ21M	9	$1.50
RZ320	9	$2.00
RZ40	22	$1.15
RZ48	9	$1.40
RZ49	9	$1.95
RZ59	9	$1.20
RZ60	9	$1.20
RZ61	9	$1.20
S022B	26	$5.98
SA1	102	$1.26
SA2	102	$1.58
SA3	102	$1.58
SA4	102	$1.30
SA5	102	$4.50
SAC1	22	$25.30
SAC1M	22	$15.33
SAC2	22	$46.51
SAC2M	22	$34.86
SAC3	22	$43.15
SAC4	22	$86.62
SAC4F	22	$89.88
SAC5	22	$112.77
SAL100	79	$18.30
SAL102	79	$26.16
SAL142	79	$20.93
SCC2	100	$2.55
SCF16	24	$84.21
SCF26	24	$96.35
SCF36	24	$128.53
SCF50	24	$172.55
SD2	7	$0.50

CAT NO	PAGE	PRICE
SD3	7	$0.90
SD4	7	$0.90
SD5	7	$1.05
SD5A	7	$1.05
SD5B	7	$1.05
SD6	7	$1.10
SD7	7	$1.15
SD8	7	$1.30
SD8A	7	$1.30
SDC4	36	$57.60
SDC8	36	$88.95
SDD15	54	$13.45
SDD30	54	$13.45
SDH15	54	$66.10
SDH30	54	$82.20
SFW124	40	$38.00
SF740	40	$43.55
SIS1	28	$9.25
SM10	14	$1.95
SM100	103	$36.95
SM20	14	$3.65
SM200	103	$80.90
SM300	103	$93.45
SM400	103	$139.15
SMB2	48	$67.45
SMC1	23	$77.91
SMC2	23	$96.49
SMC3	23	$111.40
SMC4	23	$149.10
SO239	9	$1.95
SP1	55	$36.60
SP10	39	$21.00
SP100	42	$30.00
SP1030	43	$51.30
SP120	42	$39.95
SP1230	43	$66.20
SP12HP	44	$86.96
SP15	42	$15.80
SP17	42	$4.70
SP2	55	$57.10
SP24	42	$5.50
SP4	43	$12.50
SP40	42	$9.65
SP45LT	55	$177.20
SP4F	43	$21.40
SP50	42	$12.50
SP55G	53	$26.64
SP6	43	$14.30
SP65	42	$15.45
SP6W	53	$26.40
SP8	43	$21.50
SP80	42	$18.25
SP820	43	$29.90
SP83G	55	$47.45
SP83LT	55	$18.60
SP85LT	55	$24.65
SPC1	23	$16.27
SPC1/20	23	$3.72
SPC1/500	23	$76.23
SPC2	23	$21.63
SPC2S	23	$21.52
SPC3	23	$60.16
SPC4	23	$113.61
SPC6	23	$285.60
SPC7	23	$240.24
SPG1	55	$3.40
SPG2	55	$7.30
SPG3	55	$3.15
SPG4	55	$4.60
SPH1	54	$12.87
SPH12	54	$92.40
SPH16	54	$49.15
SPH2	54	$12.87
SPH3	61	$19.94
SPH4	54	$36.30
SPH6	54	$37.60
SPH8	54	$55.80
SR1120	20	$4.50
SR1130	20	$4.32
SR41	20	$2.30
SR43	20	$5.52
SR44	20	$6.96
SR48	20	$5.16
SR5R102	18	$11.52
SR5R2	18	$2.70
SR620	20	$5.04
SR626	20	$3.52
SR6R103	18	$16.56
SR6R3	18	$3.90
SR721	20	$3.84
SR726	20	$3.68
SR920	20	$5.16
SR926	20	$5.28
SR936	20	$7.32
SRF131	18	$9.24

