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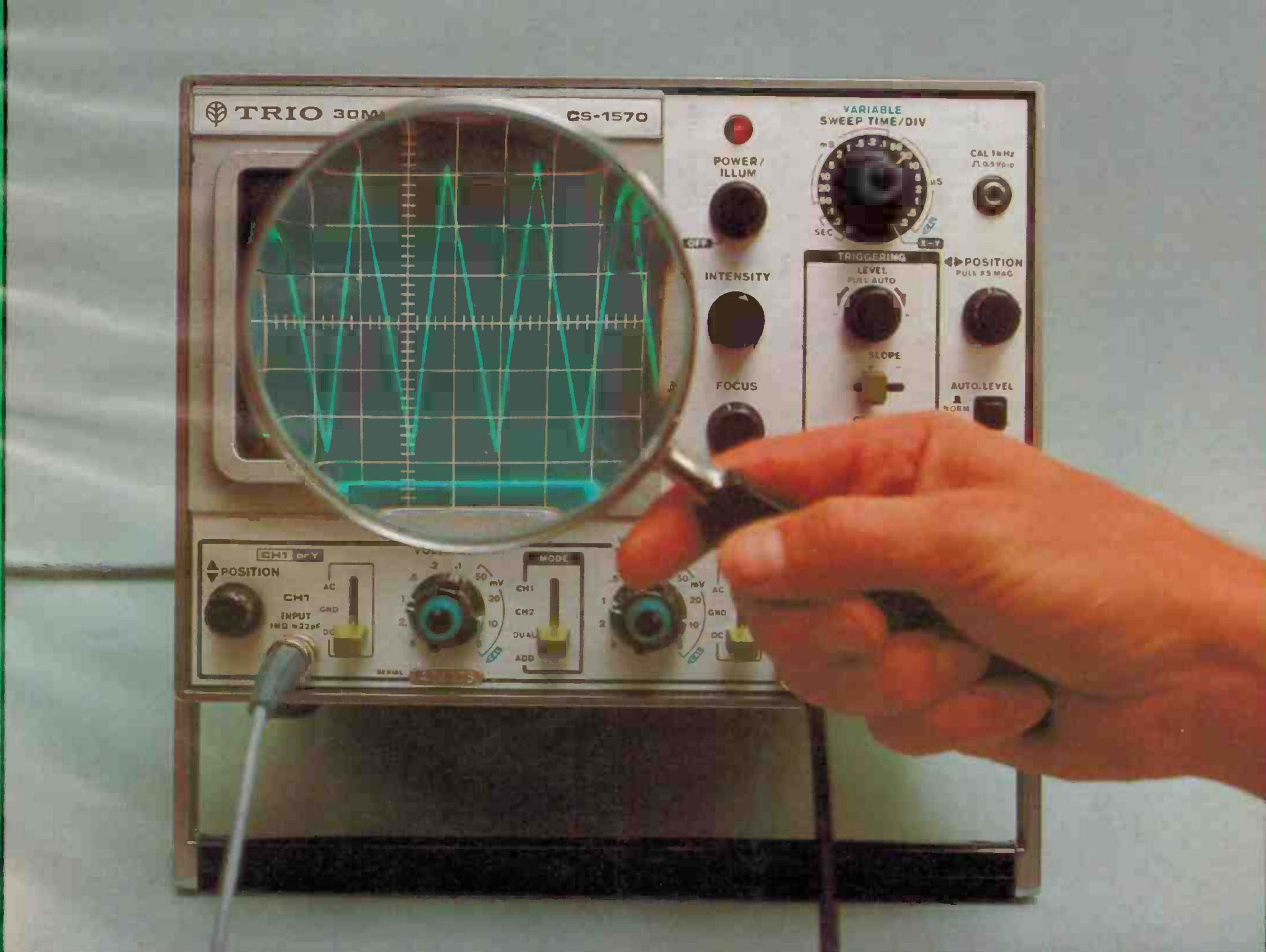

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MANAGING EDITOR
Jamieson Rowe

EDITORIAL STAFF
Mary Rennie
Jon Fairall B.A.
Geoff Nicholls B.Sc. B.E.
Peter Ihnat B.E., B.Sc.
Robert Irwin

ASSOCIATES
David Tilbrook VK2YMI
Jonathan Scott
B.Sc./B.E. (Hons) VK2YBN

DRAUGHTING
David Currie

PRODUCTION
Chris Gerelli

ADVERTISING SALES
John Whalen (National)
Cathy Darnell
Kate Stuart

ART DIRECTOR
Ali White B.A.

ART STAFF
Sharon Hill
Brian Jones
Vicki Jones

READER SERVICES
Elizabeth Barnett
Felicity Skinner

ACOUSTICAL CONSULTANTS
Louis Challis and Associates

PUBLISHER
Michael Hannan

HEAD OFFICE
140 Joynton Avenue, (PO Box 227)
Waterloo, NSW 2017.
Phone: (02) 663-9999 Sydney.
Telex: 74488, FEDPUB.

ADVERTISING OFFICES AND AGENTS:

Victoria and Tasmania: Virginia Salmon and Bruce Burrel. The Federal Publishing Company, 23rd Floor, 150 Lonsdale Steet, Melbourne, Vic. 3000. Phone: (03) 662-1222 Melbourne. Telex: 34340, FEDPUB.

South Australia and Northern Territory: The Admedia Group, 24 Kensington Road, Rose Park, SA 5067. Phone: (08) 332-8144 Adelaide. Telex: 82182, ADMDIA.

Queensland: Geoff Horne Agencies, PO Box 247, Kenmore, Qld 4069. Phone: (07) 202-6813 Brisbane. Telex: AA41398 HORNAG.

Western Australia: Cliff R. Thomas, Adrep Advertising Representative, 62 Wickham Street, East Perth, WA 6000. Phone: (09) 325-6395 Perth.

New Zealand: Chris Horsley, 4A Symonds Court, Symonds Street, Auckland. Telex: NZ60753, TEXTURE. Phone: 39-6096. Auckland.

Britain: Peter Holloway, John Fairfax and Sons (Australia) Ltd, Associated Press House, 12 Norwich Street, London EC4A 1BH. Phone: (01) 353-9321 London. Telex: 262836, SMHLDN.

Japan: Genzo Uchida, Bancho Media Services, 5th Floor, Dai-Ichi Nisawa Building, 3-1 Kanda Tacho 2-chome, Chiyoda-ku, Tokyo 101. Phone: (03) 252-2721 Tokyo. Telex: 25472, BMSINC.

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Electronics Today INTERNATIONAL

FEBRUARY 1985

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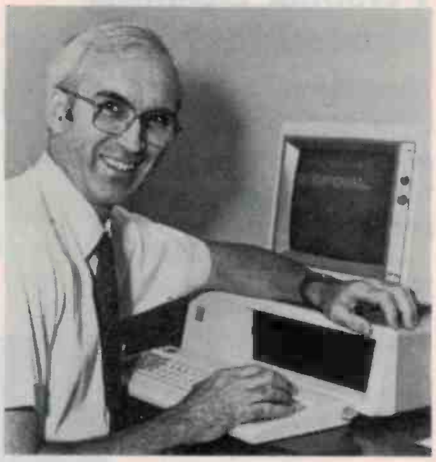

WHAT'S THIS — a different face on the editorial page? Sorry about that, but at least my face mightn't be too unfamiliar to many of you. Perhaps you might remember it from the past, when it appeared regularly in 'another well-known electronics magazine'.

Normally I wouldn't inflict myself on you, because good Managing Editors are supposed to lurk silently in the background. The reason for this current intrusion is that we've had a few changes here. Our old friend Roger Harrison has moved on, and for the last few weeks I've been manning the tiller of the good ship ETI myself. Seems like old times!

Fear not, though, you won't have to put up with my visage for long. From next month's issue, ETI will have a new Editor. We've been able to appoint David Kelly, who until very recently was Editor of the highly respected trade and professional journal 'Electronics News'.

David is very talented and enthusiastic. I'm confident that he'll be able not only to maintain ETI's existing high reputation but also to take it to even greater heights. So from next month, look for David's smiling face and words of wisdom on this page — plus even more goodies than before in the rest of the mag.

Talking about ETI itself, you've no doubt noticed another change already. We've gone back to having the full list of contents on the very front page, where most people seem to prefer it. This also saves some space, so we'll be able to fit more 'meat' in each issue.

Over the next few months you'll see a few more changes to the magazine. Nothing drastic; just things like simpler layouts, cleaner typestyles and a return to staple binding.

We're making these changes for two reasons. One is to make the magazine easier for you to read. The other is to try and contain our production costs, which have been rising alarmingly.

All in all, we're confident that these changes will help make ETI even better reading and value for money than it has been. So stay with us — you'll be glad you did.

Jim Rowe
Managing Editor

SERVICES

TECHNICAL INQUIRIES: We can only answer readers' technical inquiries by telephone after 4.30pm Mondays to Thursdays. The technical inquiry number is (02) 662-4267. Technical inquiries by mail must be accompanied by a stamped, self-addressed envelope. There is no charge. We can only answer queries relating to projects and articles as published. We cannot advise on modifications, other than errata or addenda. We try to answer letters as soon as possible. Difficult questions may take some time to answer.

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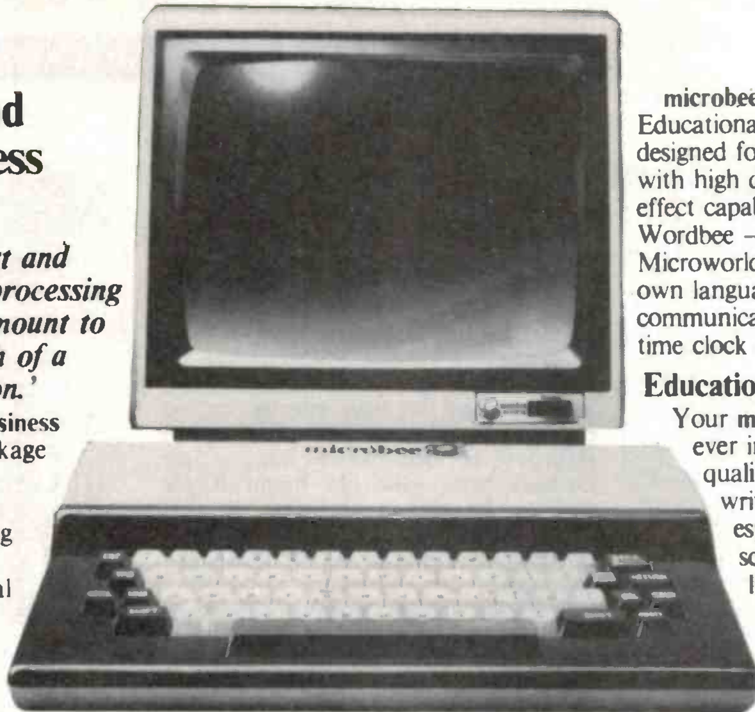

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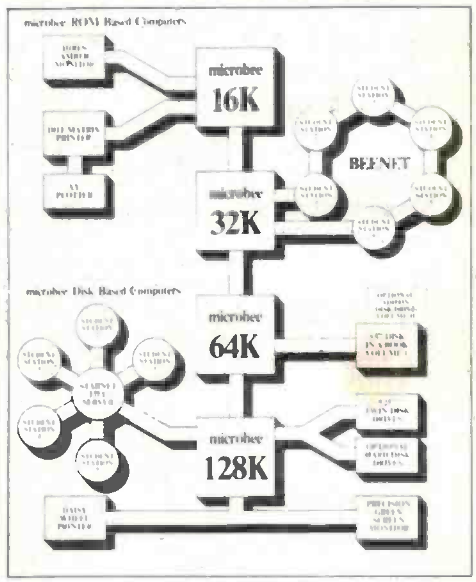

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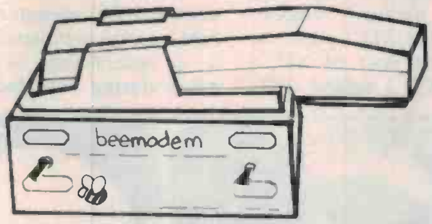

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When you buy a microbee personal computer rest assured you have made the right decision. Your **microbee** will never become obsolete — on the contrary your **microbee** is fully upgradeable and can grow from 16K to 32K to 64K and even to 128K. Disk drives can be added as can a whole host of useful and interesting peripherals such as printers, plotters and modems. Whatever level you choose to start at your **microbee** will grow with you providing challenges and encouragement along the way.

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ANZCAN — the new link

Long distance cables are not dead. Now that the earth is girdled with satellites one might be forgiven for thinking that they should be, but the opening of ANZCAN proves that there is still a place for old solutions.

The 14 000 km undersea communications cable was launched recently with a conversation between Communications Minister Michael Duffy in Sydney and his opposite number in Vancouver, Marcel Masse.

A message from Queen Elizabeth was beamed via satellite to simultaneous opening ceremonies in Sydney, Auckland, Suva and Vancouver.

The big advantage of cables over satellites for telephony is that the cable eliminates the time delay caused by the tremendous distance up to the satellite. This delay is unavoidable, since it's caused by the finite time taken for the radio waves to travel up and back.

Even at the speed of light, this delay amounts to some quarter of a second. It gets longer if there is more than one satellite path in a particular circuit, as there would be with a circuit going around the world, say from Australia to Europe.

Another advantage of undersea cables is that they last longer. ANZCAN is specified to last for 25 years. Aussat is specified for only seven. The main reason for this is that satellite power systems fail over time as the efficiency of solar cells goes down.

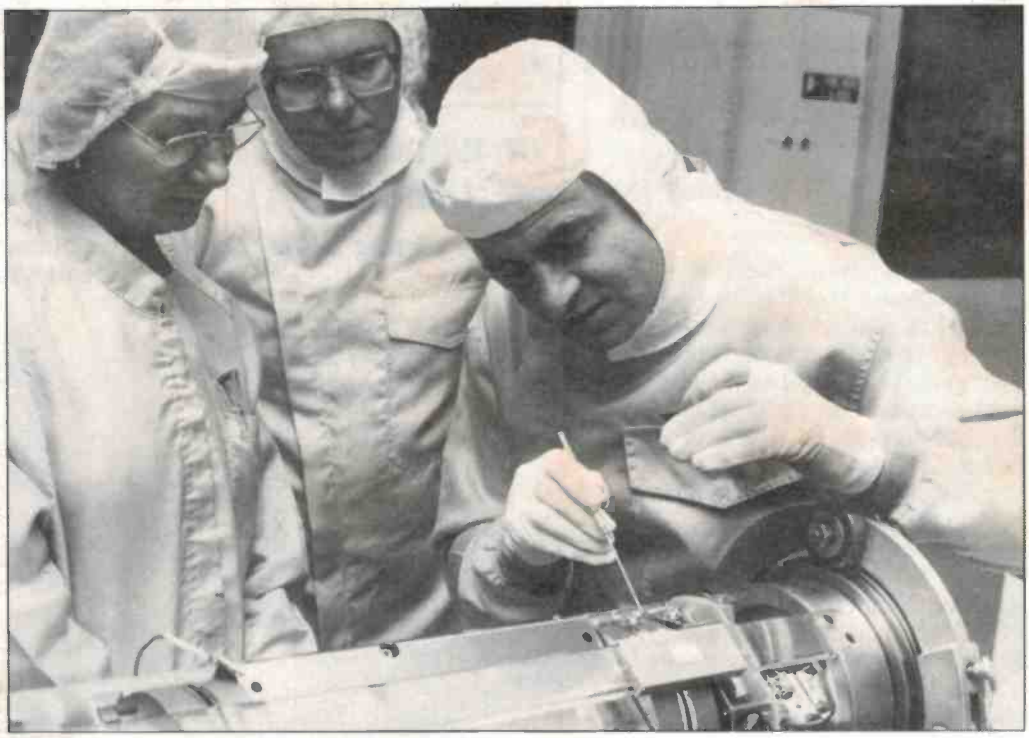
ANZCAN runs from Sydney, via Norfolk island and Fiji to Vancouver with a spur cable running from Norfolk to Auckland. At maximum capacity it can carry 1300 telephone circuits. Total cost was $400 million. The cable is owned by a 14 nation consortium and replaces the COMPAC cable, which could only carry 80 circuits.

The repeaters for the cable were built in Sydney's western suburbs at the STC plant in Liverpool. The cost of STC's contract was $39.2 million. STC had to spend $10 million to build a clean room for the manufacture of the repeaters.

The manufacture of such repeaters is an exacting task, ranking with satellite and other advanced technologies. Essentially, the specification calls for a package of amplifiers capable of giving maintainance free service on the sea bed for appoximately 25 years. Failure of any of the nearly 1000 repeaters on the cable would completely dissable it, so special care needs to be taken during manufacture. Redundancy is also built into the design, using the philosophy developed for space craft circuits.

With ANZCAN, Australia became only the fifth western nation with the capability to manufacture repeaters, along with the US, Britain, Japan and France.

STC has won the contract for the construction of repeaters for the next big cable out of Australia, the AIS cable, linking Australia, Indonesia and Singapore.



Swedish niche for the 'Bee

After some three months of intensive testing and evaluation by the Swedish School Department it was announced that Microbee is to be one of the very few approved computers used in Swedish schools.

Requirements for getting approval are extremely demanding and even brand names such as Apple and Apricot and Sinclair failed to fulfill them.

Among the approved computers Microbee was by far the most cost efficient.

This will, no doubt, echo strongly and positively throughout the rest of Europe.

Well done Microbee.

BRIEFS

The International Trade Fair for New Technology is to be held in Ghent, Belgium, from 25 February to 3 March 1985 inclusive. This fair was initially held in Ghent in May 1983, and its outstanding success ensured worldwide participation for 1985. The three cornerstones of the fair are micro-electronics, bio-engineering and new materials.

Arlec Pty Ltd has now appointed an agent for north west New South Wales. Redman Agencies which is based in Newcastle will have commenced operating as the Arlec Agent from October 1, 1984. They will stock the full range of Arlec products, servicing customers from Woy Woy to Grafton and west to Forbes. Customers are invited to contact Redman Agencies at **11 Hall Street, Newcastle NSW 2302. (049)25896.**

New video projection system

A new, versatile colour video projection system, the National TC-10010 PSN, has been launched in Australia by GEC. Designed for front and back projection from a ceiling or bench mounting, the unit will reproduce PAL, SECAM and NTSC (4.43) VTR signals onto a range of flat or curved screen sizes from 1.3 m (50″) to 2.5 m (100″) diagonal. Each projector comes complete with a full-function remote control unit.

The new projection system is being marketed by GEC Australia Limited Video Systems Division. They believe the versatility of the TC-10010 PSN makes it ideal for presenting to small or large audiences in a variety of settings whether at conferences, exhibitions or sales/training seminars.

The TC-10010 PSN has been designed to automatically detect PAL, SECAM or NTSC (4.43) input signals and reproduce them in the correct mode. If automatic detection is not required, the unit can be preset for any one format.

However mounted, the new National projector is claimed to give a high quality picture with flat or curved screens from 1.3 m (50″) to 2.5 m (100″) diagonal image size. Three special high-brightness 7″ projection CRTs and f 1.1 lenses give a high resolution of 450 lines and luminous flux of 170 lumen. A complete built-in cross hatch generator is included for precise convergence adjustment without the need for external sinc.

Each projector comes with a remote control unit (pre-wired to 1.5 m but available with optional 15 m, 30 m and 50 m cables) for routine alignment and on-the-spot adjustment. Power on/off, brightness, colour, contrast, vertical hold and static convergence can thus be conveniently controlled, regardless of the projector mounting position.

The National TC-10010 colour video projection system is available from **GEC Video Systems Division at 2 Giffnock Ave, North Ryde NSW 2113. (02)887-6222.**

New National video projection system designed for front or back projection, and ceiling or bench mounting.

". . . FEEL THE WIDTH!"

IBM (East Fishkill, N.Y.) has announced the production of experimental 8″ (203 mm) diameter silicon crystals, the largest crystals ever produced by IBM.

The East Fishkill site, one of IBM's most advanced semiconductor and packaging manufacturing and development facilities, houses the industry's largest crystal pullers for producing silicon crystals from which computer chips are built.

Standing more than two stories high and weighing nearly nine tons, each of the crystal pullers regularly manufactures crystals that yield 5″ (127 mm) wafers. The wafers are eventually processed and cut to produce individual computer chips.

The crystals are manufactured through a number of complex processes. Chunks of purified silicon, derived from common sand, are reduced to a liquid in temperatures exceeding 1400°C, 25 per cent as hot as the sun. At this point, a silicon 'seed' the size and shape of a pencil, is dipped into the molten silicon. The seed is then lifted slowly, pulling with it a trail of molten silicon which hardens to form a crystal.

The crystal column is drawn up into the cooling chamber of the crystal growing machine and eventually removed. The diameter of the crystal is determined by the temperature of the molten silicon and the speed at which the seed is lifted. The entire process takes about 24 hours.

The finished crystal is ground into a solid cylinder and sliced into wafers about 2 mm thick. The wafers are polished to a mirror-like shine in preparation for chip fabrication. Then the wafers are subjected to hundreds of manufacturing processes that build computer chips on their surfaces. The chips contain thousands of electronic circuits.

Five inch wafers hold nearly 850 chip sites. The experimental 8″ wafers have the capacity to hold more than 2000 chip sites, with an expected increase in productivity and reduction of overall cost per chip.

Arianespace to launch Aussat

The Government's satellite-owning company, Aussat Pty Ltd, is formally to sign a $A24 million contract with the European company Arianespace to launch Aussat's third domestic satellite.

According to the Minister for Communications, Mr Michael Duffy, and the Minister for Defence Support, Mr Brian Howe, Australian industry and OTC (Australia) would receive orders for work and services valued at about $18 million through offsets commitments agreed to by the Commonwealth and Arianespace. Offsets work would include the manufacture in Australia of aluminium and steel forgings and castings valued at between $7.5 and $9 million for the Ariane family of space launch vehicles; and this will include, if required, the transfer of appropriate technology to Australian companies to enable forgings and castings manufactured in Australia for the Ariane launch vehicles to meet the stringent quality control requirements for space vehicles.

The Ministers said Arianespace would also arrange the placement of orders on OTC worth $8.5 million for tracking and telemetry services at Carnarvon and Perth between 1985-1996 with possible extensions.

The contract provides a launch window extending from mid 1986 to mid 1988. The arrangements under which the third launch can take place in mid 1986 are consistent with the Government's recently announced initiative to provide commercial direct broadcasting to the remote areas of Australia at the earliest possible date.

Arianespace will use an expendable Ariane three-stage rocket to launch the satellite. "The Ariane launch site, located at Kourou in French Guiana, close to the equator enables the satellite to be placed directly into its geostationary transfer orbit 36 000 km above the equator with considerable savings in the fuel carried on board the satellite and thus increasing the life of the satellite by more than two years," said Mr Gosewinckel, General Manager of Aussat.

Arianespace is a private European commercial consortium formed in 1980 and jointly owned by thirteen major European banks, thirty-six European aerospace and electronics manufacturers, and the French National Space Agency.

For further information contact **Mr W G Gosewinckel, General Manager Aussat, (02)238-7800 or Mr Leighton Farrell, Manager — Public Affairs, Aussat, (02)238-7892, (02)683-1261 (ah).**

New aids for making pc boards and labels

Melbourne manufacturer Sesame Electronics is now producing three inexpensive pieces of equipment to assist in the manufacture of pc boards in the small lab or at home.

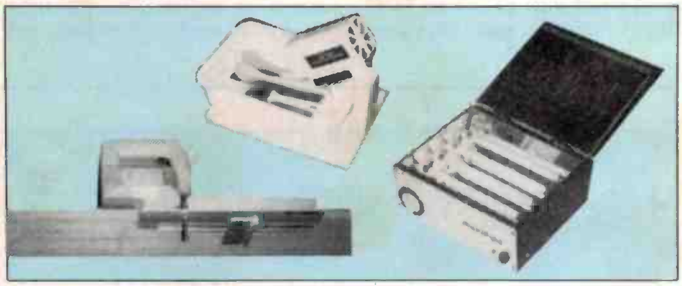
The Maxilight, the Etching Station, and the Squarecutter are respectively an ultra-violet light exposure box, a quick means of etching a pc board, and a simple way to cut blank material into rectangles.

The Maxilight is supplied in kit form, and full assembly and operation instructions are provided. It will develop artwork up to 150 x 180 mm, and is priced at $139.

The Sesame Etching Station comprises an adjustable heater/blower mounted on a base, directing hot air into a plastic dish that contains the pcb and the etching solution. The heating of the fluid, and the moving currents produced by the fan, greatly speed up the action so the etching is completed, hands free, in about 10 minutes. The Etching Station is priced at $39.

The Squarecutter will enable a pcb to be cut into a rectangle without the bother of squaring, scribing, and filing. To use it you place the material on the platform and feed it into the saw, then turn it against the perpendicular fence and repeat the cutting. A rectangle is quickly produced. The Squarecutter is priced at $39.

All prices quoted include postage. For a brochure containing more information contact **Sesame Electronics, PO Box 452, Prahran, Vic 3181. (02)527-8807.**



Robot makes 'phones

Standard Telephones and Cables Pty Ltd (STC) has installed a robot at its manufacturing plant in Alexandria, Sydney, to do work previously performed by an operator in the manufacture of telephone handsets.

The robot is a 5-axis ASEA Rb 60, which STC selected because of its absence of hydraulics, its quietness and its physical size.

While STC has always been in the manufacturing forefront and has installed at its Alexandria plant many items of equipment employing new technologies aided by various pick and place robots, the ASEA Rb 60 is the company's first application of a large scale universal robot.

Installed in the plastics moulding division, the robot forms part of an integrated system. Before the robot was introduced, each moulding machine was attended by an operator, who was required to precisely locate the removable core pieces, maintaining a high degree of precision throughout the shift as well as perform the arduous task of removing the mouldings, operating the guarding system and performing supplementary operations. The robot has now taken over those tasks and performs ten functions in one complete operating cycle rearranging and manipulating the required objects.

The complex is safeguarded by a series of sensors which protect the tooling and equipment against operator mislocation of the core pieces or any malfunction of the moulding machines, robot or rotary table.

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HIGH-FREQUENCY HORNS					
Model	Type	Low-Frequency Limit	Entry Diameter or Adaptor Required	Dimensions (cm) (Height x Width X Depth	Weight
2028	Exponential	1200 Hz	1.8 cm (Use 1034 Driver)	12.0 x 28.0 x 18.5	0.95 Kg
2040	Exponential	800 Hz	2.54 cm (Use 1044 Driver)	16.5 x 39.2 x 19.0	1.6 Kg
2052	Exponential	500 Hz	3.56 cm (Use 1072 Driver)	19.6 x 49.4 x 24.0	3.4 Kg
2042	Exponential	800 Hz	3425 (Use 1044 Driver) 3435 (Use 1072 Driver)	17.0 x 40.2 x 19.6	2.0 Kg
2048	Sectoral	800 Hz	3425 (Use 1044 Driver) 3435 (Use 1072 Driver)	22.0 x 47.5 x 34.4	5.2 Kg
2060	Sectoral	500 Hz	3425 (Use 1044 Driver) 3435 (Use 1072 Driver)	26.6 x 60.0 x 39.5	7.6 Kg
2070	Multicell	500 Hz	3835 (Use One 1072 Driver) 3870 (Use Two 1072 Driver)	32.0 x 73.5 x 46.5	16.4 Kg

HIGH-FREQUENCY DRIVERS							
Model	Nominal Impedance	Power Capacity	Frequency Response	Sensitivity (dB/1m, 1W)	Voice Coil Diameter	Dimensions (cm) (Diameter x Depth)	Weight
1034	8 ohms	50 Watts	1200 – 18000Hz	102 dB	3.44 cm	10.8 x 6.6	1.7 kg
1044	8 ohms	75 Watts	800 – 15000Hz	104 dB	4.44 cm	12.6 x 8.1	3.6 kg
1072	8 or 16 ohms	100 Watts	500 – 12000Hz	106 dB	7.20 cm	16.3 x 9.2	7.0 kg

NETWORKS						
Model	Crossover Frequency	Impedance	Power Capacity	High Frequency Attenuation	Dimensions (cm) (Height x Width x Depth)	Weight
4012	1200 Hz	8 or 16 ohms	100 Watts	0–4–8–12 dB, switch	16 x 8 x 7.0	0.5 Kg
4008	800 Hz	8 or 16 ohms	150 Watts	0–4–8–12 dB, switch	20 x 10 x 7.0	0.9 Kg
4005	500 Hz	8 or 16 ohms	200 Watts	0–4–8–12 dB, switch	19 x 15 x 8.5	1.4 Kg

Music computer to win

Sonics, Australia's magazine for music-makers, is running an interesting competition in its January/March issue. The prize is Yamaha's new MSX computer, the CX5M, plus a 49-note music keyboard, three software packages and a Taxan Vision-EX colour monitor, worth over $1600 in total!

As well as being an MSX-standard computer with 32K ROM and 48K RAM (16K VRAM), the CX5M incorporates Yamaha's 'FM voice generator' chip, which provides eight octaves of high-quality sound and the ability to produce eight different voices at once. In other words, this computer is a real music-making tool.

The accompanying software is very useful too. An FM Music Composer allows you to write music onto on-screen staves from either the typewriter or the music keyboard in up to eight 'parts' with full control of time and key signatures, tempo, dynamics and phrasing. Compositions can then be played by the CX5M, or by up to eight other instruments equipped with MIDI (the Musical Instrument Digital Interface) under the control of the CX5M.

An FM Voicing program allows you to edit and alter the pre-programmed voices or create totally new ones; and a Music Macro program adds a special set of commands to the MSX BASIC language, permitting control of the FM voice generator from within BASIC programs.

The Taxan/Kasa Vision-EX monitor has been kindly donated by Colex Australia, and is an excellent medium for reproducing the CX5M's comprehensive 16-colour graphics, although a conventional colour TV can also be used.

Entry forms are to be found in the January/March issue of Sonics magazine.

Defense fairs to boost Australian exports

A recent successful series of Australia-United States defense contractors fairs held in five mainland capitals during November last year are expected to lead to Australia's defense industry becoming a significant supplier of military spares and electronic equipment to the US Defense Department and its prime contractors.

Some 70 US participants, representing logistic support agencies and contractors, visited Brisbane, Perth, Adelaide, Melbourne and Sydney seeking Australian suppliers for goods from metal castings to printed circuit boards for electronic equipment. The Americans carried actual bid packages to discuss with Australian businessmen. The US defense department budget for military spares alone this year is worth $US30 billion. "Judging by the enthusiastic response from Australian industry representatives, the US visitors did not return home disappointed," Mr Howe, Minister for Defense Support said.

This was underlined by the overall attendances at the fairs. Some 718 Australian defense industry senior managers, representing 460 separate companies, attended the series of one-day fairs. Of these, 325 companies lodged serious inquiries concerning contract opportunities with the United States Defense Department (which has a 1985 budget projection of some $272 billion).

Mr Howe said the fairs had done much to show the US Defense Department and its prime contractors that Australia possessed skills which could be used for sound commercial reasons. "The US visitors were clearly impressed by the capability of our defense industries, particularly the prices and short lead times being quoted," he added.

The US Secretary of Defense, Mr Weinberger, has ordered a wide range of reforms in procurement practices, and US Congress also recently enacted the most significant changes in US procurement laws in over 40 years.

Mr Howe said the reforms paved the way for more competition from overseas suppliers for US Defense Department contracts.

More bytes

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- **16 user definable keys for incredibly easy use**
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- **Ergonomically designed keyboard & durable cabinet for complete portability**
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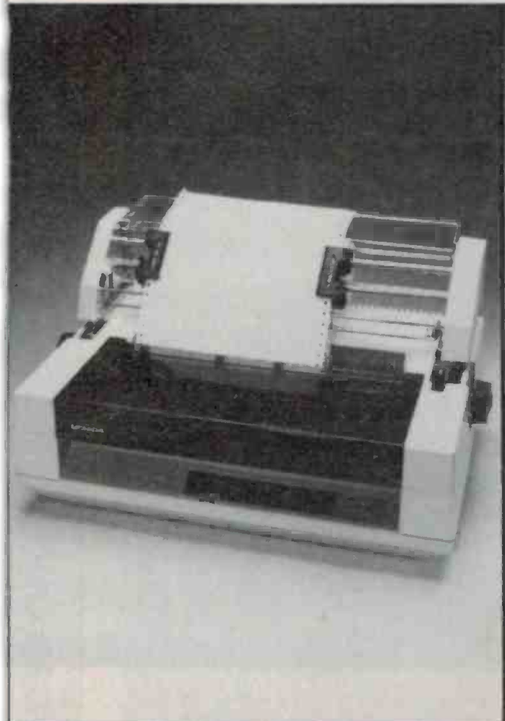

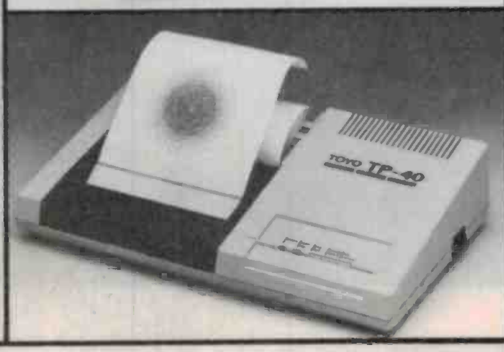

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A882

MADE IN MY IMAGE

A little philosophising on the coming high-tech revolution. Imaging is as old as evolution, according to Malcolm Goldfinch. Imaging is the reproduction of something in another form. Thus, DNA molecules are a form of imaging; animal cries, speech, writing, painting, photography, computing, video — all involve imaging, no matter how indirect the method may seem. Intrigued? . . . read on!

Malcolm Goldfinch

FOR INVESTMENT analysts in Wall Street, Gnomes in Zurich, Shogun of the Yen in Tokyo, the new 'buzz-word' is *imaging*. At last we appear to have a word that encompasses the whole field of endeavour which high-tech electronics is principally about. For humanity, imaging has been a fundamental achievement of gods. Just flip back the pages of the Bible to Genesis and find on the first page, "And God said, 'Let us make man in our image after our likeness . . . So god created man in his own image . . . male and female he created them'."

There is no denying, by either creationalist or evolutionist, that imaging is the fundamental process for the continuation of life as we know it. Only recently has it been revealed to us that the reproduction of the cells that make up our body and all living matter, is the result of the chaining together in double helix form, simple substances, like nitrogen, phosphorus, sugar, to form the DNA molecule. DNA is the original imaging device that self-replicates. It is able to do this by following a long series of coded instructions contained in its helix; not unlike a computer tape. The human brain can now 'peak' and understand these chromosome codes, and we have the ability to 'poke' new bits into them by biological engineering, thus changing the very patterns of life. It seems incredible that we still use the term 'biological engineer' to describe someone bashing bits of code in and out of a chromosome helix in a DNA molecule. Perhaps 'imagineer' would be more acceptable.

That word 'imaging' has bugged me for some months. It was used in the *Economist*, by a Polaroid press release, and an investment analyst in the US trying to de-tech and group together a lot of different high-tech goings on that seemed to turn out the same sausage. I thought it was valid and it looks more useful each day.

A hard look at imaging

If imaging is the critical basis of our present existence and progress it is worth examining in detail. It comes in two forms just like computer data, 'real-time/on-line' or 'time-shift'. Probably the first form of real-time or 'now' imaging, was a flipper, wing, arm, or leg, waggled in a certain manner when danger threatened. Possibly the original waggler died a squillion years ago, but those of the tribe who interpreted the waggle as danger and took off, survived to reproduce other wagglers, who also saw and imaged danger by a waggle. Those who did not were mostly eaten and never imaged themselves. It is not difficult to project evolutionary progress to show that grunts and screams allowed even more survivors than waggles did; language started to describe the threat, and so on. Speech was the only real-time imaging generally used on earth for some millenia, but with the imaging explosion in the 1800s there has been rapid progress; telegraph, telephone, radar, to an early-warning missile system — the current ultimate in real-time imaging!

Sadly, time-shift imaging only goes one way at present. Forward, it would revolutionise punting. Time-shift imaging probably started when some form of life noticed that if you drank from a pool at a certain spot, you got pulled in by the nose and disappeared. Probably it was a humanoid that first started to sketch, with a stick burnt in a bushfire, a drawing of an alligator with a stick-figure in its mouth. This imaging of danger was stored in time until the carbon washed off the rock. Of course, those who drew and understood such danger signals spread their DNA codes through life much more than those who became a croc's dinner. If you also put this situation on a personal computer with a program for 'future' projection, you could find on the screen a high-resolution graphic of a couple watching an XXX blue-movie in colour and stereo-hi-fi sound, on a video. Odds are this couple will do more to spread their DNA code in future generations than a couple without a video and playing tiddlywinks. The tiddlywink players will probably be consumed by boredom before going to bed. Video is the present in ultimate in time-shift imaging.

In real-time imaging we have sounds, speech, signs from the body as primary sources. As long as you agree that a time-shift of less than a second is not a time-shift of mental significance, we may include telegraph, telephones, television and all their permutations which include computer data processing within this real-time span.

In the time-shift mode dancers image past behaviour; artists image past sight; singers, musicians and actors image past sounds; writers image past thought. This last time- ▶

The phonograph was the first major advance in capturing the 'real' audio image.

TOWARDS A PERFECT IMAGE

Most of us in the business of bashing electrons on their way are likely to be considered part of this great imaging industry. Just how did it overtake us? It all started in the last century from a number of different directions.

The first reality imaging was called 'photography' (light-writing). Mande Daguerrre and William Fox Talbot were the prominent pioneers. In the process a silvered copper plate was exposed in a camera and was developed by depositing mercury fumes which amalgamated with exposed areas. Reflective and non-reflective areas against a dark background produced the photograph image.

We all know how later, others put photos together and we had the first, moving reality imaging, in time-shift, to store contemporary life; the reality, not a painting or a series of words. Such early imaging is now part of our priceless archives.

Daguerrotype stereo pair coloured images from 1853. They produced a lifelike stereo image when the case in which they were mounted was folded out.

The next step was telegraph imaging, then telephone imaging, both in real time. Then an historic time-shift by Thomas Edison, imaging of the voice, music and any sound. It was a purely mechanical device that is now electronic.

Photography is also halfway across the chemical river into the electronic world. Typewriters, telex copying machines, fax, data storage (digital-photographic), TV, video, music synthesis, hi-fi, PA, calculators, computers of all type.

All this may be a longshot from my Editor's request for a steer as to where video is going, but context in writing is somewhat similar to Einstein's fourth dimension. Without this it would be ridiculous for me to say what I wanted to at the beginning, "In the 1980s, humanity achieved its greatest emancipation through the perfection of imaging". As a rider I would add, "The advent of digital video is the final and most important link in the imaging chain". ●

shift, of writing, and to an extent drawing and dancing, is concerned with the time shifting of thought or as I prefer it *consciousness*, from the Latin 'conscius', com = with + scire = to know.

My dictionary defines philosophy in part as, "The rational investigation of being, knowledge, and right conduct". Surely this is almost a synonym for the definition of '*consciousness*', excluding "right conduct" (very contentious). All this is pertinent to imaging because it shows that writing as a means of imaging is a very blurred medium and the mental images from written codes will vary from person to person, yet *writing images* was all mankind had to shift consciousness through time. Consider how much better we would have understood the philosophy of, say Shakespeare, if he was now to read to us, passages from his plays with inflections of speech, gestures and facial expressions, using the time-shift to perfection on any home video.

Perhaps now, or in the near future, we will have a brilliant bard who can do this for posterity. Once etched into a digital glass disk, such imaging would be there in archives for all time. For thousands of generations the full image of the human consciousness projected by this person would be handed down, crystal clear and with less room for interpretation to twist and blurr real meanings.

The blurring of past time-shift, both in language and the symbols of writing, could have been a prime cause of human conflict, between tribe or nation. Where there is a grey area, the interpreters ply their trade. A study of history shows most wares were justified by a consciousness or philosophy which one tribe wished to impose on another, against their will.

Today computers can interpret languages with agreed definitions. Video can record and convey the spirit and meaning of agreement. There should be little room for manipulators of past images of fact and philosophy.

How video imaging impacts

Imaging by video is of course much fuller than by writing. Words can evoke specific details and the rest of the picture is imagined through association or not at all. My grandson can say "I want it in video". Okay. Press a button, up comes, for example a horse walking. In the time it takes to read, "big horse walking" Grandson has now seen it all and in a flash, learnt what it really looked like; not his mental image with all errors and defects. He saw, not only a big horse walking, but also, that it was a rhone stallion, white sox on two fore and one hind leg, steaming because it has been galloping in a valley on a frosty morning and making a great whinnying noise.

This is the reality image. We now live in a whole new world of realism. You may like our dream world of the past but reality is here to stay. There is a million years or more between the first written imaging and this latest high-tech, reality-imaging in video.

If this is what imaging is about, then world financiers are right to regard most electronics based industries as part of this new wider field and want to invest and participate in the action. We technocrats may have missed the mainframe because we were looking at the chips, but suddenly we find ourselves in the new world of reality; be it real-time or time-shift.

One stop imaging

For years we have had vacuums to clean, washing machines to wash, automobiles for mobiling, but we have had to have a large number of devices to do our imaging. The camera, phonograph, radio, TV, hi-fi, tape/cassette recorder-player, copying machine, microfiche . . . If the people in these industries could now see themselves as all part of the faculty of imaging, and instead of working in hundreds of different directions they work towards providing the best common means of imaging, then this new era will really have arrived. The consumer could be happy with one imaging device for all these functions.

No matter what governments or multi national organisations plan for the marketplace to-day, the consumer is dictating, worldwide, what they will and will not accept. There has been a large number of ill conceived products foisted on consumers with the technological explosion of our age. Many have been caught with junk machines of a type or a format for which there is no film, tape, cassette, or parts and technology.

Quadraphonic sound was the first megabuck disaster and there are several consumer-dictated disasters of great magni-

tude, either taking place or likely to, in video/tape, video/disc, video/cameras, film/camera's and perhaps most of all in computers. Consumer dissatisfaction has resulted from a lack of awareness by some manufacturers as to where all this new technology is heading. Consumers are not going on a trip to anywhere.

Specifications for imaging centre

The vision I see for the consumer in the immediate future, is a home imaging centre using a sophisticated dual, digital-disk system, with a disk size similar to the 5¼-inch, capable of multi-megabite digital storage and quick retrieval. It will have disk to disk copying and interchangeable drives also chainable to extra drives, and all with common inputs and outputs.

The home disk library will contain all the family still and video pictures, like a photo album, music, records or documents recorded on videocamera or fax, computer programs and data files. An analogue to digital, and reverse converter will be part of the system to interface with the telephone and or optic line. It will answer and image calls or give stored messages from voice recognition names to correct callers via computer control. The computer will be on line and in concurrency with the imaging centre at all times to take and send electronic mail and advise daily of appointments and birthdays.

All orders, receipts, income costs and expenses will be fed in and compiled into budgeted accounts and cash positions on line. All old analogue material will be digitally converted and imaged to disk for access as required. An optic cable with ports in every room will allow infrared remote control of the imaging centre from any convenient location, as well as the use of portable TV/computer hi-resolution colour monitors with infrared coupling to the fibre optic daisy-chain.

Hi-fi audio will be located with the imaging centre and remotely operated. Portable speakers will sense infrared digital audio input, from the fibre optic chain, and incorporate Carver type, high-power low-mass mini-amps.

Good news for the cleaners is no wire trails around the room. A powerpoint connection to monitor-TV and speaker-monitor will be all that is required. The computer will be controlled by an IBM-PC Junior type infrared keyboard. It is not a dream; all this exists now. Making it in lots of 100 000+ will correct the price.

Examples of use

Taking the vision further to using this imaging centre requires just a little 'imagination'.

Wanting hi-fi? Just select music from the computer databank by cursor or mouse from menu. Retrieve the imaging disks listed by computer, insert and wait for the transfer of tracks then remove from the imaging unit on computer instructions. Program now on disk 2. Return music disks to the library. Wheel speakers to the favoured location for listening, point infrared sensors to chain port, plug in speakers to any powerpoint, use controller to start selected program and continue control. Switch to FM/AM as desired.

Video? Repeat the process as for hi-fi and add portable video-monitor between speakers or wherever convenient. Replay selected discs for family or commercial video programs, family photo album, stored documents, select TV channels, optic cable programs, TeleText, etc.

Or perhaps portable video: use a normal camcorder such as the JVC GR-CJ and/or videocamera/VCR combination to shoot scenes and return to imaging centre and edit while replaying to imaging disk through analogue/digital interface.

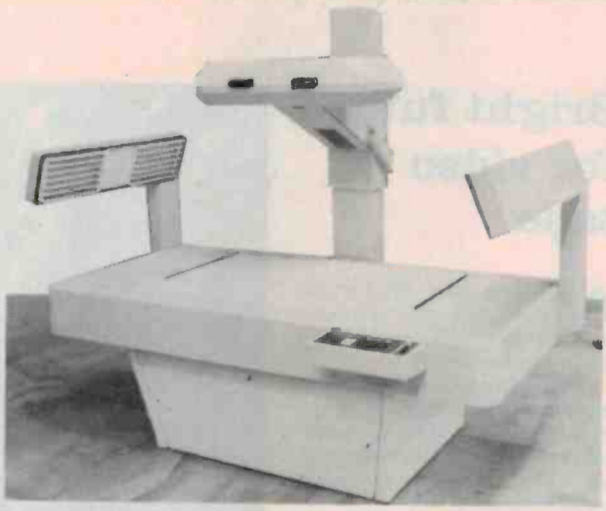
The home computer to be used with the imaging centre would have memory in the order of 0.5 to one megabyte, always on line and loaded with a housekeeping program for home function, timing, reminding, phone messaging, electronic mail, database interrogation. Just program the menu and transfer control as described for hi-fi and video. All memory data would be saved to imaging disk and in a later housekeeping session would be transferred manually under computer instruction to correct library disks. Keyboard or other input peripheral sessions could be carried out in any location on the infrared optical chain where a keyboard and monitor are located. With multi-monitors concurrent computer games and keyboard operation would be possible without inhibiting housekeeping computing.

Conclusion

This futuristic home situation may sound as though it is for the very well-heeled. Think back five years. Only the very well-heeled were supposed to have a personal computer that could word process and print an acceptable letter, as well as play games. The idea of having a central imaging with one, two or more chained disk units that are made to a world standard and replace the plethora of imaging devices of different types we are using to-day, will rationalise the interchange of imaging as well as make a dramatic cost reduction.

Like hire-purchase deals it will be possible to start with only the optical chain around the home and add the imaging and peripherals as the finances allow. For the time being existing turntables, cassette decks, compact discs, VCRs, video disks, as well as computer DOS will be required to build up the imaging centre disk library. Amplifiers, TV or monitors and speakers will go on forever, but gradually order will come out of the present incompatible and duplicated chaos. The revolt against spaghetti-like tangles of wires, spread all over the carpets and shelves will at last be put down; or will it? ●

Micrographics breakthrough from WA



About five years ago Perth businessman Gene Kostecki found himself with a problem more of us should have. He had a bundle of money, and nowhere to put it.

The traditional answer to his problem among Australian businessmen is to put the money in real estate, or to buy a smart accountant and put it at the bottom of the harbour. But Kostecki wanted to do something useful with his money. So he joined together with another businessman of similar mind called George Brown. Two bundles of money looking for a good idea.

They found their idea in the person of Siegmund Raith, an electronics engineer with an interest in archival systems. Briefly, the situation he faced was that we live in the information age. It's an age when the accepted wisdom is that more information is necessarily better.

The problem is just this: how do you know what's available and where it is? Also, how do you store it and how do you get at it? Anyone who has been inside a decent sized library, especially a library orientated to research work, will understand what a problem this is.

The solution, in use for many years now, is microfiche or 'fiche' (pronounced 'fish'). A fiche is a small transparency, just like a photographic slide only bigger. Material can be photographed and then accessed by retrieving the slide and using a projecting viewer called a 'reader'. It's small, dirt cheap, easy to store, easy to use and given reasonable handling, lasts a long time.

The methods used to make and store microfiche were worked out about thirty years ago, and nothing much has changed since. Raith's idea was to take the whole microfiche system and apply modern computer techniques to it.

Four years and a million dollars later Raith and his co-workers stepped out of the laboratory with the fruits of their labours. the result was a camera with better resolution and greater flexibility than any other on the market.

At the centre of the Eagle Eye is a 6809 microprocessor. This controls the display, keyboard, servo motors and memories that give the camera some of its unique features. It gives precise positioning of the head (in the order of micrometres) to allow reductions from 1/8 to 1/36 in size. It also controls the positioning of the film, which uses a special vacuum system to align it precisely.

The result of positioning the optical path so precisely (2.5 µm overall) is optical resolution significantly better than any other camera available. According to independent assessments, the Eagle Eye can resolve 220 lines per millimetre with black and white film, and 180 lines per millimetre with colour.

The camera can intermix large maps or drawings with items down to postcard size. The infinitely variable shutter constantly adapts to conditions of illumination and glare to ensure uniform exposure.

The 6809 also controls an interface which allows electronic titling via a fibre optic link. It also controls data transfer between the camera and an external computer system. This allows documents to be titled by computer, then recorded and stored automatically. The information can thus be used to form a data base from which information can be recalled at will.

The question arises: why use micrographics at all, why not just store information on disc or some other electromagnetic medium, where it could be directly accessed by computer? The answer is just one of cost. A single fiche contains some 10-15 gigabytes of information, at a cost of less than a postage stamp. And it can be used for maps and other graphic displays that are very difficult to digitise.

Armed with their lovely new camera, Browne and Kostecki headed off to the USA to try and drum up some sales. Before they left they approached the Department of Trade, which lined up various meetings for them. Each of these led to other contacts. Eventually they stuck the mother lode. The giant aerospace company, McDonnell Douglas, looking for some local offsets to set against the F-18 fighter program with the RAAF, agreed to act as marketing agent in the US.

With an assured market in the US and expressions of interest from Asia and Europe, Kostecki and Browne have decided to expand the operation from a six person R & D operation into a proper assembly line to turn out about 250 cameras a year. Cost? According to Gene Kostecki you won't get much change from $100 000. Sounds like the start of a healthy business enterprise!

Topline BASF tape

BASF has released its new chrome audio tape technology as the Chromdioxid Maxima II.

It combines ultra-fine Chromium Dioxide tape with a high precision cassette housing. According to BASF, the gold-labelled audio cassette performs better than the industry standard IEC II reference tape.

It conforms to the reference in sensitivity and operating point, but excells in frequency response from 8 kHz, increasing the brilliance of the reproduction and leading to a higher sound transparency. The Maxima technology also balances possible errors in the cassette recorder, such as slightly worn recording heads.

Maxima II's new patented cassette housing benefits from BASF's experience in plastics research and development.

In traditional cassette housings steel pins and axles are used to guide the tape and any deviation — as small as one fifth of one degree from the vertical — affects the tape path resulting in audibly mufled treble sounds.

But BASF's Maxima II employs the latest technology to mould plastic axles and pins with the housing to guarantee optimum vertical alignment and tape-to-head contact.

For more information contact **BASF, 55 Flemington Rd, North Melbourne Vic 3001.**

Bright future for video tape

Australians have the highest consumption of videotapes per head of population of any country in the world.

That makes it one of the most important countries in the world to Matsushita, the manufacturers of National videotape and one of the largest tape manufacturers.

In fact the General Manager of Matsushita's Export Department, Mr Mark Urakawa, visited Australia recently to discuss Australian requirements in bulk tape sales with his Australian agents, the Video Systems Division of GEC Australia Limited.

While here he made a few preductions about the future of videotape, and came up with a warning to technology buffs.

"Development of the ½" videotape technology still has some way to go," he said during a visit to one of Australia's major tape duplication houses, The Duplication Centre in Sydney.

"We are gradually increasing the density of magnetic particles of National tapes to improve picture quality."

Mr Urakawa said videotape sales in Australia were already booming, with Australians showing the highest per capita consumption of videotapes of any country in the world.

"That is likely to rise dramatically once VHS hi-fi videotapes become available," he said.

He forecast that videotapes would dominate the home market for at least the next decade or two.

"Videodiscs, which are often talked about as the replacement for videotapes, just haven't been developed to a stage where they can be used commercially."

Discs will have their uses, such as data storage, but they will not replace videotapes any more than audio discs have replaced audio tapes.

Before the advent of videodiscs, we'll see the development of high-density recording tapes to improve picture and sound quality.

And we'll also see the arrival of metal evaporated tapes with a plastic mirror surface to further improve the quality.

Much of the expansion of the market — and certainly in Australia — is going to be caused by the advent of hi-fi video. That has enthused Gordon Richmond, Managing Director of The Duplication Centre, who says that music video-cassettes will be one of the most popular units in the coming 12 months.

"Hi-fi music is already sparking a demand among consumers that will change the market," he said. "It will mean that our tape sales will go beyond the libraries and will encompass the home market. That will eventually mean the development of catalogue sales to the consumer.

Hi-fi music video is completely different to all our previous experiences. It can be retailed at a reasonable price using the highest-quality reproduction available anywhere in the world," he said.

Low cost CD player

Marantz has fired a new shot in the CD player price war, with the release of this under-$500 model. Called the CD44, it features a rugged zinc diecast chassis for extended trouble-free operation.

Other features include ultra-smooth motor powered front loading, repeat and pause function and programming for playing up to 20 tracks in any desired order. Tracks can be skipped quickly both forwards and backwards, using the player's fast forward and reverse functions.

The CD44 has a multi-function digital display which can indicate total playing time, elapsed playing time, number of tracks on the disc, the track currently being played, or the programmed track numbers. Internally the player also features digital filtering, which Marantz claims provides improved sound quality.

Finished in black satin, the CD44 is a compact 320 mm wide. It is currently selling for $499. For further information contact **Marantz (Australia) Pty Ltd, 19 Chard Road, Brookvale NSW 2100. (02) 939-1900.**

Sound facts in detail.

Ortofon have always dedicated themselves to pursuing the world's finest sound reproduction.

So when they discovered that the existing moving magnetic systems missed much of the sound detail, they did something about it.

They designed, developed and patented a new cartridge principle that could pick up as much detail as possible, accurately, from the record groove.

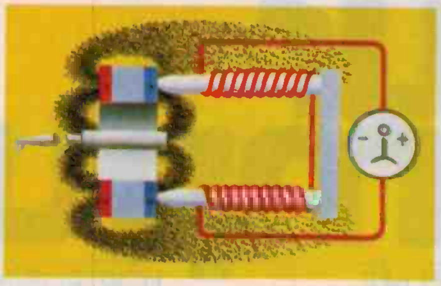
(Of course, as one of the recognized world leaders in sound reproduction, Ortofon were well-qualified in this area.)

They called it the VMS Principle.

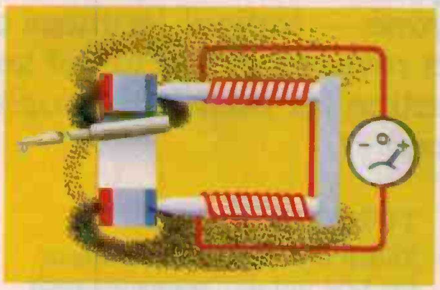
The VMS Principle (Variable Magnetic Shunt) utilizes a light tubular armature of magnetic conducting material.

This is attached to the cantilever and encircled by a powerful ring magnet. When the cantilever moves the armature closer to the ring magnet, the armature short-circuits part of the magnetic field, generating a voltage in the coils.

And the result is an increased high frequency tracking ability, low distortion and superb transient reproduction – right down to the very last detail.

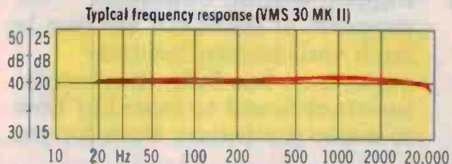


Symmetrical flux fields with the armature in the central (neutral) position. These flux fields emanate from the magnet positioned in front of the pole pins. As the fields are in balance, there are no changes in flux around and inside the coils. Therefore, no voltage is generated.



When the cantilever moves, the armature is brought closer to the ring magnet and acts as a shunt, short-circuiting part of the magnetic field. As a result, the flux field in front of the pole pins varies and a voltage is generated in the coils.

Typical frequency response (VMS 30 MK II)



Technical data	VMS 30 MK II
Weight	5 g
Type of stylus	Fine Line
Equivalent stylus tip mass	0.45 mg
Frequency response	20-20,000 Hz
Output voltage at 1000 Hz per 5 cm/sec.	5 mV
Channel separation at 1000 Hz	27 dB
Channel balance at 1000 Hz	2 dB
Compliance static, vertical	28 μm/mN
Compliance dynamic, lateral (10 Hz)	22 μm/mN
Recommended tracking force	13 mN (1.3 g)
Tracking force range	10-16 mN (1.0-1.6 g)
Tracking ability at 315 Hz lateral	90 μm
Vertical tracking angle	20°
FIM distortion	1% (13 mN)
DC resistance	800 ohm
Inductance	600 mH
Recommended load resistance	47 kohm
Recommended load capacitance	400 pF

As if that wasn't enough, the VMS also reduced sensitivity to hum pick-up and minimized distortion and non-linearity in the magnetic system.

Presumably, the cost of an Ortofon VMS Magnetic Cartridge would be high.

Surprisingly, it's not. In fact, it's especially affordable.

Check the facts on the VMS 10E MK II, 20E MK II and 30 MK II at your hi-fi or Ortofon dealer.

And while you're there, find out how to home-test your stereo equipment with the Ortofon Pick-up Test Record.

It's another sound fact in detail.

Distributed by Vanfi (Aust.) Pty. Ltd.
Melbourne: 297 City Road, South Melbourne, Vic. 3205. Tel. 690 6200.
Sydney: 283 Alfred Street, North Sydney, N.S.W. 2060. Tel. 929 0293.

ortofon
accuracy in sound

DBHS&I. VAN 0036

QUALITY 'NO FRILLS' RECEIVER

A modest, unobtrusive stereo receiver peeps out of the shop front window, retires into the lounge room corner. But under the test, the NAD 7155 shines. This receiver gives a performance worthy of much attention, with innovative extras and quality sound.

THE BRAND NAME 'NAD' is not as well known in Australia as many other major manufacturers'. The reasons for this relate to the company's previous posture with respect to advertising and public relations in general. This attitude has perceptibly changed in the last year as a result of a shakeup in company management in the USA where the company's headquarters is located.

NAD is somewhat different from all of the other companies with which I am familiar in that it is owned by the distributing companies and dealers in the five continents where the products are sold, and while the company's attitude to public relations has obviously changed in the last year, the basic design philosophy underlying its product design development and market has not. The company executives and dealers are very quick to state their attitudes on product design and performance and tell you that their aim is "to market the best possible product at the lowest possible price".

Your response to that statement, like mine, many well be "isn't that everybody's?". Well, yes it is, except that NAD believes implicitly that the correct path to achieving that philosophy lies in the deletion of unnecessary frills avoiding garish and expensive front panels and reducing the number of functional controls provided to the bare minimum.

This is aimed at not only keeping down the cost, but more significantly in producing a simpler, more straightforward design which most purchasers really prefer in the end. NAD tells you that "this puts the emphasis on performance rather than on appearance".

NAD 7155 STEREO RECEIVER

Dimensions:	*420 mm (wide) x 108 mm (high) x 380 mm (deep)*
Weight:	*9.18 kg*
Manufactured:	*NAD Electronics, Lincoln, Massachusetts, USA*
Recommended Retail Price:	*$869*

Design and function

The 7155 'digital' stereo receiver does not immediately appear to be an exciting piece of equipment. Although it offers multiple features, some of these tend to be understated in terms of the factors that we would normally expect a manufacturer to stress in his literature. Because of this approach, the most exciting features tend to be the things it *doesn't do* rather than the things it *does do*. ▶

The frontal appearance of this receiver is the least assuming of any receiver I have yet reviewed. It is neither 'brassy bronze' nor 'flashy silver' but features a neutral flat grey front panel with white screen printed lettering. The main controls and displays are set out on two basic levels with relatively few controls in each.

On the upper level, centrally located, is a smoked escutcheon digital display panel behind which station frequencies may be seen, with clear plasma display designations for FM or AM. These are supplemented by a set of five rectangular light emitting diodes (LEDs) to indicate station signal strength and a neat pair of arrows to indicate that your carrier is off frequency and which flank a central rectangular LED; this illuminates when the receiver is correctly tuned to the carrier frequency.

