STILL ONLY $2.60! NZ $3.50

February 1986

The Australian Electronics Monthly

excitement electronics

SPEECH SYNTHESIS

— technology & techniques

POLICE RADAR — faults & fallacies

Active crossover project

Amateur 70 cm band beam to build

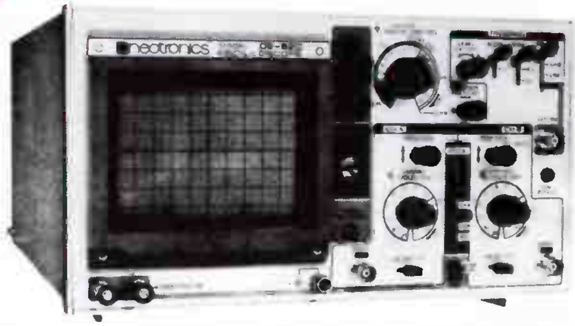
Commodore Amiga reviewed

DOS — what it's all about

• Datasystem 1 PC-compatible reviewed • A peak-reading LED RF wattmeter • Getting cheap hard copy for the Commodore 64 • New NAD preamp/power amp reviewed

NOW WITHIN YOUR SCOPE

OS-620



only **$595**

$682 INCL. TAX

● Bandwidth 20MHz ● Rise time less than 17 n sec. ● 5mV/DIV sensitivity ● Channel A, channel B, dual, add, subtract ● Component tester ● X-Y mode ● TV video synch filter.

OS-615S

- Rechargeable battery operated 6 hrs. operation
- Bandwidth 15MHz
- 2mV/DIV sensitivity
- Dual channel
- 95cm rectangular screen
- Ideal for field work

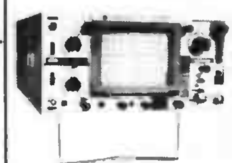
$785 **$896** INCL. TAX

OS-635

- Bandwidth 35MHz
- Rise time to 10 n sec.
- Sensitivity to 1m V/DIV
- 6KV acceleration
- Delayed sweep
- Trigger hold off
- Alt. trigger
- Single sweep

$835 **$961** INCL. TAX

OS-645



- Top of the range
- 45 MHz bandwidth (usuable to 70MHz)
- Signal delay
- Trigger delay
- 15KV acceleration
- 5mV/DIV sensitivity (1mV at reduced bandwidth)

$1285 **$1475** INCL. TAX

ALL SCOPES AND METERS ARE FULLY GUARANTEED WITH A 12 MONTH WARRANTY.

DELIVERED ANYWHERE IN AUSTRALIA $7.50 for SCOPES AND $3.50 for METERS

TAKE YOUR PICK OF TOP QUALITY METERS.

THE RUGGED ONES.

Pushbuttons or rotary selections

- DISPLAY: 3½ digit LCD. 0.5" height, with polarity and LO bat. indication.
- OVERRANGE INDICATION: 3 least significant digits blanked.
- MAXIMUM COMMON MODE VOLTAGE: 500V peak.
- OPERATING ENVIRONMENT: 0° to 50°C- less than 80% relative humidity up, to 35°C, less than 70% relative humidity from 35°C to 50°C
- TEMPERATURE CO-EFFICIENT: (0° to 18°C and 28° to 50°C) less than 0.1 applicable accuracy specification per °C
- POWER: 9V alkaline or carbon-zinc battery (NEDA 1604)
- BATTERY LIFE: 1000 hours typical with carbon-zinc cells, 2000 hours with alkaline cells.
- BATTERY INDICATOR: Display indicates "LO BAT" when less than 20% of life remains.
- DIMENSIONS, WEIGHT: 170mm x 87mm x 42mm, 343 grams.

only **$69**

$78 INCL. TAX

neotronics

FOR HIGH TECHNOLOGY ELECTRONICS

37 Ryedale Road West Ryde NSW 2114 Australia.
Telex AA 73264 Phone (02) 807 4739

VISA MasterCard

BUY DIRECT AND SAVE

Phone on the Hotline (02) 807 4739 Avoid disappointment. Order your Scope or DMM by bankcard on the phone. Just call up, reverse the charges and we'll take your order.

Prices correct and goods expected in stock at time of going to press.

The Australian Electronics Monthly

THE BACKBONE of any technological industry, and in particular any fashionable 'high technology' industry, happens to be engineers. Without the engineers, any technological activity is utterly dependent on 'outside' input and assistance. It is taken 'as read' that if Australia is to not just maintain its position amongst trading partners, but to actually advance, then we must encourage development of technology-based and high technology industries. For that, we need skilled people. Compared to our significant trading partners, we're way behind in training skilled people.

Two years ago, around 8% of Australians entering the workforce for the first time had tertiary qualifications. At that time, the figure for Japan was — 35%! The Koreans are currently ahead of the Japanese with around 40% of those entering the workforce having tertiary qualifications.

Getting down to specifics — Australia annually trains 146 engineers per million of population, compare this with Japan where 649 engineers per million of population are trained annually. In Britain, the figure's 250, West Germany — nearly 300. What a dismal performance from Australia!

Choice of engineering as a career starts with motivation of children at school. Is it part of Australia's palpable "technological cringe" that tertiary training in an engineering faculty is seen as 'the hard road', while the humanities are seen as the 'soft option'? Just any tertiary qualifications are no guarantee of a place in the workforce.

The Government's recent introduction of incentives for young people to undertake tertiary courses is a step in the right direction, but engineering as an attractive choice among the broad variety of options requires some 'education' — even 'marketing' — within our schools. A hobby interest often provides the motivation for a career choice. Passive consumer 'entertainment' — television and the video — is alleged to have had a marked negative effect on hobby activity among young people in recent years. The whole situation needs turning around. Who dares such a task?