CAT NO	PAGE	PRICE
SRF142	18	$9.72
SRF31	18	$2.20
SRF42	18	$2.30
SSS1	48	$15.80
SSS2	48	$30.25
ST1	6	$1.60
ST10	17	$1.95
ST11	17	$1.95
ST110	17	$9.00
ST111	17	$9.36
ST113	17	$9.36
ST114	17	$10.15
ST115	17	$17.32
ST116	17	$20.58
ST120	17	$9.36
ST121	17	$9.36
ST123	17	$9.36
ST124	17	$9.60
ST129F	17	$10.92
ST13	17	$1.95
ST130	17	$9.60
ST131	17	$9.60
ST14	17	$2.00
ST140	17	$11.16
ST140F	17	$14.28
ST141	17	$11.64
ST141F	17	$14.28
ST145	17	$14.28
ST146	17	$14.64
ST15	17	$3.05
ST150	17	$10.44
ST151	17	$10.92
ST154	17	$14.28
ST155	17	$14.28
ST157	17	$9.60
ST158	17	$10.20
ST16	17	$3.40
ST160	17	$11.64
ST20	17	$1.95
ST21	17	$1.95
ST23	17	$1.95
ST231	14	$5.32
ST233	40	$2.60
ST235	40	$4.20
ST24	17	$1.95
ST29F	17	$2.00
ST30	17	$2.00
ST305	14	$1.50
ST307	14	$1.95
ST308	14	$3.50
ST31	17	$2.00
ST40	17	$2.25
ST40F	17	$2.50
ST41	17	$2.25
ST41F	17	$2.50
ST45	17	$2.50
ST46	17	$2.50
ST50	17	$2.20
ST51	17	$2.30
ST54	17	$2.50
ST55	17	$2.50
ST57	17	$2.00
ST58	17	$2.20
ST60	17	$2.30
ST602	14	$1.20
ST603	14	$2.25
STC1	6	$1.90
STM1	14	$2.20
STM1A	14	$1.95
STM2	14	$1.80
STM2A	14	$1.90
STM4	14	$2.10
STM5	14	$1.50
STP1	6	$5.80
STP2	53	$6.50
SUV2	69	$6.20
SUV4	69	$8.32
SUV7	69	$4.45
SUV8	69	$4.45
SUV9	69	$6.70
SW1	37	$0.00
SW2	37	$11.25
SW3	37	$17.85
SW4	37	$20.50
SW5	37	$6.35
SW6	37	$21.35
TA11	88	$3.72
TA22	88	$4.12
TA44	88	$1.25
TA55	88	$2.18
TA66	88	$1.25
TA88	88	$4.52
TA99	87	$3.72
TAA801	48	$54.70
TAA802	48	$49.80

CAT NO	PAGE	PRICE
TAA803	48	$54.70
TB102	13	$0.75
TB52	13	$0.75
TB53	13	$1.00
TC22	25	$6.61
TC810	13	$4.25
TC144	52	$12.20
TC166	52	$14.70
TEL10	51	$8.40
TEL104	24	$31.81
TEL106	24	$47.14
TEL11	51	$7.20
TEL12	51	$9.72
TEL13	51	$4.10
TEL14	51	$7.20
TEL15	51	$3.60
TEL16	51	$5.40
TEL17	51	$7.44
TEL18	50	$21.50
TEL2	50	$7.20
TEL2C	50	$7.95
TEL3	50	$12.39
TEL4	50	$7.20
TEL5	50	$7.56
TEL6	50	$10.98
TEL7	50	$7.92
TEL8	50	$5.88
TEL9	51	$6.24
TH033	87	$16.60
TLC10	24	$130.20
TLC15	24	$178.71
TLC2	24	$24.57
TLC3	24	$37.90
TLC4	24	$48.09
TLC6	24	$76.75
TLC8	24	$97.24
TLS1	26	$2.90
TLS2	26	$2.75
TLS3	26	$4.65
TLS4	26	$14.20
TM1	59	$113.39
TNC1	10	$2.50
TNC3	10	$1.95
TNC5	10	$1.95
TNC7	10	$2.50
TNC9	10	$4.95
TNL2	61	$33.65
TPA10	58	$224.40
TPA20	58	$254.50
TPA30	58	$298.45
TPA40	58	$348.30
TPA50	58	$348.30
TPC1	52	$5.25
TS1210	13	$1.70
TS1215	13	$1.80
TV1	66	$1.96
TV10	67	$1.88
TV100	82	$13.20
TV10A	67	$1.84
TV11	67	$3.20
TV12	68	$5.60
TV13	68	$5.95
TV14	69	$8.58
TV15	69	$14.56
TV16	66	$7.54
TV17	66	$6.62
TV18	66	$6.88
TV19	69	$6.15
TV2	66	$1.96
TV200	82	$8.58
TV21	66	$2.35
TV22	66	$3.10
TV23	66	$1.96
TV3	66	$3.60
TV300	82	$35.70
TV3A	66	$4.45
TV4	66	$3.86
TV5	66	$5.46
TV6	67	$1.57
TV7	67	$3.90
TV8	67	$4.00
TV9	67	$2.10
TVA14	73	$49.10
TVA15	73	$49.10
TVH100	83	$14.90
TVS2	67	$6.62
TVS4	67	$16.25
TVS6	67	$13.26
UB1	19	$3.35
UB10	19	$7.05
UB11	19	$6.05
UB1P	19	$4.10
UB2	19	$4.70
UB20	19	$5.28
UB21	19	$6.84