To the right of this display are five push-buttons for selecting preset station frequencies and an entry button and a switch for selecting AM or FM. Above these controls are two small amber LEDs that indicate that an FM stereo station is being received and a SOFT CLIPPING indicator which shows that the soft clipping switch on the back panel has been activated. To the right of the display is a rocker bar SEARCH control that allows you to increase or decrease frequencies, and below which is a SEARCH MODE button which automatically sets the tuner into a scanning mode to search out station carriers rather than incrementally stepping the frequency control.

There are relatively few controls on the bottom row. On the left is the POWER/ON switch and the HEADPHONE socket. Besides these, there is a rotary speaker selection switch for 'A' system, 'B' system, OFF and 'A + B' system. To the right of these are a BASS control, a TREBLE control and a BASS EQualisation switch which boosts the frequencies below 60 Hz to compensate for drooping speaker low frequency response.

The next control is an INFRASONIC DEFEAT switch which disables the rumble filter roll-off characteristic, a standard feature of the input circuitry. This normal roll-off characteristic provides 13 dB of attenuation at 10 Hz. With the infrasonic defeat control activated, the low frequency attenuation is reduced to 2 dB at 10 Hz and less than 0.5 dB at 20 Hz.

A mono push button provides the ability to combine the two stereo channels, which is a function that would not often be required. The fourth control is a push button which disconnects the internal DYNamic SEParation circuit. This particular circuit selectively reduces the stereo separation at high frequencies in order to maintain a stereo signal when a weak incoming RF signal is inadequate for the maintenance of normal stereo listening quality.

One area where the functional controls seem to be more comprehensive than you might expect is in the area of functional recording and playback controls. In this area the 7155 provides two completely separate switches by means of which the recording function and the listening function can be completely separated. The designations for each of these controls are precisely the same: CD/AUXiliary, PHONO, TUNER, OFF, TAPE 1, TAPE 2. This provides the wherewithall to record off one input, playback to another and then separately listen to a third.

Two other push buttons are provided labelled LOW LEVEL, which is another title for a mute switch, providing 20 dB of attenuation. The other switch is a LOUDNESS COMPensation control which activates a loudness equalisation curve boosting the low frequencies and high frequencies to compensate for the subjective physiological response to low level audible signals.

The last control provided is a circular volume control with a centrally located indented balance control offering one of the best ergonomic design features for this control function that I have yet seen.

The rear of the receiver is neat and functional with the connections, controls and switches laid out in two rows. In the upper row is an AM ferrite loop stick antenna which the designers have carefully labelled with the caution "THIS IS NOT A HANDLE"! Beside this are spring loaded terminal connections for an external AM antenna, a balanced 300 ohm FM antenna and ground connections for the AM antenna. Unlike many other receivers, this unit also incorporates a 75 ohm coaxial socket to facilitate direct connection of a properly wired FM antenna.

In the top centre of the back panel are eight clearly labelled colour coded universal terminals for connection to the loudspeakers. The bottom row of controls features a pair of phono-sockets with a switch for changing from moving coil to moving magnet and a separate switch for setting the parallel input capacitance to 100 pF, 200 pF and 300 pF. RCA coaxial sockets are provided for CD player/AUXiliary input. This is the first unit that I have seen which acknowledges the existence of CD players and goes to the trouble of ensuring that the input circuitry is specifically designed to cope with the CD signal levels and CD player dynamic range. The adjacent sockets are provided for connecting two separate tape recorders. The pre-amplifier outputs and amplifier inputs are externally linked by two simple linking bars so that you can take connections out of the pre-amplifier or feed them back into the main amplifier input should you require it.

Three other switches are provided for setting the output impedance for 8 ohms or 4 ohms, a switch for activating the soft clipping capability and the third an extremely useful, but little used, switch for bridging the inputs so as to be able to obtain twice the individual channel's power rating but only in the mono mode.

The inside of the amplifier is extremely well laid out with the front of the amplifier containing two separate large printed circuit boards. These are mounted one above the other with the RF circuitry on the top board and the amplifier circuit located on the bottom board. The RF circuit board makes effective use of large scale integrated circuits for tuning and display functions, but most of the important tuning elements are still discreet transistors with clearly labelled circuit designations to assist maintenance, should it ever be required.

The power transformer is located at the extreme rear of the amplifier beside the large multi-finned heatsink which lies between a well perforated top and bottom panel. Behind this heatsink is a separate RF input stage pre-amplifier board to which the connections from the individual input terminals for both RF and audio frequency circuits are directed. This facilitates remote switching by means of mechanical linkages extending from the front panel. The designers have obviously gone to considerable trouble to ensure that the interaction and screening problems that many other receivers experience, are not duplicated in this particular receiver.

The construction of the chassis is well executed and rigid, incorporating a large area of perforated ventilation slots in the top cover to ensure that the unit is capable of providing proper cooling under almost any foreseeable situation — excluding the total obstruction of the air path. Even this however has been considered by the designers, there is a series of internal protection circuits backed up by circuit board fuses to provide two levels of defence in the event of overheating.

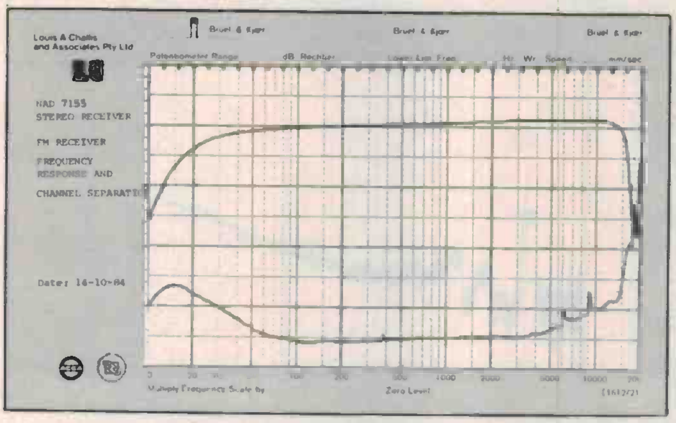
Test performance

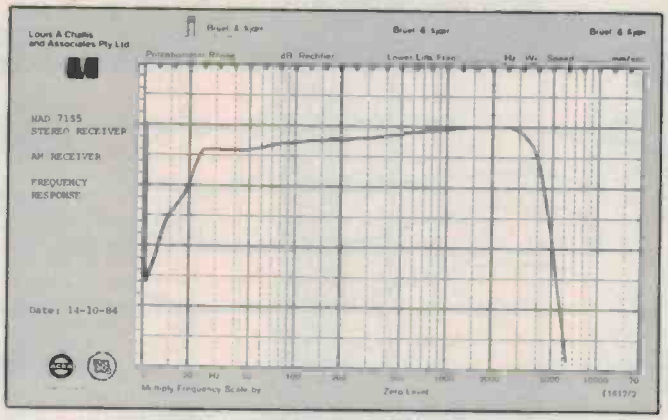
The functional and objective assessments revealed that this is a superlative unit with basic characteristics that are in most respects better than many, if not most of, the competing receivers within the same price range. The frequency response of the amplifier is ruler flat from 20 Hz to 20 kHz and extends from 10.4 Hz to 53 kHz at the −3 dB points. The sensitivities and overload points of both the auxiliary inputs and cartridge inputs have been carefully designed and selected to cope with an extremely wide range of optional units which might be connected. The amplifier distortion levels are particularly low although not the lowest that we have seen.

Notwithstanding, this performance is as good as you could ask for and better than you can reasonably utilise in normal stereo listening. The IEC high frequency total difference frequency distortion figures are good, but not exceptional. The lowest distortion is achieved at approximately the 40 watt peak level where I would expect most serious listening to take place.

The soft clipping function which NAD has stressed as a feature of its amplifier design for the last five years, proved to be particularly interesting.

As a photo of the fast Fourier analysis re- ▶





Our Ref: 4629A.219A/E140

MEASURED PERFORMANCE OF NAD MODEL 7155 RECEIVER

Serial No: 202313

FREQUENCY RESPONSE:

Tone Controls Centred

(-3dB re 1 Watt, 0.5V Input to Aux.)	Left	10.4	Hz	to	54.0	kHz
	Right	10.3	Hz	to	53.0	kHz

SENSITIVITY:
(for 1 Watt in 8 ohms)

	Left		Right	
Aux.	19.5	mV	19.0	mV
Tape	10.5	mV	19.0	mV
Phono M/M	415	µV	410	µV
Phono M/C	32	µV	31	µV
Overload M/M	170	mV	165	mV
Overload M/C	17	mV	16.5	MV

OUTPUT IMPEDANCE: 95 milliohms (@ 1kHz)

HARMONIC DISTORTION:

(A) (At rated power of 55 Watts into ohms = 21 Volts

	100Hz	1kHz	6.3kHz	
2nd	-87.0	-96.5	-96.5	dB
3rd	-78.0	-100.2	-88.8	dB
4th	-111.7	-106.1	-96.8	dB
5th	-94.9	-112.4	--	dB
THD	0.013	0.0019	0.0034%	

(B) (At 1 Watt into 8 ohms

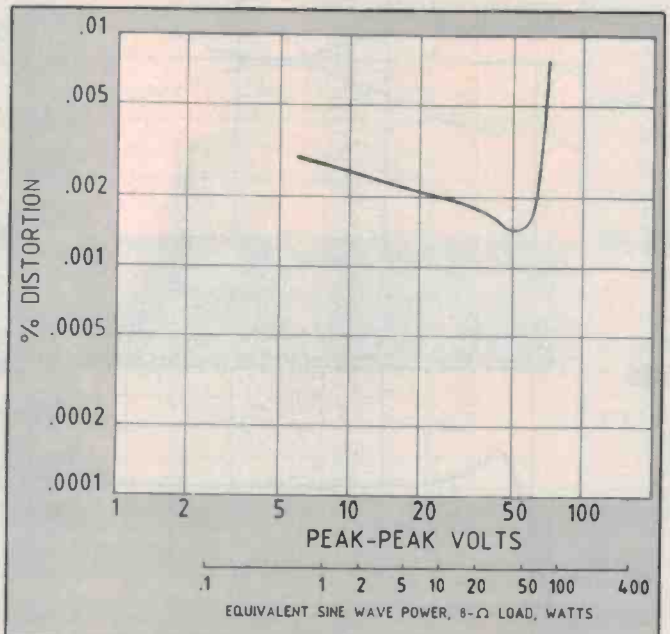
	100Hz	1kHz	6.3kHz	
2nd	-97.2	-93	-91.7	dB
3rd	-82.2	--	-92.9	dB
4th	-107.5	--	--	dB
5th	-104.4	--	--	dB
THD	0.0079	0.0022	0.0034	%

TRANSIENT INTERMODULATION DISTORTION: Less than 0.1%
(3.15kHz square wave and 15kHz sine wave mixed 4:1)

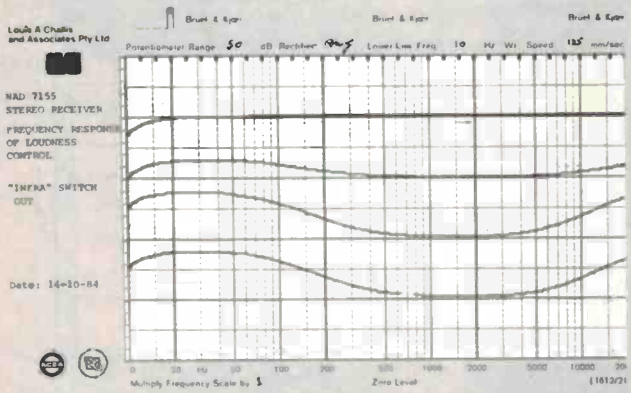
NOISE AND HUM LEVELS:
(re 1 watt with 8 ohms) with volume control set for 1 watt output with, 0.5V input (Aux.) 5mV input (Phono M/M)

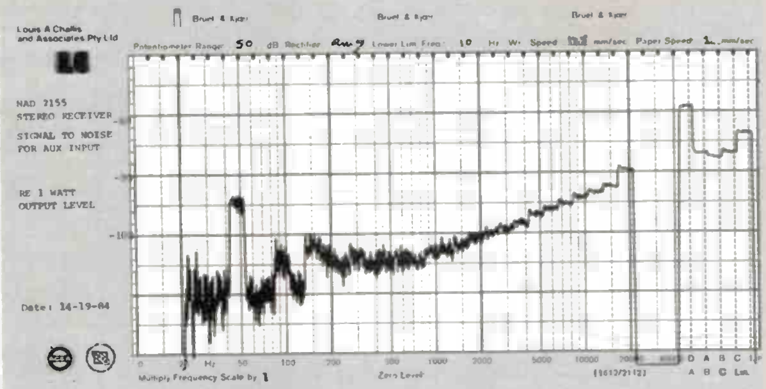
AUX.	-83.5	dB(Lin)	-87	dB(A)
PHONO M/M	-57	dB(Lin)	-70	dB(A)
PHONO M/C	-65	dB(Lin)	-71	dB(A)

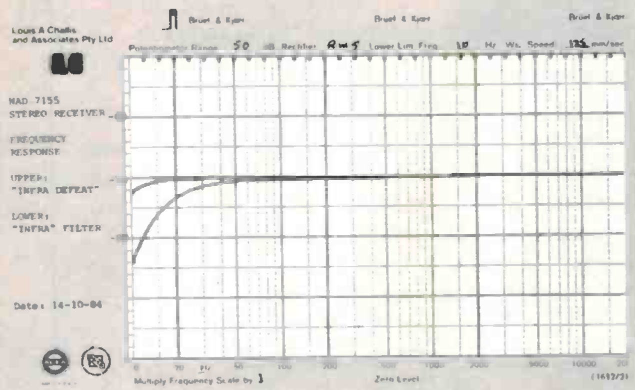
MAXIMUM OUTPUT POWER AT CLIPPING POINT:
(IHF-A-202) (both channels driven)
(20mS burst repeated at 500mS intervals) 76.0 VP-P
= 90.3 Watts
∴ Dynamic Headroom = 2.15 dB (re 55 Watts)

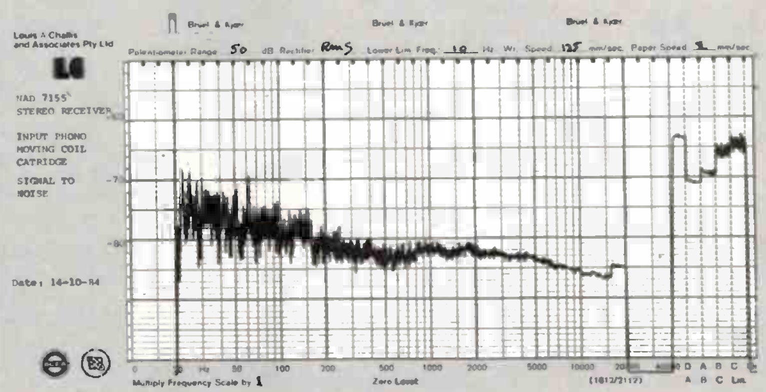


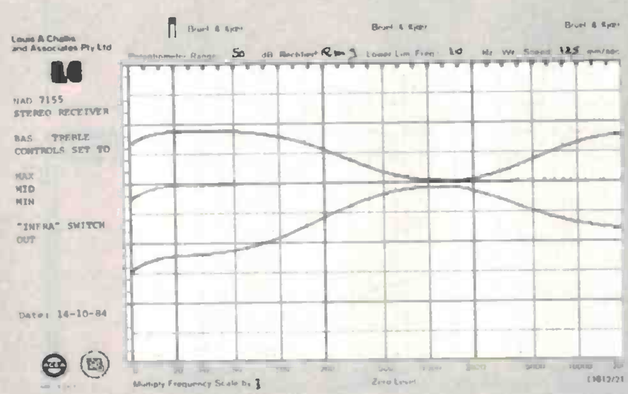
NAD 7155. IEC high frequency total difference frequency distortion.

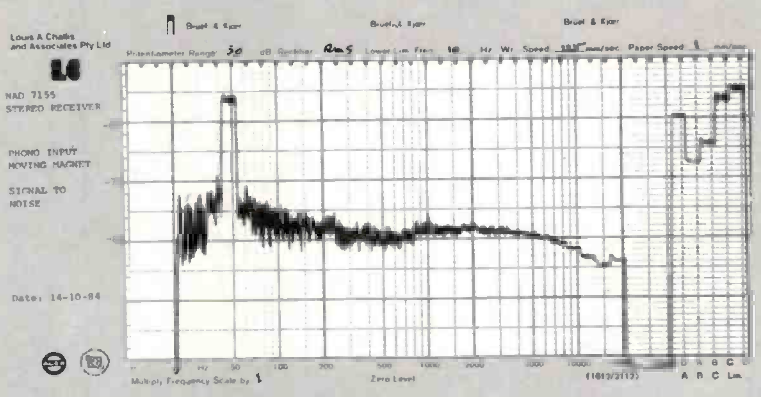

Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
FREQUENCY RESPONSE OF LOUDNESS CONTROL
"INFRA" SWITCH OUT
Date: 14-10-84

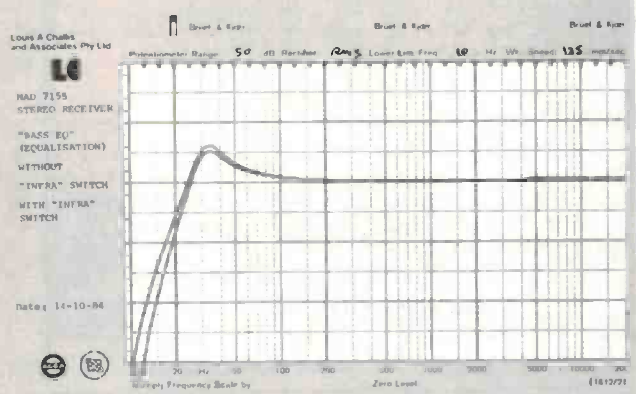

Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
SIGNAL TO NOISE FOR AUX INPUT
RE 1 WATT OUTPUT LEVEL
Date: 14-10-84

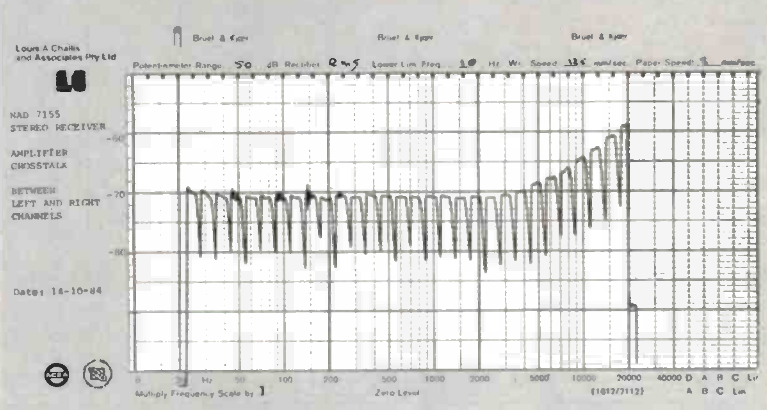

Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
FREQUENCY RESPONSE
UPPER: "INFRA DEFEAT"
LOWER: "INFRA" FILTER
Date: 14-10-84


Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
INPUT PHONO MOVING COIL CATRIDGE
SIGNAL TO NOISE
Date: 14-10-84


Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
BAS TREBLE CONTROLS SET TO
MAX
MID
MIN
"INFRA" SWITCH OUT
Date: 14-10-84


Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
PHONO INPUT MOVING MAGNET
SIGNAL TO NOISE
Date: 14-10-84


Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
"BASS EQ" (EQUALISATION)
WITHOUT "INFRA" SWITCH
WITH "INFRA" SWITCH


Louis A Challis and Associates Pty Ltd
NAD 7155 STEREO RECEIVER
AMPLIFIER CROSSTALK
BETWEEN LEFT AND RIGHT CHANNELS
Date: 14-10-84

veals (see Figure 1) in the normal clipping mode the magnitude of even order harmonics is close to that produced by the odd order harmonics. This results in a subjectively disturbing sound and typifies the worst feature of amplifier clipping. In the soft clipping mode however, the even order harmonics are at least 25 dB lower than the odd order harmonics and even though the amplifier excursions may extend into the clipping region, the subjective impact is far less disturbing and the quality of sound is 'almost acceptable'.

It is interesting to note that a number of other manufacturers have recently picked up this concept and now include it with their latest generation of amplifiers.

The output impedance of the amplifier is 95 milliohms which is quite low and ensures that with reasonable speaker cables and even with low input impedance speakers, you are capable of transferring maximum power output.

The tone controls and base equalisation switch provide usable, complementary and effective boost and cut, although most people tend not to use tone controls to any great extent, particularly when the listening rooms are well designed or incorporate adequate amounts of soft furnishing and carpet.

The signal to noise ratio of the amplifier is particularly good achieving 87 dB(A) re the 1 watt output on the auxiliary input, 70 dB(A) re the phono moving magnet input and 71 dB(A) re the phono moving coil input. These figures ensure that the amplifier noise is always well below the source noise levels on any practical programme that you may listen to. The channel separation and cross-talk capabilities are extremely good, being better than 70 dB separation at frequencies up to 2 kHz and 60 dB separation at 20 kHz. The amplifier delivers a genuine 90 watts peak output into 8 ohms, 125 watts bridged into 8 ohms and has a single channel dynamic headroom of 2.15 dB above the rated power output. This falls a little short of the manufacturer's claimed 3 dB headroom capability.

NAD makes a number of claims regarding the superior performance characteristics

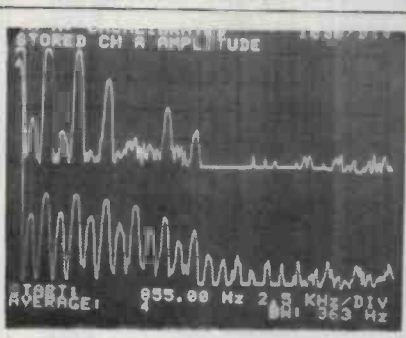
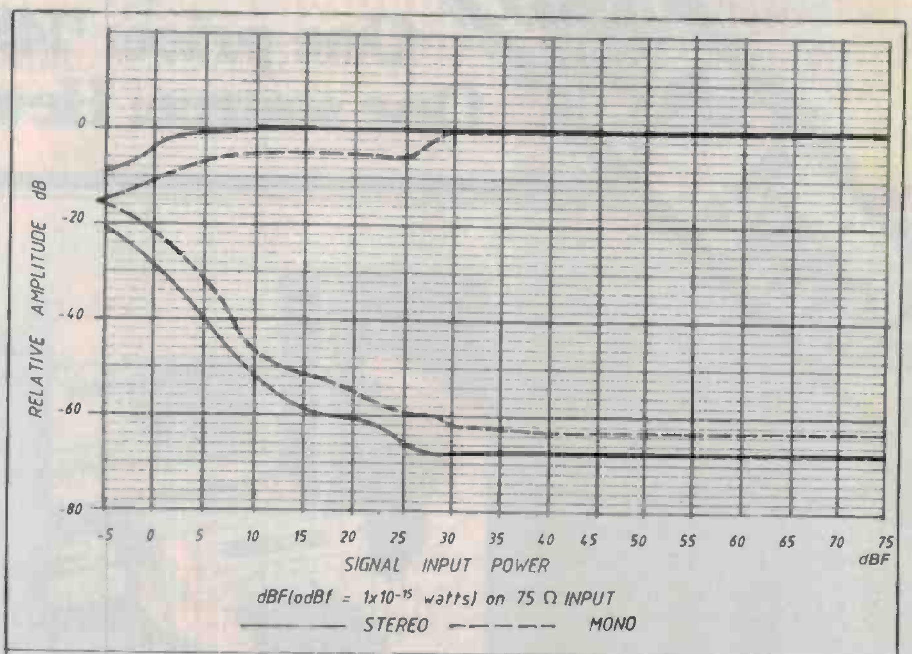


Figure 1. Fast Fourier analysis of amplifier in clipping. Upper trace with soft clipping switch activated. Lower trace normal clipping.



Sensitivity and quieting curves for the FM tuner.

of its tuner section which incorporates higher performance ceramic IF filters, optimised gains and losses for each IF stage and NAD's new dynamic separation circuit to reduce noise in weak FM stations by a happy match of conventional high blend circuitry and interchannel cross-feed at lower frequencies. These claims appear to be confirmed by our objective measurements which achieved better than 70 dB mono separation at 40 dBF and higher and better than 62 dB channel separation at 30 dBF and higher.

The maximum performance figures are greater than those shown on our graph which are limited by the signal generator rather than the receiver. The FM linearity is −3 dB from 22 Hz to 16 kHz and channel separation better than 35 dB from 100 Hz to 4 kHz. Even the AM performance is reasonably good, being 3 dB down at 70 Hz and 3.7 kHz and offering a better overall AM peformance than most other receivers currently available.

The most outstanding feature of the two tuners is their sensitivity which no other receivers in their class has yet bettered.

The subjective performance of the NAD 7155 receiver is positively outstanding. I listened to it with a wide range of inputs including CD players (Sony CDP-101), cassette recorders (Nakamichi Dragon), record players (fitted with Shure V15-IV and Audio Technica AT30E cartridges) and I listened to speakers including B & W 802Es, KEF 104s, QUAD electrostatics and even Pioneer electrostatic headphones. The performance was positively exhilarating until I reached the power limit of the amplifier, which is typically around the 100 watt level into normal speakers and slightly more into the KEF 104s.

On a few occasions when listening to other speakers with even lower efficiencies, I would have liked a little more power, but for the vast bulk of my listening the power handling capacity proved adequate. Whilst the performance was outstanding with CD players and record players, it was positively marvellous when connected up to provide the audio output from the two stereo VCRs (see November ETI).

With FM listening I was more than a little surprised when I found the receiver pulled in five local FM stations without any aerial attached and achieved maximum modulation sensitivity with only a simple folded dipole antenna lying on the floor. This sort of performance has not been achieved by any other receiver or tuner I've reviewed and is a measure of the sensitivity of the input circuitry used in the NAD 7155.

Highly commended

The selling price of the NAD 7155 does not reflect the 'no frills' concept; it is comparable with and in some cases higher than that from other manufacturers offering similar output powers from the amplifier stage. Nevertheless this receiver offers extremely good RF sensitivity which few other manufacturers can equal.

If I was to go out and select a receiver for myself I would be hard pressed to find a better unit. If you like simple 'no frills' concepts, then the NAD 7155 is most probably what you have been looking for. If you are looking for that type of subdued visual impression, combined with exceptional RF sensitivity, selectivity and particularly good audio amplification capability, then you need look no further. ●

NOW PIONEER PUTS TWICE AS MUCH STEREO FUN IN YOUR CAR.

Now with AM Stereo here, Pioneer puts twice as much stereo fun in your car with the launch of the KEA 433AM Electronic Tune AM/FM stereo cassette player.

PIONEER. FIRST IN AM STEREO.

Pioneer has always led the way in car stereo sound.

From designing the most advanced tuner/deck combinations, graphic boosters and power amps to building the widest range of speakers in Australia.

KEA 433AM lets you listen to the widest range of AM and FM stations in brilliant stereo sound.

From the top rock and roll stations to the classics. From talk-back radio to sports broadcasts, everything will sound twice as good because it's in stereo.

And like all Pioneer products the advanced features of the KEA 433AM are equally brilliant.

From AM/FM stereo, electronic station preset and seek, lock in fast forward and rewind, auto tape replay and metal tape facility to a built-in fader system for 4 speaker control.

You can own the Pioneer KEA 433AM stereo radio cassette for as little as $349.* It's a small price to pay, to make everything you listen to in your car twice as much fun as before.

PIONEER®
The power to move you.

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P10 2000

JVC's VideoMovie camcorder

— gladiator in the video colosseum

Malcolm Goldfinch

A review of the JVC GR-C1 video camera/recorder, released at the Perth Consumer Electronics Show last August. It's destined to be the first product to strike a blow to the popular Betamovie camera/recorder — the other combatant in the video colosseum.

FOUR YEARS ago on a winter's morning, I attended a gathering of the photographic industry and the opening feature was a very dark and underexposed, super-8 film of the beach at Nielsen Park in Sydney. A lovely young lady, horribly overexposed and probably goosepimpled in the winter chill, danced along the water's edge. In her wake came a hobbledy-hoy figure with an enormous video recorder around his neck, grasping in both hands a gigantic camera. The cord from camera to the recorder wound around his legs and he stumbled and fell while the nymph raced out of sight. Just then a neat figure with a small super-8 camera appeared, jogging nonchalantly past the fallen video man to catch up with Miss Goosepimples and shoot her down with a long burst of film. This scene came to mind when I first picked up the exciting new JVC camcorder, 'VideoMovie' at the Perth Consumer Electronics Show. That monstrous home-video system I saw on film had been reduced to a single, light piece of equipment which while not fitting into the palm of you hand, has a 'prosthetic' handgrip and it is easily held and operated single-handed.

The new VideoMovie GR-C1 weighs under 2.5 kg — a figure which includes battery for an hour, and a 30 minute cassette, yet it is only the size and weight of big racing binoculars. It incorporates a full video, record-playback system that will replay on any TV and also dub what it plays on to any VCR, Beta or VHS!

Film and video, (chalk and cheese)

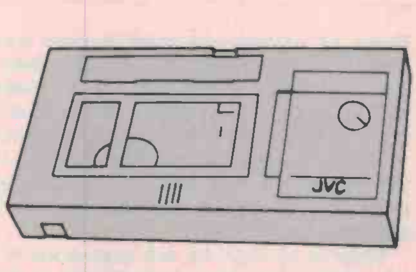
There is an enormous difference between film and video. The heavy video gear, hanging on the man on the beach equated with a camera with a sensitivity that would require film of some thousands of ASA degrees of speed, a colour and sound film processing laboratory, (in order to instantly process pictures) and a projector and screen, so the photographer could see the picture he had taken to check and correct it before leaving the subject. The videoman carried all of this in two packs, total weight say 10 kilos.

Nevertheless millions of consumer dollars worldwide have gone into video at the expense of photography. Sales of super-8 film gear to new users are just about nil. One point missed by the film people was that the video man's early morning beach scene would have been brightly exposed, not dim like the film man's. The film man did not know he was underexposed until the film came back from processing. Lights to take good video on the other hand, are quite unnecessary today.

After the Perth CES show I caught up with the VideoMovie and made it part of my family for over a week. Women accepted it at once, welcoming it as a wanted, one-piece video, simple and light like the home camera. They could now handle a video to record the family 'golden moments'. Some women are great photographers for this reason. But some men (and women) with video knowledge, were inclined to react more energetically, and saw it as revolutionary.

The VideoMovie and others to follow will undoubtedly revolutionise what we have known as home photography, despite its price at approximately $2500 recommended retail. Running costs, however, are minimal: no developing and printing charges. If the VideoMovie is a goer and first sales suggest it will be,

RF unit. This RF converter permits VideoMovie to be connected to most TV sets for playback . . .



VHS cassette adaptor. The motorised version (C-P3/U) can hold a compact VHS-C cassette in a full size VHS cassette or cartridge for use on a standard VHS recorder.

VHS-C (compact-VHS) becomes a major world video format as an add-on to VHS, just as VCR video only succeeded because it was an add-on to the billions of TV sets and their TV stations already in the marketplace with the service technology already at hand.

VHS-C's video niche

It would be misleading to describe the VideoMovie without first outlining the entirely new technical environment introduced by sub-VHS format.

Although the Shogun of world video has at least decided on the new 8 mm format tape, JVC, always the revolutionary, launched the VHS-C (compact-VHS) format tape, now used in the VideoMovie, two years ago. The cassette (90 (w) x 60 (d) x 20 mm (h)) is roughly the size of a 20 pack of cigarettes and has a 30 minute (in PAL) supply of standard VHS tape inside. The small package is something I feel the industry has needed for years. As a past 9.5, 16 mm and super-8 film user I felt a three minute film was a long time; a three hour tape, ridiculous for portable video! You lose whole scenes and never find them again without long searches. A whole lot of neatly labelled 30 minute cassettes would suit most cine users. I can hear the question, "But what about my three or four hour timeshift of TV films?". Well, VHS-C is an add-on. It is not intended for timeshift of big programmes. If you accept that, then VHS-C becomes a great new cine medium.

The VideoMovie does not have a tuner/timer, or the docking facility of the first 8 mm portable videos announced by Kodak and Polaroid for delivery sometime in 1985. The term docking is adapted to video from spacetalk. It refers to a simple no-wires method of connection, to help the technically dyslectic to couple their portable VCR into the home TV and turn the portable into a home VCR with tuner/timer. The logic of this escapes me as there is a reputed limit of about one hour for the maximum recording time for an 8 mm video camera. It is my belief that VHS-C has not gained worldwide popularity in the past for the same reason. It was considered a hopeless timeshift format. Until now, few saw it as a brilliant cine format: nothing to do with timeshift.

Oddly JVC's close associate, National, has failed to follow with hardware for VHS-C, where Sharp and Philips have. As far as I can ascertain, National has no immediate plans to do so, but during 1985 will announce a full VHS format, minicamcorder. The 'mini' concept will be limited by the large size of a VHS cassette, just as Betamovie suffers from this problem, but it will be interesting to see what National comes up with.

Easy to use

For the consumer the reason that the VideoMovie is such a leap ahead from the add-on Betamovie, is not only because you can see the video you are taking in a TV viewfinder as your shoot, but also the instant playback available anywhere there is a convenient TV set.

One novel activity the VideoMovie allows is to screen what you have taken on a TV, while recording another copy on the VCR. I found this simple and easy to do. It works on all formats of VCR, Beta, 2000, U-matic or even TV studio gear. All that is required is that you carry in the pocket or bag, a black box RF unit with connectors, smaller than a cigarette pack. Connectors go from the unit to the video-out port on VideoMovie, where it also gets power, and to the TV aerial input. An RF modulator for video and audio, it converts video and sound from the VideoMovie to a UHF TV signal with adjustable frequency to avoid local channels. A second port is for the TV aerial to be plugged into the unit and a switch allows either VideoMovie or TV input to the VCR. This signal is tuned by TV or VCR in the normal way.

But the VHS-C 64 dollar question in the US is, "Okay, I would like to play VHS-C shots on my, or my friend's home VHS-VCR: *how?*"

Answer, "No problem. JVC has produced one of those gismos that makes a messy conversion a slick trick". The C-P3/U adaptor is the same size as an ordinary VHS video cassettte and looks like one without tape spools. The VHS-C is easily placed inside it and as the catch snaps shut it comes alive in your hands. Inside a tiny motor whirrs; levers open the compact cassette, remove the tape and spread it out, a pointer on a dial shows progress and as you watch, it become full VHS format compatible. It takes four seconds for the metamorphosis and plays back or records like a normal video cassette on any VHS video. To change back, the catch is pushed and again the battery motor reverses the process; the lid opens for removal and a red wedge comes out the side to prevent accidental insertion without a VHS-C inside. It is a fun thing to use.

Existing VCR owners not anxious to duplicate their machinery just to go video-portable will find the VHS-C adaptor a useful piece of equipment.

Editing out the inevitable flub or dull bit while making a dub is fairly easy also. Just put the copying VCR in and out of pause in the record mode, copying only the scenes played on the monitor which you wish to retain. Editing is one of the great opportunities of video and often overlooked or regarded as too hard, and a small loss in quality, if good machinery is used, is far outweighed by the tight professional result.

VideoMovie specifics

The JVC VideoMovie at first looks to be an ordinary video camera. A small window revealing a tape spool gives the secret away. It is a 'camcorder', a combined videocamera and VCR.

In size, the VideoMovie is less than many of the videocameras I have reviewed recently. With lens-hood, TV finder and battery it measures 17.5 (w) x 13.6 (h) x 34 (d) cms. It comes with a shoulder rest/strap; conveniently, it hangs lens down and is not very cumbersome. Nett weight of the VideoMovie is specified as 1.9 kg! On my balance it weighed 2.25 kg with shoulder frame and carry strap, but without battery or videocassette. With 245 gm for a 1 hour battery and compact cassette at 15 gm, it was all up less than 2.5 kg! A Betamovie with battery and 130 minute video cassette and no auto focus weighted in at 3.06 kg. Combining full videocamera/VCR features and VHS compatibility, the VideoMovie represents a clear breakthrough in weight, size and convenience. Is it therefore reasonable to expect some serious quality compromises? ▶

WINNERS & LOSERS

There are winners and losers in every arena. The video gladiators have been locked in a bloody contest of claim and counter claim, feature and counter feature. At this moment, with the release of JVC's GR-C1 VideoMovie camcorder (industry name for a VCR and Videocamera in one piece), the originator of the VHS format has a foot firmly on the throat of Beta. JVC is looking for a thumbs-up, or thumbs-down to finish the contest.

The consumers, who are the audience in this colosseum, are in a bad mood about the two formats. They prevent free interchange of video as possible in audio cassettes. It looks as though the thumbs will go down for a lingering departure of Beta over the next few years.

There is no room for two champions in the video arena and the release of the GR-C1 camcorder, looks like a mortal blow to Betamovie which lacks both a TV viewfinder and instant playback, both features included in VideoMovie. If Betamovie does survive JVC's thrust, National, JVC's Samurai comrade, will probably deliver the coup de grace when they release a small camcorder with full features using a standard VHS cassette.

If this were not enough, Beta thought its hi-fi would give them an edge; but JVC has just released a video hi-fi in VHS format. It plays for eight hours, using four-hour video cassettes; audio response is in the CD audio specification area and allows recording. This format fight involves billions of dollars of turnover in years to come. It makes a football final look like a pussyfoot contest.

The article here is a hands-on assessment of this latest product of the video industry, by an expert in photography, audio, video, and Australia's pioneer of Univac, the first in computers. He also happens to have been a journalist, off and on, for 47 years.

Under test, using as benchmarks my lab monitor system, there were some faults, but not of great importance. The quality of replay from the VideoMovie via the blackbox RF converter was not top quality, but better than many economy videocamera/VCRs I have tested. Using the direct video output by BNC connector to monitor, it was of a very good standard and marginally better again when I tested the video on compact cassette, played back on my 'benchmark' VCR by using the adaptor C-P3/U. I doubt if the loss of definition compared to top video systems would be detectable on average home TVs.

The secret of the VideoMovie's size and weight lies in the entirely new head drum and loading system which has been reduced by one-third in diameter. The VHS signal pattern has been maintained by a revolutionary 4-head sequential recording system and a new 270 degree wrap/parallel loading system. Full marks to JVC!

The features in VideoMovie are really 'state of the art', with very good auto or manual white-balance with three hour memory to hold setting. It also includes iris, auto and manual, coupled to the high band saticon half-inch camera tube with a high sensitivity and a low level select, for colour down to a minimum of 15 lux with little lag (trails from bright lights on black background).

The viewfinder is detachable and as a half-inch screen CRT, it shows over the video picture, computer style function and warning messages, as well as date titling.

The lens system is a small but efficient, f/1.2, f=8–48 mm and 6:1 + macro with power zoom, daylight or tungsten filters and tripod mount.

VCR functions are full scale and at your fingertips. Every stop is auto-back-spaced for clean cuts. An automatic recording-lock system allows power conservation without editing loss. The 'review', a flash of a few seconds in the viewfinder showing the last take is almost an essential (but only included in the best video systems).

The two way shuttle search is also a great feature in playback and can be operated with the VideoMovie at eye-level during takes to check results. The light weight and shoulder frame allow the VideoMovie to be left at eye-level for long periods without fatigue. Shoulder and head-rested shots are many times more steady than shots with a hand-held videocamera.

Many accessories

Making semi-essentials accessories allows cost control of the initial purchase but they should be continually reviewed by owners. Your video can be only half alive without a good range of accessories.

Batteries are important components for video and the VideoMovie has an option of battery packs. One is approximately 30 minutes and the NB-P6U is 45 minutes. In practice I found it more like 60 minutes. They are very light and small: 0.245 gm. You could carry several in the pocket or bag. The AA-P1EG charger will run the VideoMovie without battery as well as recharge. A very small BB-P1EG charges batteries only. They take only about 30 minutes for a charging. A great feature is that these very thin batteries easily slide on or off the back of the VideoMovie or charger and lock firmly. No more flapholes to find, or wrong way ups and arounds.

The black box TV/RF unit, shoulder frame and carry strap, also the VHS cassette adaptor, have been described as essential parts of the Videomovie; there is a car battery adaptor, pause remote control and super directional microphone, extension cable, as well as the usual BNC and TV connector cords.

The VideoMovie is housed in a port wine coloured carry case with a black soft moulded interior to nest in the camcorder and all its main accessories, safe from shock and lockable from little fingers. There are handles top and side.

The last thing you would expect in a hand-held camcorder is a very comprehensive titling system, but this is just what VideoMovie offers. It is a light, small unit that shoes on to the top of the camcorder and looks like a pocket calculator. It offers some of the most sophisticated character generation I have seen in video; 46 different characters and time, set Dymo fashion, date stopwatch, lap-time. Titles can have 60 characters per frame and 14 pages of text can be memorised, one for date, lap-time and title, seven for standard titles, four for *zooming titles*, and two for *scrolling titles!* If that is not enough, you can reduce/enlarge and move them to a corner of the screen where they do not cover the bride and groom's kiss.

Summary

There is no way that the advent of JVC VideoMovie can be described as other than a revolution in video. Radio was never really portable before the transistor and neither was video really portable before this one piece camcorder. Getting all video's technology into something similar to a lady's handbag, and no heavier, when only six years ago it weighed over 10 kg, must be one of the great technical feats of this century. JVC has again shown the way and unless they can patent size and design, the competition is so fierce others must follow.

Eight mm video camcorders are close and sizes may be smaller and lighter, but will the features match VideoMovie? One great feature is the compatibility with many millions of the VHS-VCRs all over the world. The Pathe 9.5 mm home movie film with centre sprocket holes dominated home movies in the 30s, until someone showed you could expose half the commercial standard 16 mm film with 8 mm frames, then turn it over and expose the other side in the opposite direction. The processor then split it in half and you got twice the length back. The cheaply available standard was 16 mm film. Soon, pre-split 8 mm film was the big seller and 9.5 mm with a better format and bigger frames vanished. "Look behind to see what may be just ahead." ●

CROs — a closer look

Jon Fairall

ETI's mega CRO survey — all the cheapest CROs plus a bit on how they work.

THE BEST PIECE of test gear ever invented is the human brain. It's flexible, transportable and extremely cost effective. Certainly, if you can't use it you'll have difficulty using anything else.

It does have a few disadvantages though. For one thing, it can't sense electricity directly. You can't hear electricity, or see it, and feeling it could be an extremely terminal sort of test. That's where a CRO comes in.

A CRO is a device to allow you to see what's happening within a circuit. Used properly, it's an extremely powerful piece of equipment.

The basics of CRO operation have been dealt with before, both in this magazine and in numerous other articles and text books. In this article we want to take a more in-depth look at certain parts of a CRO. We have also constructed a table of most of the cheapest CROs available in Australia at present, together with some of their more important features.

Triggering

The purpose of a CRO is to 'paint' a waveform on the screen of a cathode ray tube (CRT). The vertical movement of the trace is arranged to be proportional to the voltage level of the input signal. The horizontal position of the trace is made proportional to time, so that a graph is plotted showing voltage against time.

The horizontal 'timebase' movement of the trace is achieved by feeding a sawtooth waveform of known slope to the deflection plates. This makes the trace move steadily across the screen from left to right. When the trace gets to the right hand side of the screen the beam is turned off (blanking) and moved rapidly back to the starting point again (flyback).

These two functions, the vertical and horizontal deflections of the trace, must be synchronised to present a meaningful picture on the screen. To see why, imagine what would happen if we tried to input a simple sine wave with no synchronization. The trace would oscillate up and down the screen under control of the input, while at the same time racing backwards and forwards across the screen under control of the timebase. If the timebase was set to be slow we would see a vertical line moving slowly from left to right. If it was fast we would see a broad band, it's width determined by the peak to peak voltage of the input.

But if the two were synchronised so that the timebase was locked to some exact multiple of the input frequency, then the trace would move through exactly the same path again and again. The sine wave would be drawn on the screen, an exact replica of the voltage on the input.

The process of synchronising the horizontal and vertical defections of the trace is known as triggering. Triggering is achieved by taking some of the signal being applied to the vertical amplifier and applying it to a gate circuit.

When this signal reaches some preset level the gate circuit emits a pulse, which starts a sawtooth generator running. This sawtooth is the controlling voltage for the horizontal deflection.

The exact speed at which the sawtooth generator runs is set by the time/div switch on the front panel. The level at which the triggering circuit fires a pulse to start the sawtooth generator is also set from the front panel, by a control usually labelled 'Trig level' or somesuch.

This system works well provided the signal on the input is reasonably uncomplicated. If it is a simple sine or square wave the CRO will provide a picture with the trigger level set anywhere within the peak to peak voltage of the input.

But this basic triggering circuit is not foolproof. Bear in mind that it is set up so that it fires the timebase, waits for the flyback, then waits for the voltage level to cross a certain threshold before starting the timebase again.

If the signal is not a simple repetitive wave, it can fool the trigger circuit in a number of ways. Perhaps the simplest is a complex wave where two or more waves of similar frequency but different amplitude are summed together.

In Figure 1, notice that when the trigger is set at level Y, and the sweep only runs to Z, it will provide trigger pulses both at points B and D. The trigger will not fire at C, since it is sensitive to the direction of the input, as well as its level. This can be controlled with the +/− switch on the front panel.

As a result two waveforms will be painted on the screen. First it will trigger at B, and run through to Z. Then it will look for the next negative going crossing of the trigger level voltage, which occurs at point D.

The resulting picture is shown in Figure 2. Note that if the timebase is shortened or lengthened, other combinations are possible. However if the trigger level is moved up to X in Figure 1 then triggering must take place unambiguously at E or F.

Of course, a waveform can be complex in other ways. A pulse train, for instance, could consist of a repeated but irregular sequence of marks and spaces, as in Figure 3. Assuming the first trigger point is at A, and assuming the timebase is set to sweep as far as the line Z, the next trigger point will be B. Once again, this will result in a confused image on the screen.

One way of curing this problem is to extend the timebase so that it falls around D, in which case it will trigger at C. If, for some reason you don't want to do that, another very useful function is available. This is the 'hold off' function. It actually stops the sawtooth generator for a suitable interval, to prevent retriggering. In Figure 3 this would be the time period between Z and D.

Delay

It often happens that the most interesting part of a signal can't be seen with sufficient detail in the normal display mode. This might be something like the ringing that occurs when a voltage level changes dramatically, as it does in a pulse train. (See Figure 4.)

One way of getting a closer look at any given point on the display is with the trigger delay and magnification functions. The delay holds the sawtooth generator for a period of time determined by the user, before releasing it to run normally. The effect of this is to move the displayed waveform to the left. The magnification just speeds up the trace, thus spreading it out across the screen.

When these two functions are used together the result is to magnify any given piece of the trace for closer examination. Some CROs make it possible to observe the entire trace on one channel while using a delay function of the same input on the other. Sometimes the area under inspection is highlighted, so that it is possible to precisely select a particular area for inspection.

Most CROs give the user a selection of the way in which the trigger circuit is connected to the input. Commonly, a choice of ac, dc, hi-pass, low-pass and TV input coupling is provided.

AC and dc are self explanatory. Hi-pass and low-pass filtering are there to prevent noise from causing false triggering. TV is used to optimize the trigger for looking at TV signals, either frame or line. A special TV input is used because TV signals form a difficult subject for CROs to latch onto, but at the same time are very common. Using the TV setting in conjunction with the timebase delay control, it's possible to look at

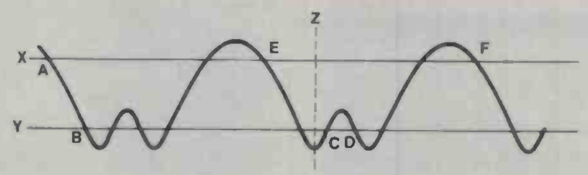


Figure 1: An irregular waveform applied to the input of a CRO. The horizontal lines are the trigger levels.

both frames and any of the lines within the frame.

Multi-trace operation

It's difficult to find single trace CROs these days. In fact there are only seven out of 64 in our survey.

There are two ways multiple traces can be displayed on the screen. One is the multi-gun approach, in which one input is fed to one gun where it forms an image in the normal manner, and the second input is fed to another gun to form a second image in the same way. This method is expensive, but it does result in very high quality CROs.

A more realistic alternative is to use one gun and one electron beam to form two traces. This is done in a number of ways. The trace can actually paint alternate lines on the screen, first doing channel 1 and then channel 2 and back to one and so on. This option is selected with the 'Alt' (alternate) switch. Another method is to switch rapidly between both traces. This is called 'Chop'.

All these modes of operation have advantages and disadvantages. For a given acceleration voltage, the multigun assembly gives the brightest display. It also operates completely independently of the frequency of the signals being displayed.

On the other hand, the single gun pattern is significantly dimmer when displaying two traces, other things being equal. It has to be, since the trace must now cover twice as much area as before — or if you like, it only spends half its time on each trace. Naturally, this problem gets worse the more traces there are.

Of course, other things are seldom equal. The accelerating voltage can be increased in multi-trace scopes to allow for the dimming of the screen. As a result single gun scopes are the standard and multiguns a rarity.

There are two other modes of operation that appear on most CROs. These are the 'Add' and 'Sub' functions. When either of these is engaged, the two inputs are added or subtracted and the resultant displayed on the screen.

There are a number of specialist applications where these functions can be useful. One rather more general one is in noise cancelling. Figure 5 shows a pulse train riding on a 50 Hz mains hum. If the mains hum can be introduced into the second channel and then subtracted from the first, the result will be waveform C.

Strictly speaking it is not necessary to have both an add and subtract function. most CROs have the facility to invert one or both traces, so it is always possible to implement a subtract function by inverting one of the channels and adding.

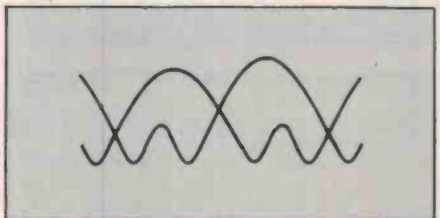


Figure 2: Display resulting from setting the trigger level too low on a complex waveform.

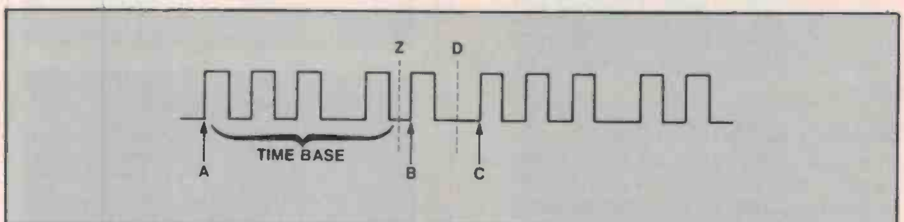


Figure 3: An irregular square wave presents a very difficult subject for a CRO trigger circuit. In this instance there is a definite sequence and it is possible to see some order in the madness.

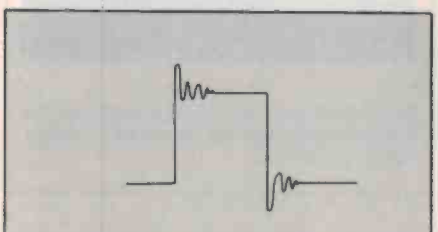


Figure 4. Close up of one of the pulses in the pulse train in Figure 3. Notice that the rapid and near instantaneous transition from lo to hi level leads to ringing in the output circuits. This can be a source of problems, leading to false states being generated in digital circuits.

Storage

There are a number of very important applications where we wish to record the response of a circuit to a non-repetitive event. An explosion, the closing of a switch or any other form of one-off transient are examples.

A normal CRO is nearly useless in this type of application. The event comes and goes before it can register as more than a flash of the trigger lock LED. What is required is a *storage* CRO. This is a type of CRO that allows you to retain an image of a single transient event.

There are a number of ways this can be done. The cheapest, and historically the first, method is the variable persistence CRO. Visual persistence is the name given to the phenomenon that allows you to see a moving spot as a line (or indeed, a succession of still images in the movies as motion.)

The phosphors that coat the inside of the CRO screen have a definite persistence as well that aids this effect. That is to say, when illuminated by the electron beam they do not immediately switch off once the bream has passed, but remain glowing for some small finite time.

It is possible to vary this time to quite a large degree. The result is that a semi-permanent record remains of the path of the trace. Naturally this is continually updated

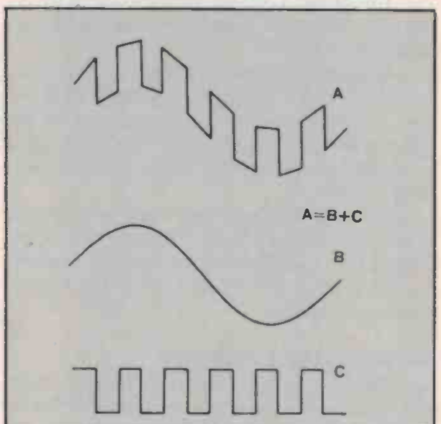


Figure 5. Information riding on some 50 Hz hum.

there are facilities to turn the trace completely off when the CRO is operated in this mode, to avoid oblitering the wanted waveform.

In fact it is often possible to operate in a single-shot mode. When this function is engaged the trace will make only one sweep after the trigger circuit has been activated. It must be manually reset in order for the next line to be displayed.

This mode, together with variable persist- ▶

ence, makes it possible to capture very short events. However it is done at the cost of turning the screen accelerating voltage up to abnormally high levels. This has all kinds of unacceptable consequences for the life of the display, so other methods of achieving the same end are preferred.

The modern solution is digital storage. This involves the sampling of the input waveform at a predetermined rate, usually several hundreds of kilohertz, and the subsequent re-display of the same. This system involves no special manipulation of the screen at all.

The input is converted into a digital word, eight to twelve bits long, and stored in on-board RAM. The display then effectively is used to read out the contents of memory.

The accuracy with which digital storage can work depends on the size of the memory available, and the rate at which the analogue to digital conversion can be made. It's usually quoted in terms of words, each word consisting of a sample or description of the voltage level at a particular point across the screen. Figures of 400 words are common for the types of CROs in this survey.

Sweep magnification

Sweep magnification is another useful function for examining portions of the waveform in greater detail. We have mentioned it before in connection with trigger delay and this is without doubt its most profitable use. However, it is common to find magnification even on CROs without any of the fancier functions. Usually, this will be of the x5 variety, although there are some with x10 and even x100.

All of these work by stretching the timebase, so that it appears that the screen is just a small window into a portion of the whole line. The big disadvantage with using magnification is that it results in a dimming of the trace.

There have been some modifications recently to this basic idea. One of these is the 'Mix-Mag' function, in which it is possible to extend part of the trace while leaving the rest as normal.

Component testers

Component testers are on optional extra that plug into the input of many different types of CRO. One CRO in our survey has a tester built in. Generally they work by passing a variable current through a component and measuring the voltage across it. The tester sends a trigger pulse to the timebase to synchronise the timbebase with the current test.

The result is a series of characteristic patterns on the screen for given types of component. A resistor shows up as a straight diagonal line — a perfect geometric expression of Ohms' law. A capacitor is an oval sloping from bottom left to top right, and an inductor slopes the other way around.

Semiconductors have their own individual shapes. Diodes tend to show flat traces in their cut-off regions and vertical traces as the junction barrier is overcome. It is possible to generate a whole family of characteristic curves for a transistor using one of these devices, as we've done in Figure 6.

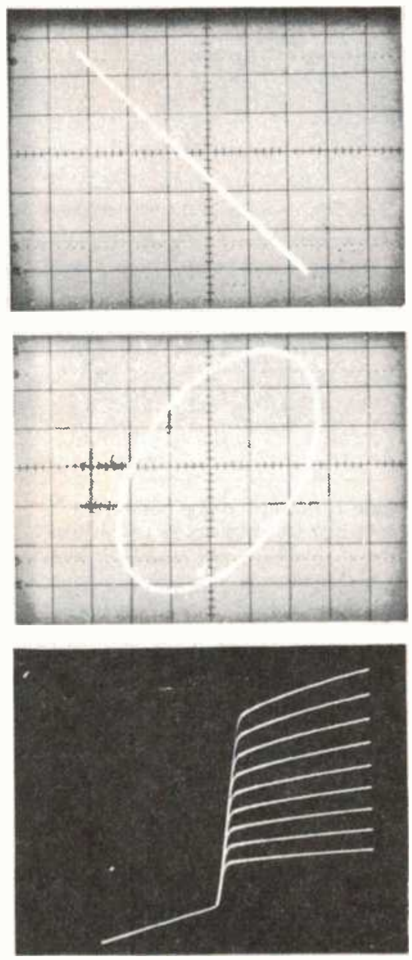


Figure 6. Output from a component tester. The horizontal axis should be interpreted as current, vertical as voltage.

Bandwidth and risetime

Probably the most fundamental measure of the quality of a CRO is the bandwidth of the vertical amplifier. As with most other devices it is measured at the −3 dB point, i.e: the point at which the amplitude response is 0.707 that of the maximum response. (See Figure 7.)

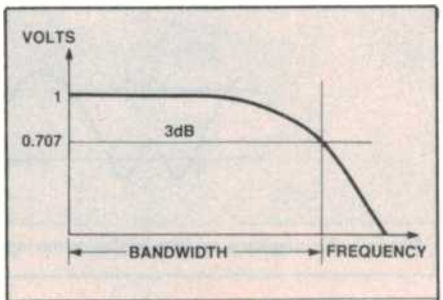


Figure 7. Frequency response versus frequency. This is the definition of bandwidth used in most ac circuits.

Risetime is a closely related figure. It tells you how long it will take the amplifier to go from 10% to 90% of the full value of an instantaneous change in voltage applied to the input. So it's a measure of how fast the output of the vertical amplifier can track the input.

In the case of a sinewave these two figures would represent different sides of the same coin, related by the formula

$$tr = \frac{0.35}{bw}$$

However, it's not difficult to imagine waveforms where this is not the case. A square wave for instance, may have a very low frequency but extremely fast rise times.

In cases like this there is still a very close relationship between the two. The quickest way to explain it is to use Fourier analysis, a mathematical technique that starts from the premise that any repetitive waveform can be expressed as the sum of a number of sine waves. Using Fourier analysis it turns out that some quite complex looking waves can be expressed as the sum of a small number of sinewaves. A good approximation to a square wave can be had by adding together just three sine waves, the first three odd harmonics, i.e: a sine wave of the same frequency as the square wave, plus ones of three and five times this frequency.

This leads to a rough rule of thumb when ordering a CRO. Buy one with a risetime equivalent to a bandwidth at least three times faster than the fastest square wave you are ever likely to need.

Of course, in all of this we have been considering the bandwidth as it applies at the input of the CRO. In practice, you don't have access to the CRO inputs so much as the CRO probes. In reality then, we need to consider the performance of the CRO *including* the probes.

As a matter of practical fact the probe leads can have a very real effect on CRO performance, especially at high frequencies. The input resistance and capacitance, should be of a similar magnitude to the input specifications of the CRO to avoid degrading the performance of the whole measuring system.

To put some numbers on this, it's worth memorising the formula:

$$Tr = 2.2RC$$

where R is the input resistance of the probe in parallel with the output resistance of the source, and C is the probe capacitance. Tr is then the rise time of the measuring system. ▶

USER'S GUIDE TO LOW COST CROS

MAKER	DISTRIBUTOR	PRICE ($)	B/W (MHz)	CH	SENSITIVITY VOLTS MAX (V)	SENSITIVITY VOLTS MIN (mV)	SENSITIVITY TIME MAX (s)	SENSITIVITY TIME MIN (µs)	RISE TIME (nS)	CRT VOLT (kV)	INPUT VOLTS (max)	Zin (M//pF)	REMARKS
Kikusui 538A	Dindima	256	5	1	5	10	0.2	1	70	1.2	—	1//30	
Goodwill GOS955	Emona	269	5	1	10	10	10	10	70	—	600	1//35	
Goodwill GOS3310	Emona	297	10	1	5	5	10	0.1	35	1.3	600	1//35	
Kikusui 559A	Dindima	399	5	1	1	10	10	1	70	1.2	—	1//30	
Hung Chang OS620	Paton	450	20	2	20	5	0.5	0.2	17	2	600	1//20	
National VP5215A	Scientific Devices	450	15	1	2	1	0.5	0.2	23.4	2	600	1//30	
Meguro MO1251	Elmeasco	465	20	2	20	5	0.5	0.2	17	2	600	1//20	Component tester
Aron BS601	Elmeasco	465	20	2	20	5	0.5	0.2	17	2	600	1//20	
Kikusui 5509	Dindima	497	10	1	5	10	0.2	1	35	1.6	—	100k//28	
Trio CS1560AII	Parameters	545	15	2	20	10	0.5	0.5	23	2	600	1//22	
Kikusui 5519	Dindima	560	20	1	10	5	0.5	0.2	17.5	2	—	1//30	
National VP5216A	Scientific Devices	567	15	2	2	1	0.5	0.2	23.4	2	600	1//30	
Kikusui 5513	Dindima	590	10	2	5	10	0.1	1	35	1.6	—	1//30	
Iwatsu SS5702	Electrical Equipment	598	20	2	10	5	0.2	0.5	17.5	2	500	1//30	
Hung Chang OS615S	Paton	600	15	2	10	2	0.5	0.5	24	1.5	—	1//20	Portable
Trio CS1012	Parameters	611	10	2	5	1	0.5	0.5	35	2	500	1//35	
Hitachi V212	Standard	613	20	2	5	5	0.2	0.2	17.5	2	500	1//30	
National VP5220A	Scientific Devices	620	20	2	2	1	0.5	0.2	17.5	2	600	1//30	
BWD 824	BWD	625	35	2	20	2	1	0.2	10	6	800	1//30	
Aron BS310S	Elmeasco	625	15	2	10	2	0.5	0.5	24	1.5	600	1//20	Portable
Hung Chang OS635	Paton	630	35	2	10	5	0.5	0.1	10	6	600	1//20	
Kikusui COS5020	Emona 539	631	20	2	5	5	0.5	0.2	17.5	2.2	—	1//30	Delay, single shot
Trio CS1022	Parameters	649	20	2	5	1	0.5	0.2	17.5	6	500	1//32	
Kikusui 5502A	Dindima	658	5	2	1	10	.01	1	70	1.6	—	1//30	
Meguro MO1252	Elmeasco	675	35	2	10	5	0.5	0.1	10	6	600	1//20	Delay
Aron BS635	Elmeasco	675	35	2	10	5	0.5	0.1	10	6	600	1//20	Delay
Hitachi V222	Standard	749	20	2	5	5	0.2	0.2	17.5	2	500	1//30	
Kikisui COS5021	Dindima	767	20	2	5	5	0.5	0.2	17.5	22	—	—	Delay, single shot
National VP5231A	Scientific Devices	770	30	2	2	1	0.5	0.2	11.7	6	600	1//30	
Trio CS1352	Parameters	845	15	2	10	2	0.5	0.5	24	1.5	600	1//22	Portable
Hitachi V203F	Standard	849	20	2	5	5	0.2	0.2	17.5	2	500	1//30	Portable, delay
BWD 821	BWD	850	50	2	20	5	1	0.2	7	6	—	1//30	Mix-mag.
Hung Chang OS645	Paton	940	45	2	5	5	0.5	0.2	7.7	15	600	1//20	Delay, single shot
Kikusui COS5041	Emona	951	40	2	5	5	0.5	0.2	8.8	12	—	—	Delay, single shot
Kikusui COS5040	Dindima	978	40	2	5	5	0.5	0.2	8.8	12	—	1//30	Delay, single shot
Aron BS625	Elmeasco	998	45	2	5	5	5	0.2	7.7	15	600	1//20	Delay, single shot
BWD 830	BWD	999	35	2	20	5	1	0.2	10	6		1//30	Delay
Iwatsu 5706	Electrical Equipment	1000	30	3	10	5	0.5	0.1	17.5	12	—	1//32	Delay
Hitachi V209	Standard	1049	20	2	5	5	0.2	0.5	17.5	1.5	500	1//30	Portable
Iwatsu 5705	Electrical Equipment	1100	40	3	10	5	0.5	0.1	8.7	12	800	1//32	Delay
Hitachi V353F	Standard	1119	35	2	5	5	0.2	0.2	10	5.2	500	1//30	Delay
Trio CS1577A	Parameters	1156	35	2	10	2	0.5	0.1	10	6	500	1//22	
Trio CS1040	Parameters	1175	40	3	5	1	0.5	0.01	8.8	12	500	1//27	
Hitachi V422	Standard	1249	40	2	5	5	0.2	0.2	8.8	12	500	1//30	
Philips PM 3211	Philips	1355	15	2	10	2	0.2	0.5	23	4	800	1//25	
Kikusui COS5060	Dindima	1392	60	3	5	5	0.5	0.05	6	12	—	—	Delay
Trio CS1060	Parameters	1495	60	3	5	1	0.5	0.5	5.8	16	500	1//27	
Hitachi V650F	Standard	1549	60	2	5	5	0.5	0.05	5.8	10	500	1//30	Delay
BWD 835	BWD	1550	60	2	20	5	1	0.05	5.8	10	—	1//30	RAN standard, delay, portable
Iwatsu SS5710	Electrical Equipment	1550	60	2	10	5	0.5	0.05	5.8	15	800	1//32	Counter and DMM available as extras
Kikusui DSS5020	Emona	1678	20	2	5	5	1	0.55	17.5	2	800	1//25	Digital storage
Hitachi V509	Standard	1795	50	2	5	5	0.2	0.1	7	12	500	1//30	Portable, delay
Hitachi V134	Standard	1837	10	2	5	5	2	2	35	2	500	1//30	Storage
Trio CS2075	Parameters	1995	70	4	5	5	0.5	0.05	5	12	800	1//22	8 trace, delay
Kikusui COS5100	Emona	1999	100	3	5	5	0.5	0.02	3.5	18		1//25	Delay, single shot
Kikusui COS5020ST	Dindina	2010	20	2	5	5	1	0.5	17.5	3.15	—	—	Variable persistence, storage
Philips PM3217	Philips	2020	50	2	10	2	0.5	0.1	7	10	800	—	Dual timebase option delay
BWD540	BWD	2100	100	2	50	5	1	0.05	4	12	—	—	Portable, single shot
Trio CS1100	Parameters	2158	100	2	5	5	0.5	0.02	3.5	16	500	1//22	Delay
Iwatsu SS5711	Electrical Equipment	2200	100	2	5	5	0.5	0.02	40	20	500	1//25	DMM available as option, delay, counter
Kikusui COS6100	Dindima	2300	100	5	5	5	0.5	0.02	3.5	20	—	1//20	Delay
Hitachi V1050F	Standard	2395	100	2	5	5	0.5	0.02	3.5	20	500	1//30	Delay
Trio CS2110	Parameters	2495	100	4	5	5	0.5	0.02	3.5	20	800	1//20	Delay, 8 trace
Kikusui COS6100A	Emona	2512	100	5	5	5	0.5	0.02	3.5	20	—	1//20	US Military, delay

The survey

We have arranged the 64 cheapest CROs we could find in price order. This is not an absolute ranking, because prices can be subject to fluctuations for all sorts of reasons. So a few words of caution: firstly, these prices do not include sales tax. If you have to pay it, add 20% for the government.

Secondly, some manufacturers include the cost of probes in their price while others don't, so you have to make allowances for that (±$50 for a decent set). Thirdly, in the nature of the case, this is a very competitive market place, so special offers and deals are likely to abound. Confirm the prices of all the models you are interested in before making a decision. And don't be afraid to haggle.

Having said all that, though, the table probably gives a pretty fair indication of what you can get for your money. As far as we are aware it is a comprehensive look at the market below $2500.

The only omission is kit CROs. These usually sell for around $220 from Dick Smith, Jaycar, Altronics and other hobbyist supplies. We have restricted our table to CROs you can buy ready to run.

I believe you'll find it interesting reading, even if you are not actually going to rush out and buy a CRO. The big surprise is just how cheap things have become over the last few years. The market starts at just $256. For $450 you can get a very respectable 20 MHz CRO. That would be sufficient for most hobbyist applications, including TV and digital troubleshooting. For less than $500 you can obtain models with timebase delay.

If you have a little more money, notice that digital storage is now available for as little as $1678. In fact, two different models of digital storage CRO and one variable — Persistence CRO are available for under $2500.

It doesn't seem to be true that cheap CROs are necessarily lacking in quality, either. At least two of these surveyed have satisfied stringent military requirements — the BWD 835 is in service with the RAN and the Kikusui COS 6100 with some sections of the US Military.

The movers and shakers

The makers and distributors have been listed in the first two columns. We use the term 'maker' rather loosely. In the nature of the case oscilloscope manufacture is a fairly incestuous business, so it can be difficult to establish just exactly who does what, and where.

There was a rumour doing the rounds that there was one big factory somewhere between Tokyo and Seoul where all the Asian CROs come from. But it was only a rumour. We do know that Aron, Application, Hang Chung and Meguro all refer to the same beast in different clothing. Others may be in the same boat.

One company does stand out from the rest, and that is Kikusui, a Japanese manufacturer which aims to take over from Tektronix as the biggest maker of CROs in the world. For the last few years they have been marketing aggressively in the USA, particularly at the low cost end of the market with the results you see in the table.

Surprisingly enough, the distribution system seems relatively well ordered. A few of the big manufacturers distribute their own product, as does the only Australian maker in our survey, BWD. Otherwise, the distributors are the familiar ones who dominate the electrical market place for all sorts of products.

The only slight confusion you might find springs from the fact that both Emona and Dindima distribute Kikusui CROs. Their price structure tends to be somewhat different so it's worthwhile making a comparison before selecting.

The table

In all cases technical specifications are those that appear in manufacturer's data. It was obviously impractical to test them all ourselves. You may feel inclined to take certain figures with a pinch of salt.

In any event, the bandwidth figure is taken at the claimed −3 dB point, and rise time represents the time taken to rise from 10% to 90% of final value. In our survey we found values between 5 MHz and 100 MHz. This should be sufficient to cover most applications outside some rare high frequency situations.

The maximum and minimum values of sensitivity for both amplifier and timebase are taken from the front panel labelling on all the machines. In general these will be extendible by five or sometimes ten with the magnification function.

Where available we have included the maximum permissible input voltage and the input impedance. This may be also be extended with the use of appropriate probes.

We have also included a column for the accelerating voltage used in the CRT. This is of some value when assessing cheap CROs, because it gives you some idea of the brightness of the trace during operation. As a rule of thumb when the voltage drops under 2 kV, you will have difficulty seeing a timebase running at 1 μs or faster.

In the remarks column we have included some of the extra facilities that can justify some CROs being more expensive than one would expect given their bandwidth and number of channels. Such things as delay lines, component testers, portability and storage facilities come into this category.

References

ETI April 84 — Bandwidth, probing, and precise interval measurements — goes into probe considerations in some depth.

ETI December 79 — The ubiquitous oscilloscope — looks at the fundamentals of how a CRO works.

ETI January 79 — Use a scope — why you need one.

DISTRIBUTORS INDEX

Altronics: Stirling Street, Perth WA 6000. (09)328-1599. Supplies a Goodwill CRO in kit form.

BWD: Miles St, Mulgrave Vic 3170. (03) 561-2888. Australian manufacturer and distributor.

Dindima: PO Box 106, Vermont Vic 3133. (03)873-4455.

Dick Smith Electronics: PO Box 321, North Ryde NSW 2113. (02)888-3200. Supplies a kit CRO.

Electrical Equipment: 192 Pacific Highway, Arncliffe NSW 2205. (02)597-1155.

Elmeasco: PO Box 30, Concord NSW 2137. (02)736-2888.

Emona: 1st Floor, 720 George St, Sydney NSW 2000. (02)212-4815.

Hewlett-Packard: 31 Joseph St, Blackburn Vic 3130. (03)895-2895. A manufacturer of a fine range of oscilloscopes. Unfortunately all out of our price range.

Jaycar: 117 York St, Sydney 2000. (02) 267-1614. Another hobby supplier with kits available.

Parameters: 41 Herbert Street, Artarmon NSW 2064. (02)439-3288.

Paton Electrical: 90 Victoria St, Ashfield NSW 2131. (02)797-9222.

Philips: 25 Paul St, North Ryde 2113. (02)888-0443.

Scientific Devices: 2 Jacks Rd, South Oakleigh Vic 3167. (03)579-3622.

Standard Communications: 6 Frank St, Gladesville NSW 2111. (02)816-4755.

Tektronix: 80 Waterloo Rd, North Ryde NSW 2113. (02)888-7066. Probably the biggest oscilloscope maker in the world, with some high quality products available. Unfortunately, it was all too expensive, and none of its CROs were included in our sample.

Vicom: 68 Eastern Rd, Sth Melbourne Vic 3205. (03)62-6931. Distributes a number of makes and models of CROs. Unfortunately, no details were forthcoming before we went to press.

While the DSX

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D.C. Brisbane, Qld

"Thank you for your letter and the advice it contained. I appreciate that advice".
T.R. Balnarring, Vic

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In the interests of fair competition, we'd like to pass on a few tips from our sixteen years of experience:

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- When customers send in too much money don't return a scrap of paper in their order with the amount on it. They could lose it! Instead, use your on-line system to itemise any credit on the invoice and then **automatically** deduct it from the next order.
- If you run out of stock don't just scrawl 'out of stock' on the order. Put it on back-order, inform the customer of the delay and check all back-orders daily until the stock arrives. When it does, post it out at no extra charge. It's expensive, but it's the type of service you should offer. Just like we do.
- Support your mail order department with at least $5 million worth of stock and surround with 150 skilled people all geared to provide the customer with the best possible service. Just like we do.
- Ensure that you despatch all orders within 24 hours of receipt: no-one wants to sit around waiting weeks for the goods to arrive. If there **must** be a delay, tell the customer why. Just like we do.
- And occasionally when you make a mistake – and you will (you're only human) be strong enough to admit it. Just like we do.

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Some time ago ETI was asked to review some NiCad batteries by a local agent, Power Sonic. Well, that is a bit of an odd request, and not one which can be done quickly, it turns out. Nevertheless, here is the result, and we trust that it is informative.

Jonathan Scott

"POWER TO THE PEOPLE"

WHAT ARE THE most interesting attributes of a battery? Well, some idea of the capacity of a cell (i.e: the actual amount of energy delivered per charge) is important. Also the span of the cell (i.e: the number of charges it will deliver before expiring) is important. These two are, of course, related, as will be shown, for the capacity varies with age, measured in time and usage. In addition some measure of how much punishment a cell will take would be informative. Availability of the less usual sizes and shapes is a final factor of concern to people who want custom cell configurations or whose gear does not use the ubiquitous 'penlite' (AA) cell.

The latter requirement is easily summed up, for Power Sonic offers a large range of cells: the standard penlite (AA) cell, C cell and D cell; the AAA cell which is thinner than the AA, the N cell which is both thinner and shorter, the 2/3AA which is not surprisingly 2/3 as long as an AA; a cell called the 'SC', which is a short C cell (clearly) and a short D cell, you guessed it, the 'SD'. There are also the F cells, which are long D cells.

In addition to the above range of standard cells Power Sonic offers the C cells and the short C cells in a fast charge type, and AA, 1/3AA, SC, C and D cells in high temperature types. We reviewed only the standard sorts, so we cannot make any comments on the special types mentioned last.

Cells can be purchased by OEMs in any configuration required, all welded together and encapsulated on heatshrink envelopes, if so desired. This facility is very useful for manufacturers who wish to minimise bad connection problems and/or prevent accidental mixing of old and new cells in their equipment, etc. Certain cell combinations are available with PCB mount connections intended as memory backup cell packages. While this is probably of little interest to individuals, it at least indicates some serious commitment on the part of the local people.

Capacity

Initially we verified that the cells delivered their quoted capacity. This they all did, with some in hand. The capacity of a battery is usually measured in Ampere-hours, or Ah. For a moment let us measure in milliWatt hours per cubic centimetre (mWh/cm^3) which is a method more often used to compare batteries of various types, because it reflects the energy stored per unit volume. The PS cells were quoted as having between 50 and 85 mWh/cm^3, which is pretty standard. It rises from the minimum with the smallest cells, because they have a lot of case per unit of active ingredients, to the maximum with the F and D cells, which are pretty hefty and have a lot of insides for the case. By way of comparison, a lithium cell

Figure 1. Life of an AA cell at the 2 C rate.

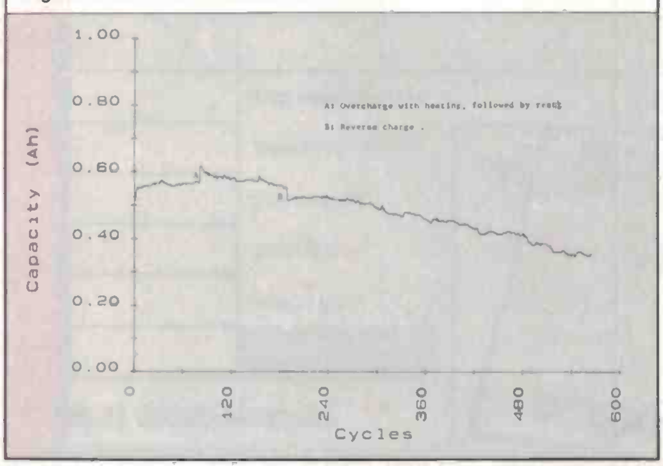
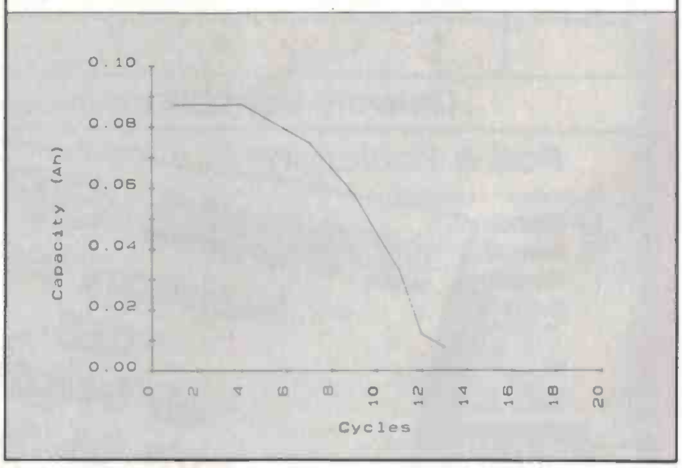


Figure 2. Destructive test of a 1/3AA, 110 mAh, cell.



POWERSONIC NICADS

Distributed by: Powersonic, Shop 43, 61-89 Buckingham St, Surry Hills NSW 2010. (02)699-2722.

Prices: (r.r.p.)	AA (500 mAh)	**$3.30**
(inc. tax)	C (2 Ah)	**$9.40**
	D (4 Ah)	**$15.90**

might have as much as 800 mWh/cm^3 (the spec for Hellensens cells, 1983), while a sealed lead acid type offers typically up to 55. The PS AA cell we tested first was specified as offering 70, but delivered 80 mWh/cm^3. (All the tests, we should note here, were carried out in a room at 25°C, at the 10 hr rate, unless specified otherwise.)

Back to familiar Ah. The 500 useful charges which you may see quoted in advertisements for NiCads seemed to us to be very optimistic. If a penlite cell was to be charged and discharged at the recommended rate (14 + 10 hrs) this lifespan represents 500 days of continuous testing. Even ETI's enthusiasm does not stretch to over a year and a third per cell. It was thus decided to do only a couple of cells, and to both charge and discharge them at a fast rate — say 1 amp. This represents really working them hard indeed! The results are shown in Figure 1. Ignoring the small variations, it can be seen that the cell started at just over the 500 mAh quoted, rose to about 600 mAh, and did not fall to 500 again until about cycle 300. The average capacity (the integral under the curve) did not fall to 500 mAh until almost 500 charges (at the accelerated rate!) had elapsed. We have not done this to another brand for comparison, but we figure it is pretty good. The small aberrations in the figure will be discussed shortly — they have been deliberately included to indicate certain responses to abuse. Cells not subjected to the odd circumstances produced similar results to the one whose graph is shown.

Thrashing!

Next we decided to see what kind of thrashing a cell can take. We noted in the literature that cells below C-size could take fast charging, by which the manufacturer means about double rate. We had run the penlite at the 2 *C* rate, which means it would be expected to discharge in half an hour if it were ideal. Ratings usually assume the *C*/10 rate, or discharge over 10 hours; 2 *C* is 20 times overspeed already. Although we did not do a comprehensive test (that is, work the cell to complete death) we noted no serious deterioration over tens of charges at 4 *C*. At 10 *C*, however, a cell overheats. It appears to be as we suspected — it is the heat that boils the internals and breaks the seal which brings about the demise of a cell. At 10 *C* a PS-1/3AA, rated at 110 mAh, died quickly, exuding its lifeblood swiftly but *harmlessly*. So we have verified (in limited trial) that the cells will run quite happily at 2 *C*, or twenty rated, but that they will die by overheating at 10 *C*.

Boiled. The 1/3AA cell destructively tested lost its 'innards' harmlessly via the end seal.

It should be noted here that the cells are rated up to 45°C charging and 65°C discharging. The lower charging temperature is because more power is dissipated when charging. When nearing full charge the cell dissipates what energy it cannot assimilate as heat, requiring greater dissipative capability for the same internal temperature.

Thus the above operation at 2 *C* has assumed that you will be careful not to overcharge the call. What does happen if the cell is overcharged by a factor of two, provided that the seal is not badly ruptured and the contents escape? What happens if the cell is discharged to less than 0 volts, such as might happen if one cell in a stack has less capacity than the others, and is reverse charged by the others still discharging? These two conditions were simulated on the cell whose 'lifeline' is pictured in Figure 1.

At the point marked A, or rather between the discharge capacity plots at either end of the short jump, the cell was doubly charged and rested until quite cool (overnight). Its temperature exceeded 60°C, but did not give indication of gassing. As you may see from the graph it exhibited elevated capacity for *some charge cycles afterward*. The capacity fell back to about where it was expected to have been in 10 to 20 cycles. How the cell appears to have held some of the excess, we are not sure.

The cell was only discharged until the terminal voltage fell to .9 V at 1 A load, so a small increase in resistance could have masked some charge retained. Alternatively, the cell may have suffered some beneficial restructuring of its electrodes. In either case the cell returned to its former self. (We favour a mixture of the above reasons. We cannot eliminate the second because we are quite sure that the cell was being fully charged at each charge phase. Also the rest may have been the beneficial factor, rather than overcharging.)

At point B the cell was reverse charged about 20% on one *C*. Again the effect lasted some charges, but this time it was such as to deplete the apparent capacity. Again the cell returned to being its former self. This indicates a fairly acceptable response to mild abuse, as so often arises in the daily use of, say, batteries in a portable appliance.

The final point of interest is the continuous array of 'noise' on the curve of Figure 1. We kept the temperature of the test room constant, and the current and times were set to within 5 mA and 14 seconds. There is clearly some other factor for which we were not controlling. We have honestly no idea what it might have been, but we are likewise sure that you will not be controlling for it either, so it does not matter greatly — the curve represents what you might expect.

In summary, though we have no good reference with which to compare the performance, it was most satisfactory in our opinion. A cell rarely gets used to the end of its natural life in our erratic and experimental environment, so the tests are not representative of what we would expect from a cell, but can be taken as good representative data for a cell used carefully and regularly in a cassette player, provided it is charged according to requirements, etc. ●

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ALARM CIRCUIT FOIL TAPE
Cat. S15080 $7.95

ALARM CONTROL MODULE
Cat. S15055 $29.95

MINI BUZZER 5—15V WHITE/BLACK
Cat. S15062 $1.95

PIEZO ALARM SINGLE TONE
Cat. S1506 $6.95

PIEZO ALARM DUAL TONE
Cat. S15070 $7.95

D.C. BELL 4" 12V 250 MA
Cat. S51072 $9.95

HEAT SENSOR
Cat. 15074 $9.95

MAGNETIC READ SWITCH N.O.
Cat. S15057 $2.50

MAGNETIC READ SWITCH N.C.
Cat. S15058 $2.95

SHOCK/VIBRATION SENSOR
Cat. S15049 $2.95

GLASS BREAKAGE SENSOR
Cat. S1505 $3.95

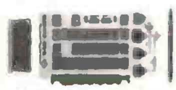
LOCAL BURGLAR ALARM CONT PAN
Cat. S15051 $69.96

ULTRASONIC BURGLAR ALARM
Cat. S15052 $80.95

ULTRASONIC MOTION DETECTOR
Cat. S15033 $39.95

KEYLESS AUTO ALARM 12V
Cat. S15054 $39.95

WALL BRACKET TO SUIT S15052
Cat. S15042 $11.95



DIGITAL MULTIMETER
YFE YF1100 FEATURES
- Large easy to read 3½ digit display
- Facilities for transistor and diode testing
- Clearly laid out front panel
- 10A DC AC range
- Priced to undersell the others!

Cat. A16025 $59.50

QUARTS CRYSTAL CLOCK MOVEMENT
- Very compact and reliable
- Self starting one second stepping motor has strong torque
- Powered by 1.5V AA battery that lasts for a year
- Supplied with two sets of hands, one short and one long
- ±15 seconds/month accuracy
- 56mm square, 15mm deep

Complete with data sheet, instructions and wall hanger bracket

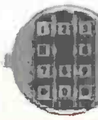
Cat. XC0100 $14.95

ELECTRET MIC INSERTS
With pins for easy board insertion.

1+	10+	100+
$1.25	$1.10	$1.00

NATIONAL RECHARGEABLE DRILL/SCREW DRIVER EZ505
- Quick 1Hr Charging
- 4 Stage Torque Control
- 2 Speed Switch
- Handle Storage Compartment
- Forward/Reverse Operation
- National Quality
- Spare Battery Pack Available

Cat. T12320 $149.00



PUSH BUTTON DIALLERS
Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number re-dial (up to 16 digits) and instructions for an easy changeover.

Cat. A12030 $19.95

COLOUR CAPPED KNOBS
Economy knobs with elevated white pointer

Cat. H10001	RED
Cat. H10002	BLUE
Cat. H10003	GREEN
Cat. H10004	YELLOW

This month's prices

1-9	10-99	100+
$0.40	$0.35	$0.30

2K OHM MULTI METER
11 Ranges, pocket size.

SPECIFICATIONS:
11 RANGES
DC VOLTAGE: 0-10-50-250-1000 volts 2000 ohms/volt
AC VOLTAGE: 0-10-50-250-1000 volts 2000 ohms/volt
DECIBELS: -10 to +22dB in four ranges
OHMMETER: 0-10 k/ohms, 0-1 mega-ohms
DC CURRENT: 1 100mA

normally $14.95
this month $9.95

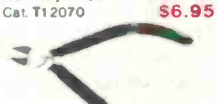
$100 PROTOCARDS SAVE $10 This month only.

Cat. H19125
Horizontal Buss
Cat. H19125 $29.50

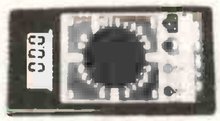
Vertical Buss
Cat. H 19130 $29.50

Pad Per Hole
Cat. H 19135 $29.50

TRANSISTOR NIPPERS
Normally $7.95! This Month
Cat. T12070 $6.95

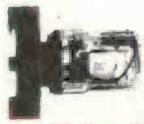


MICRO NIPPERS
Normally $9.95 This Month
Cat. T12050 $6.95



WE HAVE DONE IT AGAIN!!
New multimeter at unbeatable value for under $45! The new YU FONG YFE-1030C features:
- Large 3½ digit display. (½ inch high).
- Autopolarity, "-" display for Negative input.
- High over-load protection for all ranges.
- Over-load display, highest figure "1" or "-1" alone glows
- Power consumption 20mW approx.

Cat. $44.95



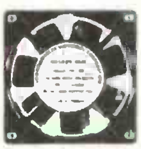
RELAY AND BASE
Can carry 10A at 28V DC or 5A at 240V AC. Supplied with Chassis Mounting Socket with screw terminals. Great for school projects and demonstrations, switching DC power supplies, central circuits and with contacts parallel up to 20A can be switched.
Normally $8.95

Cat. S14074 This month $6.95

CRYSTAL SPECIALS
Prime spec's. We just have too many in stock!

3.5795 MHz	14.318 MHz
4.00 MHz	18.0 MHz
4.1943 MHz	20.0 MHz

All $2.50 each!
10 or more $2.00!



BRAND NEW FANS
Not noisy pullouts! Stacks of uses in power amps, computers, hotspot cooling etc. Anywhere you need plenty of air.

Cat. T12461	240V	4½"
		$16.95
Cat. T12463	115V	4½"
		$16.95
Cat. T12465	240V	3½"
		$16.95
Cat. T12467	115V	3½"
		$16.95

10 Fans (mixed) less 10%

NEW!

U.V. TUBES
Fits into standard 20W flouro holder. Suitable for Scotchcal, Eprom erasing etc. As used in ETI Eprom Erasing Kit. WARNING: Do not look directly into UV Tubes!! If ordering by mail please include an extra $2 for "SPECIAL" packing.

Cat. H28600 $24.95

RITRON (ZETA) DATASETTE
For data loading and saving, this Micron Datasette suits most home computers and features tape counter, monitor function for audio verification and slide volume control for output level.

Cat. C14900 $29.95

MICRON SOLDERING IRON
240V, 30 W general purpose for electrical and electronic soldering.

Cat. T12430 This month $10.95

UNIVERSAL SOLDERING IRON STAND
Cat. T11302
$5.95 slashed to $3.95

VIDEO RF MODULATOR
At an unbelievable price!
Our RF molulators are channel selectable either Channel 0 or Channel 1

1-9	10+
$4.95	$3.95

Cat. S16040

KEY SWITCHES

1-9	10+
$3.95	$3.75

Cat. S12500

TAPERED REAMER
Great for enlarging holes that are a bit too small. Enlarges from 5mm to 20mm.

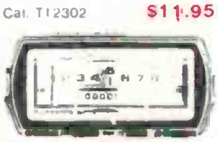
Cat. T12370 $6.95

FAIRCHILD TTL DATA BOOKS
Just arrived! This book is the same as used in the Victorian Education System. Includes data on new Fast series. Limited stock 500 only.

Cat. B10050 $14.95

POWERFUL MINI DRILL
Featuring a powerful 6000 r.p.m. motor, this lightweight (113gm) drill is ideal for many jobs. Perfect for PCB work! Has a 0.8 to 1.2mm chuck and 1mm drill bit. Requires 12V 1 AMP (use with M19010)

Cat. T12302 $11.95



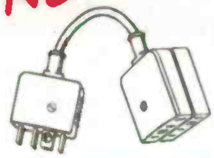
PANEL METER BARGAINS!!
250 ua Sensitivity Panel cut out 36 x 16mm. Mounting hole centres at 49mm

Cat. Q10400 normally $4.50
this month $2.95

250 ua Sensitivity centre 0 very useful for balanced circuit and applications needing a centre 0 or null indication

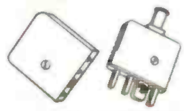
Cat. Q10405 normally $4.95
this month $2.95

NEW!!



TELECOMMUNICATION PLUG TO 2 SOCKETS.
Ideal for modem connections.

Cat. Y16014 $12.95



TELECOMMUNICATION PLUG/SOCKET

Plug	Cat. Y1601	$3.95
Socket	Cat. Y16018	$4.95

TELECOMMUNICATION EXTENSION LEADS

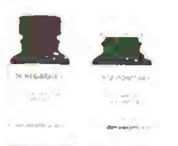
Cat. Y16010	5m	$12.50
Cat. Y16012	10m	$14.95

BREADBOARD SPECIALS
Why pay more??

Competitors Price	Our Price
Cat. P11000 100 holes $2.95	$1.50
P11005 640 holes $8.95	$5.95
P11009 840 holes $14.85	$10.95
P11012 1,680 holes $27.95	$19.95
P11015 2,420 holes $45.00	$29.95

TO3 HEATSINK

1-9	10+	100+
$1.00	$0.90	$0.75



NEGATIVE & POSITIVE CIRCUIT RESIST
Make your own presensitized PC Boards. POSITIVE PHOTO RESIST for using 1:1 tapes and pads on clear film for one off or prototypes. Resist 50ml bottle for approx. 1500 sq cm of pcb

Cat. P85500 $6.95

DEVELOPER: 70 gms of crystals to mix with 2 lt of water, enough to complement 50ml of resist.

Cat. P85504 $3.25

NEGATIVE PHOTO RESIST for using normal negative PCB images
Resist: 50ml bottle for apprx. 1500 sq cm of pcb

Cat. P85508 $5.45

DEVELOPER: 500ml bottle enough to complement 50ml of resist. No dilution reuqired

Cat. P85510 $8.50

ETCHANT: 400gms of crystals to mix with 1 to 1½ lts of HOT water

Cat. P85512 $3.25

ELECTRONIC CASSETTE DEMAGNETISER
Save $2. Rec. retail $19.95

Cat. A10006 This month $17.95

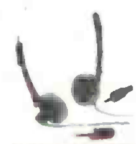
P.A. SPEAKERS
Dual cone, wide range, 200mm (8 in.) 10 W Ideal for public address, background music etc.

	1-9	10+
Cat. 1200	$9.50	$8.50

CAR REPLACEMENT SPEAKERS

Cat. C10757	5x7" Oval	$5.95
Cat. C10746	4x6" Oval	$4.95
Cat. C10705	5" Round	$4.50
Cat. C10706	6" Round	$5.95

All are rated at 4 OHM, 5 WATT

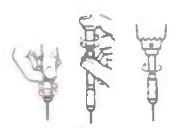


MINI STEREO HEADPHONE
Low cost hi-fi sound! Light and comfortable, as easy to wear as hair!

Cat. C14000 $4.95

3 ½" MAGNIFYING GLASS
Ideal for close inspections of solder joins etc.

Cat. T12087 $7.95



PIN VICE
It's infuriating when all you need to do is drill one hole a little big bigger and haven't got a drill that fits in your tool box. Buy one of these for drilling circuit boards. Will hold drill bits, taps, files, etc. up to 3mm

Cat. T12352 $7.95

MAGNETIC BULK ERASER
The best and by far the quickest way to erase tapes, cassettes and computer discs! Reduces noise levels below recorders own erase head level. On/off switch located in handle. 240V AC operation.

Cat. C14950 $29.50

CANNON TYPE AUDIO CONNECTIONS

We've sold 1000's because of their great value!

	1-9	10+
3 Pin line male Cat P10960	$1.90	$1.80
3 Pin chassis male Cat P10962	$1.90	$1.80
3 Pin line female Cat P10964	$2.50	$2.20
3 pin chassis female Cat P10966	$2.90	$2.70

BULK CABLE 100M ROLLS

Cat. W11222 3C2V75 OHM **$22.00**

Cat. W11224 5C2V75 OHM **$35.00**

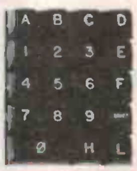
Cat. W11219 4 Core Shielded **$49.00**

MINI MODEM

300 baud full duplex
Answer originate
Plugs straight in (hardwired phone)
Superior VLSI chip performance (identical to Multi Modem)
Telecom Approval (C84/37/1173)
Incl. phone only **$199**

ALUMINIUM SHEETS .8mm

CAT.	SIZE	PRICE
H10770	150x150mm	$1.75
H10771	150x300mm	$2.50
H10772	300x300mm	$3.95
H10773	300x600mm	$6.90



HEX KEY PAD

19 Keys, Unencoded, 76 x 95mm
Cat. K46804 **$42.50**

RECHARGEABLE 12V GELL BATTERIES

Leakproof and in 3 convenient sizes, these long service life batteries are ideal for burgular systems, emergency lighting or as a computer backup power supply. Ideal for many power needs.

Cat. S15029 12V 1.2 AH **$17.95**

Cat. S15031 12V 2.6 AH **$34.50**

Cat. S15033 12V 4.5 AH **$44.95**

BLANK DATA CASSETTES

Brings out the best in any micro!

1-9	10-99	100
		$0.90

Cat. D11141

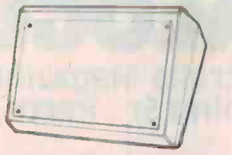
★★★ SCOOP ★★★

PRIME SPEC RED LEDS

We bought 100,000 so you can reap the benefits!

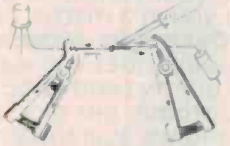
1-9	10+	100+	1,000+
10c	9c	8c	7c

Cat. Z10150



NEW SLOPING CASES

Plastic with metal front panel, available in two sizes:
Cat.H10450 190x120mm **$9.95**
Cat.H10455 265x185mm **$17.95**
(measurements are approx. only)



HEAT STOPPERS

For protecting parts which have little resistance against heat when soldering. Normally $3.50.
Cat. T12440 **$2.50**

RS232 & 'D' TYPE CONNECTORS

PART	DESCRIP.	CAT.NO.
1-9		10-25
DE 9P	9 Pin Female	P10880
$1.75		$1.60
DE 9S	9 Pin Male	P10881
$2.25		$2.10
DE 9C	9 Pin Cover	P10882
$2.55		$2.45
DA 15P	15 Pin Male	P10894
$2.10		$1.95
DA 15S	15 Pin Female	P10895
$2.25		$2.10
DA 15C	15 Pin Cover	P10892
$1.15		$1.05
DB 25P	25 Pin Male	P10900
$2.95		$2.80
DB 25S	25 Pin Female	P10901
$3.45		$3.30
DB25C	25 Pin Cover	P10902
$1.20		$1.10

36 WAY CENTRONICS CRIMP PLUG

Cat. P12200

1-9	10-99	100+
$6.50	$5.95	$5.50

SOLDER CENTRONICS PLUGS

Unreal price for absolute top quality. Normally $14.95 (Our opposition charge up to $19.95!)

1-9	10+	100+
$6.95	$5.95	$4.95

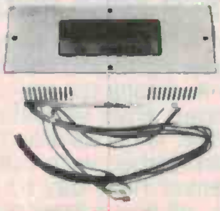
CENTRE RETURN JOYSTICK

Features 2 x 150K pots, long shaft 40mm with 25mm control ball. Bonus adjustable offset feature on pots.

Cat. X15637 1-9 **$9.95** 10+ **$8.95**

PIPER MOUSE ROBOT

This is a Super-Sonic robot, controlled by a super-sonic sound sensor and an electronic circuit (1 channel). By using the whistle included with this Kit, Piper Mouse will obey your commands immediately turning to the left, stop, turning to the right, stop, advance and stop.
Cat. K96680 **$34.95**



SWITCH MODE POWER SUPPLY

DC +5V @ .5A +12V @ .4A
DC −5V @ .5A −12V @ .4A
Cat. M16680 **$89**

JUMPER LEADS

Set of 10 high quality leads approx. 300mm long. Normally $4.95.
Cat. W12000 **$2.95**

NICAD BATTERIES

Save on carbon batteries with these Appolon Nickel cadmiums. Rechargeable up to 1000 times!

		1-9	10+
Cat. S150020	AA500 MA	$2.25	$1.95
Cat. S15021	C 1.8 AH	$4.95	$3.95
Cat. S15022	D 4 AH	$7.95	$6.95

LOW PROFILE IC SOCKETS

How cheap can they go?

	1+	10+	100+	1000+
8 pin Cat P10550	15c	14c	12c	09c
14 pin Cat P10560	16c	15c	14c	10c
16 pin Cat P10565	17c	16c	15c	11c
18 pin Cat P10567	18c	17c	16c	13c
20 pin Cat P10568	29c	28c	27c	26c
24 pin Cat P10570	35c	33c	32c	28c
40 pin Cat P10575	45c	40c	35c	30c

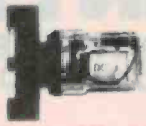
APPLE JOYSTICKS

Ideal for games or word processing.
Fits most 6502 "compatable" computers.
Cat. C14200 **$24.95**

VERBATIM DISKS

"Lowest" price possible for "Highest" quality

	1-9	10+	100+
MD525-01	3.95	2.75	2.50
MD550-01	4.50	3.95	3.75

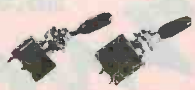


RELAY AND BASE

Can carry 10A at 28V DC or 5A at 240V AC. Supplied with Chassis Mounting Socket with screw terminals. Great for school projects and demonstrations, switching DC power supplies, central circuits and with contacts parallel up to 20A can be switched.
Normally $8.95
Cat. S14074 This month **$6.95**

ELECTRONIC CASSETTE DEMAGNETISER

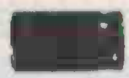
Save $2 Rec. retail **$19.95**
Cat. A10006 This month **$17.95**



ECONOMY TOGGLE SWITCHES

Unbelievable Value!

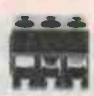
	1-9	10+	100+
S11010 (SPDT)	$1.00	$0.90	$0.80
S11020 (DPDT)	$1.20	$1.00	$0.90



10,000uF 75V ELECTROS

25% more microFarads! Ideal for those who want a more powerful amp!

Cat. R16587 1-9 **$10.50** 10+ **$9.00**



NEW JOINABLE PCB MOUNTING SCREW TERMINALS

Less than half the price of the old ones!

	1-9	10+
2 way Cat P10542	$0.50	$0.40
3 way Cat P10543	$0.75	$0.65

(please note these are the new blue ones.)

LOGIC PROBE 3800A

Features 20MHz memory TTL CMOS operation. Normally $29.50 now only

Cat. Q11272 1-9 **$19.50** 10 **$17.50**

INCREASE YOUR MEMORY

	1-9	10+
4116	1.80	1.70
4164	4.95	4.50
2716	6.25	5.95
2732	6.25	5.95
2764	8.25	7.95
27128	27.00	25.00
6116	6.95	6.75
41256 (256K)	27.50	22.50

BULK 'IC' SPECIALS

	10+	100+	1000+
LM 324	$0.70	$0.65	$0.60
LM339	$0.70	$0.65	$0.60
LM555	$0.40	$0.39	$0.35
LM723	$0.60	$0.55	$0.53
LM741	$0.45	$0.40	$0.37
LM1458	$0.80	$0.70	$0.65
LM1488	$0.60	$0.57	$0.55
LM1489	$0.60	$0.57	$0.55

PHILLIPS SPEAKER SPECIAL

Cat. C12030 AD01610 T8 **$12.95**

Cat. C12040 AD02160 SQ8 **$34.95**

Cat. C12045 AD70620 M8 **$49.00**

Cat. C12050 AD12550 W8 **$79.00**

You don't have to "imagine" Phillips quality at these prices!

SUPER HORN

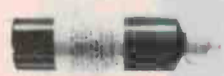
Wide dispersion tweeter handles up to 100W
Sensitivity 105dB/0.5m
Frequency Response 3kHz-30kHz
Impedance 8 OHMS
Size 145x54mm

Cat. C12103 **$12.95**

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
(Rec. Retail $12.95) **$11.95**



FULL STRENGTH FERRIC CHLORIDE

This month only!

	1-9	10+
250ml	$1.95	$1.75
500ml	$2.95	$2.50
1 litre	$4.95	$4.50

FUSE SPECIAL 3AG

Two values, 3 Amp and 1 Amp

1-99	100-999	1,000+
8c each	6c each	5c each

STOCK UP NOW

CAR ANTENNAS

We stock a wide range of car antennas including auto up/down antennas.

rie

Rod Irving Electronics

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48-50 A'BECKETT STREET, MELBOURNE VICTORIA.
PH:(03)347 9251
Mail Order and correspondance:
P.O. Box 235
NORTHCOTE 3070

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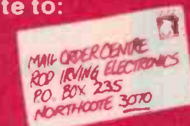

or phone ...

MAIL ORDER HOT LINE

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POSTAGE RATES

$1-$9.99	$1.50
$10-$24.99	$2.00
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Comet road freight is extra.

PROJECT ELECTRONICS

Here are 11 great projects for the beginners from the ETI Project Electronics publication (5th Edition)

043 Heads or Tails	$3.90
044 Two tone doorbell	$4.90
047 Morse practice set	$3.90
048 Buzz board	$4.50
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065 Electronic siren	$5.90
066 Temperature alarm	$5.50
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072 Two octave organ	$9.50
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All these Kits are available from us at Rod Irving Electronics!!

Cat. B11185 **$4.75**
OR "FREE!" with every order for 10 or more Kits!!!

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1985 ALTRONICS ELECTRONIC COMPONENTS CATALOGUE

YOURS FREE with this month's Electronics Australia Magazine
OR send $1 to cover P&P to Altronics, P.O. Box 8280, Stirling St., Perth, W.A. 6000

REMEMBER

Altronics staff are all keen young electronics enthusiasts — just like yourself — so when you need a little technical help, give us a call.

- ★ Quality Products at direct import prices.
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An Altronics 1st is our **INWATS Toll Free Order Line.** Bankcard holders can call us from anywhere in Australia for the cost of a local call and place your order; after validating your Bankcard, **presto** the order is on its way to you in a matter of hours. Remember with our **Overnight Jetservice** we deliver next day to capital cities and suburbs and 24 - 48 hours later to country centres. So if you're not already an Altronics Customer just pick up the phone and dial 008 999 007 and we guarantee to deliver faster than your local supplier.

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Solder Superflow 200G Reel $5.50

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2N3055 TO3 Power Transistor $1.10

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FOR THE VERY QUICK!

Here are some incredible bargains. We suggest you phone order now to reserve yours.

IMPORT SCOOP

Quality Commonwealth Computer Fan 80MM - 240V

CAT F 1020

$12

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Amazing Value

• Super quiet • Sealed sleeve bearings for long life • Sturdy die cast frame • Operating range —10 deg C to + 70 C

ECONOMY RACK CABINET

- Solid steel construction
- Black anodised front panel
- 3 unit (132mm)
- Conforms to International Standards
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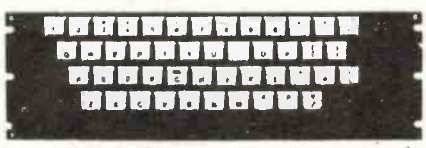
H 0400 ONLY ~~$45.00~~ **$40**

"MICROBEE KEYBOARD"



Full 60 Key Qwerty Computer Keyboard exactly the same type as has been used up to now with the famous Microbee Computer SPST keys Complete with mounting plate, all key caps etc Fully assembled Incredible value — Be Quick!

D1510 ...... **$19.95** ... ~~$29.95~~

Microbee is registered trademark of Applied Technology Pty Ltd

SPEAKER 8 OHM 2 ¼ INCH

From 69¢

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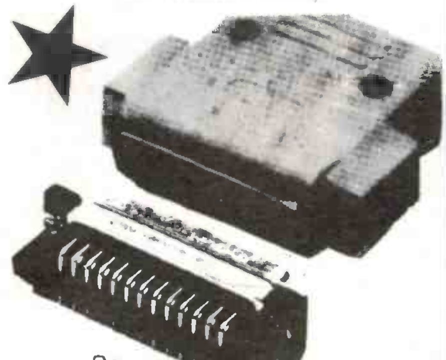
Stock Up Now and Save a Bundle

D Range Connectors all 1/2 Price



Be Very Quick This Month Only

		WERE	NOW
P 0880	DB 9 Male 9 Pin	2.50	1.25
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P 0882	DB 9 Male PCB Mnt	3.25	1.60
P 0883	DB 9 Female PCB Mount	3.95	2.00
P 0885	DB 9 Backshell Cvr	1.80	.90
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P 0895	DB15 Backshell Cvr	2.00	1.00
P 0900	DB25 Male 25 Pin	4.50	2.25
P 0901	DB25 Female 25 Pin	4.95	2.50
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P 0903	DB25 Female PCB Mount	5.50	2.75
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Fluke Series 20

John Fluke Manufacturing has expanded its line of handheld multimeters with a new family of heavy-duty analogue/digital multimeters.

The new Fluke 20 Series, like the recently introduced 70 Series, combines a digital meter with an analogue meter. The 31-segment analogue bar graph makes measurements such as peaking, nulling and capacitor checking and provides an easy way to test for erratic or unstable signals.

To keep operation simple, functions are selected with a single rotary switch. High-speed auto ranging automatically selects the correct measurement range and positions the decimal point. Display annunciators clearly indicate range, polarity and any activated features.

According to the company, the new meters have been built to withstand the environmental and electrical abuse common to construction, maintenance, petrochemical and other heavy industries. They are guaranteed to operate in calibration for one year despite drops, shock, vibration, or water and chemical spills. All components are shock-mounted and safeguarded with high-energy fuses and extensive overload protection to prevent mechanical damage or electrical shock. In most overload circumstances replacement of fuses is not even required. Extensive shielding protects the meters from excessive electromagnetic interference.

A new liquid crystal display works at extreme temperatures. Operation is guaranteed from −15°C to +55°C and to −40°C for 20 minutes. Typical continuous operation is from −20°C to +60°C.

The new 20 Series incorporates a new integrated circuit developed by Fluke exclusively for it.

The new chip improves overall accuracy and gives the meters a higher voltage capability with more current ranges. It offers 0.1% dc accuracy, 100 µV to 1000 Vac and dc, 0.1 µA to 10 A ac and dc; and 0.1 ohm to 32 M resistance. It can also measure up to 10 000 M with a conductance function and measure in-circuit resistance without turning on diodes or transistors.

Series 20: The four new meters from Fluke.

A continuity beeper, assists wiring, diode and transistor checks.

The Software Touch Hold, first introduced with Fluke's 70 Series, has been further improved in the 20 Series. Using Touch Hold, the user can take readings of critical circuitry while watching the probes. Using standard test leads, the meter captures a stable measurement and locks the digital reading in the display for viewing. It automatically beeps and updates when a new stable measurement is established. The analogue bar graph continues to follow the input signal while the digital display is held between measurements.

Fluke has given considerable attention to operator safety for the high-risk environments for which these meters are intended. The 20 Series' built-in safety features include extensive overload protection, high energy fuses and case designed to protect the operator from voltages one thousand volts greater than safety standards require.

The case is also constructed entirely from non-metallic materials with special recessed input jacks to accommodate safety-designed test leads.

For more information contact **Elmeasco Instruments, 15 McDonald St, Mortlake NSW 2137. (02)736-2888.**

Fibre optics catalogue

Now available from STC-Cannon Components is the latest Fibre Optics summary catalogue. Contents include sections on optical interconnection design, interconnection components, test instruments and installation equipment.

The Fibre Optic Summary Catalogue is available on request to **STC-Cannon Components Pty Ltd, 248 Wickham Road, Moorabbin, Vic 3189.**

New variable auto-trannies

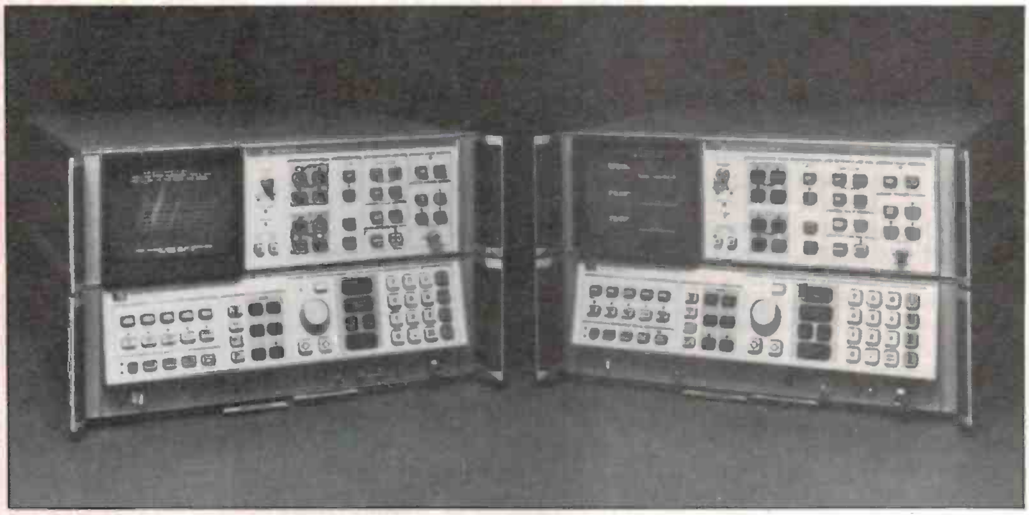
Electromark has introduced a new series of variable auto-transformers suitable for any equipment which is controlled by voltage variation. The SD range covers power ratings from 500 VA to 200 kVA and motor driven models are also available for remote control operation.

The M-types, ranging from 500 VA to 10 KVA have been manufactured in Japan to Electromark specifications for Australian use. Models up to 15A incorporate Australian standard output sockets and are fitted with input cords and plugs. A voltmeter is fitted as standard equipment and the larger models have a circuit breaker in place of the fuse.

For more information contact **Electromark, 43 Anderson Rd, Mortdale NSW 2223. (02)570-7287.**

Slide regulators: M-series regulators from Japan.

Programmable spectrum analyzers



Looking at the Spectrum: Two new spectrum analyzers from H-P with advanced logic.

According to the company, the new HP 6566B (microwave) and HP 8658B (RF) spectrum analyzers from Hewlett Packard have enhanced functions to process both incoming signals and traces as well as a set of command flow functions to make decisions like a computer.

More than 120 new functions have been added to the B versions of the HP 8566 and 8568 when compared to their A version predecessors. The signal-processing functions include Fast-Fourier Transforms and power-bandwidth calculation of incoming signals. Trace-processing functions include storing of the minimum value of a trace and finding the standard deviation of trace data.

Users of the new analyzers can define a set of front-panel keystokes for a desired measurement routine. This set then can be stored in a single softkey, accessible either from the front panel or over HP-IB (Hewlett Packard's enhanced implementation of IREE-488). This capability simplifies manual and remote operation.

New functions like IF, THEN, ELSE, ENDIF, REPEAT and UNTIL allow the user to write complete measurement programs on the HP 8566B and 8568B that can be executed without an external computer. For production test, for example, a computer can load a 'command flow' program into several analyzers. The analyzers can then run a program as stand-alone instruments.

In an automatic test system, this enhanced internal processing through softkey access of routines and through command flow programs frees the system controller to devote more time to other measurement and processing tasks.

There is 16K of RAM available for storage of user-defined routines. The new analyzers can transfer a CRT display to an X-Y plotter without an external computer. This function can be executed from a front panel or over HP-IB. It can also store and plot more than eight full 1001-point races or 80 compressed traces, also without an external computer.

Programs written for the HP 8566A and 8568A can run on the new B version analyzers. The HPL Pac and BASIC Library for the predecessor analyzers are directly compatible.

For more information contact **H-P at 41 Joseph St, Blackburn, Vic 3130. (03)895-2895.**

Low cost function generator

Parameters has released a new versatile signal generator that provides all the major functions of a standard generator plus a complete sweep generator capability.

Designated the TFG-4613 and manufactured by Topward Electric, the new generator can produce sine, square, triangle, ±ramp, ±pulse, am, fm, sweep trigger gate and burst waveforms over eight frequency ranges from 0.1 Hz to 13 MHz. Amplitude modulation frequency range is 0.01 Hz to 10 kHz to a depth of 100%. With an external source this range is extended to dc to 1 MHz.

Frequency modulation can be applied to the main waveform to ±5% over a frequency range from 0.1 Hz to 10 kHz and, once again, this may be extended from dc to 50 kHz with an external source.

Frequency accuracy of the primary waveform is ±5% of full scale and distortion is less than 0.5% THD from 10 kHz to 50 kHz. Output is continuously variable from 1 mV p-p to 20 V p-p into an open circuit.

Sweep generator range is 100:1 on any range. The sweep is linear between start and stop frequencies set by the user. Sweep rate is variable from 0.1 Hz to 10 kHz.

The output frequency of the TFG-4613 may be varied by the application of an external voltage over a 1000:1 range. The frequency versus voltage curve is linear with 0.5% over a 100:1 frequency range.

For further information please contact **Parameters Pty Ltd, P.O. Box 573, Artarmon NSW 2064. (02)439-3288.**

SUPER FEBRUARY

SENSATIONAL PRICES ON 5000 AMP-SYSTEM KITS

Check the SPECIAL PRICES for the famous ETI 5000 series deal of a lifetime.

FAMOUS JAYCAR "BLACK MONOLITH" SERIES AMP - NORMALLY $319.00

THIS MONTH $295 SAVE $24

For further savings check the package deal below

FAMOUS JAYCAR "BLUEPRINT" 5000 SERIES PREAMP - NORMALLY $299

THIS MONTH

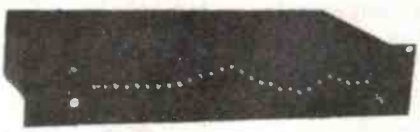
$265 SAVE $34.00

Check below for package price FURTHER savings!

FAMOUS JAYCAR 1/3 OCTAVE GRAPHIC EQUALISERS! (5000 SERIES) NORMALLY $199 EACH

THIS MONTH

2 FOR $300!!



For FURTHER savings check

★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★

THIS SPECTACULAR PACKAGE DEAL

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PACKAGE DEAL No.1

Buy the 5000 Black Monolith Power Amp and 5000 Blueprint Preamp TOGETHER for only $498!

That's right, save over $120 on normal prices or over $60 if bought separately from this months SPECIAL prices!

PACKAGE DEAL No.2

Buy the following:

	NORMALLY
Power Amp 5000 "Black Monolith"	$319.00
Preamp 5000 "Blueprint"	$299.00
Graphic 5000 Equalisers (2 off)	$398.00
	NORMALLY $1016.00

THIS MONTH YOU GET THE LOT FOR ONLY $699!!!

THAT'S A MASSIVE SAVING OF $317 (i.e. YOU VIRTUALLY GET THE "BLACK MONOLITH FREE) EVEN AT THE SPECIAL INDIVIDUAL PRICES IN THIS AD IT IS STILL A MASSIVE SAVING! - Special freight deal: anywhere in Australia $12!!

REMEMBER! WE TAKE NEARLY ALL THE CREDIT CARDS & FINANCE CAN BE ARRANGED ON THE SPOT.

February is BUY A JAYCAR CAR KIT

TRANSISTOR-ASSISTED IGNITION. "Electronics Aust." All parts inc. die cast box included!!! Hall-Effect type cat. KA1505. Normally $36.95 **FEB $29.50**

Breaker points type cat. KA1506 Normally $35.00 **FEB $28.50**

Hall-Effect points installation kit. Fits most cars (except Aust. 6's or V-8's). 90% of European, 60% of Japanese. Send for a list or return unit for full refund if it does not convert your distributor into a breakless unit! cat. KJ6655 – Normally $29.95 – **NOW $19.95**

IGNITION KILLER Ref: E.A. Feb '84 This nifty little project could prevent a thief from getting away with your car! Kills the ignition automatically cat. KA1535 **$14.95**

BONUS!! 2 x Car alarm window stickers supplied for FREE (Feb only).

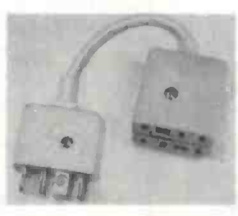
MOTORCYCLE INTERCOM Ref: EA Feb '84 Talk to your friend while riding with your helmets on with this handy gadget. Why didn't someone think of it before (kit contains all specified components). Cat. KA1533 Normally $39.95 **FEB ONLY $35.**

Jaycar ELECTRONICS

"PHONY" PRODUCTS?? These products are more "Phonie" than "Phony." And why? Because Jaycar gives you the greatest range of Phone accessories & components at the best prices!

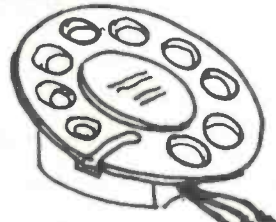
TELEPHONE PLUGS & SOCKETS

Cat. PP1400 Standard line plug only $2.95 10 up $2.45
Cat. PP1410 Line or Surface Mount Socket. Only $3.95 10 up $3.50
TELEPHONE CABLE (Solid colour coded conductors)
Cat. No. WB1602 2 pair (4 wire) Only $0.50/Metre 100M $0.45/M
Cat. No. WB1603 3 pair (6 wire) Only $0.70/Metre 100M $0.65/M
Cat. No. WB1610 10 pair (20 wire) Only $1.50/Metre 100M $1.20/M
All telephone cable covered in standard cream outer sheath.



– MAKE YOUR OWN EXTENSION LEADS & SAVE!!

ROTARY TELEPHONE DIALS Brand new dials surplus to requirements from a famous local manufacturer. They are very high quality, with governor & contacts fitted. Ideal for telephone enthusiasts. 1000's of uses e.g. combination code etc.
Cat. YT6900 **$2.95** SELLING FOR $4.95 elsewhere.