CAT NO	PAGE	PRICE
UB22	19	$8.65
UB3	19	$2.75
UB3P	19	$3.05
UB4	19	$1.95
UB4P	19	$2.15
UCH1	39	$3.15
UCH2	39	$2.70
UCH4	39	$2.90
UCH6	39	$3.30
UCH9	39	$3.80
VCA2	78	$32.65
VCL12	78	$2.20
VCL13	76	$73.50
VCL14	76	$27.98
VCS1	78	$1.55
VDC1	78	$9.30
VDC2	78	$9.30
VDC4	78	$9.30
VDK1	76	$16.86
VDK2	77	$17.55
VDK3	77	$26.22
VDK4	77	$33.43
VDS1	63	$7.65
VDS2	63	$6.95
VH310	78	$11.80
VJ8	10	$6.25
VL1	75	$7.40
VL10	75	$5.20
VL13	75	$8.95
VL15	75	$6.55
VL15L	75	$9.10
VL16	75	$5.55
VL17	75	$6.15
VL19	75	$17.55
VL1L	75	$8.45
VL2	75	$7.55
VL22	75	$16.40
VL23	76	$15.80
VL24	76	$13.90
VL3	75	$7.55
VL4	75	$5.50
VL5	75	$3.65
VL5L	75	$5.05
VL6	75	$5.55
VL6L	75	$6.95
VL7	75	$3.65
VL7L	75	$4.80
VL9	75	$2.95
VOM1	27	$16.75
VOM2	27	$33.70
VOM3	27	$84.00
VOM4	27	$58.90
VP10	10	$12.20
VP14	10	$10.60
VP21	10	$3.20
VP8	10	$5.80
VR200	52	$12.85
VS10	10	$12.20
VS14	10	$10.60
VS400	73	$68.70
VS500	74	$115.00
VS600	73	$41.25
VS8	10	$7.30
VS800	73	$96.20
VSK1	78	$9.45
VTR25	74	$79.85
VUC2	73	$87.35
WA100	99	$168.30
WFM356	98	$572.85
WFM360G	98	$134.91
WI1	49	$84.20
WI3	49	$103.15
WI4	49	$128.20
WL3	63	$33.40
WL5	63	$35.75
WMS371	99	$89.00
WMS376	98	$115.29
WPC1	56	$4.05
WPC3	56	$10.35
WS1	100	$4.90
WS2	100	$4.90
WS3	100	$5.65
WS4	100	$5.90
WS5	100	$6.30
XN206	45	$9.30
XN212	45	$15.50
XN306	45	$9.35
XN312	45	$22.30
XN316	45	$33.45

This list covers only Arista products - we sell many more. If what you want is'nt listed here, please call for information

Prices include Sales Tax • Tax free deduct 16% where applicable • 30 Day credit accounts for Gov't depts etc (minimum order $50)
Add Pack/Post $3 plus 5% of order value • All prices subject to change without notice • Quantities 10 or more deduct 10% discount

CUT THIS OUT

CUT THIS OUT

CUT THIS OUT

CUT THIS OUT

Wireless Weekly 3d

50 and 25 years ago..