Built-up 'phone leads

5 & 10 metre leads are fitted with high quality stranded wire cables featuring thick sheath wall & secure termination. Will work with PABX's etc. & are suitable for heavy commercial use. The 15 & 20 metre cable is supplied on an attractive telephone-shaped wind-up reel & the double adaptor is just that – plug two 'phones into the one socket.

Cat. YT6010 5M LEAD **NOW $12.95**
Cat. YT6012 10M LEAD **NOW $15.95**
Save $4.00
Cat. YT6018 15M LEAD **NOW $14.95**
Save $5.00
Cat. YT6014 20M LEAD **NOW $22.95**
Cat. YT6020 Telephone Double adaptor **$12.50**

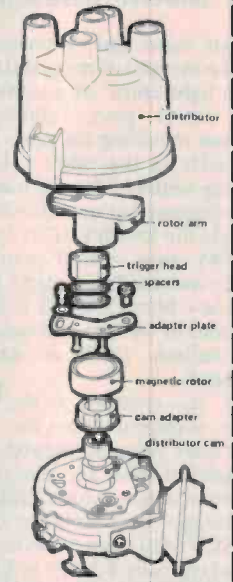
SPECIALS
.....the desperation continues!!

CAR MONTH!
THIS MONTH AND SAVE!

ARE WE BALMY? IS THE SUMMER SUN GETTING AT US?

This month you can grab the KJ-6655 Hall Effect kit for-wait for it - ONLY **$19.95!** That's right! $10 off normal low price!

NOW SAVE $10
ONLY $19.95



HALL EFFECT SWITCH VANE INTERRUPTED

PCB to suit 84T19 $3.45

NORMALLY $19.95
THIS MONTH $16.95

If you have a car that won't take the Jaycar KJ-6655 Hall Effect Kit (i.e. an Australian six or V8) this could be for you!
It is the SIEMENS (German) made Hall Switch. It will operate from −30 to +130°C. A simple soft iron vane cut with appropriate slots will commutate the unit.
Cat. HK-2101

Monitors Slashed

Popular Green & Amber screen monitors. Glare & non-glare.

	Normally	This Month	Save
Cat. XM4505 Green Standard	$199	$169	$30
Cat. XM4500 Green Screen (Non-Glare)	$219	$189	$30
Cat. XM4504 Amber Screen (Non-Glare)	$229	$199	$30

Tilt/Swivel Base For Monitors **NOW $19.95**

SANGUINE BATTERIES?

We now stock a range of imported Carbon-zinc HEAVY DUTY batteries. They are well made & we think as good as the well known brands. Our brand? The world famous HI-WATT of course! We are so confident that you will be delighted with these batteries we have a special promotion at subsidised low prices. Check the prices below & compare what you are paying for 'Name' batteries. Sale is limited to two packs per customer.
Due to high post and pack charges – personal shoppers only.

Cat. No.	DESCRIPTION	PROMOTION PRICE
SB2340	"AA" Cell Pack of 4	0.89/Pack
SB2341	"C" Cell Pack of 2	0.75/Pack
SB2342	"D" Cell Pack of 2	0.95/Pack
SB2344	"AAA" Cell Pack of 4	0.69/Pack

Note: (i) They are better than the standard blue & white Hi-Watt battery.
(ii) They are blister packed for your protection.

NEW EA KITS!

See our ads in EA this month for details of our new 100CW/CHAN INTEGRATED AMP KIT, 30V1A variable power supply & Multi-Sector Burglar Alarm.

ARE WE FAWLTY?
WE'RE DOING IT ON PIANO KITS TOO!
FAMOUS JAYCAR "LYREBIRD" 73 & 88 NOTE PIANOS AT THE LOWEST COST EVER

Even lower than our low, low prices in September last year. We are phasing these kits out now for new lines in '85. They are still technically superior to many more expensive ready-builts AND have better tone, touch sensitivity etc for **FAR LESS MONEY.**

73 NOTE: NORMALLY ________ $475
ON SPECIAL LAST SEPT. $375
THIS MONTH ________ $325
SAVE AN ASTOUNDING $150!!

88 NOTE: NORMALLY ________ $589
ON SPECIAL LAST SEPT. $425
THIS MONTH ________ $399
SAVE AN UNBELIEVABLE $190!!

Remember each kit is the same quality as our normal kits. The kits contain a stand (similar BUT NOT THE SAME) as the one shown in the illustration. A beautifully imported Italian keyboard is part of each kit as well as a realistic looking soft (sustain) pedal (imported from England) is also supplied. All pre-cut woodwork is supplied.

GAD! they've never been cheaper!!

ETI 342 CDI Type Electronic Ignition
Ref: ETI Feb '85

NEW

This brand new design virtually eliminates the controversial problems of past CDI designs. Probably its biggest new feature is that it has all but eliminated the crossfire problem. Other features:
- High reliability factor.
- Runs from 2-25 volts supply.
- Doesn't create high coil current.
- Hall-effect trigger compatible.
- Will work on virtually any type of ignition motor. (i.e. Boats, planes etc).
- Diecast Box.

A real winner! Cat. KE4690

$55

Jaycar ELECTRONICS
Incorporating ELECTRONIC AGENCIES
NUMBER 1 FOR KITS

N.S.W. SHOWROOMS
SYDNEY: 117 York Street. Tel: (02) 267 1614
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CONCORD: 115/117 Parramatta Road. Tel: (02) 745 3077
HURSTVILLE: 121 Forest Road. Tel: (02) 570 7000

QUEENSLAND SHOWROOM
BURANDA: 144 Logan Road. Tel: (07) 393 0777
Mon - Fri: 9am - 5.30 pm Saturday: 12pm
Thursday nights: 8.30pm

MAIL ORDERS: P.O. Box 480, AUBURN 2144. Tel: (02) 643 2000
HEAD OFFICE: 7/9 Rawson Street, AUBURN 2144.
Tel: (02) 643 2000 Telex: 72293

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Mon/Fri: 9am - 5.30pm, Thurs 8.30pm, Sat 12pm
Sydney
Mon-Fri: 8.30am - 5.30pm, Thurs 8.30pm, Sat 12pm
Concord
Mon-Fri: 9am - 5.30pm, Sat 12pm

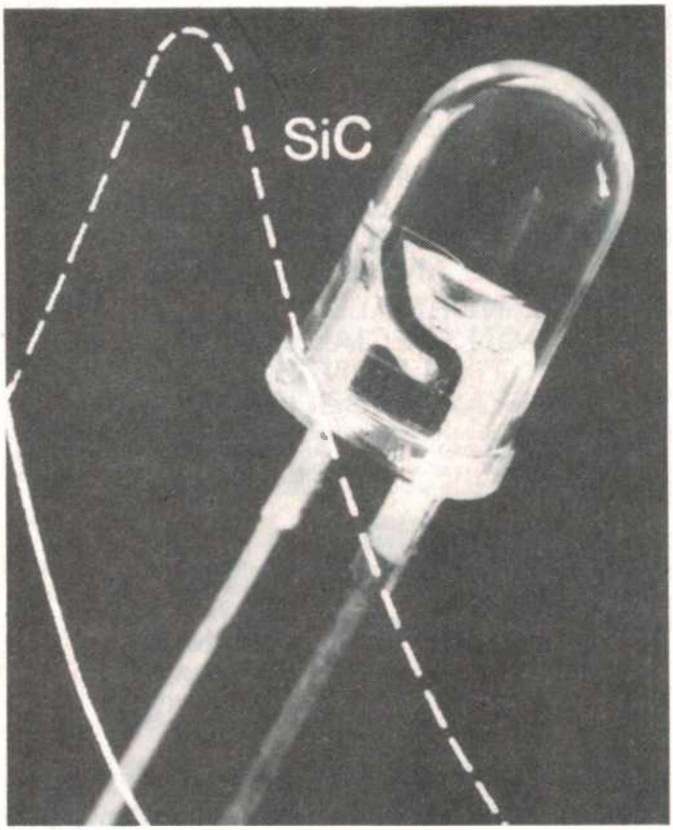
POST & PACKING	
$5 - $9.99	$1.50
$10 - $24.99	$3.20
$25 - $49.99	$4.50
$50 - $99.99	$6.50
$100 - $198	$8.00
Over $199	$10.00

COMET ROAD FREIGHT ANYWHERE IN AUSTRALIA ONLY $12

VISA
AMERICAN EXPRESS Cards Welcome
MasterCard

MAIL ORDER VIA YOUR PHONE

'Blue light' is brought to market



LEDs using crystalline semiconductors such as gallium, phosphorus and arsenic have provided red, yellow and green light for more than a decade now. LEDs that give off blue light, however, were still in the development stage.

Two years ago, Siemens devised a method of manufacturing 'blue light chips' at a considerably lower price, admittedly without matching the price level of LEDs in the other colours. Having sounded out the market, the company has now decided to include the fourth LED colour in its 1985 range — trial quantities can be indented from early 1985. The new blue LED (SLB 5410) operates at 480 nm and uses silicon carbide (SiC) as starting material.

SiC has emerged as the optimum semiconductor for blue light after years of research. Although it is labor and cost-intensive to produce, it has significant advantages over ZnSe or GaN: the SLB 5410 has a forward voltage of typically 4 V (20 mA), the corresponding figures being 10 V (20 mA) for ZnSe or GaN types.

The purity and reproducibility of the blue LED's 480 nm radiation are unequalled. Further characteristics are a high impulse stability, a narrow spectral bandwidth and a very low aging rate. These features make the new LED suitable for use as a radiation source in spectroscopic, biophysical or medical applications, as a calibration source for TV camera and photographic equipment, and, later on, possibly even as a means for producing the blue luminous dots on flat colour screens.

The blue LED is less suitable for use as a mere on/off indicator than its red, yellow and green counterparts. Apart from higher costs, the angle of radiation and the intensity are lower than in conventional LEDs. Typical values ate 4 mcd (20 mA) measured in the optical centre axis at a half-angle of eight degrees.

The SLB 5410 is mounted in a plastic package (5 mm); other packages are possible on request to **Siemens Ltd, 544 Church St, Richmond Vic 3121. (03)429-7111.**

Flash converters

Ampec electronics has announced the release of a range of CMOS flash converters.

These molybdenum gate converters provide high performance and powerful solutions for flash applications.

The 6-bit, MP7682 is a pin compatible, replacement for the RCA CA3300. It's faster (up to 30 MHz), more accurate (linearities to ± ¼ LSB), lower cost and less demanding on your signal conditioning (1 V reference). Two units in series provide 7-bit resolution, and two units in parallel double the through-put rate.

The 8-bit, MP7683 is a low power (75 mW), two-step converter with a 10 MHz sampling rate. Its low cost makes it ideal for use in applications where price and power consumption are barriers.

The MP7684 us an 8-bit version. It has parallel architecture, a single 5 V supply, a 1 volt reference, and an overflow bit makes it one of the best available.

A 9-bit version will be available in 1985.

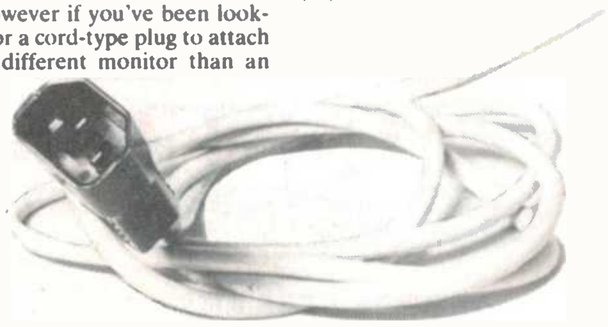
Samples, data sheets, applications boards and applications support are available. Please ring **Ampec Electronics, PO Box 112, Fivedock NSW 2046. (02)712-2466.**

IEC cord-type plug

IEC-type mains connectors are now fairly widely used on a variety of equipment. Usually a chassis-mounting plug is fitted to the equipment for power input, with a mating cord-type socket used on the end of the power cord. Both such fittings are now stocked by many dealers and retailers, along with complete cords.

However if you've been looking for a cord-type plug to attach to a different monitor than an IBM, Geoff Wood has just obtained limited stocks of a high-quality imported plugs suitable for fitting to existing cords, and is offering them for $2.95 each plus tax and postage if applicable.

Enquiries to **Geoff Wood Electronics Pty Ltd, 656A Darling Street, Rozelle NSW 2039. (02)810-6845.**



Connector catalogue

STC-Cannon Components has released the "MS standard Circular Connectors for Commercial, Military and Industrial Applications".

The 28 page catalogue details contact arrangements; alternative insert positions; solder/crimp contacts; high voltage cartridges; RFI shielding; mains power connectors and accessories.

Various shell styles, with complete technical details, are listed, i.e: wall mounting receptable, cable connecting plug, box mounting receptacle, straight plug and 90 degree angle plug. The MS Standard Circular Connectors Catalogue" is available on request to **STC-Cannon Components, 248 Wickham Rd, Moorabbin, Vic 3189.**

Wirewounds perform current sensing

Developed for four-terminal current sensing and printed circuit board mounting, the 4LPC series of wirewound fixed resistors from TRW offers resistance values of 0.01 to 1.0 ohm at 3 W, in tolerances from ±5% to ±1%. The resistors are suitable for such applications as power supply regulation, motor controls, RF sampling, feedback control loops, and overload sensors. Encased in a steatite ceramic case, the flameproof resistors offer a TCR of ±40 ppm. Typical dimensions include a length of 0.925 inch, excluding terminals; a height of 0.413 inch, excluding leads; and a width of 0.354 inch.

For further information, contact **Total Electronics, 9 Harker Street, Burwood Vic 3125. (03)288-4044.**

Nectronics — new distributor

A new components distribution company has been formed by Irene Pellett who has had 20 years experience as a sales representative for firms supplying electronics components. She is joined by Lino Giambertone as sales consultant in the venture.

Nectronics Pty Ltd will act as sole agent for Euro Dip, marketing a range of machined IC sockets, as well as for American Research and Engineering, makers of dip switches. Nectronics has also been appointed distributor for the Japanese company NEC. Other products Nectronics will carry include flat ribbon cable, connectors and sockets and other components from Japan, Europe and Hong Kong and Taiwan.

For further information contact **Nectronics, 27 Lexton Rd, Box Hill, Vic 3128.**

Manuals for semiconductors

Imark has again secured a limited quantity of data manuals with information on Japanese semiconductor devices. They include "The Transistor Manual", "The Transistor Substitution Manual", "The Diode Manual", "The FET Manual", "The Op-amp Manual" (Parts 1 and 2) as well as a series of IC manuals, computer manuals and "The Power and Industrial Semiconductor Manual".

The manuals are priced at $10.95 each plus $4 p&p 1-13 manuals.

Further information is available from **Imark Pty Ltd, 167 Roden St, West Melbourne, Vic 3003.**

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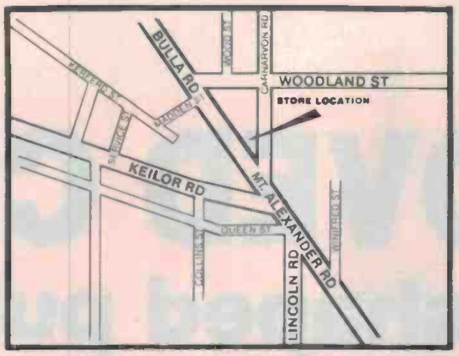

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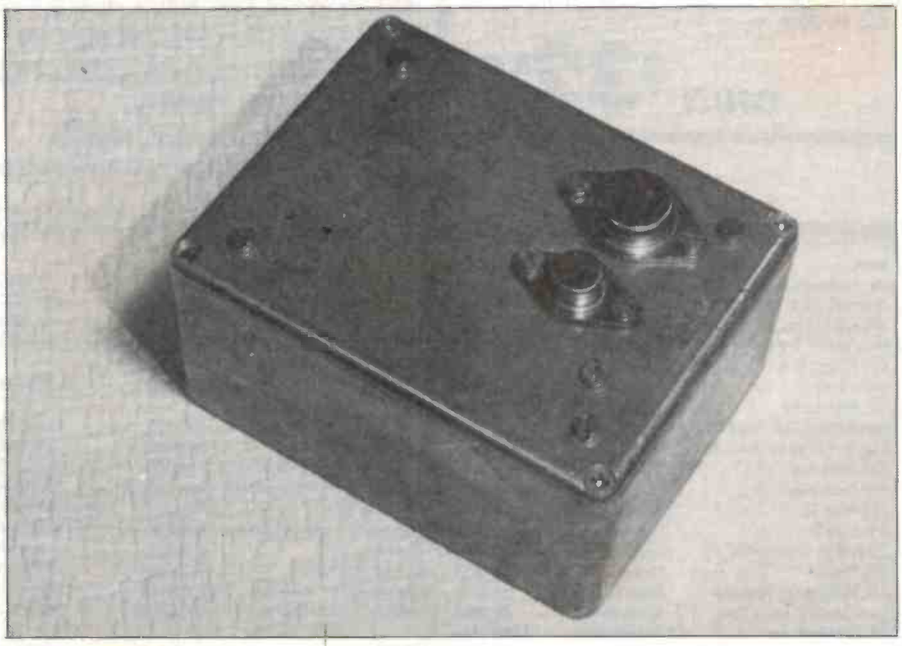
IMPROVED CDI

— using shaped pulses

Part 1

by Ian Thomas

Capacitor discharge ignition systems are much more efficient than conventional or transistor assisted systems, and they're also much better at getting maximum performance from today's engines. Unfortunately early CDI systems were also unreliable and plagued by problems such as engine cross-firing. Here's a new design which gets around all of the problems, but still gives you all of the benefits.



THERE HAS BEEN a lot of criticism of capacitor discharge ignition systems in the technical magazines recently. Some of it was well founded and some was merely relevant to particular designs. From what I've read the principle has often been blamed for problems in certain circuit realizations and so, after some discussion with our beloved editor, I decided to set the record straight.

Desirabilities

The first thing to get clear is exactly what is desirable in an electronic car ignition system. The basic requirement is to generate a spark to set fire to the air fuel mixture in the engine cylinders at exactly the right time. As most cars today have to meet emission control requirements, this means that the air fuel mixture is leaner than optimum and so the spark should last for as long as possible. The next requirement is that the voltage pulse applied to the spark plugs rises rapidly so that, if the plugs are fouled comparatively little energy is lost in the fouling and most of the energy actually goes into the spark. CDI systems are exceptionally good at this, in fact, they're too good. This means that the pulse applied to one plug will capacitively couple to other plug leads and possibly fire the fuel in other cylinders at terribly wrong times. This creates two mutually opposed requirements for the ignition system; the firing pulse leading edge should be fast but not too fast. Clearly if we are to design an ideal system the output voltage pulse rising edge should be a controlled parameter.

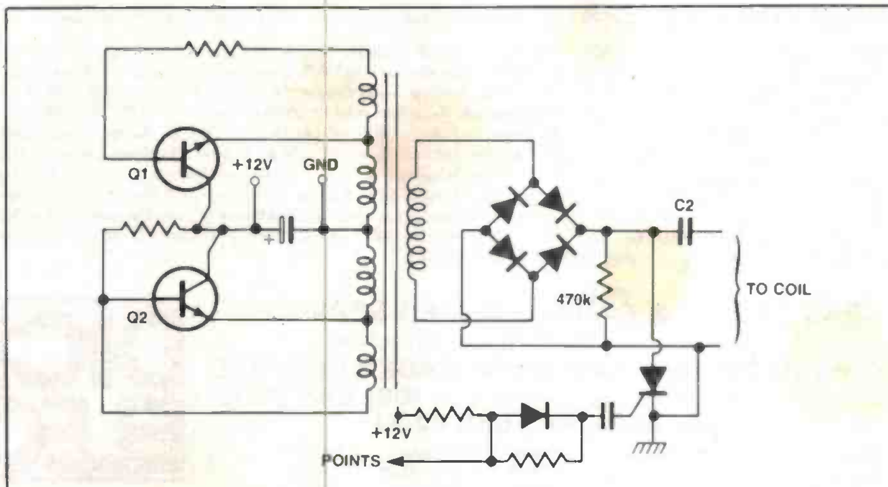


Figure 1. Basic circuit for a conventional CDI system.

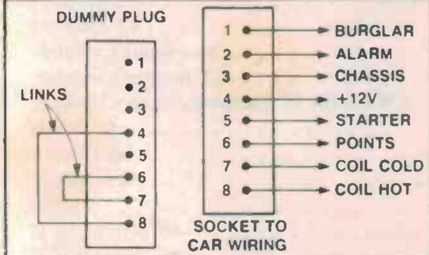
The third and, in my opinion, the most important requirement is that the system *must be reliable*. The most incredible whizz-bang, mind blowing device ever contrived could be built, but if it only works 90 per cent of the time it's not worth a damn and shouldn't be let anywhere near a vehicle. In the good old days when CDIs first made their appearance it simply wasn't appreciated just how hostile the environment under the bonnet of a car is for electronics. I'm sure that if the Marquis de Sade was alive today and thought about what electronics is subjected to near a running petrol engine he'd get that kinky warm feeling all over. It's stinking hot. There are fierce voltage transients everywhere. The power supply is subject to violent excursions. There are corrosive fluids around. All in all it's a good place not to put sensitive semiconductors. Nonetheless we went blithely ahead and attached our crude systems right next to the coil and cursed everything in sight when they fell over even though we'd used only the cheapest commercial components available.

In these more enlightened times all devices used for automotive operation are usually specified for the full military temperature range of −55°C to +125°C. In Australia the −55° may not be necessary but the +125° *is*.

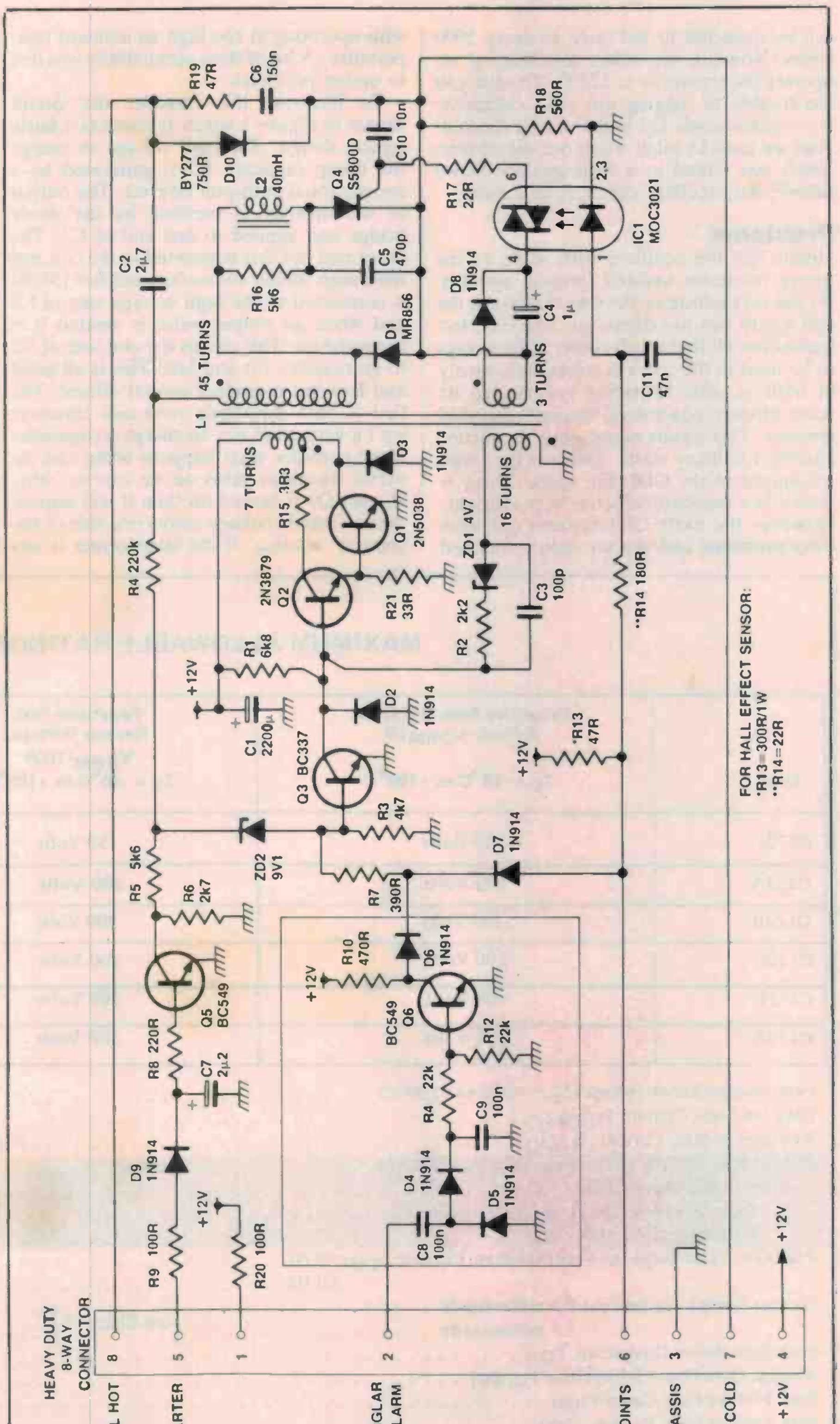
Finally, our ideal system should allow for the output pulse to be increased during starting and also it should be controllable so a car burglar alarm can shut it off. It should be triggerable from a Hall effect sensor or existing points. It goes without saying that it should not be possible to damage the device from any terminal by wrong connection or inadvertent shorts.

In the "wouldn't it be nice if . . ." category I thought an ideal system would not be effected by supply variations and would give the same output pulse no matter what the supply voltage.

As a matter of technical nicety it would also be good if the device was as efficient as possible so things didn't get too hot (see above about reliability). As a general rule the reliability of any electronic component halves for every 11°C temperature rise. That is, if a device (say a transistor) is expected to fail once in 10 000 hours at an operating temperature of 55°C then at 66°C it



Dummy plug wiring — for emergencies!



The complete circuit for our new design. Note that the section in the tone rectangle is optional. The wiring details will be given next month.

can be expected to fail once in every 5000 hours. You can see where this leads if we operate the transistor at 125°C. To save you the trouble of digging out your calculator it's a failure each 121 hours to be expected! And we used to bitch when our electronics which was baked to a light golden brown failed!! An excellent rule is *cold is good.*

Problems

Herein lies the problem with some of the newer transistor assisted ignition systems. By the very nature of the way they work the coil has to run too damn hot and the electronics not all that much cooler. The energy to be used in the spark is stored inductively in both ye olde Kettering system and its more modern equivalent transistor assisted ignition. This means many amps and hence entirely too many watts. This was the original appeal of the CDI; the spark energy is stored in a capacitor which is very efficient. However the early CDI systems did have their problems and not all were associated with operating at too high an ambient temperature. A lot of their unreliability was due to design problems.

To illustrate this consider the circuit shown in Figure 1 which represents a fairly typical design. The high voltage to charge the dump capacitor C2 is generated by a conventional push-pull inverter. The output of the inverter is rectified by the diode bridge and applied to one end of C2. The other end of C2 is connected to the coil and the dump silicon controlled rectifier (SCR) is connected to the high voltage side of C2 and when an output pulse is wanted it is triggered on. This causes the coil side of C2 to go negative far and fast! This is all good and fine but it ignores several effects. The first is that saturating push-pull inverters isn't a very good way to charge a capacitor. If we consider what happens when one inverter transistor turns on we can see why. If, say, Q1 is turned on then it will impose the full supply voltage across one side of the primary winding. If the transformer is any good then the voltage across the output winding is exactly the primary to secondary turns ratio times the supply voltage. If the capacitor is just beginning to charge then a conflict occurs and the voltage across the secondary must be taken up by other com-

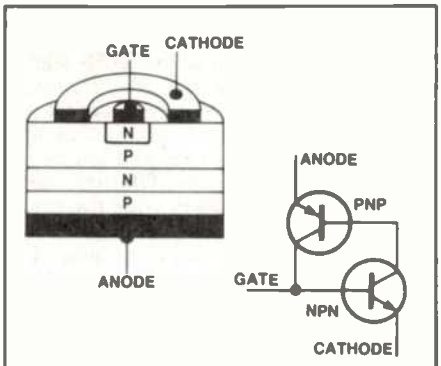


Figure 2. Internal construction of an SCR, together with its equivalent circuit.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(3) T_C = -40°C to +100°C	Repetitive Peak Reverse Voltage, V_{RRM}(1)(3) T_C = -40°C to +100°C	Non-Repetitive Peak Reverse Voltage, V_{RSM}(1)(2) T_C = -40°C to +100°C
C122F	50 Volts	50 Volts	75 Volts
C122A	100 Volts	100 Volts	200 Volts
C122B	200 Volts	200 Volts	300 Volts
C122C	300 Volts	300 Volts	400 Volts
C122D	400 Volts	400 Volts	500 Volts
C122E	500 Volts	500 Volts	600 Volts

Peak positive anode voltage (T_C = -40°C to +100°C)	560 Volts
RMS On-State Current, $I_{T(RMS)}$	8 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$	Depends on conduction angle (See Charts 3 and 4)
Critical Rate-Of-Rise of On-State Current, di/dt: (4)	
Gate triggered operation	(see Chart 10)
Switching from 200 volts	100 Amperes per microsecond
Switching from 500 volts	50 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz	82 Amperes
60 Hz	90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds (see Chart 12)	34 Ampere^2 seconds
1.5 milliseconds (see Chart 12)	27 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM}	5 Watts for 10 microseconds (see Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 Watts
Peak Positive Gate Current I_{GM}	see Chart 6
Peak Positive Gate Voltage, V_{GM}	see Chart 6
Peak Negative Gate Voltage, V_{GM}	5 Volts
Storage Temperature, T_{stg}	-40°C to +125°C
Operating Temperature, T_J	-40°C to +100°C

Figure 3. Data for a typical SCR showing the limit for the rate of rise of on-state current. (Courtesy of GE Semiconductor Data Book.)

ponents. Normally this voltage appears across the ignition coil and for the inverter to work correctly the coil must be entirely inductive. If there are large stray parasitic capacitances in the ignition coil primary then the load they present to the inverter may stall it or at best hold the main inverter transistors out of saturation until they're charged. This process is inefficient and makes for a hot inverter. Certainly the push-pull inverter will not tolerate a highly capacitive load.

The next and far more serious effect occurs when the dump SCR is triggered on. The actual works of an SCR consist of a piece of silicon, shown in cross section in Figure 2, along with an equivalent two transistor circuit. Physically the gate lead is connected to a point in the centre of the silicon die. When the SCR is triggered on a positive pulse is applied to the gate in the centre to momentarily turn on the NPN transistor in the equivalent circuit. This in turn turns on the PNP transistor and the very high positive feedback of the two transistors causes the SCR to go to a highly conductive state where it will remain until the current is removed.

However when the trigger pulse is first applied *only the region near the gate terminal is turned on*. It takes a microsecond or so for the on state to spread across the whole SCR. If the current is allowed to rise through the SCR faster than the on state spreads then the small part of the SCR that has latched on will be overloaded *and the SCR will be destroyed!* The region of the SCR will have far too high a current density flowing through it and will be burnt out. Figure 3 shows part of the data sheet of an SCR and is the absolute maximum ratings for the device. The line in colour relates to this problem. It shows that the on state current must not be allowed to rise faster than 100 A/μs. If such a circuit is to operate reliably then the current through the SCR *must* be controlled. This is normally done by inserting an inductor in series with the SCR and will ensure the SCR will survive most forms of abuse but if it's left out the CDI will have almost no resistance to a shorted coil or a highly capacitive coil primary. It doesn't matter how big the SCR is; it's easy to destroy it during the first instants of turn on.

The choice of capacitor for the dump capacitor is very important too. During the dump cycle the capacitor is discharged in about 50 microseconds (give or take) and this means torrents of amps. The old standby is Philips 'liquorice allsort' capacitors aren't good enough; devices rated for high current must be selected. If the capacitor is rated for 240 Vac operation then it's a good bet it'll be OK for CDI usage too.

Another mistake made in a lot of the earlier designs was to overdo things. Just because it was easy to do, people used to use outrageous voltages on the dump capacitors which in turn generated ridiculous ignition voltages. In my earlier days I was guilty of this sin also. I recall looking in awe under the bonnet of my car in the dark when the engine was running. The whole ignition harness was outlined in blue corona discharge. Gadzooks but it was spectacular!! Not a whole lot of use though.

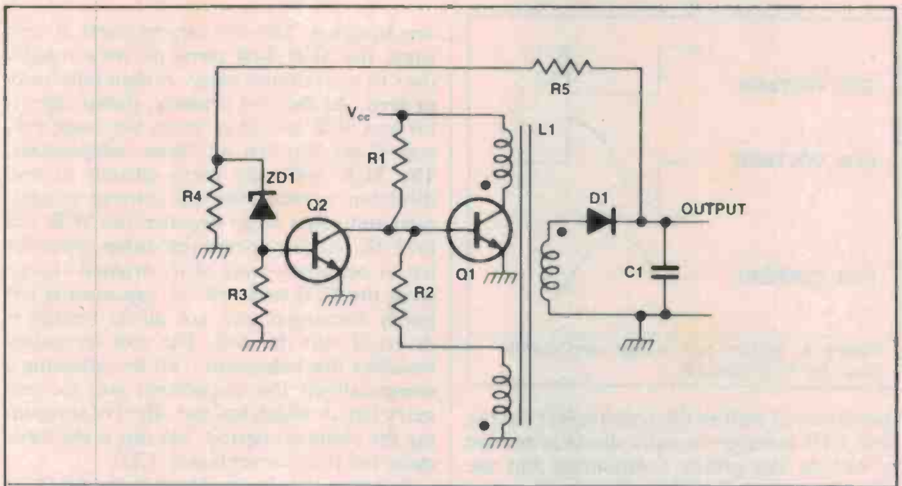


Figure 4. Basic circuit for the CDI's ringing-choke inverter.

What should be done

This more or less outlines the things to avoid doing, but what should be done? Since CDI was to be used the first decision was the choice of an inverter configuration. One of the most flexible inverter circuits available is the so-called flyback, single ended or ringing choke inverter. The basic circuit is shown in Figure 4 and works as follows. When power is first applied Q1 is biased on through R1 and current flows through the primary winding of L1. Because this imposes the full supply across the primary, the base drive winding generates a voltage equal to the primary-to-base winding turns ratio times V_{cc}. The base winding is connected with the polarity such that R2 also turns on Q1. As the voltage across L1 is constant (ignoring the saturation voltage of the transistor) the current through it will rise linearly with time and the current is described by:

$$I_{peak} = \frac{V_{cc}t}{L}$$

After a certain time R1 and R2 will not be able to provide enough base current to hold Q1 in saturation and its collector voltage will start to rise. This reduces the base drive voltage for R2 and further pulls the transistor out of saturation. The whole process runs away and results in Q1 being turned hard off. Before Q1 is turned off the current flowing through L1 represents energy stored in the inductor and this energy must go somewhere. Thus when Q1 turns off its collector voltage rises very rapidly and, as the output winding is also on the same core its voltage also rises until diode D1 is turned on. The energy stored in the inductor is dumped out through D1 into the output filter capacitor C1. As soon as all the energy is removed from L1 the voltages across all the windings go to zero (ignoring stray ringing effects) and the whole cycle can repeated. Thus C1 is 'pumped up' until its voltage is sufficient to turn on the zener diode ZD1 and hence Q2. When this happens Q2 steals all the base drive from Q1 and stops the oscillation. In fact if Q2 is removed or fails then the output voltage will rise until something breaks!

This circuit configuration has many advantages. The first is that when the current is being run up on the inductor the output diode is off and vice versa. This results in the output circuit being completely isolated from the input which means that doing bad things to the load doesn't bother the inverter at all. Even shorting out C1 completely doesn't damage anything. All that happens is that the current in L1 runs down to zero very slowly and the whole inverter acts as a constant current generator into the short. As soon as the short is removed the output voltage will rise to its regulated value again.

The second advantage is that the output voltage is determined by R4, R5 and ZD1 *only*. There is no relationship between the primary supply voltage and output at all. This enables the inverter to generate the same output voltage for a very wide range of input voltages always with (more or less) the same high efficiency. As an example the final inverter used in the ignition system will run off 2 volts to 25 volts in and the final voltage on the dump capacitor is 300 volts *over the entire input range*. The only thing that varies is the time taken to charge the capacitor.

The third advantage is that the circuit contains very few components and therefore should be very reliable. The only components that have to handle the full output power are Q1, L1 and D1. This compares *most* favourably with the more conventional circuit where there are four diodes and two ▶

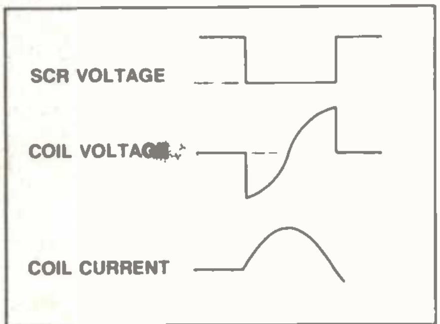


Figure 5. Ignition coil voltage and current when the SCR conducts.

transistors as well as the transformer. In the final CDI inverter an extra diode is needed as well as low power components but the overall design still comes out way ahead of the push-pull CDI system. It even compares well with the components needed for the transistor assisted ignition.

If this type of inverter has all these advantages then why hasn't it been used before? To be quite honest I have to admit I don't know. The only real drawback is that the inverter inductor has to store all the energy being transferred. This makes the inductor somewhat larger than the transformer in a push-pull inverter. Another disadvantage is that the peak current in the inductor is large (in the final design it's about 18 to 20 amps) so the power drawn from the supply is 'lumpy'. This makes supply bypassing more important and a good quality bypass capacitor must be used (but more about this later). The recent upsurge in switchmode power supplies has made both of these problems very easily solved as ferrite cores are easily available to make a suitable inductor and good electrolytic capacitors are also now common.

Since the flyback inverter will do all we want it's a cert for the final design. The next problem to be addressed is that of short spark duration with a CDI system. Referring back to the circuit diagram of a 'conventional' CDI it is instructive to consider what happens during the entire dump cycle. The first thing to happen is that the SCR is triggered on and the voltage across it collapses to zero from the original 300 to 400 volts. As the voltage across a capacitor cannot change instantly the other side of the dump capacitor which is connected to the coil immediately goes to −300 to −400 volts. The voltage rise across the coil is usually of the order of a microsecond or so. The SCR remains on and clamps the inverter end of the dump capacitor so the coil end of the capacitor resonates with the ignition coil primary inductance. Typically the coil inductance is of the order of 10 millihenries and the usual value of dump capacitor is 1μF so the combination resonates at about 1.6 kHz. The waveforms appearing on the coil primary and the coil primary current are both shown in Figure 5. The coil primary voltage is described by a −cos function and the coil current is described by a sine function. The coil current starts at zero when the SCR first turns on then rapidly rises to a maximum value. It then falls away to zero. As the coil primary, dump capacitor and SCR are all in series the same current flows through all three components. The SCR will only carry current in one direction so when the coil current reaches zero and starts to go negative the SCR will turn off. At this instant the dump capacitor has re-acquired some of its original charge so as the SCR turns off the capacitor is left partly recharged and not all its energy is diverted into the coil. The coil secondary modifies this behaviour a bit by reflecting a comparatively low impedance into the primary circuit which has the effect of shortening the resonant period; but this is the basic cycle for the 'conventional' CDI.

Suppose the dump circuit is modified by adding a diode in parallel with the ignition coil as shown in Figure 6 along with the coil primary voltage and current. The first part of the dump cycle is exactly as for the earlier circuit. The SCR turns on and forces the coil-capacitor node negative. This reverse biases the diode which has no effect on the first quarter cycle of the dump. The coil primary current rises following a sine curve and peaks when the coil voltage passes through zero. The coil secondary voltage rises very (very!) rapidly following the primary voltage until the spark gap breaks down, then collapses to a comparatively low value (only 1000 volts or so). The coil secondary current then rises following a sine curve similar to the primary except at a lower level.

However when the primary voltage attempts to change sign due to resonance with the dump capacitor the clamp diode turns on and shorts out the coil primary. This forces the currents in both the coil primary-clamp diode circuit and secondary-spark gap circuit to decay away due to losses in the two circuits and the dominant loss is the spark gap. Thus all the energy in the dump capacitor is transferred to the coil and thence to the spark gap. This has the effect of lengthening the spark duration exactly as is wanted! Even if the turbulence in the combustion chamber momentarily blows out the arc it is open circuiting an inductor carrying high current so the gap voltage immediately rises to (very) high levels again and restrikes the arc. This would seem to be a pretty good way to have things as in the final design the arc duration is usually about 0.6 to 0.8 milliseconds — about the same as in the newer transistor assisted ignition systems. The only drawback with inserting a clamp diode in a 'conventional' push-pull inverter system is that during the capacitor recharging cycle the inverter must drive into an almost purely capacitive load, as during charging the clamp diode is forward biased and shorts out the coil for the inverter. For reasons already discussed push-pull inverters just won't work into this sort of load. As luck would have it the flyback inverter is perfectly happy working into these conditions (not entirely coincidentally). There is also the further slight advantage that when the inverter is recharging the dump capacitor, the coil is inherently shorted out by the clamp diode and absolutely no charge voltages appear at the coil output. It also means that after the first quarter cycle of the dump the diode is turned on and, if necessary (if you're really in a hurry) capacitor recharging can be allowed to commence, but more of this later.

Rise time & pulses

This seems to solve all the so-called problems associated with CDI except that of too fast a rise time on the output voltage. To be honest this one had me worried for a while and the CDI which I used with great success for many years had the so called cross firing problem (but never gave a sign of it). The car I had then was a Mazda R100 and in fact there were two CDIs in it as the car had dual ignition. The rotors were fired alternately and it would seem an ideal arrangement for cross firing but then the leads were spaced well apart. All in all I have very fond memories of that car — apart from the fact that engines had to be regarded as consumables but no matter. My current iron steed is a 4.2 litre V8 Torana so cross firing had to be dealt with.

To understand the way the coil primary voltage rise time is controlled it's necessary to look into the design of the flyback inverter in some detail. A decision that was made very early on in the design was that the inverter transistor on time was to be about 20 microseconds. This is about as fast as the inverter can be run before transistor switching losses become a nuisance. For the dump capacitor to be recharged in 2 milliseconds or so the peak inverter current has to be allowed to run up to 15 to 20 amps before turn off. At first this may seem a bit fierce but there's no trouble finding suitable transistors and the main inverter transistor has a much easier life than the one used in a transistor assisted ignition! The high currents make it a good idea to run the inverter at as high a frequency as possible to make bypassing manageable. Given the inverter peak current and runup time the value of inverter primary inductance can be calculated from:

$$L_p = \frac{Vt}{I_{pk}} = \frac{13.6 \times 20 \times 10^{-6}}{20}$$

$$= 13.6 \text{ microhenries}$$

For many and varied reasons the inverter primary to secondary turns ratio needs to be 6 or 7 to 1. This from simple arithmetic means that the inductance seen looking into the inverter transformer secondary will be 36 or 49 times the primary inductance. In the final inverter the turns ratio is 6.4 to 1 so the inverter secondary inductance is about 550 microhenries. So what did I hear you say? Tut! have patience!

It isn't written in words of fire that the in- ▶

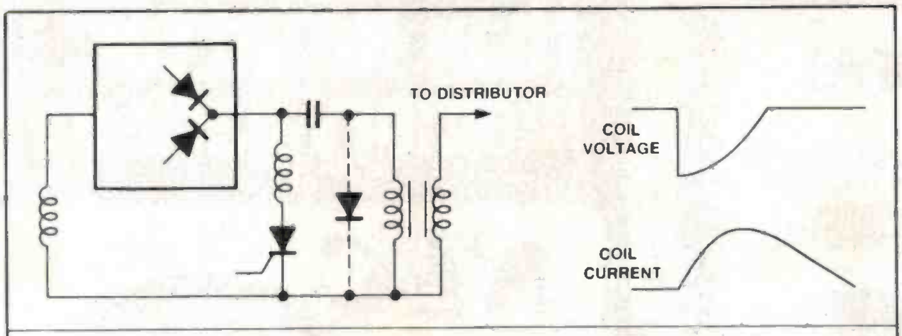


Figure 6. Using a parallel diode to modify coil current and voltage.

verter-rectifier-SCR-coil combination must be as shown in Figure 6. In the final design D1 is the rectifier diode, Q4 is the dump SCR and C2 is the dump capacitor. As long as D1 points the right way (it does) C2 will charge correctly. The only effect of moving the diode is that the secondary winding of the inverter operates at the dc voltage of C2 instead of ground (take note when deciding how much insulation is required). For the moment assume L2 and R16 are shorted out and C5 is removed. After capacitor charging is completed the inverter coil secondary, the anode of Q4 and the cathode of D1 are all at 300 volts. When the SCR, Q4 is triggered on to start the dump cycle it imposes the full 300 volts across the inverter coil secondary and the other side of the secondary starts to drive the dump capacitor negative. Everything proceeds as before *except that the output to the ingition coil is driven through 550 microhenries*. The very low impedance of the SCR is buffered by the inverter coil secondary. This means we are free to put components in parallel with the ignition coil to shape and tailor the rise time on the coil primary *exactly as we desire*. In the final design I chose to use a 150 nF capacitor so the rise time for the ignition coil primary is set by the inverter coil secondary and C6. For purposes of calculating output rise time the ignition coil can be treated as an open circuit (it's very large) and the dump capacitor can be treated as a short circuit (it's also very large). The rise time is completely controlled by the inverter secondary resonating with C6. To stop the two ringing a resistor R19 is included in series with C6 to complete the shaping of the rising edge of the voltage applied to the coil. All problems solved!

Moving the SCR to the other side of the inverter secondary has some other desirable features too. If the inverter is still charging the capacitor when the SCR is triggered, then the SCR immediately turns the inverter off as it forces 300 volts across the coil secondary which turns the base winding for the inverter off. This ensures that if there is ever any dispute for control of the inverter coil the SCR wins!

This solution did give a few problems and these are the reason for L2, R16 and C5. Since the C2 side of the inverter secondary

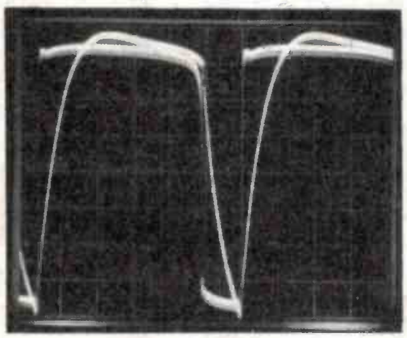


Figure 7(a). Inverter output voltage and SCR anode voltage, showing the effect of L2.

has only the steady state charging voltage on it all the switching voltage of the inverter appears on the anode of Q4 (see Figure 7[a]). This means that the SCR anode has a very large changing voltage applied to it. An SCR, like any other device has stray capacitances between anode and PNP base, and PNP base and NPN base (refer to Figure 2 again). If the anode is driven positive very fast then capacitive currents are induced in both bases of the four layer structure. The SCR cannot distinguish between capacitive currents and gate trigger currents and so if the anode voltage changes too fast then the SCR will turn on. The manufacturers specify this effect as the maximum rate of change of off state voltage or off $\frac{dV}{dt}$ and for most el cheapo SCRs it is usually a mini mum of only 10 V/µs — trouble! RCA (which seems to be pretty good at making power semiconductors) makes a device with an off $\frac{dV}{dt}$ of 100 V/µs which is the S5800 series. Lo and behold they were available in Australia!

One hundred volts per microsecond still isn't anywhere good enough but it gave me a chance! To completely solve the problem I had to use the old 'saturating inductor snubber trick'. This works as follows. L2 is an inductor wound on a toroid with very high permeability and R16 in parallel with it makes a very low Q inductor assembly. In fact its Q is so low that it forms a critically damped resonant circuit with C5 and the SCR strays (about 100 pF). This means that when the inverter secondary applies a submicrosecond square wave edge to the input of L2 and R16 the SCR only sees a controlled rising edge of (surprise! surprise!) 100 V/µs. Because R16 makes the LCR network critically damped there is no ringing and the SCR is happy (and so, presumably, are we).

But what happens when the SCR is triggered? While it is possible to make quite large inductance values with a toroidal core they are very easy to saturate with direct currents. When the SCR is off no dc can flow and the toroid passes only the small amount of ac needed to charge C5 and the SCR strays. When the SCR is triggered the resultant dc saturates the toroidal core in three or four microseconds and the inductance almost completely disappears. Clever eh? More than that it works just fine! This really completes the discussion of the basic shaped pulse CDI; the design gave me complete control over all parameters of the output spark. The system is completely insensitive to the type of ignition coil used, any sort at all will work well. In general if you have a coil with a ballast resistor for start boost it will work better if the resistor is not included but leave it in if you want. The current rundown is predominantly damped by the secondary spark voltage reflected into the primary.

Once the basic system was working fine I started to consider all the 'bells and whistles' that would be nice. The first to go in was to give the inverter some boost during engine starting. The final charge voltage on the dump capacitor is determined only by R4, R5 and R6 together and the zener diode ZD2. When the cathode of ZD2 is raised to about 10 volts through R4 it turns on Q3 and stops the inverter. R5 and R6 form a potential divider with R4. If R6 is shorted out the input to R4 must go more positive before ZD2 starts to turn on. Q5 does exactly this when the starter voltage is applied through the input network to its base and the output of the inverter goes up to somewhere over 400 volts during starting. This pushes the rating of the S5800D SCR so I don't recommend you use it this way all the time but for short periods it's OK.

The next nicety to be incorporated arose because of the remarkable performance of the final inverter. The final inverter would charge the dump capacitor to 300 volts from an input supply of *1.8 volts*. It took a while to get there (see 'Testing') but get there it did! This was wonderful but there weren't enough volts to reliably trigger the SCR. Ridiculous! All those ergs there and no way to get at them! One of the nice things about a flyback inverter is that if several output windings are wound on the coil they all give output voltages related to each other by only their turns ratios. So three quick turns around the core, a five cent diode and a 20c capacitor and a regulated 20 volt rail was available to fire the SCR. This also ensured that an optimum trigger pulse could be applied no matter what the supply voltage.

One very nasty possibility did occur to me. Inside the inverter there is a diode directly across the output to the coil. If the 'earthy' side of the output to the coil was directly connected to ground and some misguided individual connected the hot output to the battery supply then the diode would be destroyed. It's big but not that big. To stop this possibility I connected the output ground to earth through a resistor (R18 on the circuit diagram). This would have almost no effect on the inverter regulation but very nicely prevents any mishaps. Since the secondary and primary sides of the inverter were no longer tied together this required a little thought concerning triggering. As the energy to trigger the SCR is referred to the secondary ground an optocoupler ensured that no matter what was done triggering would always happen when wanted and, better, wouldn't happen if not wanted due to stray currents in R18.

Very little modification is needed to make the circuit operate from a Hall effect sensor. A little performance is lost as the Siemens HKZ101 won't work on less than 4.5 volts but all that's needed is to change R13 from the 47 ohms for points to 300 ohms and replace the 180 ohm R14 with a 22 ohm resistor. Thus when the points input is open circuit (or off for the HKZ101) at least 8 mA flows into the optocoupler at the lowest supply voltage. R20 provides the recommended current limiting for the sensor as per data sheet.

Testing the prototype

After a certain amount of fiddling around with a rats nest, I built a prototype and had the wonderful experience of having everything work almost perfectly the first time. The board layout had no errors (amazing!) and the whole thing just happened. I had an ignition coil that I'd used on the development of the earlier CDI built some years ago that served just fine for testing. It has a primary resistance of 3 ohms and a turns ratio of near enough to 100:1.

The first thing to do was ensure that all the calculations about arc duration were correct. Photographs were taken with the coil and CDI rigged up on the bench. A rats nest version of a transistor assisted ignition was also built for comparison purposes. Calculations for the transistor assisted ignition said that the rate of rise of primary voltage should be about 15 V/µs and the tests confirmed this exactly. For the CDI I had already done the design for a rate of rise (in this case fall — the pulse is negative for the CDI) of twice this value as there is a compromise between fast voltage change firing dirty plugs and the risk of cross firing. Figure 7(b) shows that, once again the calculations were spot on. The negative going pulse leading edge has a $\frac{dV}{dt}$ of so near 30 V/µs as not to matter. The photograph also shows that the coil secondary voltage also changes nearly twice as fast for the CDI.

The arc duration was measured for the CDI and the result is shown in Figure 7(c). The timebase for the CRO was changed to 100 microseconds/division and the arc duration was measured at 0.75 ms. This is almost exactly the same as is obtained in the currently fashionable transistor assisted ignition except that the CDI will maintain this arc duration up to 330 pulses per second *with no reduction in spark power at all.* This corresponds to an engine speed of 5000 rpm in my trusty V8 or 10 000 rpm in a four cylinder car. A transistor assisted ignition with dwell extension can equal this performance *but only at the expense of very high coil currents.* The pulse shaped CDI draws about 5 amps at these unrealistically high speeds and for normal driving usually draws about one amp.

The next point of interest with the CDI system is the coil secondary voltage and current. Figure 7(d) shows how these parameters vary with time during the spark. The lower trace is the secondary voltage and the upper is the current. It can be seen that before gap breakdown no current flows (reasonable!). After the gap arcs over, the gap voltage drops to about 1 kV and the current rises in a sine wave following the primary resonance of C2 and the coil primary. The secondary current peaks at about 70 mA when D10 turns on and shorts out the primary. After this the coil primary and secondary currents decay away to zero. When the secondary current reaches zero the arc is extinguished and the small amount of energy left in capacitances rings. This confirmed that all was happening as designed for in the system.

To show how the inverter works a photograph (Figure 7 [e]) is also given of the collector waveform for Q1. These pictures correspond to an engine speed of about 2600 rpm for a V8 or 5400 rpm for a four cylinder and so are representative. In the test fixture the dwell angle was 50 per cent as a square wave was used to trigger the system. The photograph shows the inverter recharging the capacitor in two milliseconds then shutting down. The rather ragged waveform a millisecond after the inverter shuts down is the CDI triggering, and voltage is due to C2 discharging through the inverter secondary being reflected back into the primary circuit. When Q1 is off its collector voltage sits at the supply voltage. It's interesting to note that the supply rail is being pulled down by the inverter when it's running and takes several milliseconds to recover. This is because rather light leads were used in the test fixture. It illustrates that when the unit is installed in a car good solid supply lines should be used.

A rough estimate of inverter efficiency was made by accurately measuring the value of C2 then measuring the current drawn by the inverter for exactly 100 pulses per second. The power out of the inverter is $\frac{1}{2}CV^2 \times 100 = 11.8$ W. To produce this output 1.4 A was needed from a 12 volt rail which gives an efficiency of 70 per cent but there are many uncertainties in the measurement.

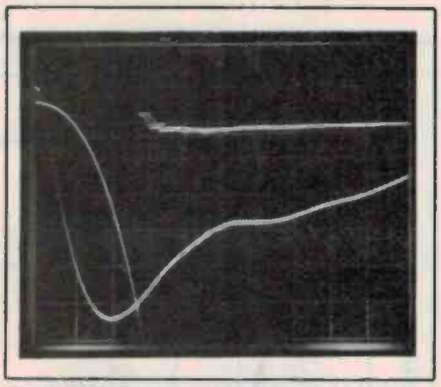


Figure 7(b). Coil primary (lower) and secondary voltage for the new CDI. Time 10 µs/div, prim 50 V/div, sec 2 KV/div.

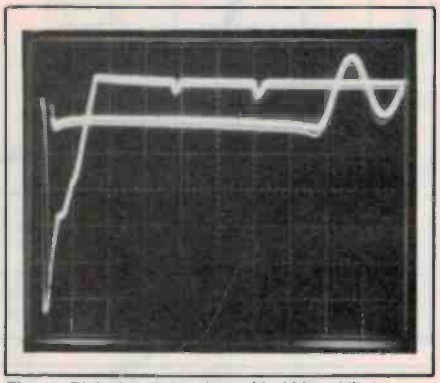


Figure 7(c). As above, but with 100 µs/div to show arc duration.

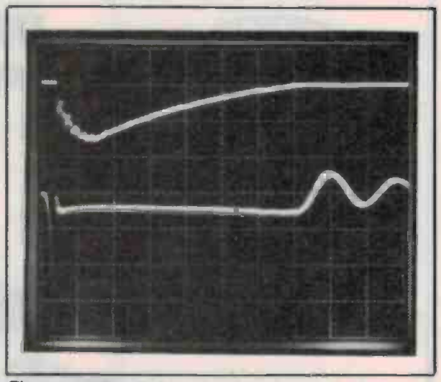


Figure 7(d). Coil secondary current (top, 50 mA/div) and voltage (bottom, 2 KV/div).

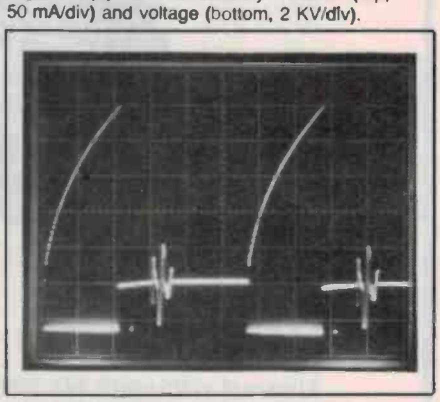


Figure 7(e). The waveform at Q1's collector (10 V/div, 1 ms/div).

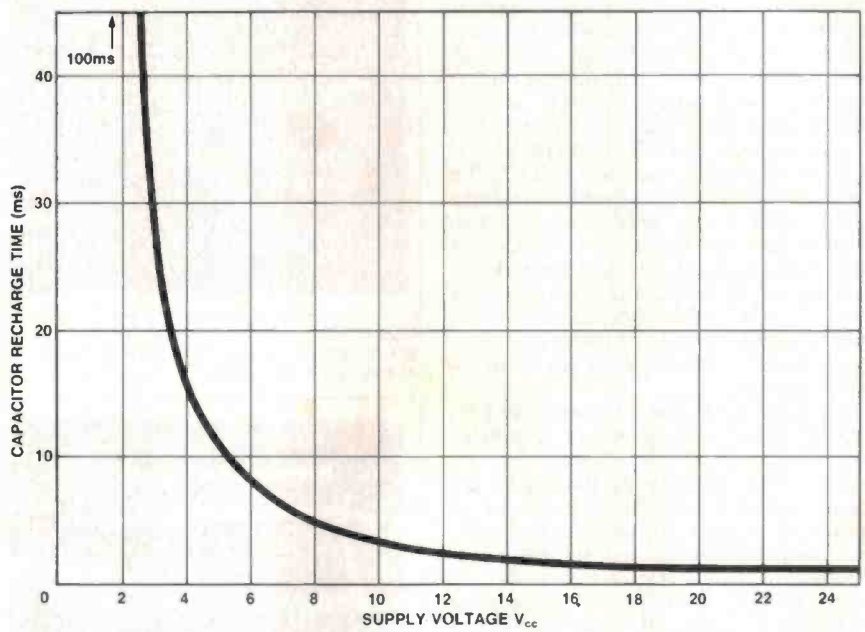
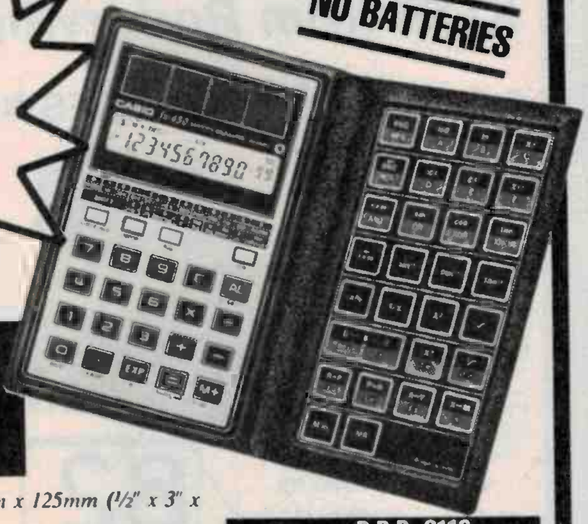


Figure 8. The time taken to recharge dump capacitor C2, plotted against battery voltage. The inverter only stops when the supply drops below 2 volts!

Finally the time taken for the inverter to recharge C2 was measured as a function of the supply voltage and the results are shown in Figure 8. For normal operating voltages of 13.6 volts the capacitor is recharged in two milliseconds but even if the voltage drops to 7 or 8 volts (not unusual during starting in winter) the inverter still gives full spark power after five milliseconds. At 25 volts in (don't ask me how you'd ever get this supply voltage in a 12 volt system) the inverter recharged the capacitor in one millisecond.