February 1938

"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.

Radiola conference: The convening of the big Radiola conference to be held in Sydney in February, arouses interest in the tremendous development of wireless during recent years.

Only sixteen years have elapsed since broadcasting was established, yet it is now estimated that in 75,000,000 homes, embracing almost every country in the world, men and women listen regularly to programmes of their local stations. So far as Australia is concerned, we have 1,000,860 licensed listeners and fully half of the popula ion live in a home with a radio receiver.

New Ever Ready factory: On January 25, the Prime Minister (Mr Lyons) opened the new factory of the Ever Ready Company at Rosebery.

Over two hundred executives in the radio industry were entertained to a luncheon at the new factory and the affair must rate as one of the most successful social functions yet organised in the Sydney trade.

RADIO, TELEVISION and HOBBIES

February 1963

"Living Doll": A doll which gives long recitations, sings or lectures her young owner on manners is a distinct possibility in American homes this Christmas.

The talkative doll owes her ability to a tiny, battery-powered wireless receiver and loudspeaker in her abdominal cavity. What she says or sings is broadcast from a diminutive broadcasting set 10 to 12 feet away. This transmitter includes a gramophone. Special records prepared by a firm of children's book publishers furnish the repertoire.

New Hearing Device: A new hearing device, made by the Ardente Company, was one of the British products reported recently in the BBC's "New Ideas" program.

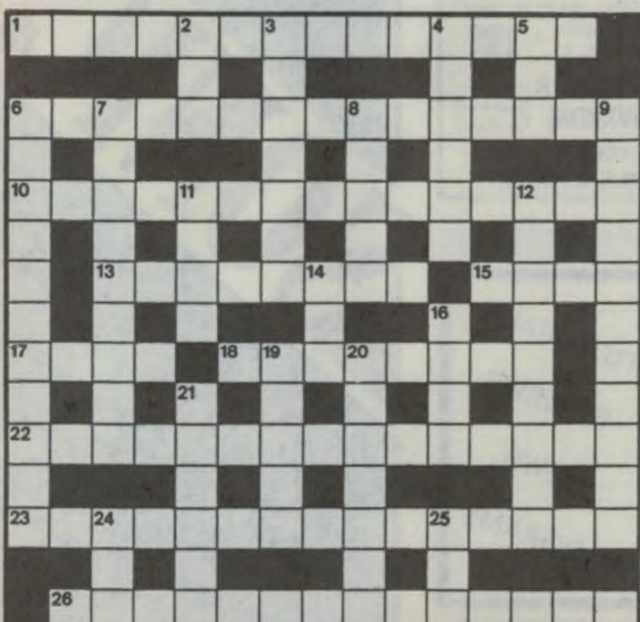
Only 38mm in length the "Premier Hearing Corrector" has a flesh coloured casing and is worn unobtrusively behind the ear.

"One of the greatest advantages," reported Michael Jacobson, "is that it incorporates the new thermistor device, which gives automatic temperature control from zero to forty degrees Centigrade. Apart from the variations of temperature caused by body heat, it can cope with the difficulties of people living in tropical countries or in regions which suffer extremely cold winters.