The inverter stopped operating at about 1.9 volts and at just over 2 volts was still giving the full 300 volts out. It's hard to imagine how you'll start an engine with the battery this flat but it's nice to know that the ignition system isn't the cause of the engine not starting!

Just to satisfy myself that the design was right I operated the CDI in an oven at 70°C for half an hour. This was a far more severe test than was ever expected in real life as the hot air in the oven wasn't moving and made heat dissipation a major problem for the CDI. Nonetheless the system came through with flying colours. However, I can't emphasise enough that if you build the CDI up it's *far* better to mount it under the dash or somewhere else that's cool. ●



PARABOLIC MICROPHONE

Build a low cost parabola, along with a high gain headphone amplifier to help when listening to those natural activities such as babbling brooks, singing birds of perhaps even more sinister noises. The current cost of components for this project is around $15 including sales tax, but not the cost of batteries or headphones. (EA Nov. '83)

83MA11 **$15.00**

MODEL ENGINE IGNITION SYSTEM

Get sure starts every time and no more glow plug burnouts on your model engines. (ETI June '83)

ETI-1516 **$41.50**

CAR IGNITION KILLER

Most car burglar alarms are easily circumvented, but not this cunning "Ignition Killer". This sneaky antitheft device uses a 555 timer to place an intermittent short circuit across the points. Until disabled by its hidden switch the circuit effectively makes the car undriveable — a sure deterent to thieves! (EA Feb. '84).

84AU1 **$16.95**
(Our kit includes the box!)

LOW OHMS METER

How many times have you cursed your Multimeter when you had to measure a low-value resistance? Well with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms. (ETI Nov. '81).

ETI-158 **$34.50**

VIDEO AMPLIFIER

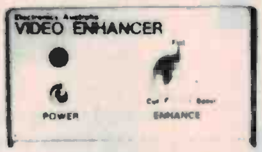
Bothered by smeary colours, signal beats and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead, it's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply. (EA Aug. '83).

83VA8 **$15.00**

MOSFET POWER AMPLIFIER

Employing Hitachi Mosfets, this power amplifier features a 'no compromise' design, and is rated to deliver 150½ W RMS maximum and features extremely low harmonic, transient and intermodulation distortion. (ETI Jan. '81).

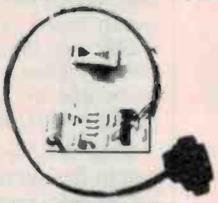
Cat. ETI 477 **$63.00**



VIDEO ENHANCER
100's SOLD

Like tone controls in a hi-fi amplifier, touch up the signal with this Video Enhancer. (EA Oct. '83).

83VE10 **$35.00**



RADIOTELETYPE CONVERTER FOR THE MICROBEE

Have your computer print the latest news from the international shortwave news service. Just hook up this project between your shortwave receiver's audio output and the MicroBee parallel port. A simple bit of software does the decoding. Can be hooked up to other computers too.

(ETI Apr. '83) **$20.00**

MUSICOLOR IV

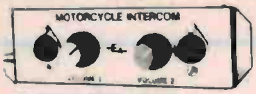
Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety. (EA Aug. '81).

81MC8 **$84.00**

FUNCTION GENERATOR

This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 160Hz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting. (EA April '82)

82AO3A/B **$79.50**



MOTORCYCLE INTERCOM
OVER 300 SOLD!

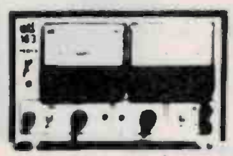
Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build! (EA Feb. '84).

84CM5 **$45.00**

TRANSISTOR TESTER
1000's SOLD

Have you ever desoldered a suspect transistor, only to find that it checks OK? Troubleshooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. '83)

83TT8 **$15.00**



LAB SUPPLY

Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges: 0-0.5A/0-5A). This employs a conventional series-pass regulator, not a switchmode type with its attendant problems, but dissipation is reduced by a unique relay switching system switching between taps on the transformer secondary. (ETI May '83).

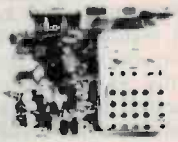
ETI-163 **$175.00**

SLIDE CROSS-FADER

Want to put on a really professional slide show? This slide cross-fader can provide smooth dissolves from one projector to another, initiate slide changing automatically from an in-built variable timer, and synchronise slide changes to pre-recorded commentary or music on a tape recorder. All this at a cost far less than comparable commercial units. (EA Nov. '81).

81SS11 **$85.00**

EPROM PROGRAMMER EP1



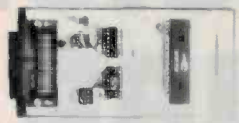
No need for a Micro with EA's great Eprom Programmer suitable for 2716/2758 Eproms. (EA Jan. '82).

82EP1 **$47.50**
With Textool Sockets **$59.95**

PHONE MINDER

Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb. '84).

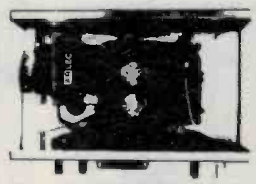
84TP2 **$24.00**



MICROBEE SERIAL-TO-PARALLEL INTERFACE

Most Microcomputers worth owning have an 'RS232' connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel 'Centronics' interface printers. Save money by building this interface. (ETI Jan. '84).

ETI-675 **$55.00**



DUAL TRACKING POWER SUPPLY

Built around positive and negative 3-Terminal Regulators, this versatile dual tracking Power Supply can provide voltages from ±1.3V to ±22V at currents up to 2A. In addition, the Supply features a fixed +5V 0.9A output and is completely protected against short circuits, overloads and thermal runaway. (EA March '82)

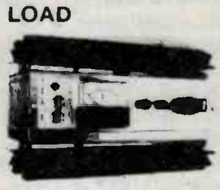
82PS2 **$87.50**

BIPOLAR PROM PROGRAMMER

Every digital workshop should have one! Can be used to program the popular fusible-link PROMS like the 74S188/288, 82S23 and 82S123 etc. (ETI June '83).

ETI-688 **$47.50**

ELECTRIC DUMMY LOAD



With this unit you can test power supplies at currents up to 15 Amps and Voltage up to 60 Volts. It can "sink" up to 200 Watts on a static test and you can modulate the load to perform dynamic tests. (ETI Oct. '80).

ETI-147 **$99.00**

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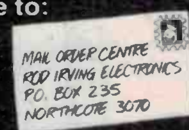

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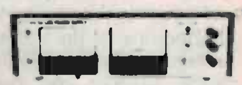

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83PS5 **$140.00**

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A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes. (ETI May '83).

ETI-164 **$9.50**

PRECISION CRO CALIBRATOR

Anyone who has used a CRO will know what an incredibly useful instrument it can be — providing you can be sure of its calibrations. This handy low-cost calibrator will let you check and adjust all main settings easily and efficiently. Designed by the Electrical Engineering staff at Sydney University, it is easily built and can also be used to check out a CRO you're considering buying.

WHEN OSCILLOSCOPES or 'CROs' first started to be used in electronics, they were simply used to 'look at' what was going on in a circuit. Just being able to 'see' what was happening to the voltages and currents was a big step forward from what had been possible before, and for a while that was enough.

But nowadays people expect to be able to use a CRO in a much more quantitative fashion, to measure instantaneous voltages, voltage changes and timing details. In order to be used in this more serious way, a CRO naturally needs to be properly calibrated.

The small low-cost calibrator described here has been designed to make calibration of almost any reasonably modern CRO a fairly simple and straightforward job. It produces pulses of known accurate amplitude and timing, whose peak-to-peak voltage and repetition rate can be varied over a wide range to allow most of a CRO's normal ranges to be checked.

While the calibrator can be used to check and adjust both gain and linearity for both the vertical and horizontal channels of an instrument, in practice most CROs do not provide a means of adjusting the linearity of the vertical amplifier(s) — only the gain. Similarly although you can use the calibrator to check horizontal linearity, most instruments only allow you to adjust the horizontal gain and average timebase sweep speed.

A CRO which was made more than ten years ago (fairly rare in the commercial world, but still common in hobby workplaces) can easily drift a few percent in a period of months. Hence the need for a handy reference like this calibrator.

In addition to its main intended use in keeping your existing CRO or CROs calibrated, it is probably also worth taking along when you are looking at new CROs with an eye to purchase. It has surprised the authors to see how badly some otherwise impressive units fared, even brand new.

We will now discuss how the calibrator is used, for those who may not have been exposed to such procedures before. In addition to checking vertical gain accuracy and sweep speed, we will also explain how to check overshoot, timebase non-linearity, the presence of a satisfactory vertical delay line for viewing non-repetitive triggering events, and vertical non-linearity.

Note that we must assume you have access to the operating manual of your CRO, for details regarding the manufacturer's recommended procedures in adjusting the instrument. This varies from instrument to instrument, and it is often important to adjust things like the vertical attenuator and timebase ranges in a particular order.

Vertical calibration

This is initially fairly simple. Referring to the first CRO screen photograph (represented in Figure 1), the instrument's appropriate present potentiometer is adjusted to obtain precisely the correct deflection. The photograph was taken on a brand new CRO on a medium voltage deflection scale, and so the trace is narrow and sharp. The adjustment should be done on the range(s) specified by the manufacturer, but the checking of calibration should be done on several of the available ranges.

Figure 2 shows the same (brand new) CRO on its most sensitive range. There are two points to note. The first is that the trace was fuzzy, primarily on account of CRO amplifier noise. This requires that the operator effect some estimate of the difference between trace centres. It is best to take one edge (in Figure 2 the lower) and adjust the vertical position so as to set the reference edge precisely on a graticule line. Then the same edge of the trace on the other part of the squarewave cycle gives the deflection.

In Figure 2 the deflection is clearly about 5.2 divisions. The second point to note is that the CRO (correct to the limit of measurement on the 50 mV/div range) is 4 per cent high on the 1 mV/div range. Thus the need to check performance against specifications on *all* ranges is very clearly demonstrated.

Horizontal calibration

Initial sweep calibration should similarly be carried out at the sweep speed specified for the particular CRO, but a check is recommended over a wider range. Figure 3 is of a set of 10 timing pulses arrayed over a CRO screen. With the fine vertical edge of the first pulse set on the first vertical graticule line, the same part of the last pulse should align with the final graticule vertical. Even on the screen of the high quality and fast writing speed CRO used for this the intensity must be set quite high to clearly show the fast vertical edges.

Timebase Linearity

Regrettably for readers, but fortunately for ETI, we were unable to locate a CRO with bad linearity. Referring still to Figure 3, had there been a non-linearity in the sweep, it would have been evident as one or more vertical pulses not being aligned with their respective graticule lines after the horizontal calibration had set the end pulses on their respective markers. We have observed such problems even on new CROs. The calibrator prevented a poor purchase in that case!

Overshoot

This phenomenon is becoming rarer on CROs these days. The only CRO we could locate with significant overshoot proved to have neither graticule illumination for clear illustrations nor the ability to give a good look for single edge blow up.

We settled for using a 10 year old CRO — also with no graticule illumination. Figure 4 shows overshoot on the edges of the inverted timing waveforms, rather than the voltage waveforms. These were easier to trigger on than the relatively infrequent edges of the voltage calibration squarewave. The overshoot is the 'wiggle' seen at the beginning of the clear horizontal parts of the trace.

Delay Line

Figure 5 shows the rising edge of the voltage calibration waveform on a high quality oscilloscope. The trace was rather dim, because the sweep occurs only at 1 kHz, despite the sweep speed of 10 ns/div. The same edge that triggered the timebase can be seen, because the CRO contains a delay line, so that the signal is delayed for long enough (some tens of nanoseconds usually) to allow the sweep to commence before the signal is applied to the vertical deflection plates. A view such as this is impossible otherwise.

The edge is not perfect. The salient feature is a minor step-like appearance at the top of the edge. This is in fact not CRO induced overshoot, but the result of mismatch in the connection from the calibrator via a 50 ohms cable to the 1 m/50 pF input impedance of the CRO. Such is the typical situation which will be encountered.

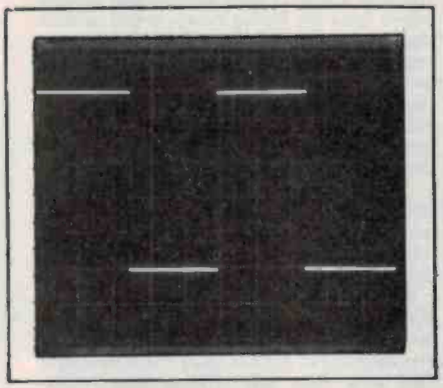


Figure 1. Vertical calibration. New Trio CS-1022 set to 0.2 ms/div, 50 mV/div.

Construction & setting up

The construction is basically a case of duplicating the prototype shown here. Initially drill the appropriate holes in the panel of the case being used. All the electronics is attached to the panel along with the switches and connectors, so the shape of the rear of the container is not important.

Once drilled, the various holes on the front label can be lined up with the holes in the panel and the label attached. After adhering the label, fit the components and their knobs where applicable. Next assemble the pc board, exercising the usual care to ensure that all the polarised components are orientated correctly. Also take care to leave the solder joints clean and free of blobs which might short tracks together. Remember that only resistors and capacitors without polarity markings can be put in either way around, because everything else is polarised in some way!

Next attach all the components which are mounted to the rear of the panel controls. These components are fixed to the panel controls to reduce the number of flying leads. Be careful to get all of them in their correct circuit locations, as reversal of components here can lead to 'satisfactory' but uncalibrated operation.

Finally connect the pc board to the panel with short lengths of hookup wire. The leads should be as short as is practicable while leaving the board accessible for alignment, servicing, etc. Long leads can give rise to unwanted coupling between the circuit sections, and may also permit the radiation of unwanted EMI (Electro-Magnetic Interference), even up to VHF frequencies, because of the sharp edges generated by the driver circuits.

With a battery connected the unit should now function. It remains only to adjust the supply to its correct voltage. This of course

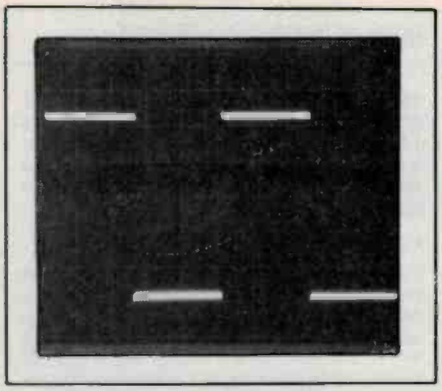


Figure 2. The same CRO as in Figure 1, at 1 mV/ div.

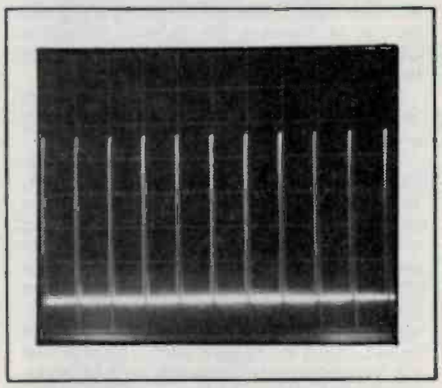


Figure 3. A seven year old Tektronix 465 is shown at 1 ms/div. Its last calibration date was not recorded, if it happened at all!

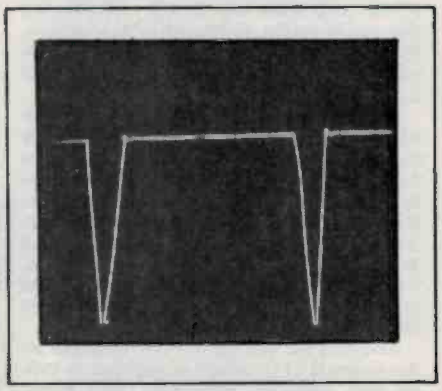


Figure 4. A BWD 511 of unguessable age. CRO calibrator set to 1µs timing pulses, CRO at 1 V/div and 0.2 µs/div. No graticule illumination available.

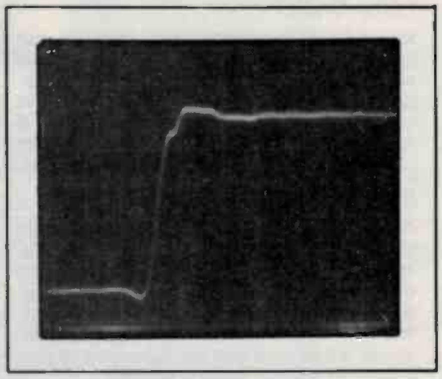


Figure 5. Tek 465 again, 20 mV/div and 10 ns/div, with the calibrator on 100 mV range.

HOW IT WORKS — ETI-170

The CRO calibrator circuit divides into six parts. These are a power supply section, a 1 MHz clock, a 10 MHz clock, a divider chain, a voltage output section and a timing pulse output section. Each will be discussed in its turn.

Power supply

The power supply consists of ICs 1, 2 and part of IC3, with their surrounding components. Q1 is used as a saturating pass element, to connect and disconnect the battery from those parts of the device which are not continuously powered. IC1 is the only IC connected all the time to the supply. Initially consider that C1 is discharged. IC1(b) and (c) have their inputs held low, so that their outputs are high. These gates are connected in parallel to increase the current delivering capacity. Because the outputs are high, Q1 is held off.

In this condition the current drain from the battery is so small that it will last its shelf life, and it may be considered unconnected.

When PB1 is depressed to turn on the instrument, C1 is charged up rapidly via R1. The inputs of IC1(b) and (c) and taken high and the outputs are thus driven low, turning on Q1. This applies almost the full battery potential to IC2, a precision supply regulator IC, via the external supply jack. Capacitors C3 and C4 decouple the rail to prevent instability problems arising from the source impedance of the battery. RV1 is used to trim the regulated supply voltage to 5.05 volts, while C5, C6 and C7 provide further decoupling and compensation.

C1 will slowly discharge via R3. When it reaches about half rail potential, IC1(b) and (c) will once again turn Q1 off, returning the instrument to the quiescent (off) condition. Thus automatic turnoff is effected. Should PB2 be fitted, it may be used to manually turn off the supply.

If the unregulated supply falls below a level where good regulation of the 5.05 volt supply by IC2 is not possible (when the battery goes flat, for example), IC3(a) and IC1(a) and (d) are wired to immediately turn the supply off. Note that IC3 is powered from the 5.05 volt rail. When the input of IC3(a) falls to below about half its supply rail, which is about 5.05 volts, it charges C2 via R5. This causes IC1(a) and (d) to discharge C1 via D1 and R2, which shuts off the supply.

Resistors R6 and R7 set the potential on the collector of Q1 which is required to initiate this automatic shutdown. This mechanism prevents any attempt to use the device when it is potentially operating incorrectly due to a low battery condition.

1 MHz Clock

The 1 MHz clock is crystal controlled and provides the timing reference for all (but the 10 MHz) timing signals and the voltage calibration squarewave. The oscillator consists of IC4(b) and surrounding components. It runs off the 5.05 volt supply, and operates continuously when the unit is in the on state.

Divider Chain

The divider chain consists of six decade counters. These provide signals divided by 10, 100, etc, up to 1 million, giving 10 per cent duty-cycle pulses of from 100 kHz to 1 Hz, all derived from the 1 MHz reference. The 'on' indicator is driven from one of these dividers, giving fast flashes with low duty cycle to give indication without wasting power.

Timing Pulse Output

IC3(b/d) and IC11 with surrounding components form the timing pulse output section. This section, when enabled, shapes the timing pulse train and delivers it to the output with 50 ohm impedance. With SW1(a) in the 'time' position, IC3(d) is enabled. The disabling system prevents the gates consuming power when not required. SW2(a) selects the timing train with the required frequency.

SW2(b) selects the capacitor which defines the shape of the output pulse. This mechanism is incorporated to provide pulses whose edges are conveniently visible on all frequency ranges.

On the 1µs range, the pulses are not modified by a capacitive load on IC11(c/d/e), but are shaped by the driving network formed by the sections of IC4 not used in the oscillator. Not only does this provide neat, visible pulses at this frequency, but it makes use of the gates in the package already handling 1 MHz signals. This reduces the chances of crosstalk between these signals, with components in very high frequency ranges, and the slower timing signals. Such crosstalk can upset triggering and interfere with the waveform being displayed.

10 MHz Clock

The 10 MHz clock circuit is built around IC12. It differs somewhat from the 1 MHz clock in order to allow clean operation at this high frequency. R39 and C18 with IC12(c/d) form the output wave of the oscillator into a pulse string for easy alignment against graticule timing marks. Note that the circuit is separately decoupled by C19, and is only powered by completing the earth return when required, as selected by the range switch SW2(b).

This circuit consumes considerable power in relation to the other parts of the calibrator, and so is not activated when not required. Its output is fed to a different connector. If it is not required, this whole section can be deleted, removing the 10 MHz 100 ns range with commensurate cost saving. If no fast CROs are likely to be encountered, this would not be a problem.

Output Section

The voltage output section, when enabled by SW1(a), produces calibrated output squarewaves at 1 kHz. The voltage level is selected by SW3. When not enabled Q2 remains off. When enabled it is switched into and out of saturation by IC11(b). Capacitor C16 is selected to precisely pull Q2 out of saturation as quickly as possible.

When fully saturated, Q2 has approximately 0.05 volts drop across it — hence the 5.05 volt supply. R16 through R36 provide a precise 1-2-5 sequence attenuator using only E12 series preferred resistor values. Signals of 1 mV p-p to 5 V p-p are developed. The output impedance is at most a few hundred ohms. Because no buffer is provided, the CRO input must not be terminated in 50 ohms.

WHILE WE'RE TALKING ABOUT CROs . . .

While we're thinking about CROs and their performance, let's consider for a moment a few general aspects of oscilloscope or 'CRO' performance which are often taken for granted.

Nowadays there are quite a few CROs available for around the same price as a humble (humble?) audio amplifier. But we expect rather different things from the two types of equipment. For example we only expect amplifiers to have a bandwidth of from 20 Hz to 20 kHz — yet for the same money we expect a CRO to have a bandwidth of dc to 20 MHz! This is a very big difference, yet some of the better CROs go a great deal further, to 200 MHz or even 500 MHz.

Astute readers will guess at once that something is traded for this wide range. But perhaps few of you may have realised just what it is that is missing from the CRO's performance.

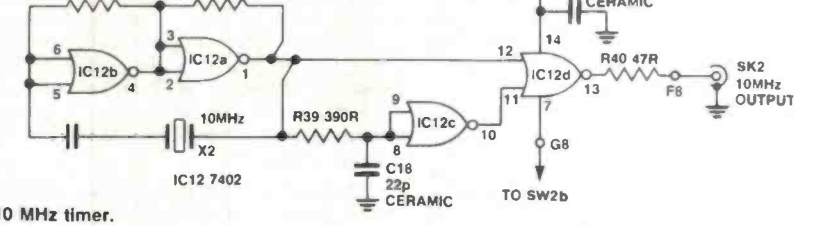
One of the things usually noted in the 'fine print' of CRO specifications is linearity. A vertical deflection linearity error of one or two per cent is typical, probably specified for a deflection of say six or seven major divisions.

In an audio amplifier this would be called distortion, and if it rose much above say .01%, today's audio enthusiast would be most unhappy. By paying more money, you can get an amplifier with ten times lower distortion again. In addition, the audio amp is expected to maintain this low level of distortion even at power output levels of 100 watts or so — a far cry from the few tens of volts, at low currents, expected from the CRO deflection amps.

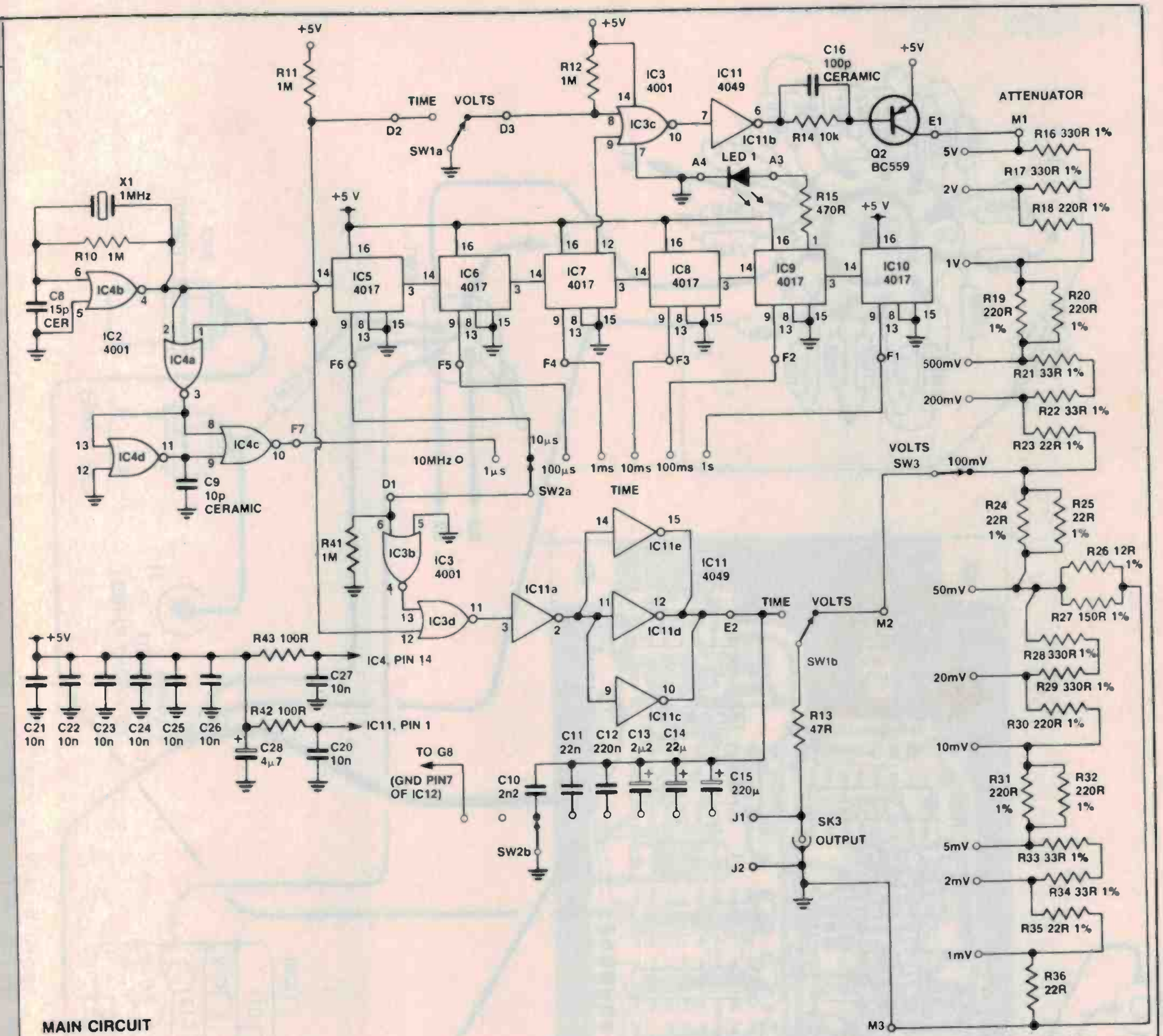
The CRO can of course get away with this relatively poor linearity because the human eye can't perceive less than about one per cent distortion, whereas our ears most certainly can — particularly on the right kind of programme material. Round two to the audio amplifier.

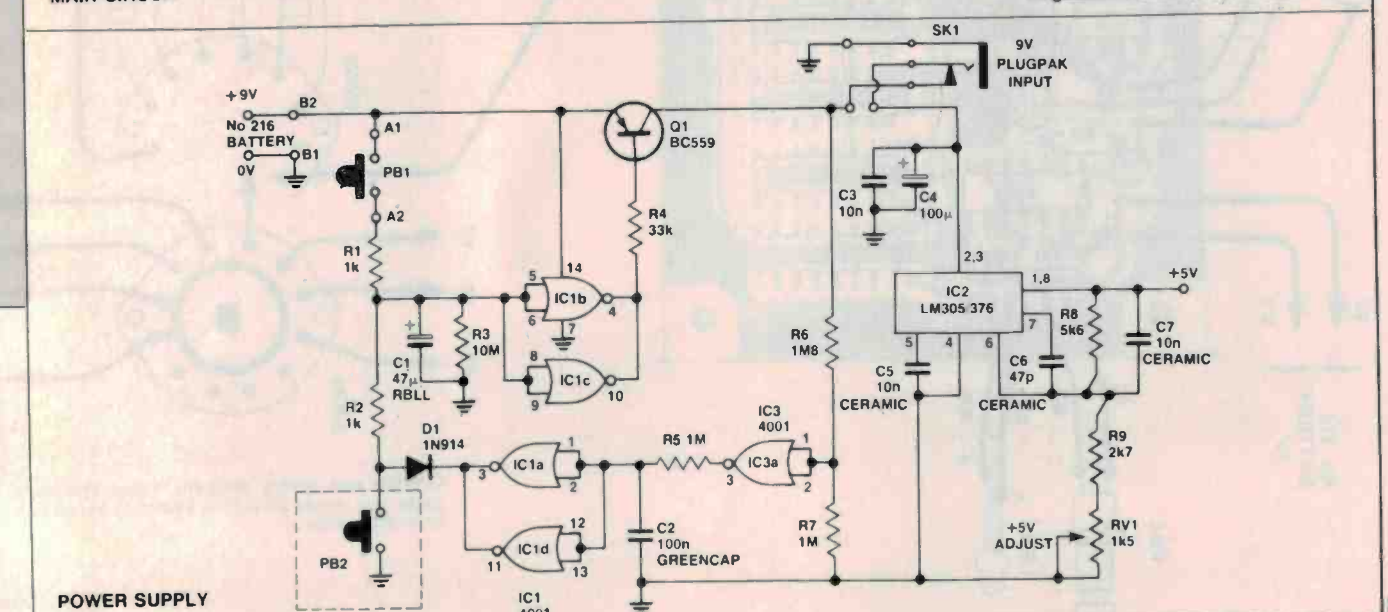
In most applications where a CRO is used, the user expects to be able to resolve the position of the trace to within 0.1 divisions, on a screen with eight vertical and 10 horizontal divisions. This represents a dynamic range of about 38 dB in the vertical direction. Compare this with the 50 dB or more you get from your cassette player, or the 96 dB from a compact disc.

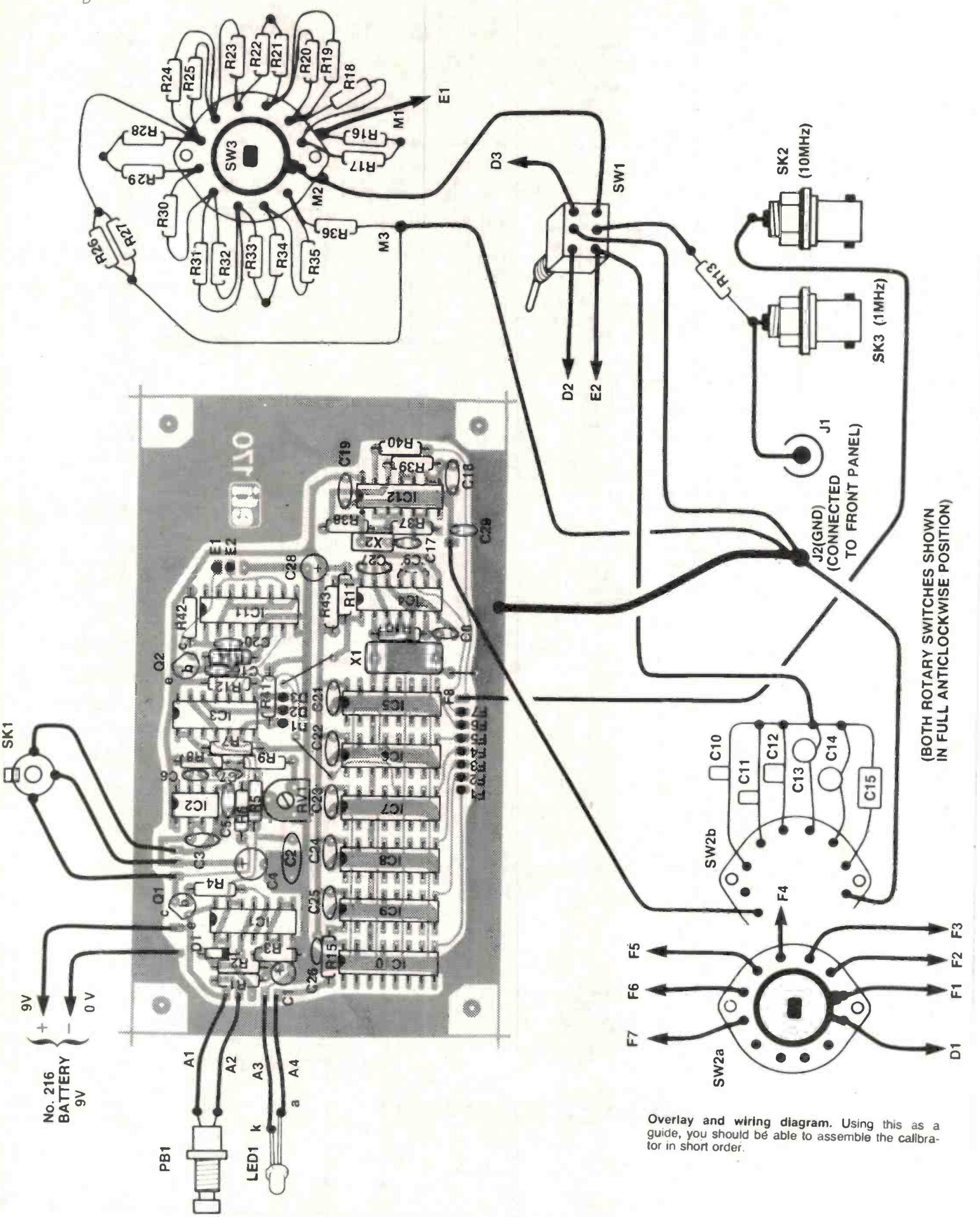
The upshot of this is that the signal-to-noise ratio of a CRO can be relatively poor, and the spot position uncertainty fairly large. Round three to the audio amplifier.



10 MHz timer.


MAIN CIRCUIT
+5V
R11 1M
R12 1M
IC3 4001
IC3c
IC11 4049
IC11b
C16 100p CERAMIC
R14 10k
Q2 BC559
E1
ATTENUATOR
M1
R16 330R 1%
R17 330R 1%
R18 220R 1%
R19 220R 1%
R20 220R 1%
R21 33R 1%
R22 33R 1%
R23 22R 1%
R24 22R 1%
R25 22R 1%
R26 12R 1%
R27 150R 1%
R28 330R 1%
R29 330R 1%
R30 220R 1%
R31 220R 1%
R32 220R 1%
R33 33R 1%
R34 33R 1%
R35 22R 1%
R36 22R
5V
2V
1V
500mV
200mV
100mV
50mV
20mV
10mV
5mV
2mV
1mV
TIME
VOLTS
D2
D3
SW1a
LED 1
A4
A3
R15 470R
X1 1MHz
R10 1M
C8 15p CER
IC4b
IC2 4001
IC4a
IC4d
IC4c
F7
C9 10p CERAMIC
IC5 4017
IC6 4017
IC7 4017
IC8 4017
IC9 4017
IC10 4017
F6
F5
F4
F3
F2
F1
10MHz
1µs
10µs
100µs
1ms
10ms
100ms
1s
SW2a
D1
R41 1M
IC3b
IC3 4001
IC3d
IC11a
IC11e
IC11d
IC11c
IC11 4049
E2
SW1b
VOLTS SW3
M2
R13 47R
SK3 OUTPUT
J1
J2
M3
R43 100R
IC4, PIN 14
C27 10n
R42 100R
IC11, PIN 1
C20 10n
C28 4µ7
C21 10n
C22 10n
C23 10n
C24 10n
C25 10n
C26 10n
TO G8
(GND PIN7 OF IC12)
C10 2n2
C11 22n
C12 220n
C13 2µ2
C14 22µ
C15 220µ
SW2b


POWER SUPPLY
+9V
No 216 BATTERY
0V
B2
B1
A1
A2
PB1
PB2
R1 1k
R2 1k
R3 10M
C1 47µ RBLL
Q1 BC559
R4 33k
IC1b
IC1c
IC1a
IC1d
IC1 4001
D1 1N914
R5 1M
IC3 4001
IC3a
C2 100n GREENCAP
SK1
9V PLUGPAK INPUT
C3 10n
C4 100µ
IC2 LM305 376
+5V
R6 1M8
R7 1M
C5 10n CERAMIC
C6 47p CERAMIC
R8 5k6
C7 10n CERAMIC
R9 2k7
RV1 1k5
+5V ADJUST



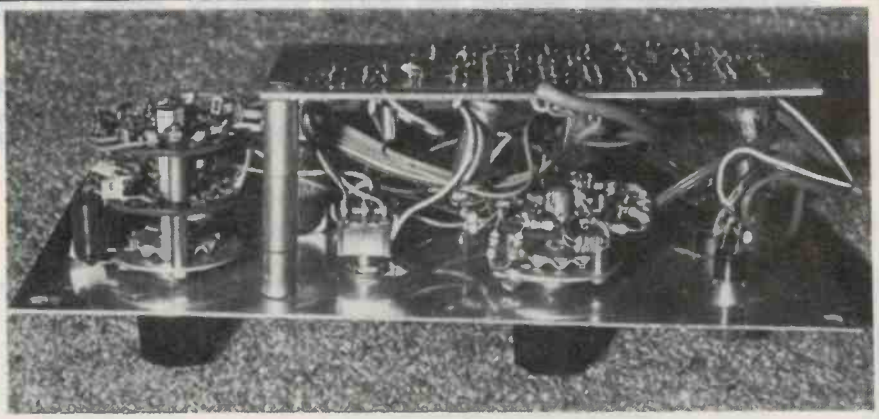
Overlay and wiring diagram. Using this as a guide, you should be able to assemble the calibrator in short order.

PARTS LIST — ETI-170 CRO CALIBRATOR

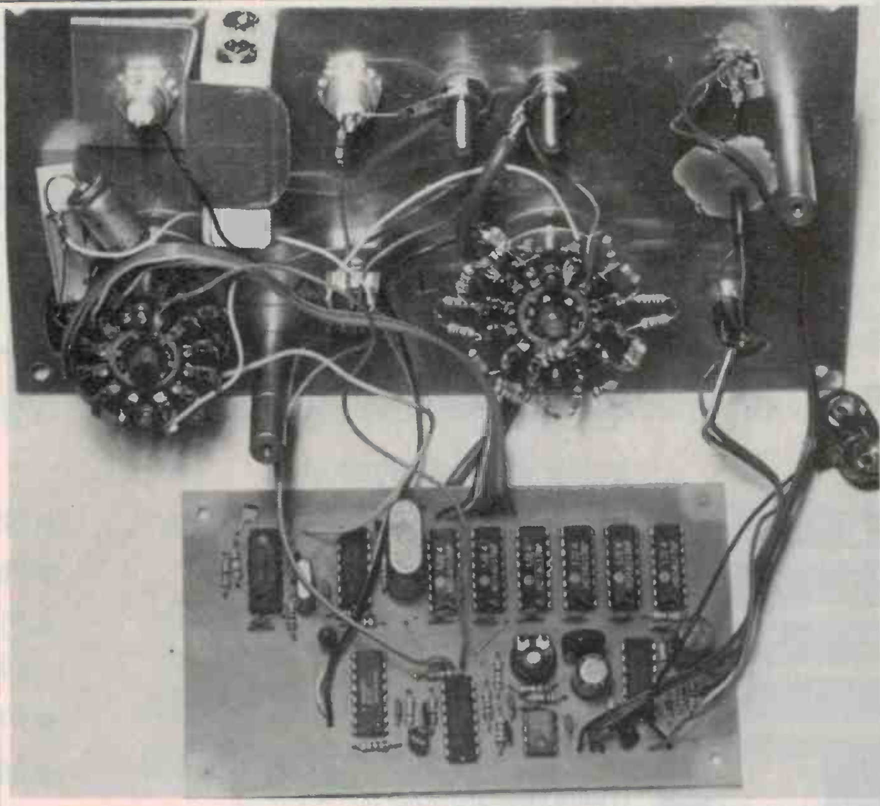
Resistors	all ¼W, 2% unless noted
R1, R2, R38	1k
R3	10M
R4	33k
R5, 7, 10, 11, 12, 41	1M
R6	1M8
R8	5k6
R9	2k7
R13, R40	47R
R14	10k
R15, R37	470R
R16, 17, 28, 29	330R 1%
R18, 19, 20, 30, 31, 32	220R 1%
R21, 22, 33, 34	33R 1%
R23, 24, 25, 35, 36	22R 1%
R26	12R 1%
R27	150R 1%
R37	470R
R39	390R
R42, R43	100R
Capacitors	
C1	47µ/16VW RB electro.
C2	100n/100V met. poly.
C3, 5, 7, 19-27, 29	10n ceramic monolithic
C4	100µ/25VW RB electro.
C6	47p ceramic
C8	15p NPO ceramic
C9	10p NPO ceramic
C10	2n2 ceramic monolithic
C11	22n ceramic monolithic
C12	220n met. poly.
C13	2µ2/35VW solid tant.
C14	22µ/6VW solid tant.
C15	220µ/16VW electro.
C16	100p ceramic
C17, C18	22p NPO ceramic
C28	4µ7/35VW solid tant.
Semiconductors	
D1	1N914 diode or similar
LED1	5 mm red LED with bezel
IC1, 3, 4	4001 CMOS quad NOR
IC2	LM305/376 regulator
IC5, 6, 7, 8, 9, 10	4017 CMOS decade divider
IC11	4049 CMOS hex inverter
IC12	7402 TTL quad NOR
Q1, Q2	BC559 or similar
Miscellaneous	
SW1	DPDT sub-min. toggle
SW2	2-pole 8-pos. rotary
SW3	1-pole 12-pos. rotary
PB1	Mom. contact sub-min. pushbutton
SK1	3.5 mm sub-min jack socket with sw.
SK2, SK3	Panel-type BNC socket
J1, J2	Tip jacks
X1	1 MHz crystal, par. res. with 30p
X2	10 MHz crystal, par. res. with 30p

ETI-270 pc board and Scotchcal label; 196 x 112 x 60 mm zippy box; 2 small knobs; 216-type 9 V battery; battery clip lead; 2 x 45 mm tapped spacers for pcb mounting; hookup wire, nuts, bolts, etc.

Estimated price: $60



Mounting the pc board to the panel. The leads should be as short as possible to avoid coupling between circuit sections and to prevent unwanted radiation.



Inside the case. Apart from the ICs and other components mounted on the PCB there are few other components required and these are mounted directly on the switches. Note the battery clamp bracket, attached to the front panel by the 10 MHz output socket.

requires a known accurate reference. We used a 3½-digit multimeter, which is adequate. It should be attached to the regulated supply rail, and RV1 adjusted to give the specified 5.05 volts. This gives 1% accuracy to the unit. As most CROs are good only to 2% or so, this is reasonable.

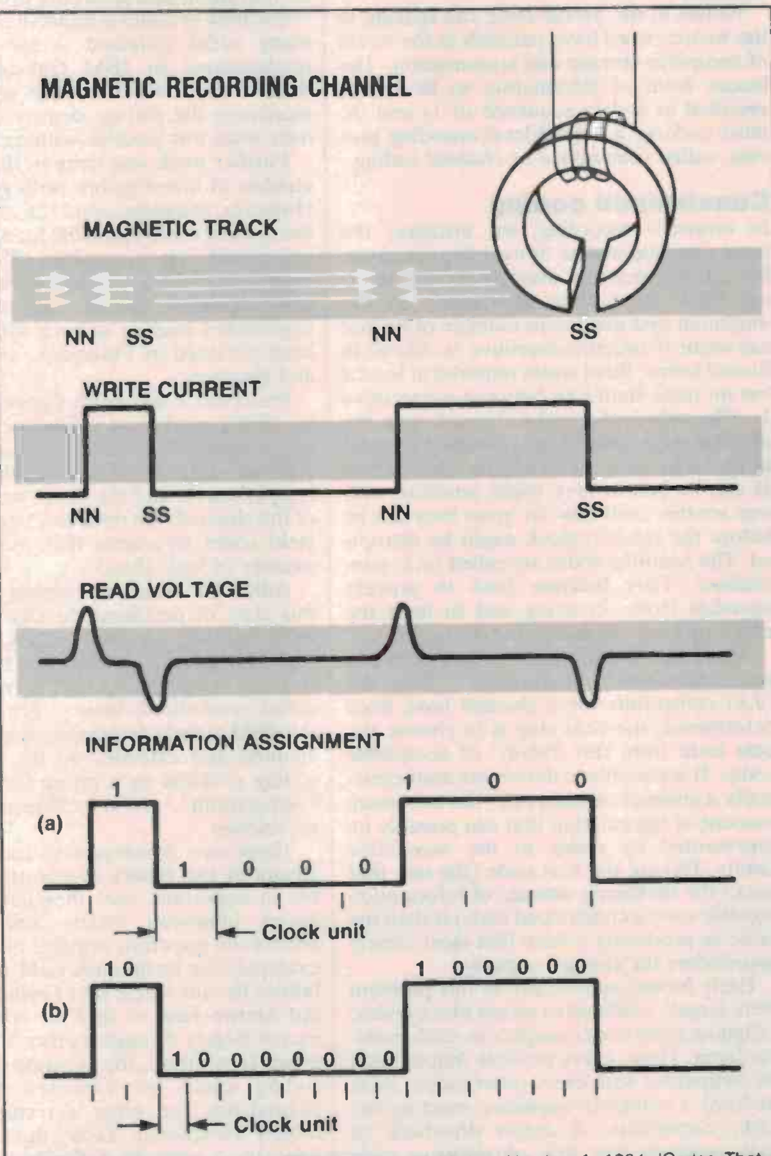
Further accuracy can be obtained if required by using the following alignment procedure. Switch the circuit to volts. Attach a 4½-digit meter to the volts output. Short IC3 pin 10 to rail momentarily, and set RV1 for 5 volts on the 5 V range. This gives accuracy limited only by the attenuator chain resistor tolerance.

Artwork: Front panel artwork and drilling diagram are available on request to ETI, PO Box 227, Waterloo, NSW 2017. ●

A technique called constrained or channel coding, explored for some time at IBM Research, makes possible faster, more error-free transmission and recording of digital data.

KEEPING THE MESSAGE CLEAR

T. Murphy



This item was reprinted from IBM Research Highlights, Number 1, 1984; 'Codes That Keep the Message Clear'

Figure 1. The two assignments at right show examples of encoded information: (a) is encoded under [0,3] constraints while (b) is [1,7].

STORIES IN THE popular press covering advances in computer technology often report on the contributions of physicists, engineers, and computer scientists. But the efforts of mathematicians and information theorists often remain hidden behind a jumble of blackboard scratchings and talk of 'sets', 'sequences', and 'mappings' that defy the comprehension of the outsider.

A case in point is *channel* or *constrained* coding. The increased capacities of today's high-end disk and tape storage systems have, in part, been made possible by the advances of researchers in this area of applied mathematics. Peter Franaszek, Roy Adler, and Martin Hassner are among those, at IBM Research and elsewhere, who have examined the problems of constrained coding theoretically, and have evolved algorithms (which can be computerized) for the design of optimised solutions and of actual hardware for coding and decoding.

"IBM is really the place where this was done," says Franaszek, who was responsible for some of the earliest work in the theoretical treatment of the constrained coding problem. "Previous approaches to this problem have been largely replaced in the industry by techniques often developed within IBM."

But at first glance it may not be obvious why there would be any particular problem with putting digital information onto a medium, or 'channel', such as magnetic tape or disk. The best way to store computer data might seem the straightforward method of taking the sequence of 1s and 0s and representing them directly. Following such a theory, a sequence such as 100110100110 might best be represented in the storage channel by a series of magnetizations of opposite polarity that correspond directly — one-to-one — with the elements of the sequence.

This approach, however, presents a number of practical difficulties in a real storage system. For example, intersymbol interference, i.e: the interference of adjacent 1s and 0s. This interference can occur because a channel is a physical system, and no physical system reponds instantaneously and with ▶

perfect sharpness. There is always a degree of uncertainty. In the data sequence above, this could result in '11' being read as '1' — resulting in the wrong number being recorded. In transmission channels there is an analogous problem called 'spectral shaping'. And, in both storage and transmission, the internal 'clock' of the system can also be disrupted by the input of arbitrary streams of data.

These kinds of problems are not particular to computers, or even to the 20th century. Messages sent in Morse code could not be understood if they were transmitted as continuous strings of *dits* and *dahs* with no pauses. No one could read a book or business letter or a newspaper if the words had no spaces between them. The information would be there in each case, but it would be unusable.

Pauses in the Morse code and spacing in the written word have parallels in the world of computer storage and transmission. The binary form of information to be saved, encoded as a data sequence of 1s and 0s, must undergo a second-level encoding process, called *constrained* or *channel* coding.

Constrained coding

In magnetic recording, for instance, the most common means of avoiding intersymbol interference and maintaining the internal clock is to place restrictions on the minimum and maximum number of 0s that can occur between consecutive 1s. Stated in formal terms, these codes required at least d but no more than k 0s between consecutive 1s. The values of d and k depend upon the physical properties of the particular channel in question; that is, how close consecutive 1s can be before they might interfere with one another, and how far apart they can be before the internal clock might be disrupted. The resulting codes are called *(d,k) constrained.* They function both to prevent mistakes from occurring and to limit the effect of those mistakes that do occur.

There may be many codes that meet any particular set of *(d,k)* constraints. Once the *(d,k)* constraints for a channel have been determined, the next step is to choose the best code from this 'family' of acceptable codes. It is possible to determine mathematically a channel capacity; i.e: the maximum amount of information that can possibly be represented by codes in the acceptable family. Picking the best code (the one that packs the maximum amount of information possible onto a constrained code) is then the same as producing a code that most closely approaches the channel capacity.

Early formal approaches to this problem were largely confined to *mixed block* codes: assigning fixed coder outputs to each possible input. Here, every possible output must be compatible with every other output so as to form a complete sequence meeting the *(d,k)* constraints. A major drawback of such methods was that obtaining a code closely approaching the channel capacity would have required, in many cases, coders of impractical complexity. A consequence of this was that the recording or transmission system often operated well below its potential.

Solving the problem

Perhaps the earliest systematic methods for overcoming this problem were Franaszek's results during the 1960s that avoided the use of fixed blocks and made use of the notion of codes based on *finite state descriptions.* Finite state descriptions are produced by abstract mathematical structures known as *finite state machines.* These descriptions enable each segment of information to be coded while taking into account how both the incoming bit stream and neighbouring segments of information were coded. The resulting codes allowed efficient computer optimization, and generally produced large reductions in coder complexity. One of the many codes obtained is the (2,7) code implemented in IBM high-capacity disk drives. This code has been credited with increasing the storage density substantially over what was possible with earlier codes.

Further work was done in this area by a number of investigators, with good results. However, instances could still arise in which the densest coding possible for a given channel would require coders of unbounded complexity. This suggested the need for more general forms of codes. Two approaches leading to such solutions have been obtained by Franaszek, and by Adler and Hassner.

Franaszek's method is a generalisation of his earlier work, and is likewise based on a knowledge of the information stream to be encoded (usually called *look-ahead* in coding parlance), and the finite state structure of the channel. He obtained algorithms that yield coder structures that use a minimal amount of look-ahead.

Adler and Hassner provided solutions to this class of problems through a different mathematical approach. They discovered and developed a relationship betwen constrained coding and a field of mathematics called *symbolic dynamics.* Their results in this field include techniques that have been adapted and extended to the constrained coding problem by a group including Don Coppersmith, John Moussouris and themselves.

These new developments have not only advanced the theory of constrained codes but in important cases they have also produced improved coders and decoders. Numerous questions remain, however. For example, the techniques yield many possibilities for any single set of constraints. It is not known how to find an optimal code, except largely through a process of trial and error. In addition, the question of how such coding could be extended to include redundancy for error detection remains largely unexplored. Today this is generally done by a separate coder/decoder. These and other issues suggest that this field will remain a lively area for investigation. ●

A 'speech-tailored' COMMUNICATIONS SPEAKER

Robert Irwin
Roger Harrison
VK2ZTB

After all the care taken with the design and performance of modern communications receivers and transceivers, they're virtually all let down right at the end of the chain — the loudspeaker. Speech 'intelligence' can be marred by various deficiencies in the audio amp and speaker response, making the signal sound 'muddy' or just 'hard to copy', despite good signal strength. With this speaker it's 'Q5 all the way'.

IN ANY COMMUNICATIONS SYSTEM where speech is used, 'intelligibility' is enhanced by restricting the frequency response, over and above simple channel bandwidth considerations. Restricting the voice frequency spectrum to a range from about 100 Hz to about 3 kHz removes many of the characteristic components generated during speech but does not reduce intelligibility. Telecom employs a frequency range of 300 Hz to 3 kHz in the telephone system, for example.

In amateur radio, the emphasis is on speech intelligibility. Any unnecessary speech spectrum components present will generally only degrade the useful information. For this reason, most transmitting equipment these days incorporates speech response filtering in the audio system.

But this is not always the case with the receiver. The audio amp may have a little bottom-end rolloff and some simple highcut response tailoring. Problem is, the signal coming out of the detector will contain components spanning right across the audio spectrum. When receiving speech, low audio frequency noise will 'muddy' the signal, reducing intelligibility, making it hard to 'copy'. Likewise, higher audio frequency noise (spits and crackles) can make the signal difficult to copy as the ear is quite sensitive to this.

The internal speakers in communications receivers and transceivers generally have what can best be described as an 'indifferent' response. Many have a 'peaky' response at the higher audio frequencies, about 4 to 10 kHz, and equipment cabinets make the bottom end response 'lumpy'.

A nondescript speaker in any sort of box, or just on a baffle, can remarkably improve the sound from a receiver or transceiver — apart from throwing the sound in the right direction (i.e: at you!). But, by 'tailoring' the response to remove the unwanted audio spectrum components coming out of the receiver, the result can be dramatic indeed.

This project employs a number of little 'tricks' to obtain the appropriate tailored response for improved intelligibility. It involves choosing a driver that partly has a natural response approaching what we want and then using L and C filter elements to finish the job.

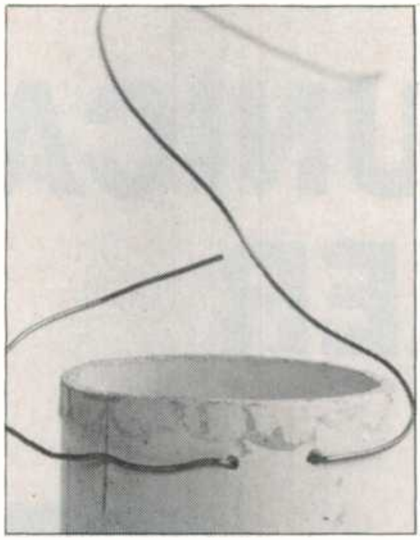
The ETI-742 Communications Speaker is designed to plug directly into the extension speaker outlet on a receiver. Its power handling capability, at 10 watts, is more than ample for the application and it should make not just a useful adjunct to any 'shack', but a decorative one as well.

The speaker

Because of the small frequency range that needs to be covered there are no exacting demands on the speaker to be considered. Rather than use a filter to tailor the bass end of the range, a speaker which naturally rolled off the bottom end could be used. The only demand on the top-end performance of the speaker is that it extends beyond 3 kHz or so. The speaker we selected was a Pioneer 4 ohm, 6" (150 mm) car speaker sold by Jaycar (type H16CP60-02C). These speakers have a free-air resonance of around 150 Hz, are rated to handle 10 W RMS and have the advantage of being very cheap.

After running a frequency response we found that this speaker had one other unex-

COIL WINDING DETAILS



The coil on the prototype was wound on a piece of 50 mm internal diameter, PVC pipe which can be obtained from most hardware or plumbing supply stores. Cut off a 90 mm length of the pipe and drill a pair of 1.2 mm holes about 5 mm from edge on both ends of the pipe. These holes will be to secure the coil wire. The coil was wound from 18 B&S, 20 swg enamelled copper wire. Start by threading the wire in one hole and out the other on one end of the pipe. Leave about 100 mm protruding as a connection lead. Wind a layer of about 60 turns on to the pipe making sure that the turns are close wound and neat. When you have completed the first layer you can secure the turns with a bit of sticky tape and wind another layer back the other way on top of the first. Repeat this once again so that you end up with a coil of three, 60 turn layers (180 turns in all). The end of the coil should be at the opposite end to which you started. The wire can be secured by threading it through the two holes at this end once again leaving bout 100 mm as a connection lead. Note that before soldering the leads of the coil to anything you will have to scrape the enamel off the ends.

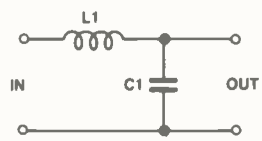


Figure 1. Low pass LC filter.

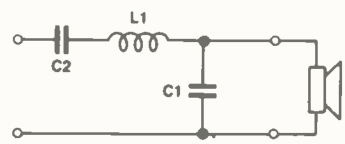


Figure 2. Speech filter network.

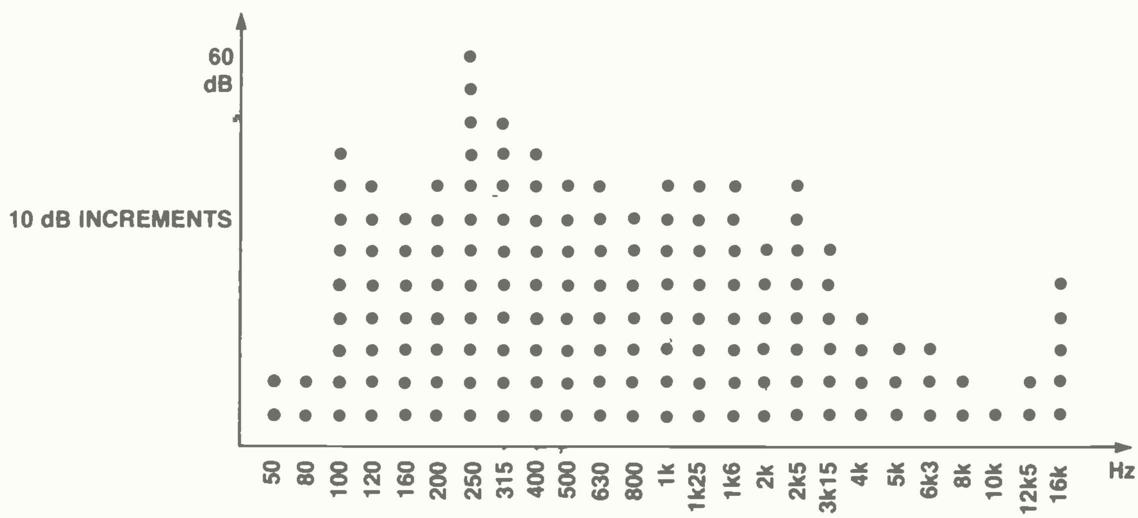


Figure 3. Typical frequency response of the male voice saying "Aaaahhhh". The response was measured on an Ivie IE-30A Spectrum Analyser.

pected advantage. There was a dip in the response around the 300 Hz region. You may think that uneveness in the response would be the last thing to praise in a speaker, but in this case it is very useful indeed as the region around 200 to 300 Hz often makes speech sound 'muddy' through an amplifiction system.

Often, in speech reinforcement systems, a parallel resonant circuit in series with the driver is used to artificially create a dip in the response in this region.

Although the driver is a 4 ohm type, the majority of modern (and not-so-modern) receiver audio amps will drive this impedance without complaining (but check to be sure).

Tailoring the response

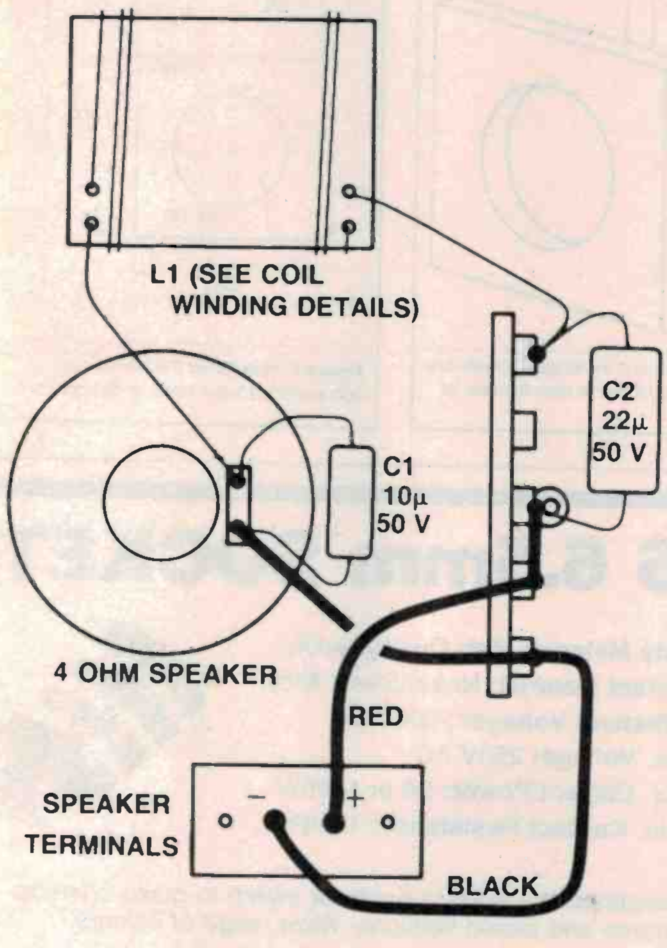
The first step in adjusting the frequency response is to roll off the top end of the speaker, Figure 1 shows the circuit of an LC low pass filter network. I happened to have a 1 mH coil lying around from a previous crossover design so I conveniently let L1 be 1 mH (see 'Coil Winding Details'). The corner frequency of the low pass network is given by:

$$2\pi f = 1/\sqrt{(LC)}$$

If we let the rolloff frequency be 2 kHz, then the value of C is 6.8 µF. It was found that, due to slight peakiness in the driver's response around 2 kHz, it was better to start rolling off a bit earlier so a value for C1 of 10 µF was used.

The frequency response was reviewed again and it was found that the top-end response rolled off quite nicely, so now for the ▶

Figure 4. Wiring up the filter and speaker.



PARTS LIST — ETI-742

Speaker
SP1 .... 150 mm 4 ohm car speaker

Capacitors
C1 .... 10 µF 50 V bipolar electrolytic
C2 .... 22 µF 50 V bipolar electrolytic

Inductors
L1 .... 1 mH air core inductor (see coil winding details)

Miscellaneous
2-way spring terminal block; 5-way tag strip; 300 x 0.2 mm hookup wire; 300 x 900 x 13 mm particleboard; 800 x 13 x 13 mm beading; wood glue; screws; nails; non-hardening sealant.

Price estimate: $10-$12

bottom end. The speaker resonance gave quite a peak at 200 Hz so a series capacitor was called for. This cuts back the peak at 200 Hz and also rolls the bottom end off at a steeper rate. Because the two poles of the combined network interact with one another to some extent, a certain amount of experimentation was required to find a value for this capacitor that would bring the peak down to a suitable level. It was found that a value of about 22 μF gave the appropriate response (see Figure 2).

Construction

The speaker and filter were mounted in a 225 x 225 x 150 mm chipboard enclosure. There is no particular problem with the construction of this box as all the joints are butt joints (about as far as my woodworking abilities go) and there are no nasty ports or braces to confuse the would-be woodworker.

The enclosure itself is not all that critical, as long as it is roughly the same size. The prototype was made from 13 mm thick chipboard. You will need a piece about 300 x 900 mm. If you have some off-cuts that will be suitable then use them, otherwise Figure 6 shows how to cut the box from a 300 x 900 mm sheet which is a standard size sold in hardware stores.

Once you have cut all the pieces, sandpa-

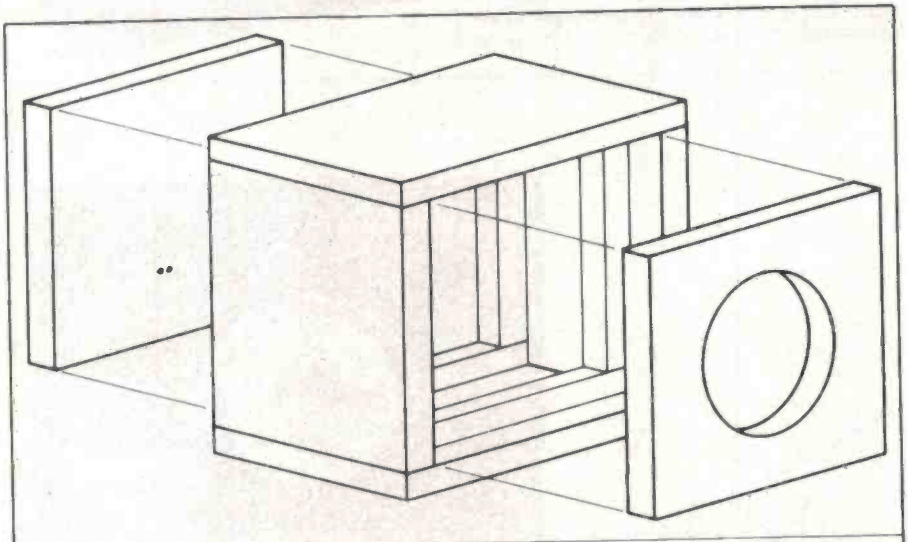


Figure 5. How the box fits together. Note that the sides butt against the top and the bottom. Cleats are used to mount the front and back panels on. NB. The rear cleats are set in 13 mm in from the rear of the box. The face board is set in 5 mm in front of the box.

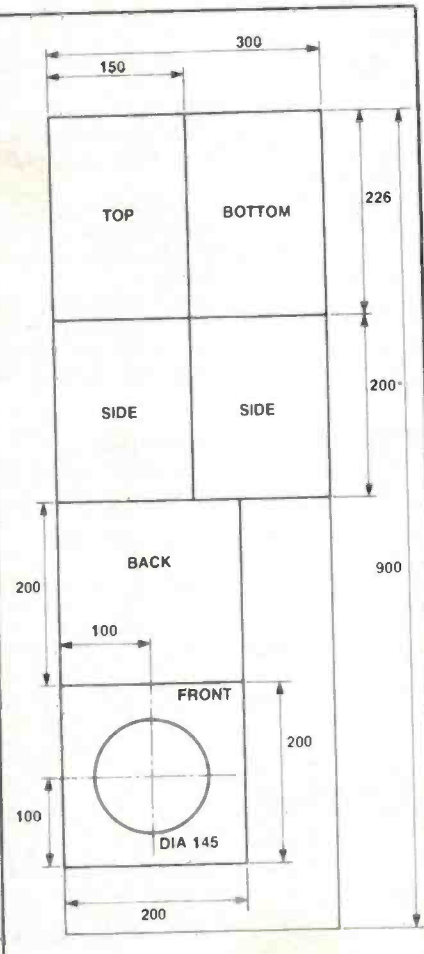


Figure 6. How to cut the box from a 900 x 300 x 13 mm sheet of chipboard.

per down all the rough edges. Care should be taken when cutting the hole for the speaker in the front baffle. Be sure that you do not make it too big otherwise there may not be enough 'meat' left around the edges to screw the speaker on to.

Assemble the top, bottom, sides and front baffle together. All the joints should be glued and then screwed or nailed together (if you are using screws then drill small pilot holes first to ensure that the chipboard doesn't split).

The front baffle should be mounted about 5 mm back from the front edge so that a grille can be mounted if desired. To ensure that the back of the box will sit properly, cleats made from 13 mm square beading should be nailed 13 mm in from the back edge.

To complete the woodwork, two holes should be drilled in the bottom of the back panel for the speaker terminals.

The box can now be finished off in any way you please. The prototype was finished with an iron-on wood laminate that can be bought from most hardware stores. The laminate is cut to size with a pair of scissors and placed in position. A hot iron (clothes iron not soldering iron! Ask your mother how it works if you've never used one!) is then run over the top of the laminate thus melting the glue on the underside and bonding the laminate to the surface. The front baffle was painted matte black.

Once the box is finished you can mount the speaker to the front baffle. Use some silastic sealant around the edge of the speaker to form an air-tight seal. The coil was mounted next. It is positioned on the floor of the box and to one side. I secured it with Araldite. A small piece of tagstrip was screwed to the floor also. The components can now be wired up according to the wiring diagram. Note that C1 is wired directly across the speaker terminals. Finally, wire up and mount the speaker spring terminals on the back panel. Before closing up the back, some acoustic stuffing should be placed inside the box to cut down on box resonances. The back can now be screwed on.

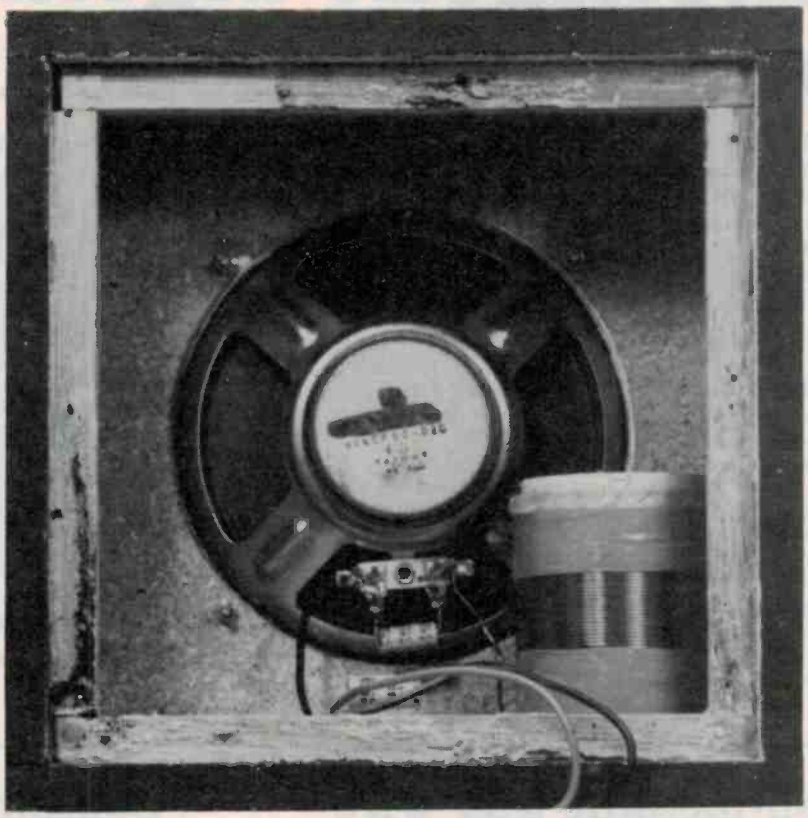


Figure 7. The inside story. A picture showing the positioning of the coil inside the box. The coil was held in position with Araldite.

Listening

All that's left to do now is to hook the speaker up to your receiver and find someone to listen to. If your receiver doesn't have an extension speaker outlet then you can disconnect the internal speaker and connect up a socket here. We tested the speaker out on an Icom IC-R71A communications receiver and found that it gave better clarity than the internal speaker, apart from the advantage of throwing the sound forward.

"Cuts out all the crud on the bottom end," was the knowledgeable opinion of our humble editor. He was right. I could actually hear what was being said on 3565 kHz without all that rumble and mud. (Judging by the conversation it may have been better if all the crud had been left in!). Happy listening! ●

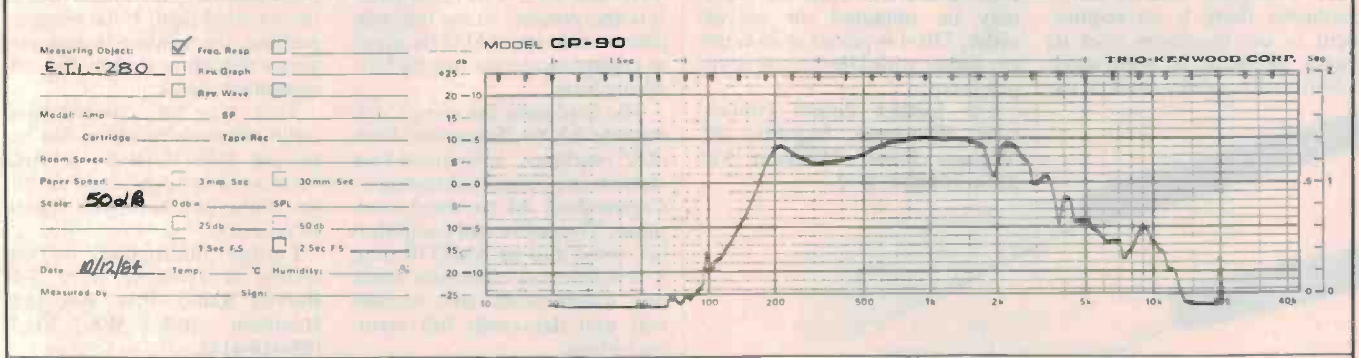


Figure 8. Overall frequency response of the ETI-280.

Intelligent digital communications interface

GFS Electronic Imports has undertaken the manufacture of a new digital communications interface unit, the model CPU-100. It's designed for interfacing a dumb ASCII terminal to a radio transceiver via a modem, which GFS can also supply.

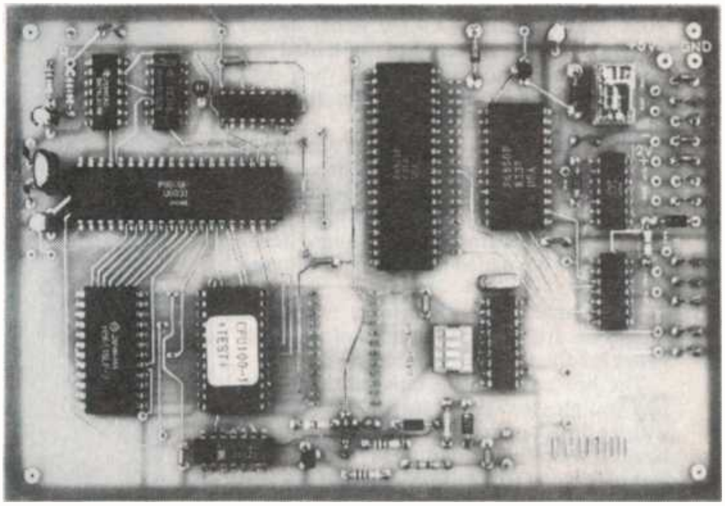
Using a 6809 microprocessor, the CPU-100, via ROM software, is able to perform a wide variety of functions. These include transmission of both BAUDOT and ASCII at user definable speeds, as well as digital selective calling. SITOR transmission may also be possible given the appropriate software.

Because of its built in intelligence the CPU-100 is extremely flexible. For example it may be configured for either simplex or full duplex operation depending on its end user's requirements.

A wide variety of applications exist. These include accessing a mainframe computer from a vehicle or aircraft and radio teletype operation where a number of stations operate on the one frequency, and the calling station wishes to address each one separately via selcal.

GFS is able to supply the CPU-100 as a pre-wired and tested printed circuit board, or as a fully housed unit including its MDK-17 modem. Special applications software can also be made available.

For further details contact the manufacturer, **GFS Electronic Imports, 17 McKeon Rd, Mitcham, Vic 3132. (03)873-3777.**



The CPU-100 interface unit. It interfaces a mainframe to a radio transceiver.

Non-metallic guy wire

GFS Electronic Imports recently released a new alternative guy wire manufactured using continuous yarn fibreglass filament and vinyl chloride sheath.

Known as Debeglass Wire, GFS claims it offers its users a number of advantages over using steel as a guy wire, such as, a higher tensile strength than steel wire of the same diameter, no corrosion, as well as lighter weight than an equivalent diameter of steel wire.

As Debeglass wire is not a conductor there is no requirement to use insulators over its length as there is with steel. Additionally, unlike steel, it exhibits extremely low elongation.

Debeglass is available in sizes, 4 mm, 5 mm and 6 mm diameter. The tensile strength of DB-4 is 430 kg, DB-5 is 560 kg while DB-6 is 970 kg.

Applications exist for Debeglass wire in many areas from the guying of radio masts to the supporting of HF antenna arrays. It is also uniquely suited to use in marine and other highly corrosive environments.

GFS Electronic Imports advises that it keeps stocks of the DB-4 and DB-5 while the DB-6 may be obtained on special order. DB-4 is priced at 48 cents per metre with DB-5 at 68 cents per metre.

For further details contact **GFS Electronic Imports, 17 McKeon Road, Mitcham Vic 3132. (03)873-3777.**

Computer talk by 2-way radio

West Australian mining companies are using portable computers to improve two-way radio communications.

Radio communications firm T R Barrett of Spearwood, South of Perth, has helped the companies set up communications networks using its commercial two-way radios with Commodore computers.

Transmission can be via HF (3 to 30 MHz) single sidebank or VHF and UHF FM radio links. It is also possible to use the computers and its AMTOR units to communicate via regular telephone lines.

The field units are using Commodore SX 64 'Executive Portable' machines, while most base stations are connected through a Commodore 64 personal computer. The radios and computers are wired into an AMTOR unit, a sophisticated electronic black box which sends and receives text and data with full error-correction.

The AMTOR unit (which is normally used for advanced Amateur Radio communications) continuously checks each character as it is received, and transmits signals back every split second so that the sending station's computer knows the message has been received properly.

Each sequence takes only 450 milliseconds: 250 ms is used to transmit, 70 ms for verification, and the rest in sending the signal from one station to the other at the speed of light. If the text gets garbled, the sending station just keeps repeating it until the two computers agree.

This type of computerised radio communication is fast replacing radio teletype services because of its speed and reliability. It also offers a higher degree of security.

Further information on the system is available from **T R Barrett Radio, P.O. Box 198, Hamilton Hill, WA 6163. (09)418-4141.**

New mm wave detector series

Four new millimetre frequency detectors, offering excellent tangential sensitivity for use in many applications, have just been announced by Alpha Industries.

The frequency range 18 GHz to 220 GHz is covered in nine bands. For example the fixed tuned units have −55 dBm sensitivity at 35 GHz and biased type detectors have −68 dBm sensitivity at 35 GHz.

For applications in test sets and integrated subsystems the 971/925 series of self-biased detectors operate over the full waveguide band without tuning. At 50 GHz and above, beam lead GaAs Schottky barrier diodes are used.

Series 973 detectors provide flat, self-biased response with VSWR ranging from 1.6:1 to 2:1, over full waveguide bands up to 60 GHz. The detector output is typically 200 mv/mw at 35 GHz.

The 965D series of detectors has the highest tangential sensitivity, ranging from −48 dBm to −68 dBm depending on frequency. These detectors feature a field replaceable wafer with a GaAs Schottky barrier diode. Provided as part of this detector assembly is a battery bias supply.

For information contact **Benmar International, P.O. Box 4048, Sydney NSW 2011. (02)233-7939.**

Tara Patch. A connection system for telephone and radio.

Phone-radio interface

After three years of planning and development Australia's only phone-patch unit specifically designed for radio amateurs and CB operators is now available.

Marketing manager of Tara Systems, Neil Parkinson said it was the latest model in a range of Tara radio/telephone interconnection units in use throughout Australia by emergency services, government agencies, and business enterprises.

"It's not only a phone-patch but can be used as an interface between up to three different base radio sets. This enables the user to engage in cross-band operations at the flick of a switch, or provides an easy way to record all communications by plugging in a cheap cassette recorder."

The basic unit will do everything normally expected of a phone-patch for radio amateurs and CB operators but it can be adapted to suit individual special requirements.

The only external adjustment, a slider volume control, adjusts output from the monitor speaker.

All radio signal levels are internally preset but can be adjusted to suit individual needs.

For further information contact **Tara Systems, 6 Malvern St, Bayswater Vic 3153. (03)729-0118.**

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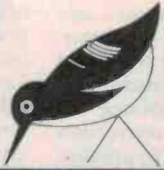

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Book Sales

MORE GREAT BOOKS ON PAGE 118

PARALLEL PRINTER SWITCH

Tired of plug swapping whenever you want to change from one printer to another? This low-cost project should suit you down to the ground. It lets you have two Centronics-type printers connected up permanently, so that you can select one or the other at the flick of a switch.

Geoff Nicholls

IF YOU HAVE both dot matrix and daisy-wheel printers to go with your computer, you probably find changing from one to the other a hassle with a modern computer system. With both serial and parallel ports you might be able to run one printer on each, but what if you have a modem as well?

Fear not, I have a solution! This project switches the 12 most critical Centronics signals from one printer port to two printers. It is really nothing more than an electronic 12 pole two position switch but it has one advantage over a massive switch — the switching can be optionally controlled by a single TTL level signal. In the prototype I have used a small toggle switch to select the printer, but you may use any method you want.

By now some readers are probably wondering why a software switching system was not used, for example, detecting an 'escape' code sequence to select the printer through the data being transferred. There are a number of traps in that approach, one of the hardest to overcome being the problem of bit image graphics where a psuedo escape sequence can occur in the middle of a graphics data dump.

To explain further, when a printer is being sent normal text there is a number of non-printing control codes used to select printer options like enlarged printing, different line spacing, subscripts etc. Most of these are done in so-called escape sequences, where the ESC character code (27 decimal) is first sent and then the next two characters received are not printed, but used to define a unique control code sequence. This system works because the ESC code is not used for any other purpose in ASCII text. When graphics data is being sent, any 8-bit code can occur however, and it is likely that the number used for ESC will come up sooner or later. This does not cause problems for the printer because the protocol for graphics data transfers is rigidly defined — the printer 'knows' that the data is for graphics and does not interpret any pseudo control codes.

But if the printer switch was to use an escape sequence to change printers, it too would have to 'know' when a graphics dump was occurring and ignore the data until the dump was over. This means the project would need to have inbuilt tables for the various types of printers on the market, and would almost certainly require a microprocessor. Once you have a micro on board there is a whole host of extra features that could be included such as 'spooling' or providing a buffer memory, conversion from one data format/baud rate to another etc. However, as this seems to be getting away from the concept of a printer switch, the simple approach was adopted for this project.

Construction

The overall cost of the project is largely determined by the choice of connectors for the Centronics ports. The pc board has been laid out to take 26-way pin headers with two rows of 13 pins spaced 1/10 inch between rows and pins. These can connect to insulation displacement (ID) transition connectors and thence to ID Centronics plugs and sockets, via ribbon cable. This method was used for the prototype, although many readers will want to save some money by using solder-type Centronics connectors and soldering the wires straight to the pc board.

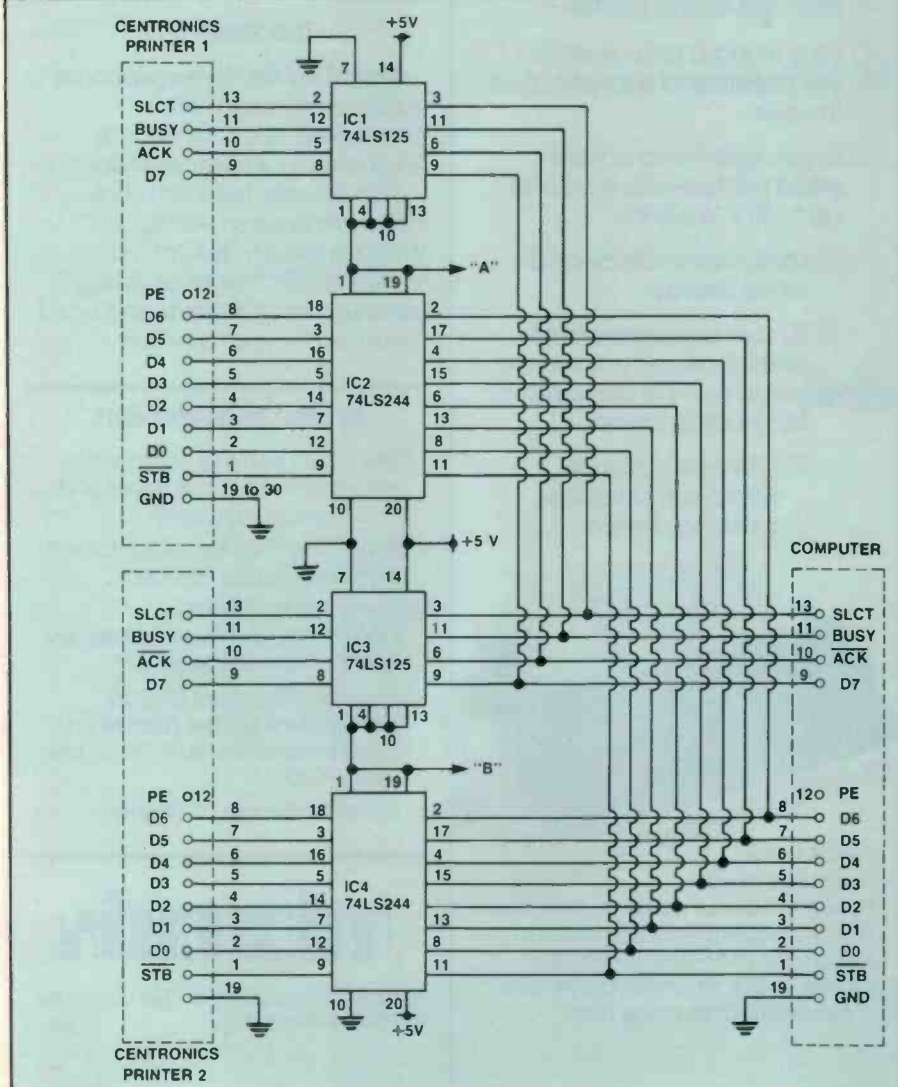
If you use pin headers it will be necessary to cut some pins off the printer 2 header and the computer header. You can check the header against the pc board to see which pins to cut — they are the ground pins numbered 20 to 30 on the Centronics port. (There was no way to get the signal tracks through if the ground pins were left, without going to a double sided pc board or a lot of extra links.)

The only ground to the pc board from the computer port will be through Centronics pin 19 if the ID construction method is used. I had trouble with one supposed 'Centronics' interface that did not connect pin 19, so be warned! You could run a wire along the upper side of the pin header to connect pins 20 to 30 to pin 19, but if you do, try to keep all solder blobs to a minimum size so the transition connector has plenty of pin length left to contact the socket.

If you are using ID connectors you will need 26-way ribbon cable between the headers and Centronics plugs/socket. Crimp the ribbon down at the pin 1 end of the Centronics connectors. Constructors using solder-type Centronics connectors should connect pins 19 to 30 together with a wire on the back of the connectors, thence to the pc board.

Start the pc board by soldering in the 10 links. If you use uninsulated wire be careful to pull the wire tight to avoid shorts. The resistors can be wired in next, followed by the two capacitors and the transistor. The five ICs can go in now; all DIL types mount with the same orientation (most of them

HOW IT WORKS — ETI-666

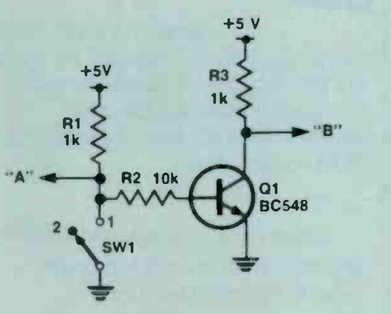


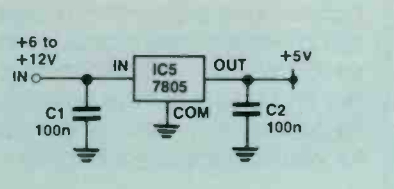
The circuit uses tristate buffers to interface the 12 Centronics signals from the computer to the two printers. Nine of the signals go from the computer to the printer (D0 to D7 and STB-BAR) while the remaining three signals come from the printer to the computer (SLCT, BUSY/READY-BAR and ACK-BAR).

When printer 1 is selected, the tristate outputs of IC1 and IC2 are enabled while the outputs of IC3 and IC4 go into the high impedance state. The reverse happens for printer 2. The printer selection switch directly controls the output enables for IC1 and IC2, while transistor Q1 inverts the switch level to control IC3 and IC4.

This ensures that each computer output line drives only one line at once. Similarly only one set of printer return signals is connected back to the computer, from the selected printer.

IC5 regulates the dc input voltage from the plug pack to provide the 5 V supply required for the TTL buffers.





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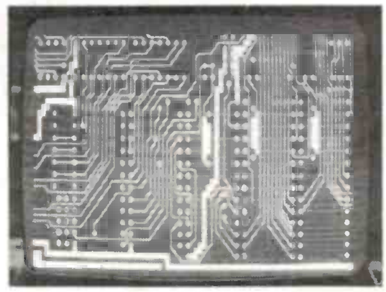

Dual-layer color display of a 2" by 4" section of a 10" by 16" circuit board

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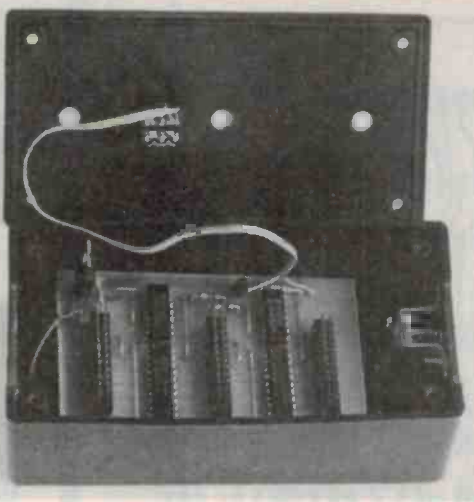


The Inside view. Note the position of the switch and socket. The ID cables have been removed.

have pin 1 marked with a dot on the pc board). Remember that IC5 is the regulator in the TO-220 package.

I mounted the printer selector switch along the long axis of the box lid, 48 mm from the end where the printer 1 cable comes out. If you are using a different box, be careful to avoid fouling the back of the switch on one of the pin headers.

Connect two pairs of hookup wire for the leads to the power supply and the printer selector switch. The power supply input should be wired to a socket suitable for the

PARTS LIST — ETI-666

Resistors
- R1, R2 .... 1k0 5% 1/4 W
- R2 .... 10k 5% 1/4 W

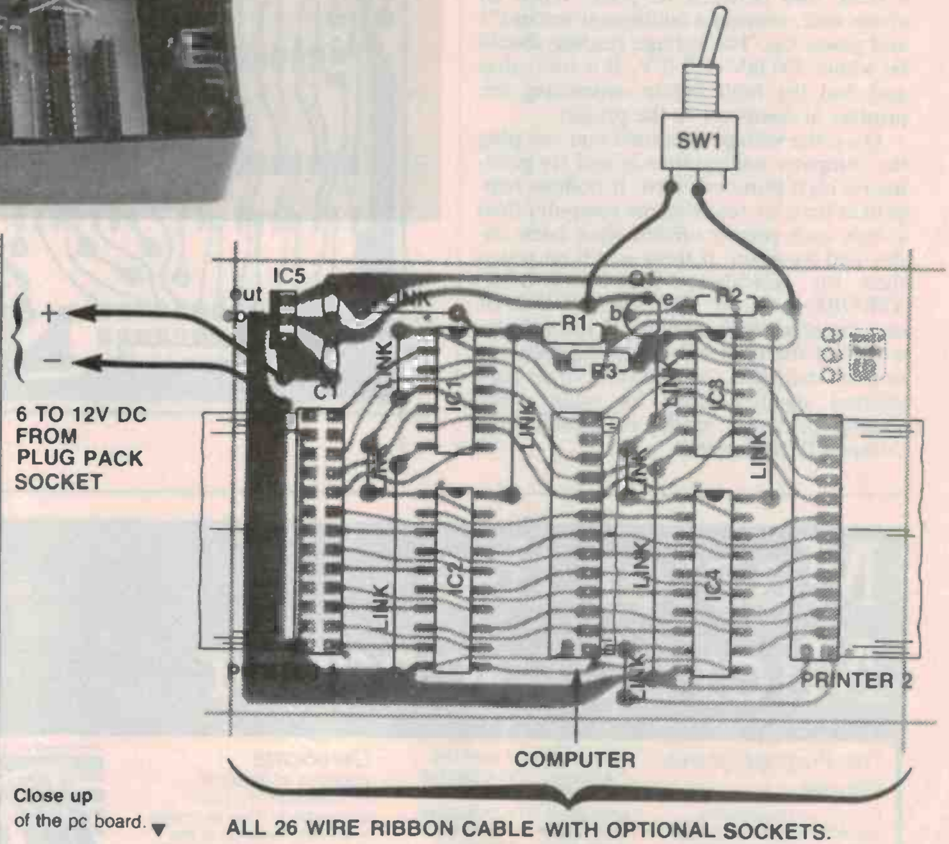
Capacitors
- C1, C2 .... 100 nF ceramic bypass caps

Semiconductors
- IC1, IC3 .... 74LS125 Quad tristate buffer
- IC2, IC4 .... 74LS244 Octal tristate buffer
- IC5 .... 7805 +5 V Regulator
- Q1 .... BC548 etc NPN transistor

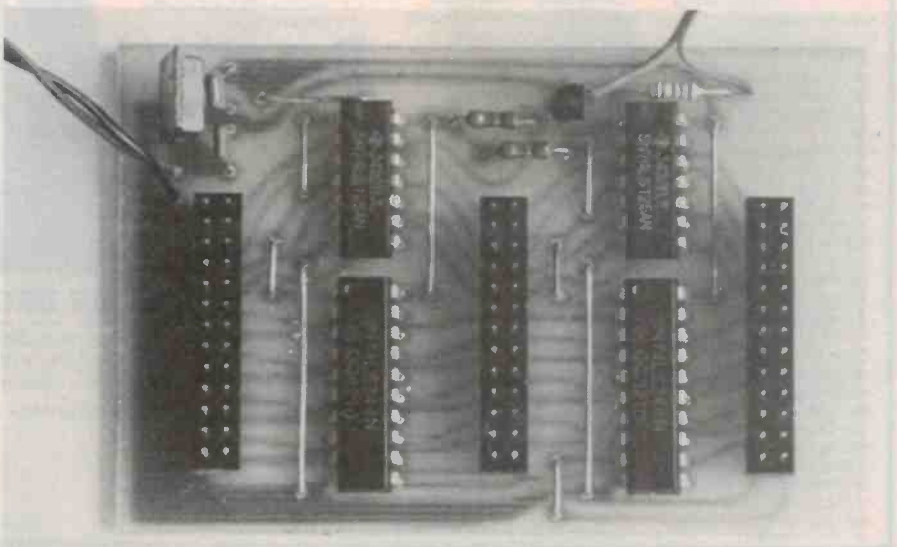
Connectors
- Either insulation displacement types 3 x 26-way pin headers
  - 3 x 26-way ID transition sockets
  - 2 x Centronics ID plugs
  - 1 x Centronics ID sockets
- or solder types .... 2 x Centronics solder plugs
  - 1 x Centronics solder socket

Miscellaneous
ETI-666 printed circuit board; single pole single throw switch; 6 to 12 V dc plug pack; socket to suit plug pack; plastic case to take 60 x 90 mm pc board; 26-way ribbon cable; hookup wire, link wire, solder etc.

Price estimate: $25
(not including connectors)
$50-$70
(including connectors)



Close up of the pc board.



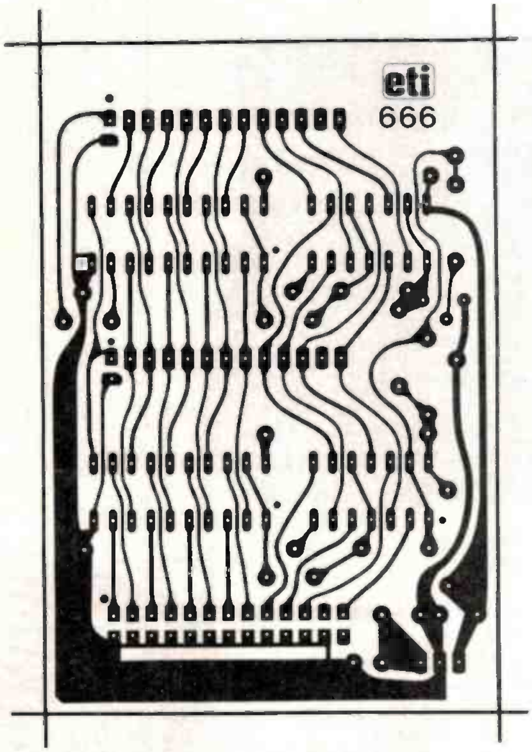
plug pack to be used. Watch the polarity and note that the plug pack must produce a dc voltage between 6 and 12 V.

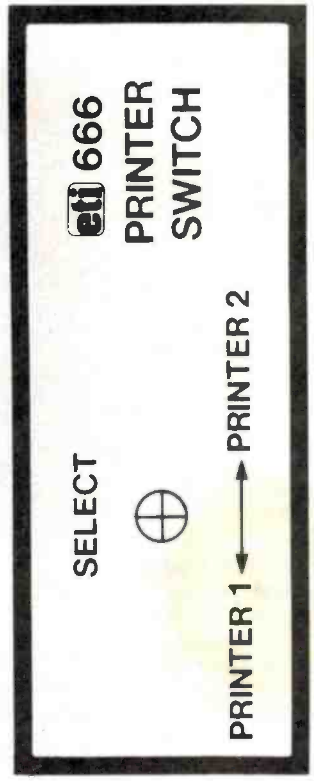
I filed away part of the box to allow the ribbon cables to pass under the mounted lid. Two of the cables pass out one end, with the remaining one out the other.

Testing

Carefully check all wiring and look over the pc board for solder blobs, especially where a track runs between IC pads. When all seems well, connect a multimeter across C2 and power up. The voltage reading should be within 200 mV of 5.0 V. If it isn't, stop and find the fault before connecting the printers or computer to the project.

Once the voltage is correct you can plug the computer and printers in and try printing on each printer in turn. If nothing happens at first, try resetting the computer then switch each printer off-line then back on-line and try again. If there is still no action then the handshake lines ACK-BAR, STROBE-BAR or BUSY/READY-BAR may be stuck high or low. If the printers work but the print-out is garbled then one or more data lines could be stuck or perhaps shorted together. Look for solder blobs joining pc board tracks or insufficiently crimped ID connectors. ●





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Here's an incredible opportunity to get the sort of multimeter to suit your needs at virtually unbeatable prices!

Univolt's continuing design and development program has brought two new models to the marketplace and this is the first time the DT-1000 and PD-1800 models have been offered here. The DT-860 was first offered two years ago and, as a sort of 'anniversary deal', Benelec are again offering the DT-860, but this time at a lower price!

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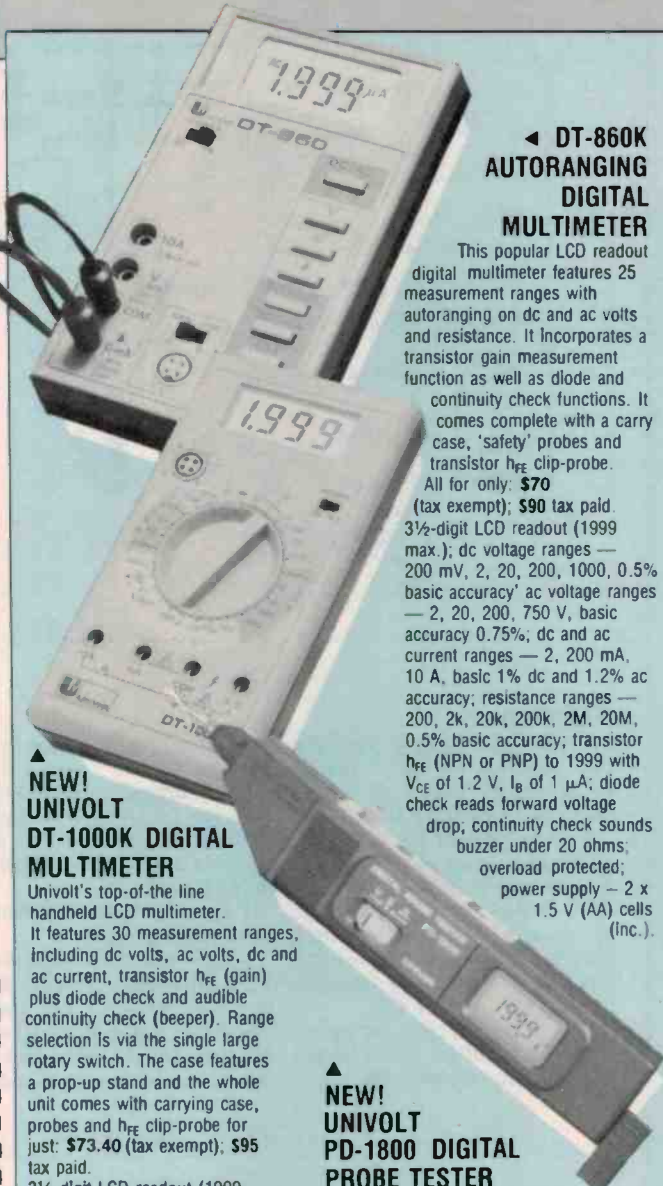

◄ DT-860K AUTORANGING DIGITAL MULTIMETER

This popular LCD readout digital multimeter features 25 measurement ranges with autoranging on dc and ac volts and resistance. It incorporates a transistor gain measurement function as well as diode and continuity check functions. It comes complete with a carry case, 'safety' probes and transistor h_{FE} clip-probe.
All for only: **$70** (tax exempt); **$90** tax paid.
3½-digit LCD readout (1999 max.); dc voltage ranges — 200 mV, 2, 20, 200, 1000, 0.5% basic accuracy' ac voltage ranges — 2, 20, 200, 750 V, basic accuracy 0.75%; dc and ac current ranges — 2, 200 mA, 10 A, basic 1% dc and 1.2% ac accuracy; resistance ranges — 200, 2k, 20k, 200k, 2M, 20M, 0.5% basic accuracy; transistor h_{FE} (NPN or PNP) to 1999 with V_{CE} of 1.2 V, I_B of 1 μA; diode check reads forward voltage drop; continuity check sounds buzzer under 20 ohms; overload protected; power supply – 2 x 1.5 V (AA) cells (inc.).

▲ NEW! UNIVOLT DT-1000K DIGITAL MULTIMETER

Univolt's top-of-the line handheld LCD multimeter. It features 30 measurement ranges, including dc volts, ac volts, dc and ac current, transistor h_{FE} (gain) plus diode check and audible continuity check (beeper). Range selection is via the single large rotary switch. The case features a prop-up stand and the whole unit comes with carrying case, probes and h_{FE} clip-probe for just: **$73.40** (tax exempt); **$95** tax paid.
3½-digit LCD readout (1999 max); dc voltage ranges — 200 mV, 2, 20, 200, 1000 V, 0.5% basic accuracy; ac voltage ranges — as for dc but 750 V on top range, basic 1% accuracy; dc and ac current ranges — 200 μA, 2, 20, 200 mA, 10 A, 1% basic accuracy on dc, 1.2% on ac; input impedance — 10M; resistance ranges — 200, 2k, 20k, 200k, 2M, 20M, 1% basic accuracy; transistor h_{FE} (NPN or PNP) to 1000 with V_{CE} of 2.0 V, I_B of 10 μA; diode check reads forward voltage drop; continuity check sounds buzzer under 20 ohms; overload protected; power supply — 9 V No. 216 battery (inc.).

▲ NEW! UNIVOLT PD-1800 DIGITAL PROBE TESTER

Wow! — a tiny digital volt-ohm-continuity probe with the 3½-digit LCD readout built-in! Great for the toolkit, great for the beach! It features autoranging on volts and ohms as well as autopolarity indication. A beeper sounds in the continuity test mode. There are four dc and ac voltage ranges and four resistance ranges. It measures a tiny 163 mm long, 28 mm high and 19 mm deep! How much? **$50** (tax exempt); **$65** tax paid.

3½-digit LCD readout (1999 max.); ac and dc voltage ranges — 2, 20, 200, 500 V, basic accuracy 0.5% dc, 1% ac; resistance ranges — 2k, 20k, 200k, 2M, basic accuracy 0.7% (in-circuit test capability — uses 0.3 V on ohms range); input impedance — above 10M; power supply — 2 x 1.5 V (LR-44) cells (inc.).

This offer is exclusive to readers of Electronics Today and products can only be obtained by sending in the attached coupon (or a clear photostat or hand-copied facsimile).
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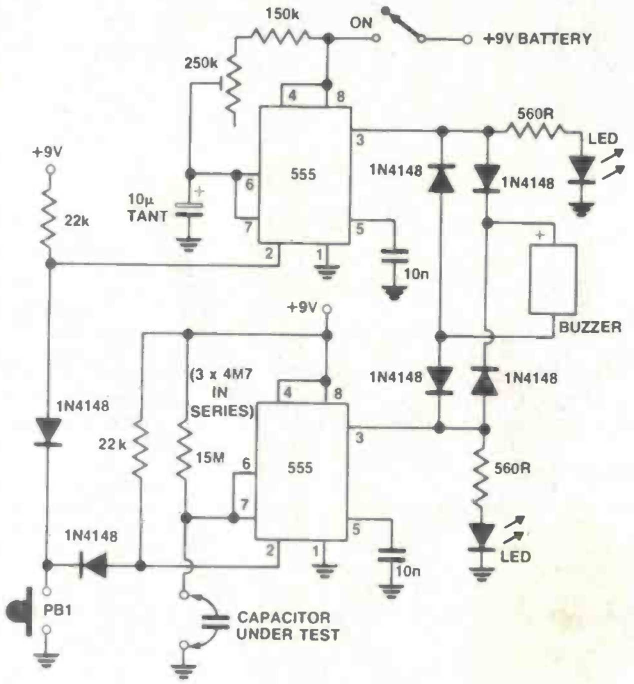


Capacitance tester

A. Glover of Cootamundra NSW 2590 sent us this idea for a simple, ultra low cost capacitance tester. It works by comparing the value of a known capacitor with one under test. The amount of time the voltage on pin 3 of the 555 is high is proportional to the value of the capacitance hanging off pin 6 and 7. In the circuit shown, when the two capacitors are of the same value the LEDs will be on for the same length of time and the buzzer will not sound. Any discrepancy in value will result in one LED being on for longer than the other and the buzzer sounding.

Flasher

M. Howe of Mitcham, Vic used this variation on the common LED flasher theme in which daylight controls the flasher.

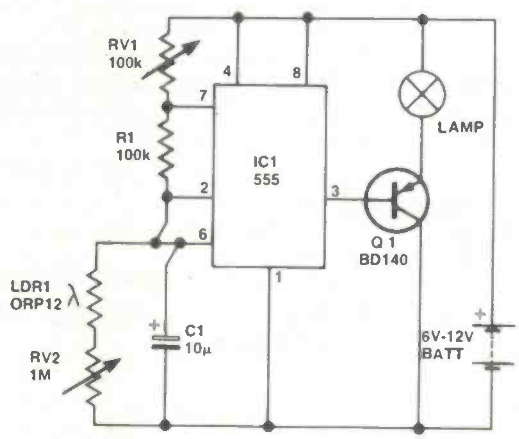
During daylight hours RV2 is adjusted to keep voltage at pins 2 and 6 of IC1 just below 2/3 Vcc. As darkness falls the resistance across the LDR increases until pin 6 sees 2/3 rail voltage and the 555 starts to operate, flashing the light via Q1.

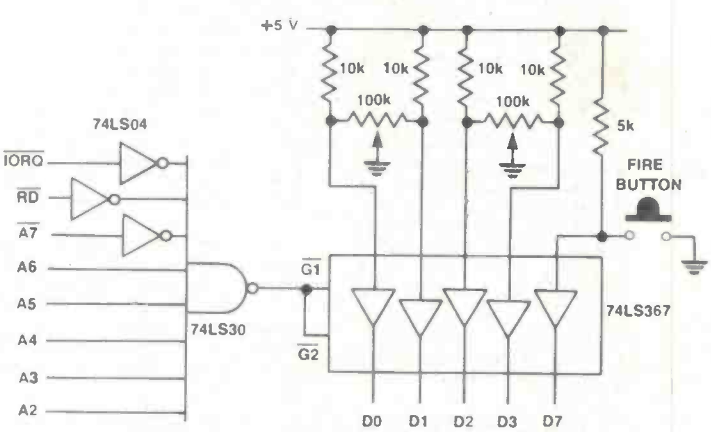
When the sun rises the opposite occurs and C1 is effectively shorted out, stopping the 555.

The prototype, using a 6 V battery, flashes every 1-2 seconds. Current consumption in daylight is 2.4 mA. Operating current depends on the globe used. In daylight RV2 holds pins 2 and 6 at 3.8 V.

I used a BD140 as Q1 because I had a few to spare.

All components except the LDR and light-bulb will fit on a pc board only 25 mm square. The LDR is not affected by the operation of the globe and they can be mounted side by side.





Nine position joystick

This simple circuit was sent to us by **R. Howie of Mansfield Qld.** It should work with any computer running the Z80 processor and equipped with an expansion port. The two joystick pots are used as voltage dividers for the 74LS367. Gating signals are supplied from the computer via the 74LS30. This circuit is cheap and very easy to build.

IDEA OF THE MONTH

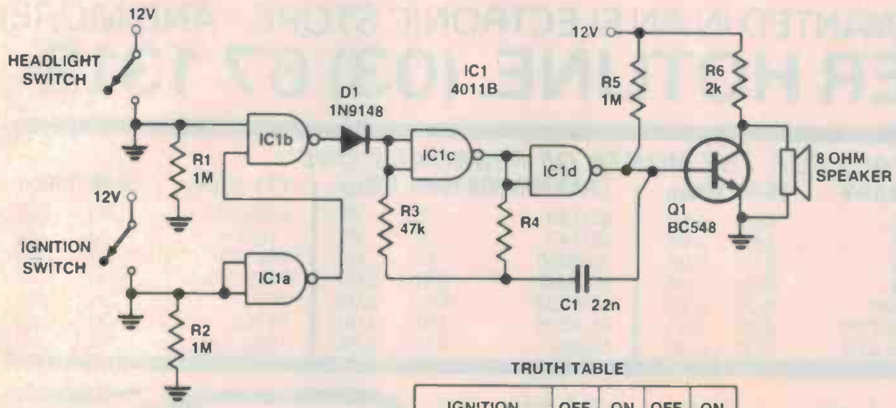
Headlight Warning

Jeff Lefaro, Mulgrave Vic 3170

To help prevent leaving the car lights on after switching off the engine, and thus flattening the battery, a simple circuit such as this one can be implemented.

The circuit consists of an oscillator which can be enabled or frozen with respect to the inputs on IC1b. If both these inputs are high then there will be no current passing through D1 and the oscillator can produce the desired tone.

The frequency output is proportional to R4 and C1, and can be varied to suit, although R4 should not be reduced to less than 5k. The value of C1 should not be changed drastically as the output many become inaudible.



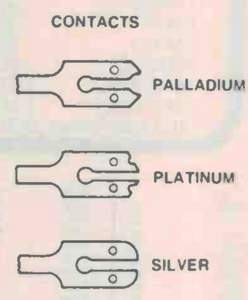
TRUTH TABLE

IGNITION	OFF	ON	OFF	ON
HEADLIGHTS	OFF	OFF	ON	ON
OSCILLATOR	OFF	OFF	ON	OFF

"RELAYS" AGAIN

Contact material

Further to the article which appeared in the February 84 edition of ETI, **Donald Sutherland of Wanganui, NZ** has written to us noting a method of determining the materials of which a contact is made, at least for the BPO 3000 and 600 types. The shape of the spring tips indicates the contact material.



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7407	.80
7409	.60
7410	.55
7411	.70
7412	.70
7413	.55
7414	.75
7416	.80
7417	.80
7420	.60
7421	.80
7423	.90
7425	.90
7426	.70
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7432	.70
7437	.60
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7440	.90
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7448	1.20
7450	.90
7451	.90
7453	.70
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74161	1.20
74162	1.20
74163	1.40
74164	1.20
74165	1.20
74166	1.70
74167	3.20
74174	1.45
74175	1.20
74176	1.40
74177	1.40
74178	2.15
74180	1.20
74182	1.50
74184	4.80
74190	1.50
74191	1.20
74192	1.60
74193	.80
74194	1.10
74195	1.00
74196	1.20
74197	1.10
74198	2.10
74199	2.20
74221	1.90
74251	1.70
74279	1.20
74283	2.45
74290	.90
74293	.90
74298	2.45
74365	1.50
74366	1.50
74367	1.50
74368	1.00

74LS SERIES

74LS00	.35
74LS01	.40
74LS02	.40
74LS03	.40
74LS04	.50
74LS05	.50
74LS08	.40
74LS09	.80
74LS10	.50
74LS11	.80
74LS12	.80
74LS13	.90
74LS14	.50
74LS15	.80
74LS20	.50
74LS21	.90
74LS22	.90
74LS26	.90
74LS27	.50
74LS28	.90
74LS30	.40
74LS32	.40
74LS33	.70
74LS37	.70
74LS38	.80
74LS40	.80
74LS42	.60
74LS47	1.00
74LS48	1.40
74LS49	1.80
74LS51	.70
74LS54	.80
74LS55	.80
74LS73	.60
74LS74	.60
74LS75	.60
74LS76	.85
74LS78	1.10
74LS83	.70
74LS85	.60
74LS86	.80
74LS90	.60
74LS91	.60
74LS92	.60
74LS93	.70
74LS95	1.15
74LS96	1.20
74LS107	.90
74LS109	.90
74LS112	.70
74LS113	.70
74LS114	.80
74LS122	1.30
74LS123	.90
74LS125	.80
74LS126	1.20
74LS132	1.00
74LS133	4.90
74LS136	1.50
74LS138	.80
74LS139	.80
74LS151	1.20
74LS152	1.95
74LS153	1.00
74LS154	2.95
74LS155	1.00
74LS156	1.50
74LS157	1.10
74LS158	1.00
74LS160	1.00
74LS161	.80
74LS162	1.50
74LS163	1.10
74LS164	.90
74LS165	1.00
74LS166	2.55
74LS169	2.45
74LS173	.90
74LS174	.90
74LS175	.80
74LS181	4.00
74LS190	1.50
74LS191	1.20
74LS192	1.20
74LS193	1.20
74LS194	1.20
74LS195	.90
74LS196	.90
74LS197	1.75
74LS221	2.00
74LS240	1.90
74LS241	1.90
74LS242	1.90
74LS243	1.90
74LS244	1.50
74LS245	2.10
74LS247	1.30
74LS248	1.50
74LS249	1.60
74LS251	1.50
74LS253	1.20
74LS257	.70
74LS258	1.20
74LS259	1.50
74LS266	1.20
74LS273	1.95
74LS279	.60
74LS283	1.50
74LS290	1.50
74LS293	1.30
74LS295	1.75
74LS298	1.20
74LS323	6.50
74LS352	2.20
74LS353	2.20
74LS365	1.00
74LS366	1.00
74LS367	.60
74LS368	1.00
74LS373	1.90
74LS374	1.90
74LS375	1.00
74LS377	2.15
74LS378	1.20
74LS379	1.90
74LS386	1.00
74LS390	1.80
74LS393	1.80
74LS393	1.80
74LS395	2.00
74LS447	1.90
74LS490	3.20
74LS629	5.95
74LS640	3.95
74LS670	2.75

74F SERIES

74F00	.75
74F02	.79
74F04	.92
74F08	.79
74F10	.79
74F11	.79
74F20	.79
74F32	.79
74F64	.79
74F74	.89
74F86	1.19
74F109	.98
74F138	1.79
74F139	1.79
74F151	1.79
74F153	1.79
74F157	1.79
74F158	1.79
74F175	2.78
74F181	5.98
74F182	2.73
74F189	7.44
74F190	4.86
74F191	4.86
74F194	2.41
74F241	3.72
74F243	4.34
74F244	3.72
74F251	1.93
74F253	1.93
74F258	1.93
74F350	4.34
74F352	1.93
74F353	1.93
74F373	4.84
74F374	4.84
74F399	2.78
74F521	4.22
74F533	4.84
74F534	4.84

74S SERIES

74S00	.55
74S02	1.00
74S03	1.00
74S04	1.00
74S05	1.50
74S08	1.00
74S10	1.00
74S11	1.00
74S15	1.60
74S20	1.20
74S30	1.00
74S32	1.00
74S40	1.20
74S51	.80
74S64	1.20
74S74	1.30
74S86	1.60
74S109	2.50
74S112	1.30
74S113	1.30
74S132	3.50
74S133	1.20
74S135	2.10
74S138	3.30
74S139	3.30
74S140	1.90
74S151	3.10
74S153	2.00
74S157	3.10
74S158	3.10
74S161	5.90
74S174	4.50
74S188	4.10
74S189	8.50
74S194	3.30
74S241	6.90
74S253	4.90
74S257	3.30
74S258	3.30
74S283	7.90
74S287	4.90
74S288	4.90
74S373	9.90

74C SERIES

74C00	.45
74C02	.60
74C04	.75
74C08	.80
74C10	.80
74C14	.75
74C20	.80
74C30	.80
74C32	.80
74C42	1.90
74C48	2.50
74C73	1.40
74C74	1.70
74C76	1.90
74C83	2.30
74C85	1.95
74C86	1.50
74C89	8.90
74C90	1.90
74C93	1.90
74C95	2.00
74C107	1.20
74C150	6.50
74C151	4.20
74C154	6.00
74C157	3.75
74C160	1.90
74C161	1.90
74C162	2.00
74C163	2.00
74C164	2.50
74C165	2.50
74C173	1.90
74C174	1.90
74C175	1.90
74C192	2.00
74C193	1.80
74C195	2.90
74C200	14.00
74C221	2.75
74C240	3.75
74C244	3.95
74C373	5.75
74C374	5.45
74C901	2.95
74C902	2.50
74C903	2.50
74C904	2.50
74C905	14.50
74C906	2.90
74C907	2.90
74C908	2.75
74C910	13.95
74C911	12.50
74C912	12.50
74C914	4.50
74C915	4.00
74C917	15.50
74C918	2.90
74C920	12.50
74C921	12.50
74C922	7.50
74C923	7.90
74C925	8.90
74C926	7.95
74C928	9.00
74C929	9.50
74C930	6.50
74C932	2.50
74C941	2.50
74C989	8.90

4000 CMOS

4000	.35
4001	.35
4002	.50
4006	1.70
4007	.40
4008	1.20
4009	.80
4010	.90
4011	.40
4012	.40
4013	.60
4014	1.50
4015	1.20
4016	.75
4017	1.20
4018	1.50
4019	.80
4020	1.50
4021	1.50
4022	1.40
4023	.50
4024	1.20
4025	.45
4026	1.90
4027	.75
4028	1.10
4029	1.40
4030	1.10
4031	2.95
4032	2.75
4033	2.75
4034	3.50
4035	1.95
4040	1.20
4041	1.50
4042	1.00
4043	1.60
4044	1.20
4046	1.80
4047	1.20
4048	1.20
4049	.75
4050	.75
4051	1.30
4052	1.50
4053	1.50
4055	3.90
4060	1.80
4063	1.80
4066	1.10
4067	4.95
4068	.45
4069	.75
4070	.80
4071	.40
4072	.80
4073	.80
4075	.60
4076	1.50
4077	.80
4078	.80
4081	.40
4082	.55
4085	1.80
4086	1.80
4089	3.50
4093	.75
4094	2.00
4098	2.10
4099	2.50
4104	5.50
4160	1.25
4161	1.25
4162	1.25
4163	1.25
4174	1.25
4175	1.60
4194	1.95
4411	12.50
4419	3.45
4469	14.50
4495	3.95
4500	8.90
4502	1.80
4503	.90
4507	.40
4508	4.50
4510	1.50
4511	1.00
4512	1.10
4514	2.90
4515	2.90
4516	1.45
4518	1.90
4519	1.90
4520	1.20
4521	3.90
4522	1.90
4526	1.70
4527	2.65
4528	1.90
4529	1.80
4531	1.65
4532	2.65
4534	11.90
4536	6.50
4538	3.50
4539	1.65
4541	1.60
4543	2.50
4553	5.50
4555	1.10
4556	1.25
4558	2.25
4560	3.75
4569	2.50
4572	1.20
4583	1.65
4584	.85
4585	2.10
4599	3.45
4702	5.50
4703	18.50
4723	2.50
4724	1.95
4725	8.90
4731	11.50
40085	1.95
40097	.90
40098	1.95
40106	.75
40160	1.90
40161	1.90
40163	2.00
40174	1.90
40175	1.90
40193	1.80
40194	1.80