FEBRUARY CROSSWORD

ACROSS

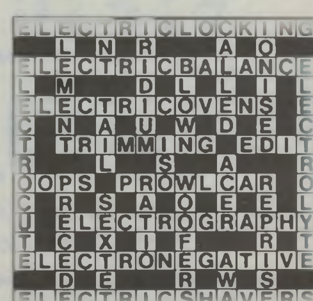
1. On the surface, it's the ideal power tool for a flat output. (8,6)
6. Grass or snow, it is signally degrading. (10,5)
10. Carrier, evidently with a load circuit. (8,7)
13. Initiates an electronic response. (8)
15. Drop out. (4)
17. Normally reliable electrical appliance with 26th element! (4)
18. Television camera tube. (8)
22. Current means of joining. (8,7)
23. No, not a bionic ear, this makes sounds. (10,5)
26. Coating with gold by electric deposition. (14)



DOWN

2. Thin-film transistor. (1,1,1)
3. Decreasing use of 17 across. (7)
4. Repeating 0.1 recurring! (6)
5. Recording company. (1,1,1)
6. Colloquial term for an interrupted light system? (8,3)
7. Point at which charge enters component, etc. (9)
8. Alloy with very low coefficient of expansion. (5)
9. Part of a CRT. (8,3)
11. Set of three players. (4)
12. Making contact before the solid state! (9)
14. Transfer of charges by charges. (1,1,1)
16. Abbreviation of former energy unit. (4)
19. Its hair-raising charges are not 21 down. (5)
20. Making sound due to feedback. (7)
21. Non-dynamic. (6)
24. Electrophorus species, the electric ——. (3)
25. Medium in which some contacts are broken. (3)

SOLUTION FOR JANUARY



EA marketplace EA marketplace

ADVERTISING RATES FOR THIS PAGE

SMALL ADS: The minimum acceptable size of 2 centimetres x one column costs only $40. Other sizes up to a maximum of 10 centimetres are rated at $20 a centimetre. CLASSIFIEDS: $4 for 40 letters. Just count the letters divide by 40 and multiply by $4, ROUND UP TO NEAREST WHOLE NUMBER. CLOSING DATE: Ads may be accepted up to the 18th of the month two months prior to issue date. PAYMENT: Please enclose payment with your advertisement. Address your letter to THE ADVERTISING MANAGER, ELECTRONICS AUSTRALIA, PO BOX 227, WATERLOO, NSW 2017.

FOR SALE

NEARLY 1500 PRINTER BUFFER KITS NOW SOLD: Prices start at $39 for a 256K short form kit. All items advertised are in stock. Dealers enquiries welcome. Bulk discounts. Schools, Govt. depts. orders accepted. Oh yes!!, IBM compatible. Australian designed and manufactured. Ideal project for user groups or students. For a free catalogue send a 37c stamp to Don McKenzie, 29 Ellesmere Cres., Tullamarine 3043.

EX-ABC AUDIO TAPES: ¼" wide on 10½" **Standard** metal spool $6.85. **Robust** metal spool $12.85 7" spool $2.85. 5" spool $1.25. Post extra. Also in stock ½", 1" and 2" tapes. Waltham Dan, 96 Oxford St., Darlinghurst, Sydney. Phone (02) 331-3360.

AMIDON FERROMAGNETIC CORES: Large range for all receiver and transmitter applications. For data and price list and 105X220 SASE to: R. J. & U. S. Imports, P.O. Box 157, Mortdale, N.S.W. 2223. N.S.W: Geoff Wood Electronics, Lane Cove. Webb Electronics, Albury. A.C.T.: Electronic Components, Fyshwick Plaza, Vic.: Truscott Electronics, Croydon. W.A.: Willis Trading Co., Perth.

NEW RADIO VALVES: For entertainment or industrial use. Waltham Dan, 96 Oxford St., Darlinghurst, Sydney. Phone (02) 331-3360.

VZ USERS: Short basic program saves binary tapes to tape AND disk. Send $5 to P. Brennan, P.O. Box 334, Mordialloc 3195.

COMPONENTS: Wide range of parts for receiver, transmitter and other electronic equipment. Semiconductors, valve, plate by-pass capacitors, coaxial connectors and a lot more. Mail enquiries welcome. Sorry, no catalogue available. D. Dauner Electronic Sales, 51 Georges Crescent, Georges Hall, N.S.W. 2198. Telephone (02) 724-6982.