HY SPEED CMOS

74HC00	.75
74HC02	1.10
74HC04	1.10
74HC08	1.10
74HC10	1.10
74HC11	1.10
74HC14	1.10
74HC20	1.15
74HC27	1.20
74HC30	1.10
74HC32	1.10
74HC42	2.10
74HC51	1.20
74HC74	1.60
74HC76	2.00
74HC85	3.00
74HC86	1.95
74HC107	1.60
74HC112	1.60
74HC132	2.60
74HC138	2.10
74HC139	2.10
74HC153	2.00
84HC157	3.75
74HC161	2.40
74HC164	2.60
74HC174	2.00
74HC175	2.20
74HC193	3.40
74HC221	3.95
74HC240	3.95
74HC241	3.95
74HC244	3.95
74HC245	3.95
74HC251	1.80
74HC253	2.20
74HC257	1.80
74HC259	3.20
74HC266	1.70
74HC273	3.95
74HC365	1.60
74HC366	1.60
74HC367	1.60
74HC373	5.95
74HC374	5.95
74HC393	2.95
74HC640	4.50
74HC670	3.95
74HC4002	1.10
74HC4017	2.50
74HC4020	2.50
74HC4022	2.20
74HC4024	1.95
74HC4040	2.50
74HC4049	1.95
74HC4051	2.20
74HC4053	2.20
74HC4060	2.50
74HC4066	1.60
74HC4511	2.85
74HC4538	4.50
74HC4543	4.95

MEMORY

2102	2.50
2114	2.75
2708	8.50
2716	6.50
2532	9.50
2732	7.95
2764	11.50
27128	39.50
38E70	45.00
4116	2.95
4164	7.50
6116P3	7.95
6264P15	54.00

6800 SERIES

6800	5.90
6802	6.95
6808	11.50
6809	10.00
6810	3.50
6820	5.40
6821	4.95
6840	6.50
6844	12.80
6845	12.50
6847	5.50
6875	14.95
68B00	9.80
68B02	12.95
68B09	19.80
68B10	7.50
68B21	6.95
68B40	10.50
68B44	45.00
68B45	19.80
68B50	7.95

Z80 SERIES

Z80A CPU	4.95
Z80A PIO	4.50
Z80A CTC	5.40
Z80A SIO	12.95
Z80A DMA	15.50
Z80B CPU	11.50
Z80B PIO	11.20
Z80B CTC	12.00
Z80B SIO	25.00
Z80B DART	25.00

LINEAR AND SPECIAL FUNCTION

LH0002N	14.95
LH0042CH	11.95
LH0070H	15.80
LH0071H	19.50
TL061	1.50
TL062	2.90
TL071	1.20
TL072	1.45
TL074	3.25
TL081	1.50
TL082	1.50
TL084	2.50
ADC0800 LCN	22.50
ADC0808 LCN	6.50
DAC080	4.50
DAC0808	4.50
MO9381	25.00
LMIOCH	7.50
MC10116	1.50
TDA1170	4.95
TDA1180	6.50
11C90	15.50
L120A	4.50
L121	4.50
DAC1220LCW	14.95
LM13600	3.50
LF13741N	.80
SAK140	9.50
MC1310	9.50
MC1350	1.95
MC1408	7.50
MC1445	5.95
MC1456	1.95
MC1458	.75
MC1466	14.50
LM1488	.95
LM1489	.95
MC1494	8.40
MC1495	8.90
MC1496	2.50
TR1602	8.50
WD1691	29.50
VAA170	5.95
FD1771	19.00
FD1791	39.00
FD1793	39.00
FD1795	39.00
FD1797	39.00
UAA180	3.75
LM1830	3.90
TR1863	8.90
LM1886	7.50
LM1889	6.50
ULN2001	1.65
ULN2002	2.80
ULN2003	1.50

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ULN2004	1.80
WD2143	14.50
TCA220	7.90
TDA2020	5.50
TDA2030	5.50
XR2206	7.95
XR2207	7.95
XR2209	6.90
XR2211	7.45
XR2216	5.90
XR2243	7.95
M2560ABI	9.90
2651	23.00
WD2791	54.00
WD2793	59.00
WD2795	59.00
WD2797	59.00
TDA2822	7.50
LM2917-8	4.90
LM2917-14	4.90
L296	9.50
L297	12.00
L298	9.50
AY-3-10150	7.50
AY-3-8910	14.50
MN3001	17.50
LM301AN	.50
LM301AHC	1.50
LM307N	.95
LM307H	1.50
LM3028	2.00
CA3046	1.90
CA3059	5.95
LM3080	1.90
UA3086	1.85
UA3089	3.90
UA308TC	.90
UA308ATC	2.50
UA308HC	1.70
UA308AHC	3.80
LM310N	3.20
LM311N	.90
LM311H	1.75
LM318N	4.50
LM319N	4.90
CA3130E	2.10
CA3130T	2.90
CA3140E	1.25
CA3140T	2.50
OM321	15.00
LM324	.80
LM325	4.50
LM329DZ	.90
LM334Z	1.90
MC3340	1.85
LM335Z	2.20
OM335	22.00
LM336Z-2-5V	2.80
LM339N	1.10
LM339AN	1.40
LM3401	1.00
LF347	3.20
MC3470	12.50
LM348	1.80
LM349N	1.60
OM350	10.50
LF351N	1.00
LF353N	1.80
LF356N	2.40
LF357N	2.40
LM358N	1.20
LM377	4.90
LM378	3.95
LM380-8	1.75
LM380-14	1.90
MC3340	1.85
LM381	2.70
LM382	2.50
LM383	3.50
LM384	3.50
LM386	1.80
LM387	2.00
LM388	1.80
LM389	2.00
LM3900	1.20
LM3905	1.75
LM3909	1.95
LM3911	2.90
LM3914	4.95
LM3915	5.50
LM3916	5.50
LM391	280
LM393	1.00
LM394	4.95
LF398N	5.50
UA4136	1.85
ZN414	1.95
LM4250	3.50
L465	12.50
MM5303	750
MM5309	13.95
MM5369	2.95
NE5534N	1.95
NE5534AN	2.95
NE555	.40
NE556	100
NE558	4.95
NE565	1.60
NE566	2.75
NE567	1.95
NE571	5.50
MM58167	14.95
MM58174	14.95
MSM5832	15.50

6502	12.50
6502A	13.50
6505	13.00
6507	13.00
6520	5.40
6522	12.50
6522A	12.95
6532	13.50
6545	18.95
6551	12.90
LM709	1.30
UA710	1.00
ICL7106	11.95
ICM 7127A	18.50
LM711N	1.10
LM711H	140
UA733	1.50
Ua739	2.50
LM741N	.40
LM741H	1.20
UA747	1.30
UA748	1.00
75107	2.20
75110	2.20
75150	2.20
75154	2.20
75451	.90
75452	.90
75453	.90
75461	640
75462	1.50
75491	1.90
75492	1.90
M751 BI	9.50
ICM 7555	2.75
ICM 7556	2.95
M7618	12.50
SN76488	8.95
8035	6.90
8038	650
8039	7.90
8060	19.80
8080	800
8085	9.50
8121	1.70
8130	5.90
8131	5.90
8136	5.90
81LS 95	295
81LS 96	350
8ILS 97	350
8ILS98	350
8155	650
8156	10.50
8292	3.50
8212	2.90
8214	4.90
8216	2.90
8224	350
8226	450
8228	540
8238	950
8243	7.95
8251	4.90
8253	7.50
8255	5.50
8257	12.95
8259	6.50
8279	8.50
8303	4.95
8304	5.50
8741	55.00
8748	65.00
8749	58.00
8755	33.00
8T26	2.95
8T26	2.95
8T28	2.95
8T97	1.80
95H90	8.50
REGULATORS	
7805 UC	.80
7806 UC	1.00
7808 UC	1.00
7810 UC	1.20
7812 UC	1.15
7815 UC	1.15
7818 UC	1.20
7824 UC	1.20
7905 UC	1.45
7906 UC	1.95
7908 UC	1.95
7912 UC	1.45
7915 UC	1.45
7805 KC	2.20
7808 KC	2.20
7812 KC	2.20
7815 KC	2.20
7818 KC	2.20
7824 KC	2.20
7905 KC	2.50
7908 KC	2.50
7912 KC	2.50
7915 KC	2.50
78L05	.50
78L09	.50
78L12	.50
78L15	.75
79L05	1.20
79L12	1.20
79L15	1.20
78505K	4.50
78512K	4.50

78505 UC	2.50
78512 UC	2.50
LM309K	1.90
LM317T	1.65
LM317K	3.50
LM317HUK	9.50
LM323K	6.50
LM337T	2.80
LM337K	6.35
LM338K	9.50
LM350T	4.95
LM350K	7.25
LM396K	18.95
UA494	4.50
LM723N	.75
LM723H	1.50
78H05KC	8.95
78H12KC	8.95
78HGKC	9.40
79HGKC	15.50
78P05KC	15.95
78540	3.30
SH1605	19.08
OPTO	
4N26	1.15
4N28	1.20
4N33	1.50
4N35	1.50
MCT6	2.50
MCT2	1.50
6N137	9.80
AD12	1.40
BPW34	3.00
BPW50	2.20
CQY89	1.20
FPT100B	3.50
FND500	1.80
L320R 3mmLED	.14
L320G 3mmLED	.20
L320Y 3mm LED	.22
L520R 5mmLED	.14
L520G 5mm LED	.20
L520Y 5mm LED	.22
LT302	1.80
LT303	1.80
MAN72A	2.50
MAN74A	2.50
MOC3011	2.95
MOC3020	2.50
MOC3012	2.95
ORP12	2.80
TIL31A	2.95
TIL81A	2.95
TIL111	2.50
TIL116	2.50
TLR113A 5mm LED SGS	.20
TLG113A 5mm LED SGS	.25
TLY113A 5mm LED SGS	.30
TLO113A 5mm LED SGS	.30
TLR 123 3mm LED SGS	.20
TLG123 3mm LED SGS	.20
TLY123 3mm LED SGS	.30
TLO123 3mm LED SGS	.30
LC5M 5mm LED CLIP	.05
LC3M 3mm LED CLIP	.05
CBR05 LED CHROME BEZZEL	1.20
CBG05 LED CHROME BEZZEL	1.20
CBY05 LED CHROME BEZZEL	1.20
Z0157 LED WATER CLEAR	.10
Z0160 RECT. LEC. RED	.22
Z0162 RECT LEO BRN.	.23
Z0164 RECT. LED YEL.	.24
DIODES	
IN4002	.10
IN4004	.12
IN4007	.14
IN4148	.08
IN5404	.30
IN5408	.36
OA47	.45
OA90	.30
OA91	.30

OA95	.30
OA202	1.30
BA102	1.10
BAW62	.25
BYU96E	.85
BY255	
1300V. 3A.	1.10
P600G GAMP	.60
IN3492 25A STUD	2.80
IN3492 R 25A STUD	2.80
BRIDGES	
BRW02 1.5 AMP	.40
BRW04 1.5 AMP	.50
DB04	1.20
SB204 2 AMP	1.10
RS 204 INLINE	1.20
RS404 INLINE	2.10
BR34 3 AMP	1.40
BR64 6 AMP	1.80
BR104 10 AMP	2.50
BR154 15 AMP	3.50
BR254 25 AMP	4.00
BR354 35 AMP	4.95
TRANSISTORS	
AC126	1.20
AC127	1.20
AC128	1.20
AC187	1.50
AC188	1.45
AD149	3.00
AD161	1.75
AD162	1.75
BC107	.40
BC107B	.45
BC108	.40
BC108B	.42
BC108C	.45
BC109	.40
BC109C	.45
BC177B	.50
BC178A	.50
BC179	.50
BC182	.40
BC212	.30
BC317B	.35
BC308	.30
BC327B	20
BC328	.20
BC337B	.25
BC338	.25
BC546B	
BC547C	.17
BC548C	.17
BC549C	.17
BC550C	.16
BC556B	.17
BC557B	.17
BC558B	.17
BC559B	.17
BC560B	.17
BC639	.45
BC640	.45
BCY70	1.20
BCY71	1.20
BD115	4.50
BD135	.55
BD136	.55
BD137	.55
BD138	.55
BD139	.55
BD140	.55
BD181	2.00
BD182	2.40
BD233	.85
BD234	.85
BD235	.85
BD236	.85
BD237	.85
BD238	.85
BD262	1.20
BD263	1.20
BD435	1.00
BD437	1.00
BD438	1.00
BD439	1.00
BD647	1.80
BD649	1.80
BD675	1.80
BD676	1.80
BD677	1.80
BD678	1.80
BD679	1.80
BD681	1.60
BD682	1.60
BDV64B	3.80
BDV65B	3.80
BF115	.95
BF167	1.10
BF173	.95
BF180	1.20
BF184	.60

BF198	.40
BF199	.40
BF337	1.20
BF458	.95
BF459	1.00
BF469	1.15
BF470	1.15
BF494	.60
BFY50	1.00
BFY90	1.50
BU126	2.50
BU208A	4.50
BU326A	3.50
BU406D	2.95
BU407D	2.50
BU426	3.50
BUX10	14.95
BUX80	4.25
BUY185	9.50
BUY48	4.95
BUY69A	8.50
MEL12	.95
MFE131	2.40
MJ1001	3.50
MJ15003	6.50
MJ15004	6.50
MJ2500	2.95
MJ2955	1.40
MJ3000	6.00
MJ4032	8.50
MJ4035	8.50
MJ413	6.50
MJ5402	6.50
MJ802	6.80
MJE 13005	2.95
MJE 13007	2.95
MJE 2955T	1.40
MJE 2955	2.50
MJE 3055T	1.45
MJE 3055	3.00
MJE 340	1.20
MJE 350	2.20
MJE 520	1.50
MJE 521	1.80
MJE 700	1.40
MJE 800	1.40
MPS A05	.60
MPS A06	.60
MPSA12	.60
MPSA13	.80
MPSA14	.80
MPSA42	.75
MPSA56	.80
MPSA64	1.20
MPSA70	.60
MPSA92	.80
MPSA93	.80
MPF102	.90
MPF105	.90
MPSL01	.65
MRF237	5.90
MRF 245	53.00
MRF454	52.00
MRF475	7.70
MRF901	3.75
TIP110	1.40
TIP112	1.40
TIP115	1.40
TIP117	1.40
TIP 120	1.40
TIP122	1.40
TIP122	1.40
TIP126	1.40
TIP127	1.40
TIP132	1.40
TIP137	1.40
TIP2955	1.50
TIP3055	1.50
TIP29A	.65
TIP29C	.70
TIP30C	.65
TIP31	.70
TIP31C	.70
TIP32	.75
TIP32C	.75
TIP34A	1.80
TIP34A	1.80
TIP41	1.30
TIP41C	1.35
TIP42A	1.30
TIP42C	1.35
2N1304	3.50
2N1306	4.80
2N1309	4.95
2N1613	1.00
2N22118A	.75
2N2219A	.85
2N2221A	1.00
2N2222A	.75
2N2369A	.85
2N2484	.80
2N2646	.95
2N2647	2.50
2N2894	1.00
2N2904A	.95
2N2905A	.95
2N2906A	.95
2N2907A	.95
2N301	4.00
2N3019	1.00
2N3053	.90
2N3054	1.90
2N3055	.95
2N3107	1.50

2N3110	.95
2N3440	1.50
2N3441	2.90
2N3442	3.40
2N3563	.30
2N3565	.30
2N3566	.30
2N3567	.30
2N3568	.30
2N3569	.30
2N3638	.30
2N3639	.30
2N3640	.30
2N3641	.30
2N3642	.30
2N3643	.30
2N3644	.30
2N3645	.30
2N3646	.30
2N3694	.30
2N3704	.60
2N3771	5.50
2N3772	5.70
2N3773	5.90
2N3819	1.10
2N3866	2.20
2N3904	.50
2N3906	.50
2N4030	1.40
2N4032	1.95
2N4033	1.95
2N4036	1.50
2N4121	.50
2N4124	1.00
2N4233	4.50
2N4236	1.90
2N4237	1.90
2N4248	.35
2N4249	.35
2N4250	.35
2N4258	.40
2N4355	.45
2N4356	.45
2N4401	.30
2N4402	.30
2N4403	.30
2N4427	2.50
2N5088	.90
2N5089	.90
2N5179	1.20
2N5190	1.95
2N5191	1.80
2N5192	1.80
2N5193	1.80
2N5195	1.80
2N5210	1.20
2N5245	1.20
2N5303	6.50
2N5401	.95
2N5457	.95
2N5458	.85
2N5459	.90
2N5461	.90
2N5485	.90
2N5486	.90
2N5590	16.50
2N5591	18.50
2N5770	.30
2N5777	1.50
2N5830	.30
2N5831	.30
2N5873	1.40
2N5874	1.70
2N5944	15.50
2N5944	15.50
2N5946	19.50
2N5961	1.20
2N6027	.95
2N6028	1.00
2N6080	18.50
2N6083	21.90
2N6084	32.00
2N6122	1.00
2N6123	1.00
2N6124	1.00
2N6125	1.20
2N6126	1.50
2N6129	1.50
2N6130	1.50
2N6131	1.50
2N6133	1.50
2N697	1.00
2N918	1.00
2SC1061	1.50
2SD325	2.95
2SD 350A	5.00
2SD353	5.95
2SJ49	5.90
2SK134	5.90
SCR's	
C103D	.85
C106D	.90
C122D	1.60
C122E	1.65
C220D	6.50
TRIACS	
SC141D	1.45
SC1460	2.50
SC151D	2.85
SC260D	7.95

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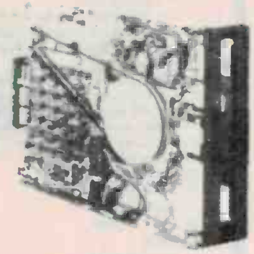

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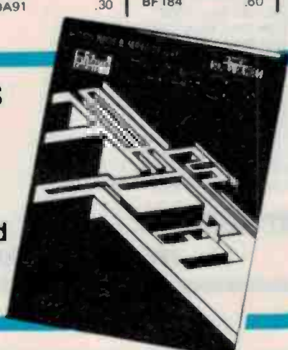

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STEREO UNITS
S1 ETI 484 Compressor Expander
S2 ETI 482 50 watt per channel Amplifier
S3 ETI 482A Preamp Board
S4 ETI 482B Tone Control Board
S5 ETI 485 Graphic Equalizer
S6 ETI 480 50 watt Amplifier
S7 ETI 480 100 watt Amplifier
S9 ETI 443 Expander Compressor
S10 ETI 444 Five watt stereo
S12 ETI 438 Audio Level Meter
S13 ETI 440 25 watt Stereo Amplifier including metalwork
S18 ETI 426 Rumble Filter
S19 ETI 429 Simple Stereo Amplifier
S21 ETI 417 Over led Distortion Monitor
S35 ETI 470 60 watt audio amplifier module
S36 ETI 4000 Series 60 watt stereo amplifier
S37 ETI 451 Hum Filter for Hi-Fi systems
S38 E.A. Stereo Infrared Remote Switch
S39 ETI 455 Stereo Loudspeaker Protector
S40 E.A. Super-Bass Filter
S42 E.A. Stylus Timer
S43 ETI 3000 Series Amplifier 25 w/ch
S44 ETI 477 Mosfet power amp module inc. brackets
S45 ETI 457 Scratch/Rumble Filter
S46 ETI 458 VU Level Meter
S47 ETI 479 Bridging Adaptor
S48 ETI 5000 Series Power Amplifier
S49 ETI 494 Loudspeaker Protector
S50 EA Infrared TV Sound Control
S51 HE 121 Scratch & Hiss Filter
S52 EA 100W Sub Woofer Module
S53 EA Stereo Simulator
S54 EA Headphone Amp.
S55 ETI 412 Peak Display

STAGE
ST1 ETI 592 Light Show Controller (3 ch.) (1000 w/ch)
ST2 ETI 593 Colour Sequencer (for use with ETI 592)
ST3 ETI 551 Light Chaser 3 ch. 1000 w/ch
ST4 E.A. Light Chaser 3 channel
ST5 E.A. Twin Tremolo for Organs/Stage Amps
ST7 ETI 499 150 w Mosfet P.A. Module
ST8 ETI 498/499 150 w Public Address Amplifier
ST9 E.A. Musicolor IV
ST10 EA Musicolour III

PRE-AMPLIFIER AND MIXERS
P1 ETI 445 Stereo Pre-amplifier
P2 ETI 449 Balance Mic Pre-amplifier
P6 ETI 419 Mixer Pre-amplifier — 4 ch.
Mixer Pre-amplifier — 2 ch.
P10 E.A. Playmaster 145 Mixer
P11 ETI 446 Audio Limiter
P12 ETI 471 High Performance Stereo Pre-amplifier — less F/P & Backing Plate
P13 ETI 473 Moving Coil Cartridge Pre-Amp
P14 ETI 474 High to low Impedence Interface
P15 ETI 467 4 Input Guitar/Mic. Pre-amp suits ETI 466 — includes power supply
P16 E.A. Moving Coil Pre-Amplifier (Battery)
P17 E.A. Moving Coil Pre-Amplifier (Plug pack)
P18 ETI 478 MM Moving Magnet Pre-amp (Series 5000)
P19 ETI 478MC Moving Coil Pre-amp (Series 5000)
P20 ETI 478 Series 5000 Pre-Amplifier
P21 E.A. Vocal Cancellor
P22 ETI 416 Balanced Preamplifier
P23 HE 112 Micromixer
P24 EA Effects Unit
P25 EA Stereo Simulator

GUITAR UNITS
G1 ETI 447 Audio Phaser
G2 ETI 413 2-100W Bridge Amp.
G5 ETI 413 100 watt Guitar Amplifier
G14 ETI 452 Guitar Practice Amplifier
G15 ETI 466 300 watt Amp module
G16 ETI 454 Fuzz Sustain
G17 HE 102 Guitar Phaser
G18 ETI 450A Bucket Brigade
G19 ETI 450B Mixer for above
G20 E.A. guitar Pre-amplifier
G21 Sonics ME2 Sonics ME2 Wah Wah Pedal-less pedal

AUDIO TEST UNITS
AT1 ETI 441 Audio Noise Generator
AT2 ETI 128 Audio Millivolt Meter
AT4 ETI 102 Audio Signal Generator
AT5 E.A. A.F. Tone Burst Generator
AT7 ETI 137 Audio Oscillator
AT9 HE 105 Bench Amplifier
AT10 E.A. Audio Test Unit
AT11 E.A. Function Generator
AT12 ETI 464 Audio Test Unit

TIMERS
T1 ETI 650 STAC Timer
T2 ETI 564 Digital Wall Clock
T3 E.A. Universal Timer and Stopwatch
T4 ETI 540 Universal Timer
T5 ETI 265 Power Down
T6 EA 4 Digit L.C.D. Clock or Control Timer
T7 EA Event Counter

COMMUNICATION EQUIPMENT
CE1 ETI 711 Remote Control Transmitter Switch
CE2 ETI 711R Remote Control Receiver
CE3 ETI 711D Remote Control Decoder
CE4 ETI 711B Single Control
CE5 Double Control
CE6 ETI 711P Power Supply
CE7 ETI 707A 144 Mhz Converter
CE8 ETI 707B 52 Mhz Converter
CE9 ETI 708 Active Antenna
CE11 ETI 780 Novice Transmitter
CE12 ETI 703 Antenna Matching Unit
CE29 E.A. Short Wave Converter for 27 Mhz
CE31 E.A. 27 Mhz Pre-amp
CE32 E.A. 10-30 Mhz Pre-amp
CE33 ETI 718 Shortwave Radio
CE34 ETI 490 Audio Compressor
CE35 ETI 721 Aircraft Band Converter (less XTALS)
CE36 ETI 726 or 10 metre Power Amp
CE37 ETI 475 Wide Band A.M. Tuner
CE38 E.A. Masthead Pre-amplifier
CE39 ETI 731 R.T.T.Y. Modulator
CE40 ETI 729 UHF TV Masthead Preamp.
CE41 ETI 735 UHF to VHF TV Converter
CE42 HE 104 AM Tuner
CE43 HE 106 Radio Microphone
CE44 E.A. R.T.T.Y. Demodulator
CE45 E.A. Voice Operator Relay
CE46 ETI 733 RTTY Converter for Microbee
CE47 ETI 1517 Video Distribution Amp.
CE48 EA Video Enhancer
CE49 Wideband Amp.
CE50 ETI 1518 Video Enhancer
CE51 EA VCR Sound Processor

METAL DETECTORS
MD1 ETI 549 Induction Balance Metal Detector
MD2 ETI 561 Metal Locator
MD3 ETI 1500 Discriminating Metal Locator (undrilled case)
MD4 ETI 1500 Discriminating Metal Locator (predrilled case)
MD5 ETI 562 Geiger Counter with ZP 1310 Tube
MD6 ETI 566 Pipe and Cable Locator
MD7 E.A. Prospector Metal Locator including headphones

TEST EQUIPMENT
TE2 ETI 133 Phase Meter
TE4 ETI 129 R.F. Signal Generator
TE6 ETI 706 Marker Generator
TE8 ETI 122 Logic Tester
TE9 ETI 124 Tone Burst Generator
TE11 ETI 116 Impedance Meter
TE12 ETI 533 Digital Display
TE15 ETI 704 Cross Hatch Dot Generator
TE16 ETI 120 Logic Probe
TE17 ETI 121 Logic Pulser
TE34 ETI 487 Real Time Audio Analyser
TE35 ETI 483 Sound Level Meter
TE36 ETI 489 Real Time Audio Analyser
TE37 ETI 717 Cross Hatch Generators
TE38 E.A. 3 Mhz Frequency Counter
TE42 E.A. Transistor Tester incl. BiPolar & F.E.T.S.
TE43 ETI 591 Up Down Pre-setable Counter
TE44 ETI 550 Digital dial (less case) includes ETI 591
TE45 ETI 144 Expanded Scale R.M.S. Voltmeter
TE46 ETI 148 Versatile Logic Probe
TE47 ETI 724 Microwave Oven Leak Detector
TE48 ETI 150 Simple Analog Frequency Meter
TE49 ETI 151 Linear Scale Ohm Meter
TE50 ETI 152 Linear Scale Capacitance Meter
TE51 E.A. Digital Capacitance Meter
TE52 ETI 589 Digital Temp. Meter
TE53 E.A. T.V. C.R.O. Adaptor
TE54 E.A. XTAL Locked Pattern Generator
TE55 E.A. Decade Resistance Sub Box
TE56 E.A. Capacitance Sub Box
TE57 E.A. Decade Capacitance Sub Box
TE58 E.A. Tantalum Capacitance Sub Box
TE59 ETI 140 1 Ghz Frequency Meter/Timer
TE60 ETI 572 PH Meter
TE61 ETI 135 Panel Meter
TE62 E.A. Modulated Signal Injector
TE63 HE 103 Transistor Tester
TE64 HE 111 Ohm meter
TE65 ETI 157 Crystal Marker
TE66 ETI 161 Digital Panel Meter
TE67 ETI 255 Analog Thermometer
TE68 EA Transistor Tester
TE69 ETI 175 20 MHz Dig. Frequency Meter (Hand held)
TE70 ETI 166 Function Pulse Generator
TE71 X-tal Locked Pattern Generator

MODEL TRAIN UNITS (see also "SOUND EFFECTS")
MT1 ETI 541 Model Train Control
MT2 E.A. 1974 Model Train Control
MT6 E.A. 1978 Train Control less Front Panel
1978 Train Control with Front Panel

SOUND EFFECTS
SE1 E.A. Sound Effects Generator*
SE2 E.A. Musical Tone Generator
SE3 E.A. Cylon Voice
SE4 E.A. Steam Whistle
SE5 ETI 607 Sound Effects
SE6 E.A. 492 Audio Sound Bender
SE7 E.A. Electronic Sea Shell Sound Effects
SE8 ETI 469A Percussion Synthesiser
SE9 ETI 469B Sequencer for Synthesiser
SE10 EA Effects Unit
* set as for Steam Train and Prop Plane noise

VOLTAGE/CURRENT CONTROLS
V1 ETI 481 12 volt to ± 40v D.C. 100 watt Inverter
V2 ETI 525 Drill Speed Controller
V6 E.A. 1976 Speed Control
V10 E.A. Zero-voltage switching heat controller
V11 E.A. Inverter 12v D.C. Input 230v 50 hz 300VA output not incl. switch 35 amp.
V12 ETI 1505 Flourescent Light Inverter
V13 EA Electric Fence
V14 ETI 1506 Xenon Push Bike Flasher
V15 ETI 1509 DC-DC Inverter
V16 ETI 1512 Electric Fence Tester
V17 EA Fluro Light Starter
V18 ETI 1524 Electronic Mouse Trap

WARNING SYSTEMS
WS1 ETI 583 Gas Alarm
WS3 ETI 528 Home Burglar Alarm
WS4 ETI 702 Radar Intruder Alarm
WS7 ETI 313 Car Alarm
WS12 ETI 582 House Alarm
WS14 E.A. 1976 Car Alarm
WS15 E.A. 10 Ghz Radar Alarm
WS16 E.A. Light Beam Relay
WS17 ETI 247 Soil Moisture Indicator
WS18 ETI 250 Simple House Alarm
WS19 ETI 570 Infrared 'Trip' Relay
WS20 ETI 585 T&R Ultrasonic Switch
WS21 ETI 330 Car Alarm
WS22 ETI 322 Over Rev Car Alarm incl. case
WS24 ETI 1506 Xenon Bike Flasher
WS25 ETI 340 Car Alarm
WS26 EA Deluxe Car Alarm
WS27 EA Ultrasonic Movement Detector

PHOTOGRAPHIC
PH1 ETI 586 Shutter Speed Timer
PH3 ETI 514B Sound Light Flash Trigger
PH4 ETI 532 Photo Timer
PH7 ETI 513 Tape Slide Synchronizer
PH12 ETI Sync-a-Slide
PH14 ETI 558 Mast Head Strobe
PH15 ETI 553 Tape Slide Synchronizer
PH16 E.A. Digital Photo Timer
PH17 ETI 594 Development Timer
PH18 ETI 568 Sound or light operated Flash Trigger including optional parts
PH19 E.A. Sound Triggered Photoflash
PH20 HE 109 Extra Flash Trigger
PH21 E.A. Photographic Timer

POWER SUPPLIES
PS1 ETI 132 Experimenters Power Supply
PS2 ETI 581 Dual Power Supply
PS3 ETI 712 CB Power Supply
PS4 ETI 131 Power Supply
PS6 ETI 105 Laboratory Power Supply
PS7 ETI 111 I/C Power Supply
PS9 E.A. 1976 Regulated Power Supply
PS11 E.A. C.B. Power Supply
PS12 ETI 142 Power Supply 0-30 V 0-15 A (fully protected)
PS13 ETI 472 Power Supply
PS14 E.A. Power Supply for Dream 6800
PS15 ETI 577 Dual 12V supply
PS16 E.A. Power Saver
PS17 ETI 480 PS Power Supply for ETI 480 (100 watt Amp.)
PS18 E.A. Bench Mate Utility Amplifier/Power Supply
PS19 HE 108 Power Supply
PS20 ETI 163 0-40 V. 0-5 A
PS21 EA Dual Tracking Power Supply

COMPUTER AND DIGITAL UNITS
C1 ETI 633 Video Synch Board*
C2 ETI 632M Part 1 Memory Board V.D.U.*
C3 ETI 632P Part 1 Power Supply V.D.U.*
C4 ETI 632A Part 2 Control Logic V.D.U.*
C5 ETI 632B Part 2 Control Logic V.D.U.*
C6 ETI 632C Part 2 Character Generator V.D.U.*
C8 ETI 632 U.A.R.T. Board*
C9 ETI 631-2 Keyboard Encoder*
C10 ETI 631 A/Sch. Keyboard Encoder
C14 ETI 638 Eprom Programmer
C15 ETI 637 Cuts Cassette Interface
C16 ETI 651 Binary to Hex Number Converter
C17 ETI 730 Getting Going on Radio Tele Type
C22 ETI 660 Basic Computer
C23 ETI 660 Basic Computer incl. colour option on board expandable memory, RF modulator, case and power supply
C24 ETI 760 Video RF Modulator
C25 E.A. Eprom Programmer
C26 ETI 668 Microbee Eprom Programmer
C27 ETI 733 RTTY Computer Decoder
C28 EA Video Amp for Computers
C29 ETI 649 Microbee Light Pen
C30 ETI 675 Microbee Serial — Parallel Interface
C31 ETI 688 Programmer for Fusable — Link Bipolar Proms
C32 ETI 676 RS232 for Microbee
* all V.D.U. projects priced less connectors

BIO FEEDBACK
BF1 ETI 546 G.S.R. Monitor (less probes)
BF2 ETI 544 Heart Rate Monitor
BF3 ETI 576 Electromyogram

AUTOMOTIVE UNITS
A1 ETI 317 Rev. Monitor
A2 ETI 081 Tachometer
A3 ETI 316 Transistor Assisted Ignition
A4 ETI 240 High Power Emergency Flasher
A6 ETI 312 Electronic Ignition System
A7 ETI 301 Vari-Wiper
A14 E.A. Dwell Meter
A15 E.A. Variwiper
A16 E.A. Tacho for Tune-ups
A17 E.A. Ignition Analyser and Tachometer
A18 E.A. Strobe Adaptor for Ignition Analyser
A19 E.A. 1975 C.D.I. Capacitor discharge Ignition
A22 ETI 318 Digital Car Tachometer
A23 ETI 319A Variwiper Mk. 2 (no dynamic Braking)
A24 ETI 319B Variwiper Mk. 2 (for dynamic braking)
A25 ETI 555 Light Activated Tacho
A26 ETI 320 Battery Condition Indicator
A27 E.A. Transistor Assisted Ignition
A28 ETI 324 Twin Range Tacho less case
A29 ETI 328 Led Oil Temp Meter less V.D.O. probe
A30 ETI 321 Auto Fuel Level Alarm
A31 ETI 332 Stethoscope
A32 ETI 325 Auto Probe Tests Vehicle Electricals
A33 ETI 333 Reversing Alarm
A34 E.A. Low fuel indicator
A35 ETI 326 Led Edpanded Voltmeter
A36 ETI 329 Ammeter (expanded scale)
A37 ETI 327 Turn and Hazard Indicator
A38 ETI 159 Expanded Scale Voltmeter
A39 EA Optoelectronic Ignition
A40 ETI 335 Wiper Controller
A41 EA Ignition Killer for Cars
A42 EA L.C.D. Car Clock
A43 EA Cruise Control
A44 ETI 337 Automatic Car Aerial Controller

ELECTRONIC GAMES
EG1 ETI 043 Heads and Tails
EG2 ETI 068 L.E.D. Dice Circuit
EG3 E.A. Electronic Roulette Wheel
EG4 ETI 557 Reaction Timer
EG5 ETI 814 Dinky Die
EG6 E.A. Selectalott
EG7 HE 107 Electronic Dice
EG8 E.A. Photon Torpedo
EG9 HE 123 Alien Invaders
EG10 EA Roulette Wheel

MISCELLANEOUS KITS
M1 ETI 604 Accentuated Beat Metronome
M4 ETI 547 Telephone Bell Extender
M5 ETI 602 Mini Organ (less case)
M7 ETI 044 Two Tone Doorbell
M10 ETI 539 Touch Switch
M25 E.A. Digital Metronome
M37 ETI 249 Combination lock (less lock)
M39 E.A. Electronic Combination lock (including lock)
M46 E.A. Power Saver for induction motors
M48 E.A. Lissajous Pattern Generator
M53 ETI Soil Moisture Alarm
M54 E.A. Electrochune Keyless Organ
M55 E.A. Pools/Lotto Selector
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COMPUTERISED CIRCUIT ANALYSIS

Designing amplifier circuits? This article shows how to design programs to take the sweat and guesswork out of the operation.

Lance Wilson
Jon Fairall

MOST READERS of this magazine will, sooner or later, find themselves in a position where they have to design basic amplifier circuits. This need not be a tedious and time-consuming task if you develop some of the ideas presented in this article. We have included a demonstration program for the sake of interest, but the object of this exercise is to show you how to go about the problem of designing with a computer. You can write your own program to suit your own computer and your own design.

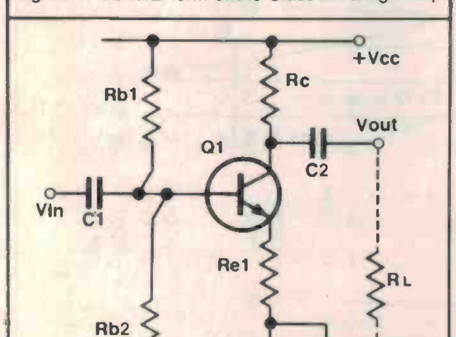
The fundamental circuit for a Class A amplifier is given in Figure 1. The first step in analysing a transistor circuit is to establish the biasing, since it is this that sets up the effective gain of the amplifier. For the circuit in Figure 1 the first step is to establish the base voltage, Vb. A standard but simplified equation which allows a quick solution is:

$$Vb = \frac{Rb2 \times Vcc}{Rb1 + Rb2}$$

From this we can determine Ve very quickly if we assume that there will be a drop of about 0.6 V across the base-emitter junction of the transistor:

$$Ve = Vb - 0.6$$

Figure 1. General form of the Class A voltage amp.



We now have access to the current flowing in the emitter resistor from Ohm's law, since we know the voltage across the resistor and its value:

$$Ie = \frac{Ve}{Re}$$

where Re = Re1+Re2.

Since we also know that the emitter current must be more or less the same as the collector current we can also work out the collector voltage:

$$Vc = Vcc - RcIc$$

AC response

With this series of simple steps we have worked out all the voltages around the transistor plus the current flowing between the collector and the emitter. We are now in a position to begin an examination of the circuit's response to an input signal, i.e: its ac response.

The gain of an amplifier is given by:

$$Av = \frac{\text{collector load}}{\text{emitter load}}$$

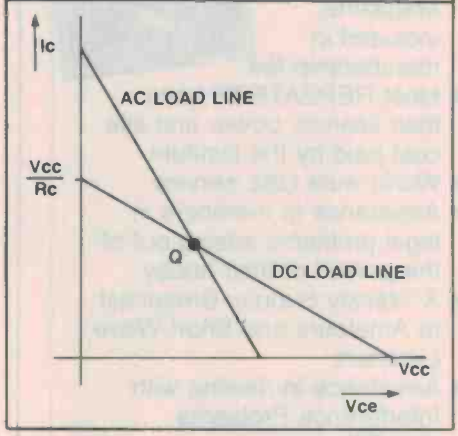
Bear in mind that these values apply to ac conditions only. The collector load includes all the resistances that tie the collector to either the ground or supply rails. (Supply is ac-shorted to ground through the power supply.) It includes at least the collector resistor Rc, the load resistance Rl and the collector-emitter leakage resistance. This latter is usually so high that it can be ignored in low frequency, small signal applications.

The emitter load, likewise, includes all the resistances between the emitter of the transistor and either rail. In practice this will mean the unbypassed emitter resistor Re1, but not Re2. Remember we are talking about ac and assuming that all the capacitors are short circuits, so Re2 is effectively shorted. It also includes the base-emitter resistance, r_e, which is given by 30/Ic.

The result of this is that we can establish a gain equation for the circuit of Figure 1:

$$Av = \frac{Rc}{r_e + Re1}$$

Figure 2. Plotting the ac and dc load lines.



Obviously, different configurations will have different equations, but the principle remains the same, so you can work out the relevant equation for your particular application.

So far, we have sufficient information to generate a program that will predict certain elements of the performance of an amplifier given the circuit. If you input the values of the resistors the program should come back at you with the gain. If you go to a textbook you should be able to extract equations to give you input and output resistance as well.

The question not answered, and the one we would like to know, is whether the combination of resistors we have chosen is an optimum. The classic method of doing this is with the *load line*.

Load Lines

Load line analysis involves drawing a pair of straight lines corresponding to the ac and dc loads on the transistor. It is actually a graph of Ic and against Vce. The load line is thus all the possible combinations of Ic and Vce that can exist at the collector of the particular amplifier under consideration.

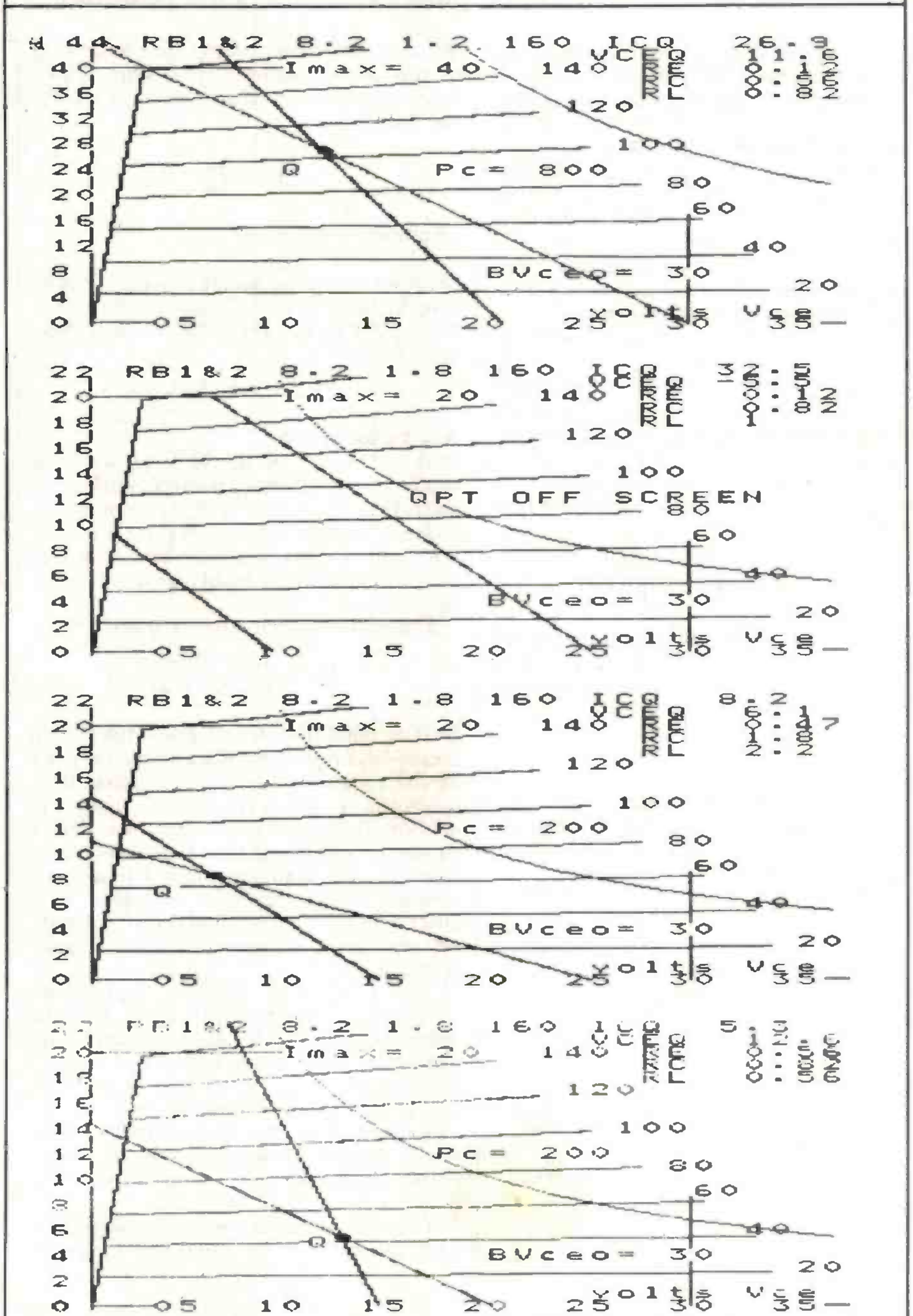
We can determine the dc line quite easily (see Figure 2). When no current flows i.e: Ic=0, then Vce=Vcc. This defines the bottom point of the line; i.e: the intersection with the horizontal axis. At the other end of the line, when Vce is at a minimum, Ic is ▶

determined by the value of the resistors through which it flows (Vce is assumed to be zero). The dc load line is just a straight line between these two points.

The operating point, Q, at which the amplifier is biased, must lie somewhere on this line. The ac line intersects the dc line at this point. It is drawn with slope equal to the inverse of the ac collector load. For an unloaded amplifier this will just be Rx, with the result that the ac slope will be the same as the dc slope. However, when the amplifier is loaded the slope of the line will tend to increase as the total collector resistance decreases.

As with the dc load line, the ac line determines the combination of values of Ic and Vce that can exist in the amplifier with a ▶

The plot quickens. Screen dumps of load lines plotted by the program over the page. The beauty of the technique is its ability to show the results of any variation quite quickly.



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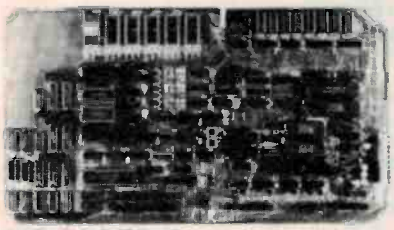

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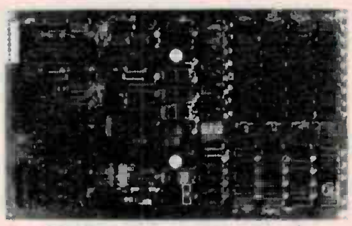

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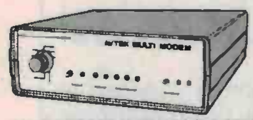

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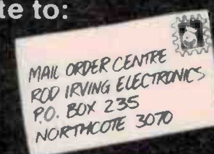

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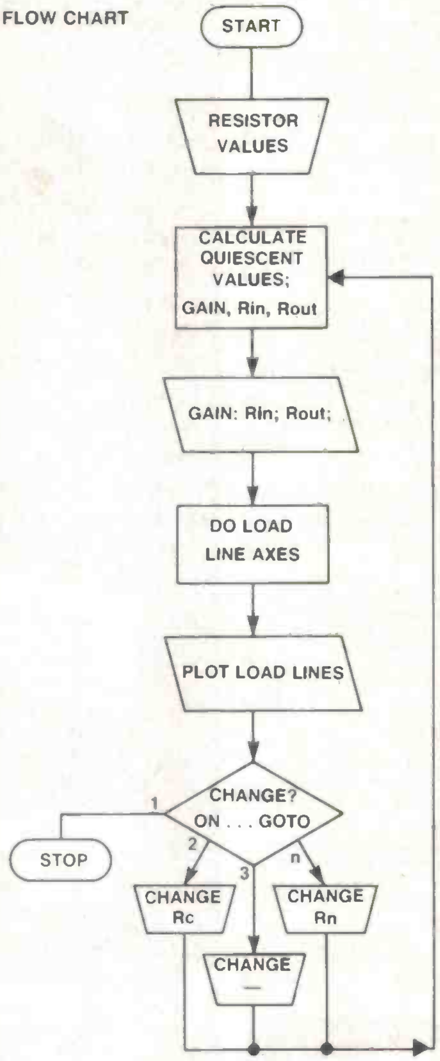


specific load. We are now in a position to ask the question about the amplifier we have designed, namely: what is the maximum output voltage I can get from this amplifier without distortion? In most applications the aim of the exercise, after all, is to magnify the input as much as possible while distorting it as little as possible.

Non-linearities

Non-linearities will occur whenever the output gets close to either end of the load line. Clipping will occur if you try to push the output past it. The idea then is to arrange your gain for a given input such that it can drive the output close to, and not right to, the end of the line. You also want to arrange things such that both positive and negative voltage excursions begin to slip at the same time. There is no point building something that will leave the positive side of the wave unclipped while distorting the negative wave badly. This state of affairs will come about when the Q point, i.e: the quiescent voltage of the transistor collector

PROGRAM LISTING

```
10 REM**********************************
11 REM* THIS PROGRAM PLOTS A SET OF    *
12 REM*TRANSISTOR CHARACTERISTICS WHEN*
13 REM*CERTAIN PARAMETERS ARE ENTERED.*
14 REM*THEN LOAD LINES ARE PLOTTED FOR*
15 REM*VARIOUS VALUES OF COMPONENTS.   *
16 REM**********************************
35 PAPER 1: INK 7
38 PRINT "*****************************"
39 PRINT "*                           *"
40 PRINT "* *  *   *  **  *  * * * ***"
41 PRINT "* * * * * * * * *  * *** * *"
42 PRINT "* * * * *** * * *  * *** ***"
43 PRINT "* * * * * * * * *  * *** * *"
44 PRINT "* ** *  * * **  ** * * * ***"
45 PRINT "*                           *"
46 PRINT "*    LANCE WILSON, 1984     *"
47 PRINT "*                           *"
48 PRINT "*****************************"
49 PAUSE 2000
50 CLS
55 REM**WRITTEN FOR THE MEMOTECH*****
56 REM**          MTX500          *****
57 REM**GRAPHICS DUMP FOR CP80 PRINTER*
58 REM~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
65 REM*THESE LINES SET VIRTUAL SCREENS,
66 REM*1ST FOR TEXT, THEN GRAPHICS.
70 CRVS 2,0,3,0,36,5,40
75 VS 2: CLS : PAPER 6: INK 7
80 CSR 4,0: INPUT "COMPLEX:Y/N?";A$
81 LET PMAX=200
82 LET VSF=2: LET ICMAX=20
83 LET BVCEO=30: LET HFE=100
84 IF A$="N" THEN  GOTO 100
85 CLS : CSR 4,0: INPUT "HFE:?";HFE
86 CSR 4,1: INPUT "MAX PC:?";PMAX
88 CSR 4,2: INPUT "ICmax:?mA";ICMAX
90 CSR 4,3: INPUT "BVCEO:?";BVCEO
92 LET VSF=INT(ICMAX/10)
100 CLS
102 CSR 4,0: INPUT "    ENTER STEP";STP
104 CLS : CSR 4,0: INPUT " ENTER Vcc";VCC
105 CSR 4,0: INPUT " EMITTER&COLLECTOR R";RE,RC
106 CSR 4,3: INPUT "RB1,RB2= ?";RB1,RB2
107 LET ID=VCC/(RB1+RB2)
108 VS 4: CLS : COLOUR 2,11: COLOUR 3,4
109 COLOUR 0,1: COLOUR 1,15: COLOUR 4,6
110 REM**SETS UP AXES AND SCALES*******
111 LINE 20,12,255,12: LINE 20,12,20,190
112 CSR 5,22: PRINT "05  10  15  20  25  30  35"
113 CSR 22,21: PRINT "volts Vce"
114 FOR I=0 TO 11 STEP 1
115 CSR 0,(11-I)*2: PRINT I*VSF
117 NEXT I
118 REM**DRAWS CHAR. CURVES     *******
119 LET X=20: LET Y=10
120 LET NEWX=X+STP/10: LET NEWY=Y+STP
122 LINE X,Y,NEWX,NEWY
123 LINE NEWX,NEWY,250-.8*Y,NEWY*1.11
125 CSR 30-Y/12,21-Y/7: PRINT Y+10
126 LET X=NEWX: LET Y=NEWY
127 IF Y>150 THEN  GOTO 130
128 GOTO 120
129 REM*AFTER TOP CURVE, PLOT PCMAX
130 FOR I=1 TO 230
135 LET YP=PMAX*100/(VSF*I)
140 IF YP>175 THEN  GOTO 150
142 COLOUR 3,6
145 PLOT 20+I,YP+12
150 NEXT I
151 CSR 16,10: PRINT "Pc=";PMAX
153 REM******UPPER IC & VCE LIMITS*****
154 LET ILIM=ICMAX*16/VSF+12: IF ILIM>190 THEN  GOTO 990
155 LINE 20,ILIM,80,ILIM
156 CSR 10,22-ILIM/9: PRINT "Imax=";ICMAX
157 LET VLIM=BVCEO*6.2+20: IF VLIM>250 THEN  GOTO 990
158 LINE VLIM,12,VLIM,80: CSR VLIM/9-4,18: PRINT "BVceo=";BVCEO
159 REM****NEXT CALCS. FOR QPT. AND****
160 REM****** DC LOAD LINE ************
161 LET ICQ=((RB2*VCC)/(RB1+RB2)-.6)/RE
```

```
162 LET IBQ=ICQ/HFE
163 IF IBQ*6>ID THEN  GOTO 300
165 LET VCEQ=VCC-ICQ*(RC+RE)
170 LET IQX=ICQ*16/VSF+12
175 LET VQX=VCEQ*6.2+20
177 IF VQX>250 OR IQX>190 THEN  GOTO 850
179 IF VCEQ<0 THEN  GOTO 2000
180 CIRCLE VQX,IQX,2
185 CSR .8*VCEQ+1,22-1.65*ICQ/VSF: PRINT "Q"
190 CSR 22,0: PRINT "ICQ ";INT(ICQ*10)/10
191 CSR 22,1: PRINT "VCEQ ";INT(10*VCEQ)/10
192 CSR 24,2: PRINT "RE ";RE
193 CSR 24,3: PRINT "RC ";RC
194 CSR 4,0: PRINT "RB1&2";RB1;RB2
199 GOTO 800
300 REM**
305 VS 2: CLS
308 LET S=ID/IBQ
310 CSR 6,10: PRINT "Id/Ib Ratio is ";S
311 CSR 8,12: PRINT ":rather low!"
315 PAUSE 8888
320 GOTO 106
400 REM****** AC LOAD LINE ************
405 VS 2: CLS
410 INPUT "RE BYPASSED?";A$
420 INPUT "RL=? ";RL
425 LET RAC=(RC*RL)/(RC+RL)
430 LET VPK=ICQ*RAC
435 LET VPX=(VCEQ+VPK)*6.2+20
440 VS 4
443 CSR 24,4: PRINT "RL ";RL
445 LINE VPX,12,VQX,IQX
450 LET IPK=ICQ+VCEQ/VPK*ICQ
455 LET IPX=IPK*16/VSF+12
457 IF IPX>192 THEN  GOTO 480
460 LINE VQX,IQX,20,IPX
470 PAUSE 7777
475 GOTO 1000
479 REM***** LIMIT CONDITIONS *********
480 LET IPX=190: LET IPK=(IPX-12)*VSF/16
482 LET VA=VCEQ-RAC*(IPK-ICQ)
483 LET VAX=VA*6.2+20
484 LINE VQX,IQX,VAX,IPX
488 PAUSE 7777
489 GOTO 1000
800 REM
810 LET IX=VCC/(RE+RC)*16/VSF+12
812 LET VX=VCC*6.2+20: REM SCALEUNITS
814 IF IX>190 THEN  GOTO 900
815 LINE 20,IX,VX,12
820 PAUSE 8888
830 GOTO 400
850 REM********************************
855 CSR 15,10: PRINT "QPT OFF SCREEN"
860 GOTO 190
900 REM*TO COVER OFF-SCALE LOADLINE
905 LET IC=ICMAX
906 LET IX=IC*16/VSF+12
910 LET VX=(VCC-IC*(RC+RE))*6.2+20
916 PAUSE 9000
920 LINE VCC*6.2+20,12,VX,IX
930 GOTO 830
990 CSR 5,2: PRINT "ICMAX OFF SCREEN"
998 STOP
999 REM**********GRAPHICS DUMP**********
1000 LPRINT CHR$(27);"A";CHR$(8);
1010 FOR J=191 TO 0 STEP -8
1020 LPRINT CHR$(13);CHR$(10);
1030 LPRINT CHR$(27);"K";CHR$(254);CHR$(1);
1040 FOR I=1 TO 255
1050 LET R$=GR$(I,J,8)
1060 LPRINT R$;: LPRINT R$;
1070 NEXT I
1060 NEXT J
1099 STOP : REM************************
2000 VS 2: CLS
2001 PRINT "NEGATIVE COLLECTOR VOLTAGE"
2002 PRINT "NOT ALLOWED"
2004 PAUSE 7777
2005 GOTO 104
```

is midway between the maximum voltage excursions.

Departures

To get this far in the analysis we have made certain assumptions about the circuit which are not strictly true. Whether they are significant or not depends on the individual case. It is important to realise they are there, however, so that if you start getting results that are not as predicted you know where to look.

The first problem is that the transistor has a saturation voltage that depends primarily on the current. Saturation voltage is drawn on a load line diagram as part of the transistor collector characteristics. Usually these are drawn as a family of curves indicating the relationship between collector current and voltage for a given base current. These curves will be more or less flat in the linear operating region of the transistor, falling off on the left-hand side as the transistor goes into saturation.

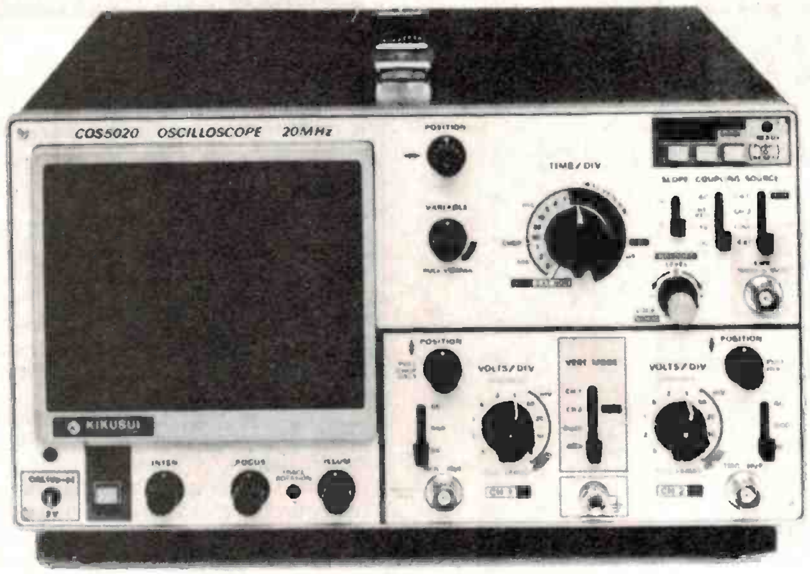
In order to achieve a really accurate determination of the transistor characteristic you ideally need to make a plot for each individual transistor. Failing that, manufacturers' data is a good source for typical figures. However, for our purposes it is probably just as useful if you think of the transistor characteristic as a line passing through the origin. The slope is set by at least one typical combination of current and voltage supplied from manufacturer's data. If you don't have access to this information then a value of 0.3 V at 2 mA is typical for small signal transistors.

A second source of errors is likely to be the assumption that all the capacitors are short circuits and that stray capacitances around the circuit are negligible. As frequency goes up this will become more and more of a problem.

So far, we have thought through this problem as a simple linear process, a not very difficult programming exercise involving a few calculations and the ability to draw some lines. This doesn't really explore the potential of the computer in this regard, though. Its biggest advantage is the fact that you can very quickly see what happens to a host of different parameters of the amplifier if you change values of any of the biasing resistors, or indeed if you change resistor configurations.

We have included a flow chart that should give you some idea of how to go about writing the program. It includes a menu for making individual changes to resistors and then re-running to see the effect. We have also included a listing of a BASIC program that draws a load line diagram complete with transistor characteristics and both load lines. This is written for the Memotech computer and so will need to be rewritten by anyone using a different type of machine, but close study of how it works will be instructive.

Good luck! ●



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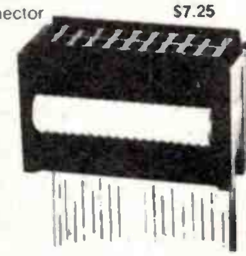

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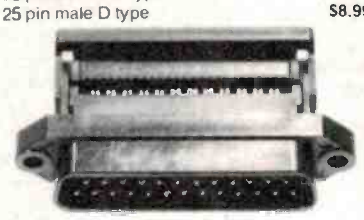

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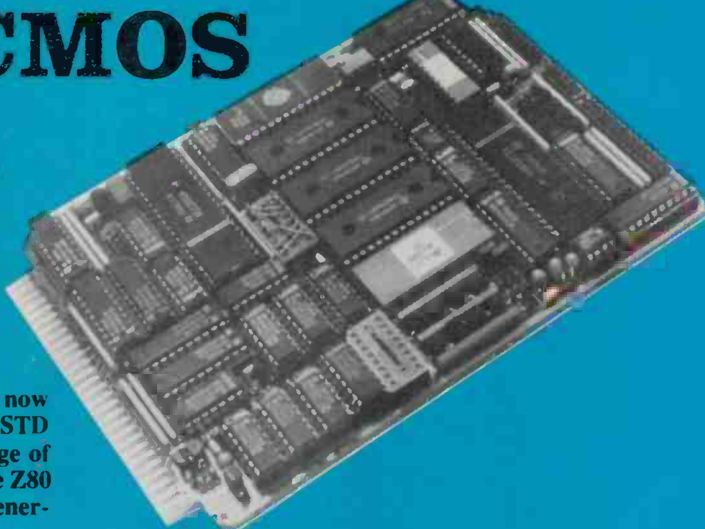
JED-STD/800, an Australian CMOS single board computer



The new JED-STD/800 CMOS single board computer now in production is a completely CMOS design on the STD buss. Using the National NSC800 CPU, it takes advantage of the Z80 machine code (directly, or via any language where Z80 compilers exist), or in XTBASIC, a version of BASIC generated by JED and tailored for control applications.