R.C.S. RADIO PTY. LTD.
Established 1933
IS THE ONLY COMPANY
WHICH MANUFACTURES AND
SELLS EVERY PCB & FRONT PANEL
published in EA and ETI
651 Forest Road Bexley 2207
AUSTRALIA
RING (02) 587 3491 FOR INSTANT PRICES
24-HOUR TURNAROUND SERVICE

PRINTED CIRCUIT BOARDS
Minimum postage & packaging on all EA & ETI Project PCBs
Catalogue 1976-85 (inc components) $1.50
PCBs made to order — 48 hr prototype service
Bankcard Mastercard
Acetronics PCBs
112 Robertson Rd Bass Hill 2197
(02) 645 1241

A NEW CONCEPT FOR LOW VOLTAGE PROJECTS
COPPER FOIL TAPE: thin pure copper tape backed by special hi-tack adhesive. Current carrying capacity, 5 amps. FULLY TESTED at 24V 5A. Not recommended for mains voltage.
4mm RRP $8.03 6mm RRP $9.84 33 metre rolls
GIFFORD PRODUCTIONS
PO Box 62, St Kilda, Vic 3182. (03) 534 3462

DO YOU WANT TO BE A RADIO AMATEUR?
The Wireless Institute of Australia, established in 1910 to further the interests of Amateur Radio, conducts a Correspondence Course for the A.O.C.P. and L.A.O.C.P. Examinations conducted by the Department of Communications. Throughout the Course, your papers are checked and commented upon to lead you to a successful conclusion.
For further information, write to:
THE COURSE SUPERVISOR
W.I.A. (N.S.W. DIVISION)
P.O. Box 1066
PARRAMATTA, N.S.W. 2150.

your computer
TUTORIALS
REVIEWS
NEWS
PROGRAMS
A magazine for all computer users and enthusiasts, Your Computer has something for everyone

SONICS MAGAZINE
MUSIC
SOUND RECORDING
STAGE LIGHTING
For: Musicians, Road Crews, Recording Engineers, Lighting People, Managers, Promoters and anybody interested in what goes into today's music-making.

Next month in Electronics Australia

Build a Braitenberg vehicle!

What's a Braitenberg vehicle? A cute little mobile robot that can exhibit all kinds of interesting behaviour. They're fun and educational. Next month we tell you how to make your own — cheaply and easily.

Low cost current tracer probe

Commercial current probes for troubleshooting in digital circuits are very expensive. Here's how to make one yourself that works almost as well, for much less. Easy to build, too!

Beginners' reflex radio

In the old days they really knew how to get good performance from a handful of parts. Here's a little radio project for beginners, that uses the same principles. Easy to get going, and very low cost.

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

Electronics Australia Reader Services

"Electronics Australia" provides the following services:

Subscriptions: All subscription enquiries should be directed to: Subscriptions Department, Federal Publishing Co. PO Box 227, Waterloo 2017. Phone: (02) 693 6666

BACK ISSUES: Available only until stocks are exhausted. Price: $4.50

PHOTOSTAT COPIES: When back issues are exhausted, photocopies of articles can be supplied. Price: $4.50 per project or $9 where a project spreads over several issues.

PCB PATTERNS: High contrast, actual size transparencies for printed circuit boards and front panels are available. Price: $5 for boards up to 100 square centimetres; $10 for larger boards. Please specify positive or negative.

PROJECT QUERIES: Advice on projects is limited to postal correspondence only, and to projects less than five years old. Price: $5. Please note that we cannot undertake special research or advise on project modifications. Members of our technical staff are not available to discuss technical problems by telephone.

OTHER QUERIES: Technical queries outside the scope of "Replies by Post", or submitted without fee, may be answered in the "Information Centre" pages at the discretion of the Editor.

PAYMENT: Must be negotiable in Australia and made payable to "Electronics Australia". Send cheque, money order or credit card number (American Express, Bankcard, Mastercard, or Visa Card), name and address (see form). All prices include postage within Australia and to New Zealand.

ADDRESS: Send all correspondence to The Secretary, "Electronics Australia", PO Box 227, Waterloo, NSW 2017. Please note that we are unable to supply back issues, photocopies or PCB artwork over the counter.

Back Issues ....

Photostat copies ....

Total price of magazines/photocopies, including postage and handling.

No off issues reg .... x $4 = $..........

Cheque* Money Order ☐ Please tick box to indicate method of payment

**Please make payable to the Federal Publishing Company Pty Ltd*

Mastercard ☐ American Express ☐ Visa ☐ Bankcard ☐ Tick ☑

Card Expiry Date

☐☐☐☐ ☐☐☐ ☐☐☐☐ ☐☐☐☐☐☐☐

Credit Card No.

Signature ....
(Unsigned Orders cannot be accepted)

NAME ....

ADDRESS: ....

.... POSTCODE ....

ADVERTISING INDEX

This index is provided as an additional service. The publisher does not assume any liability for errors and omissions.

A.C.E. RADIO

10B/3 KENNETH ROAD, MANLY VALE, NSW, 2093. PHONE: (02) 949 4871
CHECK OUT THESE BARGAIN BASEMENT SPECIALS. FAX: (02) 451 4170
DON'T MISS ON OTHER SPECIALS.
GET ON OUR MAIL LIST.

$20.00 MIN. ORDER

Quality ETONE SPEAKERS AUSTRALIAN MADE 38CM WOOFERS

Hi Fi 8 OR 16 OHMS.

4180 100 W RMS.
1 @ $111. 2 @ $215.

4350 120 W RMS.
1 @ $133. 2 @ $261.

P.A. 8 OR 16 OHMS

4310 60 W RMS.
1@ $114. 2 @ $222.

4510 100 W RMS.
1 @ $156. 2 @ $204.

P&P 1 @ $6. 2 @ $10.

30 CM Hi Fi WOOFER 50 WATTS RMS

RES. 35Hz.Fq.Rs.35-4500

$37.95 OR $65.50/PAIR

P&P 1 @ $3. 2 @ $4.50

POLYPROPYLENE Hi Fi WOOFERS

12" 80 W RMS $51.
2 FOR $94.00
10" 60 W RMS $46
2 FOR $85.00
8" 50 W RMS $40
2 FOR $74.00

P&P 1 @ $3. 2 @ $4.50

THE COMPACK SOLUTION TO PAPER DISPENSING

ELIMINATE CLUTTERED TABLE TOPS.

2 MODELS: COMPACK (ABS) WILL SUPPORT A 30KG PRINTER + PRINTMATE
BOTH HAVE A TRAY CAPACITY OF 500 CONT. SHEETS 8.5" × 11".

COMPACK $49.50

PRINTMATE $32.60

P&P $3.50 EACH.

UNIVERSAL MONITOR STAND

WITH PAN & TILT ADJUSTMENT
SUITS ALL MONITORS

GREAT VALUE $18.00 EACH.
P&P $2.00

3.5" DISKETTE BOX

HOLDS 90 DISKS

$20.95 EA.

LOCKABLE 2 KEYS.

P&P $2.00

5.25" DISKETTE BOX

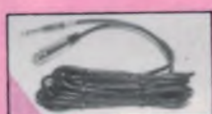
HOLDS 100 KISKS
$28.50 EA.
LOCKABLE 2 KEYS.