According to the manufacturers the board is proving popular in applications where low power consumption and small physical size demand an unusual approach. The CMOS logic provides the low power consumption (less than 0.5 of a watt). The board is very cost competitive with other N-MOS Z80 boards because so many functions (which normally need extra boards) are packed onto one board. It can be only partly loaded, if required, for even lower cost systems (one advantage of production in this part of the world).

The JED STD/800 card puts up to 56K of memory on the STD CPU card, as well as featuring an RS232 serial I/O, 30 bits of parallel I/O, two 16-bit counter/timers, eight analogue inputs (8- or 10-bit) and a real-time clock. The possibility of using only one card in the system, thus eliminates motherboards and racks.

To make programming easy, the board comes as standard with XTBASIC, a fast BASIC interpreter with many control oriented commands and functions built in (allowing, for example, direct control of the analogue system and real-time clock from BASIC).

JMON, a powerful monitor program is also included. It provides facilities for machine code checkout (including hardware single-step of NSC800 machine instructions), and is able to exchange programs and data with CP/M systems using the serial interfaces and a 'talk-though' mode.

Source listings of JMON and the XTBASIC are automatically supplied in the manufacturer's belief that customers are much more able to understand the workings of hardware/software systems if the software sources are readily accessible.

To develop 'on-card' a BASIC control or applications program, a user simply plugs in a terminal and types in the program, using the built-in editor. The program is tested in the final hardware situation, and, when working properly, a low-cost PROM programmer (available from JED) is plugged into the parallel connector at the top of the board, and the program transferred to PROM memory. The PROMs are then plugged into the board.

There is space on-board for 32K bytes of user program. As standard, there are 8K bytes of RAM and the BASIC/Monitor PROM is in high memory.

There are links on the board and data storage locations in the built-in EEPROM which control startup and direct it to the user's program automatically. The EEPROM also controls I/O device driver selection and baud rates. Extra space in the EEPROM is available for users.

In most applications, all the I/O needed is already on the card. The parallel I/O includes 8 or 12 power FETs as relay or opto-osolator drivers, and software to interface directly to a Centronics printer or plotter. If more is needed, it can either be added by calling on other STD buss cards on the market from JED or someone else, or it can be put onto a JED wire-wrap or point-to-point prototyping card; the only overhead with the STD buss is a handful of low-cost logic parts.

Direct serial interface is provided to both LED (or LCD) multi-digit displays and to the JED DataSafe, a portable one-inch by two-inch by four-inch diecast metal box containing up to 64K of CMOS battery backed RAM, designed for data capture in harsh environments.

The current consumption of this card is approximately 100 milliamps total, (depending on memory configuration), and it needs only a single 5 volt supply. A dc/dc converter on board generates −5 volts for RS232 output.

A plug-in card, the JED-STD/805, adds a second story to the STD/800, with two CMOS UARTs, adding two RS232C serial channels, or a single RS232C channel and the choice of an RS422 channel or a current loop with opto-isolators, designed for use around a factory environment. The manufacturer claims it has already found many applications in Australian industry, research, and educational institutions, finding control, field data logging, and teaching uses.

JED also manufactures other STD buss cards and accessories. One of the most popular has been the low-cost battery backed RAM/PROM card. This can hold up to 56K of RAM, or any combination of RAM or PROM. It sells for about half the cost of imported cards of smaller capacity. Other items include a TTL or CMOS I/O board, the JED-STD/820 handles I/O to the OPTO-22 power I/O rack, and adds counter/timers and extra RS232C I/O to an equivalent to the Prolog 7507 or 75C07 boards; an 8-channel, 12-bit analogue output card is also in production. Low cost cabinets are also locally made.

Full data sheets, and any JED products are availble from **JED Microprocessors, 28 Anderson St, Boronia Vic 3155. (03)762-3588.**

Laser unit offers two gigabytes of data storage

New technology from France offers a solution to the problem of accumulating libraries of data disks and tapes for Australian computer users.

Distributed in Australia by Pulsar Electronics, the new Gigadisc uses solid-state laser technology and will store 1000 megabytes (one gigabyte) of data on each single or double-sided disk cassette.

Gigadisc can be connected to almost any computer via the Small Computer System Interface (SCSI), and allows the direct accessing of any record.

The unit is attracting major interest as a low-cost storage medium for the holding of large banks of data such as continuous satellite data, says Pulsar's Managing Director, Mr Phillip Delacretaz. Other areas of high interest included TV stations storing multiple video images, CAD/CAM users, medical and scientific institutes and companies with large data bases.

"We have even had an inquiry from a large law firm seeking ways of storing large volumes of important correspondence," Mr Delacretaz said. "The low storage maintenance costs of Gigadisc make it extremely competitive with tapes, which need to be rewound every two years."

Developed by the French company, Thomson-CSF, and distributed nationally by Pulsar, the computer peripheral can record and store data, text, digital image and speech over a period of at least 10 years.

"The viable storage life of recorded magnetic media remains limited to two to three years, even in a controlled environment," Phillip Delacretaz said.

The read/write unit of Gigadisc includes a laser and a photo/detector, and the data can be accessed by three methods, random, optomised random and sequential.

A computer interface controller can be integrated into the Gigadisc unit, which can handle up to eight Gigadisc units. Associated with this controller is an automatic error detection and correction module.

The Gigadisc is supplied in a cassette which simplifies all handling, storage, loading and unloading operations. It also provides an additional level of environmental protection.

The disks supplied by Pulsar Electronics are preformatted into sectors and tracks and each sector is directly addressable by its logical address. Spiral organisation of the tracks allows for continuous reading and writing of streams of information.

The read-write unit is supplied either as a rack-mounted chassis or as a small stand-alone unit capable of being installed in an office environment.

With the use of the innovative laser technology, writing on the Gigadisc is achieved by the thermal alteration of a metallic film on the disc while reading is done by a laser diffraction technique.

The inner surface of the disk is coated with a layer of polymer and a thin metallic film and while writing, the laser beam evaporates the polymer layer, causing thermal alteration ("bubbling") of the metallic film. According to Pulsar Electronics, this type of laser technology took more than seven years to develop.

Pulsar will retail the basic Gigadisc model in Australia, for approximately $20 000. Extra two Gigabyte cassettes will be approximately $500.

For additional information contact **Mr Phillip Delacretaz, Pulsar Electronics, Catalina Drive, Tullamarine, Vic. (03)330-2555.**

Low-cost line conditioning

Arlec Pty Ltd has just introduced the first of a range of line conditioners designed and manufactured in Australia for use with microcomputers and other types of voltage sensitive electronic equipment.

Rated at 250 Vac, the 80250 is designed for operation on 50 Hz only and supplies a stable 240 volt RMS sine wave output, within close voltage limits for varying mains inputs extending from 190 V to 260 V.

According to the manufacturer, input voltage fluctuations of up to 15% are regulated to within 3% at the output ensuring a constant supply with less than 5% harmonic distortion.

This performance has been achieved by means of an entirely new core structure which is the subject of a patent application. An electrostatic shield is also incorporated for further noise reduction.

The 80250 is inherently short circuit protected and does not need any protective devices. It will operate continuously at 275 V input and take transients up to 1 kV peak without damage. In common with all Arlec products it is guaranteed for two years.

Further information is available from **Arlec Pty Ltd, 30 Lexton Road, Box Hill, Vic 3128. (03)895-0222.**

Stepper motors

A range of four Stepping motors, manufactured by the diversified Japanese conglomerate Toyo Corporation, has just been released. The units are designed for floppy disk drives, printers, typewriters or any other application requiring precision control.

Two of the four units utilise permanent magnet motors with four phases and offer a choice of 6 V or 12 V. Step angle in both cases is 7.5° (48 steps per revolution). Holding torque is 1100 g-cm (12 V model) or 2600 g-cm (6 V model).

The other two units utilise a hybrid type motor with 4 phases, both rated at 12 V. There is a choice of step angles: 3.75° (96 steps) or 3.6° (100 steps per revolution). Holding torque is 540 g-cm minimum.

For further information, please contact **Amtex Electronics, 36 Lisbon St, Fairfield NSW 2165. (02)728-2121.**

CLUB CALL

The Newcastle Microcomputer Club meets on the second and fourth Monday of each month in room G12 of the Physics Building, University of Newcastle at 7.30 pm. The club which publishes a monthly news letter is not formed around any specific brand of computer. Interested parties should contact Angus Bliss on (049)67-2433 extn 326 (office hours) or Tony Nicholson on (049)52-6017 (after hours weekdays).

Microbug Australia is the Melbourne based Microbee users group. The club meets on the second Wednesday of the month at the Victorian State College, Burwood campus, 221 Burwood Highway, Burwood, Vic, starting at 7 pm. The Vice President is A. S. Reid, phone (03)873-4455.

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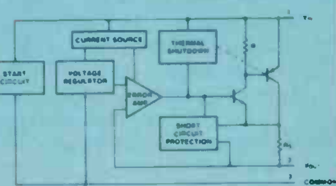

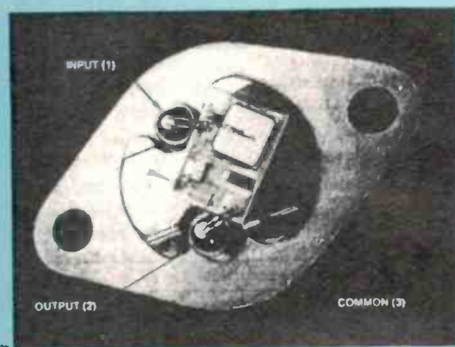

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- INTERNAL SHORT CIRCUIT CURRENT LIMIT
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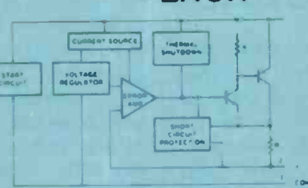
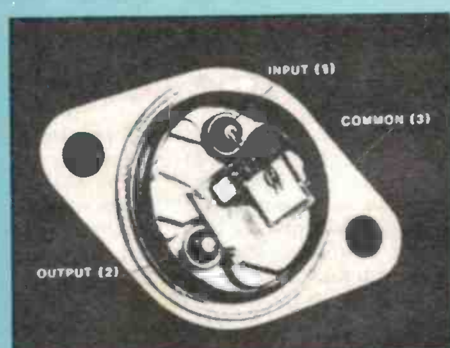
- 70 W POWER DISSIPATION
- PIN-FOR-PIN COMPATIBLL WITH THE µA78H12
- STEEL TO-3 PACKAGE





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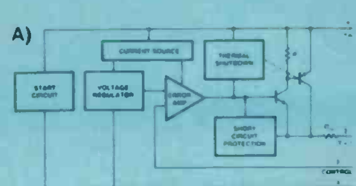
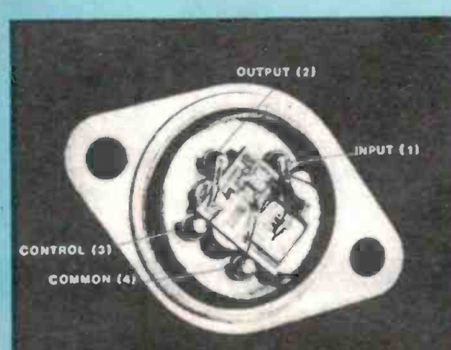
- 70 W POWER DISSIPATION
- ELECTRICALLY NEUTRAL CASE
- STEEL TO-3 PACKAGE
- ALL PIN-FOR-PIN COMPATIBLE WITH µA78HGA





VICDUMP

L. Murakami, West Beach SA 5024

This program may be of interest to readers who persevere with using an RS-232 printer with the VIC-20. (Real men don't use Commodore peripherals!) The purpose of the program is to enable one to dump a block of memory (in hex) to an RS-232 printer. It was developed because VIC-20 machine code monitors such as VICMON and HESMON do not support RS-232 printers.

Program structures is as follows:

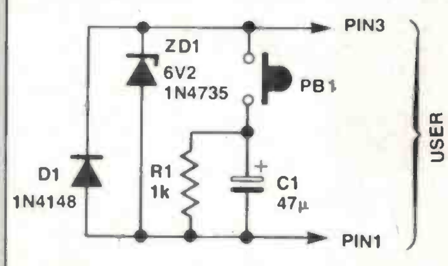
- Line 40 opens the RS-232 channel at a data rate of 300 baud. The baud rate can be readily changed by changing the CHR$ value e.g: CHR$(165) for 150 baud and CHR$(167) for 600 baud.
- Lines 70-160 gets from the user the desired printer column width from the options of 20, 40, or 80 columns.
- Lines 180-240 inform the printer as to the column width. The program was developed using an Axiom EX800 series printer which uses the ASCII character codes GS, RS and US for setting the column width. Other printers may require the CHR$ values in lines 220-240 to be changed.
- Lines 260-410 get from the user the required address range (in hex) of the memory block to be dumped.
- Lines 430-580 dump the data to the printer.
- Lines 600-610 are the program exit point whereby the RS-232 channel is closed so that other programs can be run.
- Lines 640-720 perform a hexadecimal to decimal conversion while lines 740-870 perform the opposite function.
- Lines 890-1010 get the desired character string from the keyboard.
- Lines 1030-1110 are used to instruct the user as to the format that is to be used for entering the column width and address range.

The program is suitable for any version of the VIC-20.

```
10 REM***********************************
20 REM*************"VICDUMP"**************
30 REM***OPEN RS-232 PORT,(300BAUD)*****
40 OPEN128,2,0,CHR$(166)
50 DIMDAT$(25)
60 REM*****GET PRINTER COLUMN WIDTH*****
70 MODE$="COLUMN WIDTH"
80 MAT$="20 *40 *80"
90 GOSUB1030
100 PRINT
110 PRINTCHR$(42);
120 LGH=2:GOSUB890
130 IFFLAG=1THEN110
140 IFFLAG=2THEN600
150 IFFLAG=3THEN100
160 FORI=1TO250:NEXTI
170 REM****SET PRINTER COLUMN WIDTH*****
180 IFHEX$="20"THEN220
190 IFHEX$="40"THEN230
200 IFHEX$="80"THEN240
210 GOTO100
220 WID=5:PRINT#128,CHR$(31):GOTO260
230 WID=10:PRINT#128,CHR$(30):GOTO260
240 WID=25:PRINT#128,CHR$(29):GOTO260
250 REM**GET MEMORY BLOCK TO BE DUMPED**
260 MODE$="HEXDUMP"
270 MAT$="AAAA-AAAA"
280 GOSUB1030
290 PRINT
300 PRINTCHR$(42);
310 KOUNT=0
320 LGH=4:GOSUB890
330 IFFLAG=1THEN300
340 IFFLAG=2THEN600
350 IFFLAG=3THEN290
360 LGH=4:BASE=4096:GOSUB640
370 KOUNT=KOUNT+1
380 IFKOUNT>1THEN400
390 BGN=DEC:PRINTCHR$(45);:GOTO320
400 TER=DEC
410 PRINT:PRINT
420 REM**DUMP MEMORY BLOCK TO PRINTER***
430 DEC=BGN:N=1:GOSUB740
440 PRINT#128,CHR$(58);HEX$(0);
450 FORI=1TOWID
460 DAT$(I)=CHR$(32)+CHR$(63)+CHR$(63)
470 NEXTI
480 FORJ=1TOWID
490 DEC=PEEK(BGN)
500 N=3:GOSUB740
510 DAT$(J)=CHR$(32)+HEX$(0)
520 BGN=BGN+1
530 IFBGN=65536THEN550
540 NEXTJ
550 FORI=1TOWID:PRINT#128,DAT$(I);:NEXTI
560 PRINT#128
570 IFBGN<TERORBGN=TERTHEN430
580 GOTO290
590 REM*********CLOSE RS-232 PORT********
600 CLOSE128
610 END
620 REM**********************************
630 REM*****CONVERT HEX TO DECIMAL******
640 DEC=0
650 FORI=1TOLGH:SUB=48
660 CODE=ASC(MID$(HEX$,I,1))
670 IFCODE<58THEN690
680 SUB=55
690 DEC=(CODE-SUB)*BASE+DEC
700 BASE=BASE/16
710 NEXTI
720 RETURN
730 REM*****CONVERT DECIMAL TO HEX******
740 HEX$(0)=""
750 IFN=3THENRMD(2)=DEC:GOTO800
760 HEX(1)=INT(DEC/4096)
770 RMD(1)=DEC-HEX(1)*4096
780 HEX(2)=INT(RMD(1)/256)
790 RMD(2)=RMD(1)-HEX(2)*256
800 HEX(3)=INT(RMD(2)/16)
810 HEX(4)=RMD(2)-HEX(3)*16
820 FORI=NTO4:ADD=48
830 IFHEX(I)>9THENADD=55
840 HEX$(I)=CHR$(HEX(I)+ADD)
850 HEX$(0)=HEX$(0)+HEX$(I)
860 NEXTI
870 RETURN
880 REM**GET CHARACTERS FROM KEYBOARD***
890 HEX$="":FLAG=0
900 FORI=1TOLGH
910 GETHC$:IFHC$=""THEN910
920 PRINTHC$;
930 IFHC$=CHR$(13)THENFLAG=1:RETURN
940 IFHC$=CHR$(88)THENFLAG=2:RETURN
950 TEST=ASC(HC$)
960 IFTEST<48THENFLAG=3:RETURN
970 IFTEST>70THENFLAG=3:RETURN
980 IFTEST>57ANDTEST<65THENFLAG=3:RETURN
990 HEX$=HEX$+HC$
1000 NEXTI
1010 RETURN
1020 REM*******INFORMATION BANNER*******
1030 PRINTCHR$(147);
1040 FORI=1TO22:PRINTCHR$(184);:NEXTI
1050 PRINT"MODE";SPC(3);MODE$
1060 PRINT"FORMAT *";MAT$
1070 PRINT"PRESS  RETURN TO REDO"
1080 PRINT"PRESS  X TO EXIT"
1090 FORI=1TO22:PRINTCHR$(185);:NEXTI
1100 PRINT
1110 RETURN
READY.
```

ERRATA

Mr C. Morris has advised that his C64 program hints (September 1984) are not as useful as he first thought. If you fit a 'momentary-on' switch between reset and ground you might damage some ICs. This circuit should perform the reset function without destroying your computer.



ROCKY RALLY ▷

D. Simpson, Armidale NSW 2350

This game is written for the VIC-20 in the standard 5K. The car is driven using the two cursor keys or the joystick to avoid the rocks and the barriers. There are three stages accompanied by variations in colour and sound.

```
1 GOTO13000
2 POKE 36879,95:PRINT"":S=0:FORX=0TO21:POKE38884+X,0:NEXTX:CC=2:VC=0
3 POKE650,128
5 Q=7933:GOSUB12000
6 DIMJS(2,2):POKE37139,0:DD=37154:PA=37137:PB=37152
7 FORI=0TO2:FORJ=0TO2:READJS(J,I):NEXTJ,I
9 FORX=0TO4:POKE8164+X,8:NEXTX:FORX=0TO6:POKE8164+X+15,8:NEXTX
10 K=INT(RND(1)*8):POKEK+8170,25:POKEK+38890,CC:POKE8169,
   8:POKE8178,8:PRINT
11 GOSUB18:S=S+5
12 PRINT"SCORE:"S
13 IFS<250THENFORX=1TO90:NEXT:POKE36874,128
14 IFS>750ANDS<2000THENPOKEINT(RND(1)*8)+1+8164+6,25:POKE36877,128:
   POKE36879,40:CC=0
15 IFS=250THENPOKE36875,128:POKE36879,108:POKE36874,0:CC=3:VC=0
16 IFS>1700THENPOKEINT(RND(1)*8)+1+8164+6,25
17 GOTO10
18 GOSUB9000:IFS2=-1THEN27
19 IFS3=1THEN30
20 GETCC$:IFCC$=""THEN27
21 IFCC$=""THEN30
22 IFPEEK(Q)=25ORPEEK(Q)=8THEN740
23 POKEQ-7922+38642,0
26 POKEQ-22,32:POKEQ,17:RETURN
27 POKEQ,32
28 Q=Q-1
29 GOTO20
30 POKEQ,32
31 Q=Q+1:GOTO20
740 PRINT"BANG!"
741 POKE36878,15:POKE36874,0:POKE36875,0:POKE36877,0:POKEQ-22,0:POKEQ
-21,60:POKEQ,61:POKEQ+1,62
742 POKE36877,220
750 FORR=1TO200:NEXTR
760 PRINT"***GAME OVER***"
765 POKE36877,0
769 PRINT""
770 PRINT"SCORE:"S
780 FORR=1TO1500:NEXTR
790 PRINT"TRY AGAIN?(Y/N)"
800 GETK$:IFK$=""THEN800
805 S=0:C1=0
810 IFK$="Y"THEN:CLR:GOTO2
811 IFK$="N"THEN1
```

VIC-20

```
10 PRINT"❐      WORD SORT"
20 PRINT"       ─────────"
30 DIMW$(300):N=0
40 PRINT"■ENTER WORDS TO BE     SORTED OR              'Q' TO QUIT"
50 PRINT"'B' TO GO BACK■"
60 W$="":INPUTW$:IFW$="Q"THEN110
70 IFW$="B"ANDN<>0THENPRINT"BACK 1":N=N-1:GOTO60
80 IFW$=""THENPRINT"ERROR":GOTO60
90 N=N+1:W$(N)=W$
100 GOTO60
110 T=0
120 FORI=1TON-1
130 IFASC(LEFT$(W$(I),1))<ASC(LEFT$(W$(I+1),1))THEN150
140 W$=W$(I):W$(I)=W$(I+1):W$(I+1)=W$:T=1
150 NEXT
160 X=X+N:IFX>N↑2THEN180
170 IFT=1THEN110
180 FORI=1TON:FORL=1TON
190 IFW$(I)=W$(L)ANDI<>LTHENFORJ=LTON+1:W$(J)=W$(J+1):
NEXTJ:N=N-1:W$(J+1)=""
200 NEXTL:NEXTI
210 PRINT"■■■";:INPUT"PRINTOUT(Y/N)";P$
220 IFP$="Y"THENOPEN1,4:CMD1:GOTO270
230 FORI=1TON
240 PRINTW$(I)
250 NEXT
260 END
270 FORI=1TONSTEP2
280 PRINTW$(I)CHR$(16)"40"W$(I+1)
290 NEXT
300 PRINT#1:CLOSE1
310 END
```

VIC-20

◁ WORD SORT

A. Elphick, Frenchs Forest NSW 2086

This program will sort out a number of words or sentences into alphabetical order and delete any words or sentences that are repeated more than once.

When entering the words, 'Q' will continue with the program and 'B' will delete the last word entered.

Lines 10-100 input the words to be sorted, lines 110-170 sort the words alphabetically, lines 180-200 delete any words that are repeated more than once, and lines 210-310 print out the result. This program will work on any configuration of memory.

```
815 GOTO800
820 PRINT"***GAME OVER***"
830 END
9000 POKEDD,127:S3=-((PEEK(PB)AND128)=0):POKEDD,255
9010 P=PEEK(PA):S2=((PAND16)=0):RETURN
12000 POKE36878,13
12002 FORX=1TO3
12005 POKE36875,180
12006 FORR=1TO50:NEXTR
12010 POKE36875,190
12011 FORR=1TO20:NEXTR
12015 POKE36875,200
12016 FORR=1TO50:NEXTR
12021 FORR=1TO50:NEXTR
12022 NEXTX:POKE36875,0
12023 RETURN
12920 POKE36875,210
13000 CLR:POKE36879,14:POKE36869,240:PRINT"■■■■ ** ROCKY RALLY **     "
13005 PRINT"■■   BY DUDLEY SIMPSON"
13007 PRINT"■■■      TO DODGE ROCKS    "
13010 PRINT"■■USE KEYS:                "
13011 PRINT"■■CRSR↑=LEFT CRSR←=RIGHT"
13012 PRINT"■■OR USE JOYSTICK          "
13017 PRINT"■■YOU ACCELERATE AT 250 "
13018 PRINT"■■AVALANCHES OCCUR AFTER 750 POINTS          "
13020 PRINT"■■SD GOOD LUCK!!                              "
13030 PRINT"■■ HIT ANY KEY TO START "
13035 PRINT"■"
13040 GETB$:IFB$=""THEN13040
13045 PRINT"■":GOTO13102
13050 POKE36869,255:GOTO2
13102 IFPEEK(52)=28THEN13107
13103 POKE51,0:POKE52,28:POKE55,0:POKE56,28:CLR:CB=7168
13104 READA:IFA=-1THEN13107
13105 FORN=0TO7:READB:POKECB+A*8+N,B:NEXT
13106 GOTO13104
13107 GOTO13050
13140 DATA32,0,0,0,0,0,0,0,0
13141 DATA8,204,204,48,48,204,204,48,48
13142 DATA17,165,255,189,36,165,255,189,24
13143 DATA25,62,95,189,250,118,62,60,24,0,7,26,101,168,144,136,158,0
13144 DATA60,224,24,166,65,113,89,63,1,61,166,146,136,102,24,7,0,0
13145 DATA62,133,105,81,134,24,96,128,0,-1
13200 DATA-23,-22,-21,-1,0,1,21,22,23
```

```
1 REM**VIDEO TITLE BOARD
2 REM BY PAUL & BARB JOHNSON
9 PRINT"■"
10 PRINT"■1-WHITE":PRINT"■2-GREEN"
11 PRINT"■3-BLUE":PRINT"■4-LT.BLUE"
12 PRINT"■5-LT.YELLOW":
   PRINT"■6-BLACK"
13 PRINT"■■PICK SCREEN COLOUR"A$
14 INPUTA$
20 IFA$="1"THENGOTO30
21 IFA$="2"THENGOTO60
22 IFA$="3"THENGOTO90
23 IFA$="4"THENGOTO120
24 IFA$="5"THENGOTO150
25 IFA$="6"THENGOTO180
30 FORC=24TO31
31 POKE36879,C
32 PRINT"■"
50 FORT=1TO1000:NEXTT
51 NEXTC
52 GOTO30
60 FORC=88TO95
61 POKE36879,C
62 PRINT"■"
80 FORT=1TO1000:NEXTT
81 NEXTC
82 GOTO60
90 FORC=104TO111
91 POKE36879,C
92 PRINT"■"
110 FORT=1TO1000:NEXTT
111 NEXTC
112 GOTO90
120 FORC=232TO239
121 POKE36879,C
122 PRINT"■"
140 FORT=1TO1000:NEXTT
141 NEXTC
142 GOTO120
150 FORC=248TO255
151 POKE36879,C
152 PRINT"■"
170 FORT=1TO1000:NEXTT
171 NEXTC
172 GOTO150
180 FORC=8TO15
181 POKE36879,C
182 PRINT"■"
200 FORT=1TO1000:NEXTT
201 NEXTC
202 GOTO180
READY.
```

VIC-20

VIDEO TITLE BOARD

P & B Johnson, Leigh Creek SA 5731

This program was designed for use in conjunction with a video. We use it for titling our own home-made movies.

We have chosen these screen colours as the other colours don't combine well with writing.

To insert the title in the required colour enter the text in lines nos. 33-49, 63-79, 93-109,123-139,153-169 or 183-199.

DAY

David Rapson, Bellevue Heights, SA 5050

This program can be used to calculate the day of the week for any date after 1582.

```
00100 REM              PROGRAM DAY
00110 REM This program, when given any date after 1582 will
00120 REM calculate the day of the week.
00130 REM This can give Granny quite a surprize..
00140 REM Written by David S Rapson  S. Australia 5050   11/3/84
00150 CLS
00160 INPUT "Enter date: dd,mm,/yyy ";D1,M1,Y1
00170 PRINT
00180 IF D1<1 OR D1>31 THEN 160
00190 IF M1<1 OR M1>12 THEN 160
00200 IF Y1<1582 THEN 160 :REM Gregorian calendar only!
00210 IF M1=1 OR M1=2 THEN LET F1=365*Y1+D1+31*(M1-1)+FLT(INT((Y1-1)/4))-FLT(INT
(0.75*FLT(INT(((Y1-1)/100)+1))))
00220 IF M1>2 THEN LET F1=365*Y1+D1+31*(M1-1)-FLT(INT(0.4*M1+2.3))+FLT(INT(Y1/4)
)-FLT(INT(0.75*FLT(INT((Y1/100)+1))))
00230 F2=-F1/7 :REM 7 days in one week!
00240 A1=F2/10 :REM cant have integer>65534, need special routine as f1 is about
 720,000 depending on the date.
00250 A2=FRACT(A1)
00260 A2=FLT(INT(A2*10))
00270 F2=FLT(INT(A1))*10+A2 :REM end of integerising section!!
00280 D2=F1+(F2*7)
00290 PRINT "That's a ";
00300 IF D2=0 THEN PRINT"Saturday"
00310 IF D2=1 THEN PRINT"Sunday"
00320 IF D2=2 THEN PRINT"Monday"
00330 IF D2=3 THEN PRINT"Tuesday"
00340 IF D2=4 THEN PRINT"Wednesday"
00350 IF D2=5 THEN PRINT"Thursday"
00360 IF D2=6 THEN PRINT"Friday"
00370 PRINT: PRINT"Another date?  ";
00380 Y1$=KEY$
00390 IF Y1$="Y" OR Y1$="y" THEN 150
00400 IF Y1$="N" OR Y1$="n" THEN END
00410 GOTO 380
```

SUN

David Rapson, Bellevue Heights, SA 5050

This program will calculate the time of sunrise and sunset for any place in the world. The program is based on Adelaide, but given the decimal latitude (+ for North, – for South) and longitude (– for West, + for East) any other place can be calculated.

```
00100 REM         Program SUN
00110 REM This program will calculate the time of Sunrise and
00120 REM  Sunset for any place in the world.
00130 REM The program is based on Adelaide, but given the decimal
00140 REM  latitude(- for south), longitude(- for east), and the
00150 REM  time difference to Greenwich, London,(- for west)
00160 REM  any other place may be calculated.
00170 REM The default location can be changed at lines 200,240
00180 REM Written by David S Rapson          12/10/84
00190 CLS
00200 PRINT"Are you in Adelaide? ";
00210 Y1$=KEY$
00220 IF Y1$="Y" OR Y1$="y" THEN 250
00230 IF Y1$="N" OR Y1$="n" THEN 270
00240 GOTO 210
00250 L1=-35 : L2=-135.58 : G5=+9.35 :REM lat, long, GMT difference for Adelaide

00260 PRINT : GOTO 310
00270 PRINT "No" : PRINT
00280 INPUT"What is the town's Latitude;(+ for N,- for S) ";L1
00290 INPUT"What is the town's Longitude;(+ for West,- for East) ";L2
00300 INPUT"And it's GMT differerce;(+ for East of Greenwich) ";G5
00310 PRINT : PRINT
00320 INPUT"Enter date; eg. dd,mm ";D1,M1
00330 IF D1<1 OR D1>31 THEN 310
00340 IF M1<1 OR M1>12 THEN 310
00350 S1=0 :REM Correction for Daylight saving, Nov-Mar inc.
00360 IF Y1$="N" OR Y1$="n" AND L1>0 THEN 390
00370 IF M1<2 THEN LET S1=1
00380 IF M1>10 THEN LET S1=1
00390 C1=0.01745329
00400 T1=0.988*(D1+30.3*(M1-1))
00410 H1=23.5*(COS((T1+10)*C1))
00420 E1=0.123*(COS((T1+87)*C1))-(SIN(2*(T1+10)*C1))/6
00430 X1=SIN(H1*C1)/COS(H1*C1)*SIN(L1*C1)/COS(L1*C1)
00440 C2=(1.570796-ATAN(X1/SQR(1-X1*X1)))/C1:REM arccos(x1)/c1
00450 G1=12-E1+(L2-C2)/15
00460 G2=12-E1+(L2+C2)/15
00470 R1=G1+G5
00480 R2=G2+G5
00490 IF R2>12 THEN LET R2=R2-12 :REM keeps 12 hour time
00500 B1=(R1-FLT(INT(R1)))*60/100 :REM converts decimal to mins
00510 B2=(R2-FLT(INT(R2)))*60/100
00520 U1=FLT(INT(R1))+B1+S1
00530 U2=FLT(INT(R2))+B2+S1
00540 PRINT : PLAY 24,1
00550 PRINT"Sunrise ";[F5.2 U1];" am"
00560 PRINT"Sunset  ";[F5.2 U2];" pm"
00570 PRINT: PRINT "Another date ?";
00580 Z1$=KEY$
00590 IF Z1$="Y" OR Z1$="y" THEN 310
00600 IF Z1$="N" OR Z1$="n" THEN END
00610 GOTO 580
```

THE CONVERTER

Jon Barnett, Northmead, NSW 2152

The Converter converts an assembly file listing into a BASIC listing. To use it, assemble and save it to tape. Load the assembly listing you wish to convert, making sure it does not clash with the conversion program. Load the Converter in and run it. It will warm-start to BASIC once the conversion process has finished. Next it must be saved to tape by typing: "OUT 2:LIST:PRINT CHR$(26):OUT 0". Cold-boot to BASIC and reload the program by entering IN 2.

Now replace the characters which indicate tab spacing with space characters to achieve proper spacing like that of an assembly listing. Save the list-

```
00010 ;        ****************************************
00020 ;        *************THE  CONVERTER*************
00030 ;        ****************************************
00040 ;        *THIS PROGRAM WILL DECODE ANY ASSEMBLER*
00050 ;        *FILE AND CONVERT IT INTO A BASIC FILE.*
00060 ;        **************BY J.L.BARNETT************
00070 ;        *DESIGNED FOR THE MICROBEE V5.1 SERIES.*
00080 ;        *WAS WRITTEN ON THE 10TH,FEBRUARY 1984.*
00090 ;        ****************************************
00100 ;
00110 ;
00120 ;
00130 ;
00140 ;PROGRAM STARTS AT 7A00H
00150         ORG    7A00H
00160 DGOSPR  EQU    800CH      ;LOCATION OF BASIC PRINT ROUTINE
00170 START   LD     B,12
00180         CALL   DGOSPR
00190         LD     C,14
00200         LD     HL,MESSAG
00210         CALL   PRINT
00220         LD     BC,(10BH)
00230         CALL   ADDRES
00240         PUSH   DE         ;SAVES THE LOCATION OF PROGRAM
00250         EX     DE,HL
00260 ;THE END OF THE FILE IS SEARCHED FOR
00270 SEARCH  LD     B,2
00280 FINDFF  LD     A,(HL)
00290         INC    HL
00300         CP     255
00310         JR     NZ,SEARCH
00320         DJNZ   FINDFF
00330         DEC    HL
00340         LD     A,127
00350         POP    DE
00360         CP     H          ;CHECKS IF HL POINTS TO ROM AREA
00370         JR     NC,CONTIN
00380 ;ERROR MESSAGE DISPLAYED AND DELAY GENERATED
00390         LD     HL,ERRORN
00400         LD     C,8
00410         LD     B,12
00420         CALL   DGOSPR
00430         LD     B,10
00440         CALL   DGOSPR
00450         CALL   PRINT
00460         CALL   0AAF8H     ;DELAY ROUTINE FROM BASIC
00470         JR     START
00480 CONTIN  LD     HL,900H
00490 ;LINE NUMBER IN ASSEMBLER FORMAT IS REVERSED
00500 ;AND THIS BECOMES THE CORRECT FORM FOR BASIC
00510 ;HL IS THE POINTER TO SOURCE CODE AND DE IS
00520 ;THE POINTER TO THE GENERATED BASIC PROGRAM.
00530 LINENU  LD     A,(DE)
00540         LD     C,A
00550         INC    DE
00560         LD     A,(DE)
00570         LD     (HL),A
00580         INC    HL
00590         LD     (HL),C
00600         CP     255        ;LOOKS FOR END OF FILE MARKERS
00610         JR     NZ,NOTEND
00620         CP     C          ;*
00630         JR     Z,BASIC
00640 NOTEND  INC    HL
00650         INC    DE
00660         LD     A,(DE)
00670         LD     B,A
00680         INC    A
00690         LD     (HL),A     ;BYTE CONTAINING THE LINE LENGTH
00700         INC    DE
```

BANISH THAT 'BAD LOAD' ETI, September 1984.

Max Maughan, Engineering Manager of Applied Technology, (designer and manufacturer of Microbees) has advised that the idea of the September issue "Banish that 'Bad Load'," is good for microphone input on a standard cassette recorder, but under test by him on the Micron data cassette the signal was very weak; it would reload on the Micron cassette but not on a standard recorder.

Applied Technology is presently selling a Datatree computer cassette data unit which will not work with the circuit added and this is a reason why the output from the Microbee cannot be set to suit a microphone input only.

Also, with the Datatree the cassette load or input circuit in the Microbee is not needed. The Datatree cassette has a TTL level output and cannot be connected directly to pin 27 on the PIO. The circuit cannot be changed to suit the one application, advises Max.

ing to tape as a BASIC program using SAVE. The reason I wrote this program was that I have an assembler but no printer and my friend has a printer but no assembler. Therefore to get any listings required of me to change assembler to BASIC.

```
00710        INC   HL
00720        LD    (HL),32   ;INSERT A SPACE AFTER LINE NUMBER
00730        INC   HL
00740        LD    C,91
00750 ;THE REST OF THE LINE,CONTAINING THE ACTUAL SOURCE CODE
00760 ;IS NOW STORED.TAB CHARACTERS (9) ARE REPLACED BY ALTE-
00770 ;RNATE CHARACTERS.THE FIRST TAB IN A LINE WILL BE REPL-
00780 ;ACED BY [,THE SECOND BY \,THE THIRD BY ],THE FOURTH BY
00790 ;CHR(94),ETC.THIS ALLOWS FORMATTING THE FILE TO NORMAL
00800 ;ASSEMBLY LISTINGS USING THE BASIC GX COMMAND.
00810 CONTEN LD    A,(DE)
00820        CP    9          ;CHECKS FOR TAB CHARACTER
00830        JR    NZ,NOTTAB
00840        LD    A,C
00850        INC   C
00860 NOTTAB LD    (HL),A
00870        INC   HL
00880        INC   DE
00890        DJNZ  CONTEN
00900        LD    (HL),13   ;CARRIAGE RETURN INSERTED
00910        INC   HL
00920        JR    LINENU
00930 ;BASIC POINTERS ARE SET AND MACHINE CODE PROTECTED
00940 BASIC  LD    (2258),HL ;POINTER TO PROGRAM END
00950        LD    HL,32512
00960        LD    (1758),HL ;VARIABLES AREA POINTER
00970        LD    HL,(900H)
00980        LD    (2304),HL ;FIRST LINE NUMBER
00990        LD    SP,7A00H
01000        LD    HL,79FFH
01010        LD    (0A0H),HL ;TOP OF MEMORY POINTER
01020        CALL  8021H      ;WARM START BASIC
01030 ;ROUTINE PRINTS MESSAGE:HL=START OF MESSAGE,C=LENGTH
01040 PRINT  LD    B,(HL)
01050        INC   HL
01060        CALL  DGDSPR
01070        DEC   C
01080        JR    NZ,PRINT
01090        RET
01100 ;GETS THE START LOCATION IN HEX AND STORES IT IN DE
01110 ADDRES CALL  $+4
01120        LD    D,E
01130        CALL  KEY
01140        RLCA
01150        RLCA
01160        RLCA
01170        RLCA
01180        LD    E,A
01190        CALL  KEY
01200        OR    E
01210        LD    E,A
01220        RET
01230 ;KEYBOARD TRAP ROUTINE,BC HAS LOCATION ON SCREEN
01240 KEY    INC   BC
01250 KEY1   CALL  8006H
01260        LD    (BC),A
01270        SUB   48
01280        JR    C,KEY1
01290        CP    10
01300        RET   M
01310        SUB   7
01320        CP    10
01330        JR    C,KEY1
01340        CP    16
01350        JR    NC,KEY1
01360        RET
01370 MESSAG DEFM  'START ADDRESS:'
01380 ERRORM DEFM  'NO FILE'
01390        DB    7
01400        END
```

GRAPHICS CREATOR

S. Robjohns, Somerton Park, SA 5044

This program is written for the Microbee Personal Computer and allows you to draw shapes on the computer screen in HIRES and LORES graphics. A cursor can be moved over the screen area and lines drawn between selected points as determined by the user. The co-ordinates of these points are retained and printed out so that they can be used in PLOT statements in later programs to recreate the shapes.

The command keys which control the cursor are: 'E' — to move cursor up, 'X' — to move cursor down, 'S' — to move cursor left, 'D' — to move cursor right, 'M' — to save cursor position, 'I' — to start another trace, 'L' — to end graphic and print coordinates.

Each graphic can comprise a maximum of 30 independent shapes each containing up to 100 lines. These values may be changed in lines 130 and 410 to suit other memory capacities. When using HIRES graphics you are limited to 128 PCG characters. This number is continually monitored and displayed in the top left corner of the screen. Also directly below this number appears a letter which corresponds to the last command given from the keyboard. This can be useful when you are not sure whether you have entered the 'M' or 'I' commands.

In the program as presented, it is assumed a printer is connected to receive the printout of the point co-ordinates. If this is not the case then the following lines should be changed to:

480 SPEED 50
600 SPEED 0

This will allow time to use the 'CTRL S' command to halt the output if necessary.

```
00100 REM    HIRES/LORES - Graphic Creator
00110 REM              S.L. Robjohns
00120 CLS
00130 DIM A(101,31),B(101,31),M(31)
00140 CURS17,5:UNDERLINE:PRINT"HIRES/LORES Graphic Creator":NORMAL
00150 CURS13,3:PRINT"Enter 'L' FOR LORES : 'H' FOR HIRES";:CURSO
00160 KO$=KEY$:IF KO$="" THEN 160
00170 IF KO$="H" OR KO$="h" THEN HIRES:CO$="HIRES :":X=256:Y=102:Q=511:R=203:GOT
O 190
00180 IF KO$="L" OR KO$="l" THEN CLS:LORES:CO$="LORES :":X=64:Y=19:Q=127:R=33:GO
TO 190 ELSE 160
00190 FOR Z=1 TO 64:CURSZ,3:PRINT"-":NEXT Z
00200 CURS5:PRINT"I":CURS69:PRINT"I"
00210 CURS8:PRINT"Cursor Movement :  E - up  X - down  S - left  D - right"
00220 CURS72:PRINT"M - save point   I - another trace   L - finish graphic"
00230 SET X,Y
00240 C=0:I=0:J=0:K=1:W=0:T=0:K1$=" "
00250 CURSO:PRINT USED
00260 ON ERROR GOTO 620
00270 CURS65:PRINT K1$
00280 IF X=0 THEN RESET X,Y:X=1:SET X,Y:GOTO 320
00290 IF X=Q THEN RESET X,Y:X=Q-1:SET X,Y:GOTO 320
00300 IF Y=0 THEN RESET X,Y:Y=1:SET X,Y:GOTO 320
00310 IF Y=R THEN RESET X,Y:Y=R-1:SET X,Y
00320 K1$=KEY$
00330 IF K1$="E" OR K1$="e" THEN LET E=X:F=Y:Y=Y+1:SET X,Y:RESET E,F:GOTO 370
00340 IF K1$="X" OR K1$="x" THEN LET E=X:F=Y:Y=Y-1:SET X,Y:RESET E,F:GOTO 370
00350 IF K1$="S" OR K1$="s" THEN LET E=X:F=Y:X=X-1:SET X,Y:RESET E,F:GOTO 370
00360 IF K1$="D" OR K1$="d" THEN LET E=X:F=Y:X=X+1:SET X,Y:RESET E,F
00370 IF W=1 THEN SET U,V
00380 IF K1$="M" OR K1$="m" THEN LET W=1:U=X:V=Y:T=0:GOTO 430
00390 IF K1$="L" OR K1$="l" THEN LET I=I+1:M(I)=J:GOTO 470
00400 IF K1$="I" OR K1$="i" THEN LET I=I+1:M(I)=J:J=0:K=K+1:T=1
00410 IF I=30 OR J=101 THEN CURS16,4:PRINT"Maximum number of shapes or lines":GO
TO 650
00420 GOTO 250
00430 J=J+1:A(J,K)=X:B(J,K)=Y
00440 IF J<2 THEN 250
00450 PLOT A(J,K),B(J,K) TO A(J-1,K),B(J-1,K)
00460 GOTO 250
00470 CLS
00480 CURS16,7:INPUT"Ready printer, then press RETURN";K3$:CLS:OUT#1 ON:REM SPEE
D 50 (without printer)
00490 PRINT:PRINT CO$:PRINT
00500 IF T=1 THEN LET I=I-1
00510 FOR P=1 TO I
00520 PRINT"PLOT  (";
00530 IF M(P)<=0 THEN LET M(P)=1
00540 FOR G=1 TO M(P)
00550 PRINT A(G,P);" ,";B(G,P);
00560 IF G<M(P) THEN PRINT" ) TO (";
00570 NEXT G
00580 PRINT" )":PRINT
00590 NEXT P
00600 OUT#0:REM SPEED 0 (without printer)
00610 END
00620 IF ERROR C = 16 THEN LET C=1:GOTO 640
00630 CLS:PRINT"Error ";ERROR C;" in Line ";ERROR L:END
00640 CURSO:PRINT USED:CURS14,4:PRINT"You have used all the PCG characters"
00650 CURS12,16:PRINT"Do you wish to save these coordinates?";
00660 K2$=KEY$:IF K2$="" THEN 660
00670 IF K2$="Y" OR K2$="y" THEN LET I=I+1:M(I)=J-C:GOTO 470
00680 IF K2$="N" OR K2$="n" THEN CLEAR:GOTO 120 ELSE 660
```

SHOP AROUND

The information in this section is to assist readers in the continual search for components, kits, printed circuit boards and other parts for ETI projects and circuits.

ETI-342 Pulse-shaped CDI

Most of the components for this project should be readily available from the majority of electronics suppliers. You may have to shop around for the potcore for L1 and toroid for L2, however; we'd suggest you try places like *Geoff Wood Electronics* or *Radio Despatch Service* in Sydney, or *All Electronic Components* in Melbourne. The same places should be able to help with the more esoteric capacitors: C1, C2 and C6, and with the less common semiconductors D1, D10, Q4 and IC1. If you're after a complete kit, try *Altronics* in Perth, *Jaycar* in Sydney and *Rod Irving* in Melbourne. *Dick Smith Electronics* has advised that it may also be producing a kit.

ETI-170 CRO calibrator

The only parts in this project that are likely to cause any availability problems are the rotary switches, SW2 and SW3. These aren't as readily available nowadays as they were, although most suppliers should be able to get them for you even if they don't normally carry stocks. If you have trouble, suitable switches from the 'Lorlin' range (type RA for SW2, type CK for SW3) are available from *C& K Electronics Pty Ltd*, at PO Box 229, Parramatta, NSW 2150 or 15 Cowper Street, Harris Park. Phone (02)635-0799. For complete kits, try *Altronics*, *Jaycar* or *All Electronic Components*.

ETI-742 Speech-tailored speaker

The 6-inch speaker used in our prototype was from *Jaycar* in Sydney, type H16CP60-02C. Low in cost, it's ideal for the job; in fact the design is based on this speaker, so it would be unwise to make any substitutions. Everything else should be readily available.

ETI-666 Printer switch

The only parts in this project that may involve a little shopping around are the insulation-displacement connectors. You should be able to get these from *Geoff Wood Electronics*, *Radio Despatch Service*, or *Sheridan Electronics* in Sydney and from *All Electronic Components* or *Rod Irving Electronics* in Melbourne. *Jaycar* and *Altronics* would also be worth trying. If all else fails, or if you want to save money, solder-type Centronics plugs and sockets will be available from an even wider range of suppliers.

Artwork

Here are prices for this month's projects:

ETI-342: pcb — $3.30
ETI-170: pcb — $3.60; panel — $5.10
ETI-666: pcb — $2.15; panel — $1.60

Mark Lingane

COMMODORE PLUS/4

Commodore goes for the low-end business market! This powerful little package comes with built in business software designed to be really user friendly as well as 'user useful'. It's packed with features not offered elsewhere, so Commodore might be onto a winner.

THE NEW Commodore Plus/4 is the next generation 64. In brief, it can be described as having everything the model 64 should have had, but didn't.

The Plus/4 is something of a 'different' beast for Commodore. It is so-named because of the four applications programs *included in read-only memory in the machine.* Quite a departure for many computer companies, Commodore not excepted. The four programs are the sort of thing a small business person or freelancer could usefully use in day-to-day business: word processing, file management, spreadsheets and graphics. The four programs can *share and exchange* information and the Plus/4 has a 'split screen' or 'windowing' facility which allows viewing of the operating parts of two of the packages simultaneously.

For the record, the hardware has 64K of RAM (60K available to the user), a 'help' key (which *all* newcomers will make much use of) and an advanced version of BASIC for those who want to get into programming. It will work in conjuction with many of the VIC-20 and Commodore 64 peripherals. It costs only around $599 and, while aimed initially at the smaller business market, the Plus/4 is expected to appeal to home computer buffs, too.

Commodore Australia is no 'johnny-come-lately' on the computer scene. They've been operating here for four years and have sold over 200 000 computers, they claim, during that time. They have an Australia-wide network of outlets and a corporate structure to support increasing sales here, having undergone a bit of a rearrangement a few months back.

First impressions

The first thing you notice about the Plus/4 is its bold new look. It is charcoal black with white keys which gives a 'space' look to the whole machine. However, the keyboard has a 'clackety' feel about it which gives the impression of a cheap set of keys. All the graphics characters, and colour functions etc are printed on the keys giving the keyboard a cluttered look. The keys are easy to read though.

At last Commodore has included all the colour functions on the keys; something that was missed on the 64. Instead of remembering that to get the colour orange you need to press the Commodore key and the 2, now you just look at the key and it has the letters 'ORG' on it, indicating the colour orange.

New features

A new feature includes a flashing characters feature. Press the 'Flash' key and whatever you type will flash on and off. Ideal for warnings.

One of the most important new features is that of window capability. Not quite the same as Apple's Macintosh but still, it's a start. On the 40 characters by 25 lines you can define your own screen, for example, a 20 character by 10 line screen in the middle of the screen or a 40-by-5 at the bottom of the screen as a control window. Possibilities are limited only by your ingenuity.

The cursor keys are now arranged in a cross. That is, there are now four cursor keys, each one pointing in the appropriate direction. A great idea which should have been incorporated in the Commodore machines much earlier.

Another new feature included (as against omitted on the 64) is the Disk Operating System. Useful commands such as DIRECTORY, DLOAD, DSAVE, SCRATCH (deletes files), RENAME, BACKUP and many others are available. This feature is about the best one that could have been included on the Plus/4. The time that it will save and the ease of use is immeasurable, I think.

BASIC etc

Commodore has also included a decent BASIC this time round. It features a massive 75-word command/function vocabulary, including DRAW, SOUND, COLOR and many others. Commands are included for graphics, sound, editing and debugging. The Plus/4 is a real breeze to program without delving into the murky depths of machine code.

Speaking of machine code, the Plus/4, like the Commodore 16, has a built-in machine language monitor. This includes 12 powerful commands such as Assemble, Disassemble, Transfer and others which will make Commodore 64 owners sick with envy. What will make the 64 owners even more jealous is the fact that when they bought their 64 it boasted 64K of RAM with only 39K available, whereas on the Plus/4 the power-up message states that there is over 60K free for BASIC programming! I can see the previous 64 owners ▶

reaching for the bank book now. But *still* the Plus/4 has more features.

Plusses for the Plus

The function keys are predefined. This means that when you press them something happens; not like the 64 where they must be programmed. The keys can be changed by simply typing the word 'KEY' and all the functions that the keys are doing are displayed and can be altered.

The function keys and the powerful BASIC included means that you don't need to be a programming genius to use the machine to its full potential. Quite a different machine to the 64 in that way. This change may be caused by the fact that the Plus/4 is aimed at the business market and not the home user or computer boffin, and the business people who cannot always afford the time to learn how to program the machine to make it do simple tasks.

For example, to clear the high resolution screen on the 64 in BASIC took about two minutes and a lot of number remembering. On the Plus/4 one statement is required, SCNCLR, and is instantaneous. Which would you prefer?

Another business plus is that the Plus/4 fits into a brief-case very easily as it is about three quarters the size of the Commodore 64. The keyboard is the right height to minimise wrist fatigue, unlike the 64 which was too high off the table surface to facilitate hours of constant typing.

Graphics

The graphics have been improved greatly. Impossible, I hear you say! No so. Now, instead of having 16 colours to choose from you have 128. That is, 16 colours with eight shades each (though I cannot see how you can have eight shades of black).

The graphics can almost equal the supreme graphics of the Atari home computers. The high resolution screen has not changed much from the 64. It is still 320 by 200 pixels or 160 by 200 in multicolour mode (more than one colour on the screen at a time).

With the command GRAPHIC you can jump into high resolution mode. Following the command with the number two gives you four lines of text at the bottom of the screen, a feature which is fairly common to most forty character screens.

Sound

With the sound it looks as though Commodore has taken a backward step as they have dropped the powerful programmable SID chip and replaced it with a more common tone generator. This step was most probably done with business use in mind. Sound enveloping and programming ADSR might seem a bit excessive if you only want to produce simple monotonic sounds.

On-board software

The real strength behind the Plus/4 is what comes on board and how its name is derived. On board there are four business packages; word processing, spreadsheet, database and a graphics package. This makes the Plus/4 a sort of 'Super-Adam' (Colecovision's home/business computer system).

Each of these programmes can be accessed by pressing just one key. The ultimate for business? — a complete office at the touch of a button! But if Commodore wishes to pursue the lower end business market they definitely need an 80 column alternative. This I think is the only weak point of the Plus/4.

Summary

The Plus 4 has many plusses and very few minusses. I am almost tempted to say that it has everything that a computer user might want. But that would mean that the Commodore Plus/4 is the perfect machine. I don't think we are at that stage of the ultimate computer, but the Plus/4 takes us that one step closer. ●

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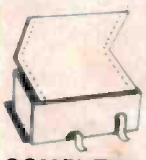

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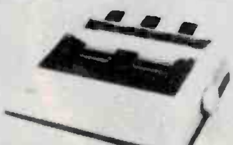

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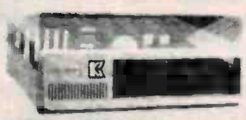

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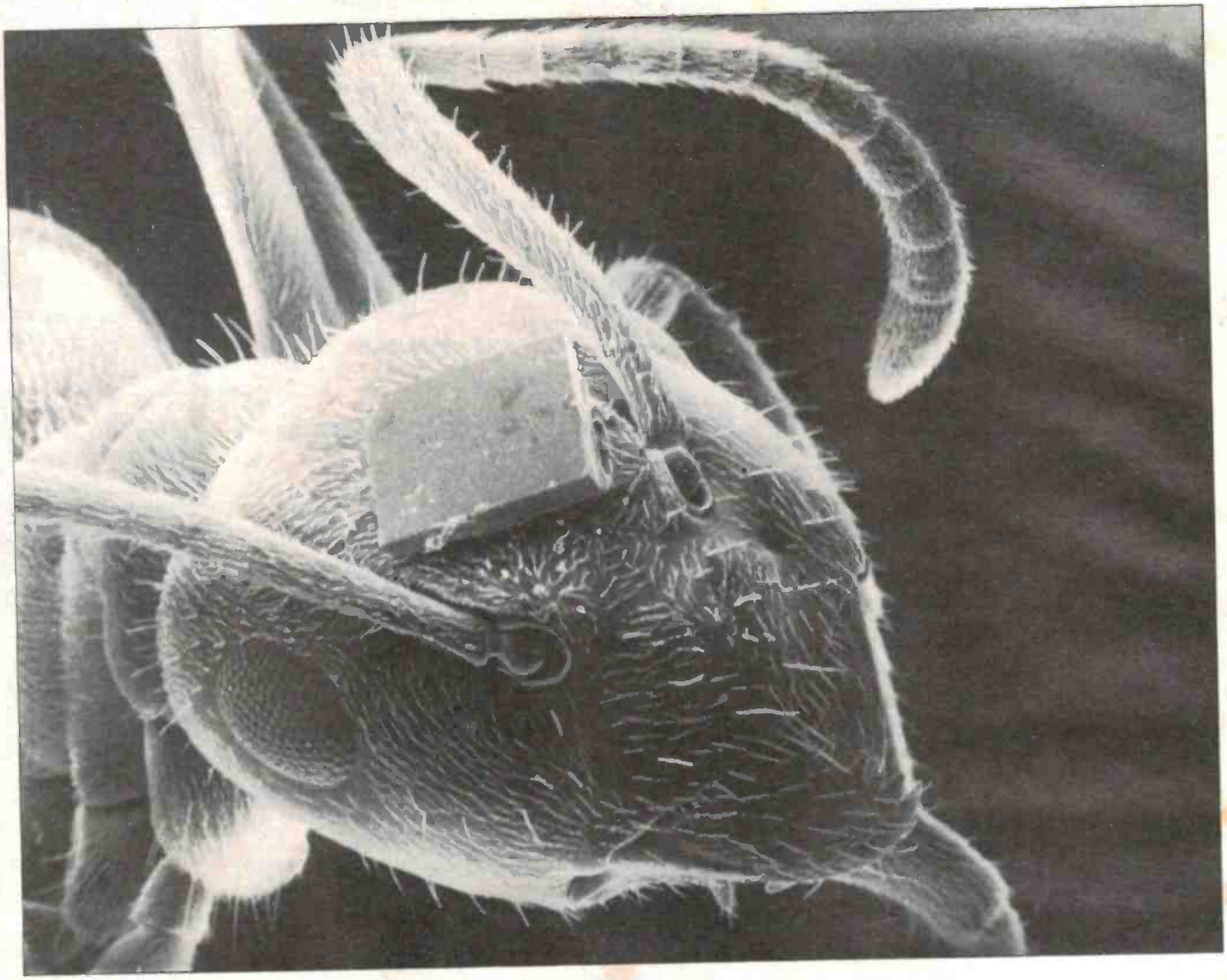

Ants

We received the picture above from an outfit calling itself British Telecom. I take it this is the pommy version of our own dear phone company. Anyway, this go ahead organisation has designed a chip configured as a laser to project pulses of light through hair thin optical fibre.

The electron microscope pic shows just how small the chip is — that's an ant's head it's sitting on.

Questions arise. Why is it so small? What is it doing on an ant's head? Is it really a chip at all?

At a recent lunchtime brain storming session, held at an establishment not terribly far from our office, ETI staffers tried to solve this and other mysteries of the universe. Numbers between 41 and 43 were not well received. Neither were references to flea brains.

One thought held that this was the British answer to threats to the empire. The idea being that the chip is actually an extremely clever mind control device embedded in the ant's brain. By judicious selection of ant types it should be possible to find animals that will eat just about anything. So it becomes possible to direct legion after legion of ants to attack the enemy telecommunications and energy supplies, eat his bridges and buildings, destroy tapes and magnetic recording media. In short, to really screw things up.

The idea is not new. For a while the CIA (why does every Australian wind up talking about the CIA sooner or later?) was training dolphins to carry explosives to enemy shipping. They gave up on the idea when someone pointed out that the dolphins might get such a kick out of blowing up enemy ships they might start blowing up friendly ones as well. (Of course, the mathematics of this situation start to look very different if you come from a country without much of a navy . . .).

Other thought provoking military applications were suggested. For instance, the ants could be liberated in enemy territory, each with this little laser cap on its head. When approached by the enemy the laser can be used to zap them. It's a sort of cheap star wars scenario. (And hopefully about as practical.)

Non military uses? Well, what about a radio transmitter so that entomologists can keep track of bugs and other small animals. What about medical uses? As long as doctors like sticking things into, up, down and through our collective bodies, there should be a place for a device like this. In fact, if you think about it, it really gives new meaning to the phrase: "ants in your pants".

Going . . . going . . .

Several pubs in the Waterloo, Zetland area of Sydney have reported a significant downturn in profitability since the demise of a large bearded person with a raucous laugh from this area. He was last seen staggering from the Doncaster Hotel in the direction of greener pastures. It is not known whether the pubs will survive this trauma.

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