P&P $2.00

MICROPHONE CABLE

4.75 M LONG
3 PIN FEMALE CANNON PLUG TO
6.3 MM JACK PLUG

$9.95 EA



P&P $2.00

I.D.C. RIBBON CABLE. 26 WAY $2.50/MTR 5M UP $1.90

P&P $2.00

CAR ALARM

FANTASTIC VALUE
WORKS EVERY TIME
MANUAL
$65.00 EA.
REMOTE
$85.00 EA.
FULL INSTRUCTIONS SUPPLIED

P&P $4.00

QUALITY KEYBOARDS

86 KEY QWERTY
"PRE LOVED" WAS $35.00. PRICED TO CLEAR.
$15.00

94 KEY QWERTY
"PRE LOVED" WAS $40 EA. PRICED TO CLEAR.
$25.00

109 KEY QWERTY
"NEW" "LOW PROFILE" WAS $55. PRICED TO CLEAR.
$40.00

LIMITED STOCK P&P $5

5.25" (limited stock)
HALF HT.
DISK
DRIVES

MITSUBISHI
1Mb 96 TP1 160 TRACKS
GREAT VALUE $150 EA.
P&P $5.00

10Mb (limited stock)
HARD DISK DRIVE HALF HT.
CHEAP $250 EA
CONTROLLER CARD
$144.00

P&P $5.00

SEAGATE WINCHESTER DRIVE.

EX-COMPUTER FANS

MUFFIN TYPE

4" 240VAC 50/60HZ

$10.00 EA.

WHILE STOCKS LAST.

P&P $2.50

SPECIAL MOTOROLA 2N3055

10 FOR $13.00

P&P $2.00

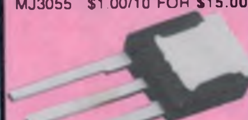
BRIDGE RECTIFIERS

1.5 A 200 PIV 10	$3.95
10 A 150 PIV 5	$10.00
10 A 400 PIV EA	$3.75
15 A 400 PIV EA	$4.15
35 A 400 PIV EA	$4.99
10 A 1000 PIV EA	$5.95
15 A 1000 PIV EA	$6.50
35 A 1000 PIV EA	$7.50

P&P $2.00

TRANSISTORS

BC337		10 FOR $ 1.70
BC548		10 FOR $ 1.00
BC549		10 FOR $ 1.00
BD139	$0.70/10	FOR $ 6.50
BD140	$0.70/10	FOR $ 6.50
TIP31C	$1.20/10	FOR $11.00
TIP32C	$1.20/10	FOR $11.00
MJE350	$1.00/10	FOR $ 7.50
MJ3055	$1.00/10	FOR $15.00



P&P $2.00

TOP QUALITY KONICA AUDIO TAPES

KX 60	3 FOR $ 6.00
KX 90	3 FOR $ 7.20
GRAND MASTER 1	3 FOR $ 7.20

VIDEO TAPES

E 180	2 FOR $19.00
E 240	2 FOR $28.50

WHILE STOCKS LAST

P&P $3.00

CAPS 190MFD 400VDC

$8.50 EA.
P&P $2.00

TRANSFORMER SPECIALS

0-24V @ 1A	$ 9.50
0-12V @ 250mA	$ 6.50
12-0-12 @ 500mA	$ 6.50
0-40V @ 300mA	$ 6.50
20-0-20 @ 2AMPS	$19.50
0-15V @ 1A	$ 9.50
0-18V @ 1.8A	$11.50
P&P NSW $2 INT.	$ 5.00

ATCO FLAT PACK

12-0-12 2A **$15.59**

P&P $5.50

ARLEC POWER TXFMER

9V @ 3A + 16V @ 2A + 16V @ 1A
$16.95

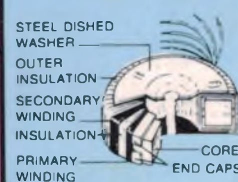
P&P $5.50

C-CORE TRANSFORMERS

JT266 0-18V 8AMP
JT248 0-10V 10A
JT249 8.5-0-8.5 4A & 15 VCT
JT274 0-9.5V 10A & 2X 0-12V 1A
JT320 36-0-36V 2A

ALL ONE PRICE $38.00

P&P $6.50



TOROIDAL POWER TRANSFORMERS

160VA & 300VA

240/12 + 12
240/18 + 18
240/25 + 25
240/30 + 30
240/35 + 35
240/35 + 35 + 15
240/40 + 40
240/45 + 45

160 WATT **$53.50**
OR 2 UP **$49.50**
300 WATT **$68.71**
OR 2 UP **$66.50**

P&P $6.50