Roger

Roger Harrison
Editor

CONTENTS →

Roger Harrison VK2ZTB
EDITOR

David Tilbrook B.Sc.
PROJECT ENGINEER

ADVERTISING/MARKETING
John Whalen

PUBLISHER
Adrian Farrow

DRAUGHTING
David Currie

PRODUCTION
Marni Raprager
Lisa Rathgen
Angela Wilcox

ACOUSTICAL CONSULTANTS
Robert Fitzell Acoustics Pty Ltd. AAAC

EDITORIAL ASSOCIATES
Neil Duncan VK3AVK
B. App. Sci., Dip. Ed., M. Ed. Studs
Alan Ford FIAADP MBIM VK2DRR/G3UIV
Tom Moffat VK7TM
Jonathan Scott VK2YBN
B. Sc./B.E. (Hons)
Bill Thomas B.A.
Kerry Upjohn M.A.

TYPESETTING
Authotype Photosetters Pty Ltd
397 Riley St. Surry Hills 211 5076

Published by: Kedhorn Holdings Pty Ltd. an associated company of Westwick-Farrow Pty Ltd. WB Building, Cnr Fox Valley Rd & Kiogle St. (PO Box 289) Wahroonga 2076 NSW
Ph: (02) 487 2700 **Tlx:** AA71460 Sydney Whats New. International AA10101 Whats New.

Subscriptions: $31.20 Australia, NZ$45 New Zealand; overseas rates on application

Australian Electronics Monthly is printed in 1985 by Offset Alpine, Cnr Wetherill & Derby Sts, Silverwater, NSW, and distributed by Network Distributing Co. *Cover price $2.60 (maximum and recommended Australian retail price only, recommended New Zealand retail price, $3.50). Registered by Australia Post, Publication No. NBP 7435. ISSN No. 0815-5046.

ENQUIRIES
Advertising: John Whalen (02) 487 2700
Editorial: Roger Harrison (02) 487 2700
Technical: David Tilbrook (02) 487 1483 only after 4.30 pm EAST

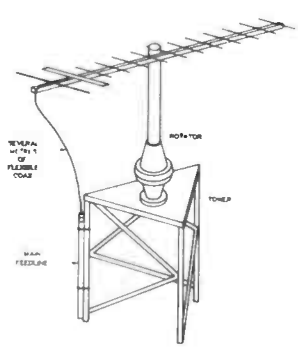
Vic. Ad. Sales: Saddleton Cox & Assocs, 13 Stewart St, Mount Waverley 3150; (03) 233 7933.
Pam Stewart or Leon Trimmings
Melb Correspondent: Ian Boehm c/- Saddleton Cox, (03) 233 7933.
Qld Ad. Sales
PO Box 247, Kenmore Qld 4069; (07) 202 6813.
Sue Horne or Rosemary Lergessner
W.A. Ad. Sales: Hugh Scott, 122 Aberdeen St. Northbridge WA 6000, (09) 328 9177

ADVERTISERS INDEX

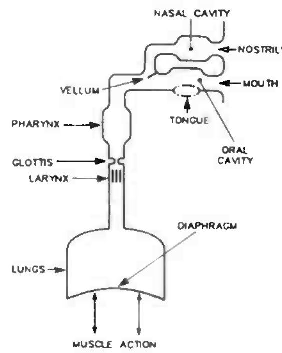
COVER

This month's cover feature is speech synthesis. The computer keyboard and monitor are from Dick Smith Electronics. Photography by Mark Rowland. 'Ralph' the Cocky was shot with assistance from Featherdale Wildlife Park. Design by Marni Raprager.

PROJECTS TO BUILD



CIRCUITS & TECHNICAL

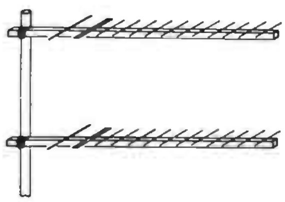


PRACTICAL COMPUTING

Weller Crossword
Crossword No. 7 will appear next issue, giving you time to submit No. 6, from the January issue, for which entries close last mail February 17th.

NEXT MONTH!

BUILD AN ELECTROMYOGRAM
Ever wanted to dabble into 'biofeedback', but didn't know where to start? This is no 'gimmick' project — you'll be able to get real use out of it. The unit picks up the minute electrical impulses generated by muscle activity and gives a sound 'feedback' signal. You can use it to explore what happens with your bodily actions and reactions, as well as for relaxation via biofeedback.



'STACKING' YOUR YAGIS
So you've built one of our Star Project 13-element UHF Yagis but would like to improve your antenna performance further. Build another one and 'stack' the pair for more gain. You need a 'phasing harness' to feed them — here's how you do it.

GETTING IN AND OUT OF THE MICROBEE
Tom Moffat explains the mysteries of the Microbee's parallel I/O port and how it takes in and puts out data.

CLOSE EYE ON COMET HALLEY
The satellite Giotto will make a close encounter with Halley's Comet over the next few months, providing scientists and the world with a unique view. This article explains what the mission's all about and what is hoped will be achieved.

* The Radio Communicators Guide to the Ionosphere and Electronics For Starters had to be held over this month due to lack of space. Look forward to them next month.

While these articles are currently being prepared for publication, unforseen circumstances may affect the final contents of the issue.

The Great business offer from Microbee

THE 128K SMALL BUSINESS COMPUTER

Microbee Small Business Computers are already providing invaluable help to thousands of Businesses around Australia, indeed around the World. It would seem that there are few professions or areas of commercial endeavour that cannot be streamlined or made to be more "accountable" with a Microbee Computer.

Butchers, Bakers, etc.

Users range from publishers to pathologists, even car yards are finding the Microbee Small Business System the cost effective technology tool that keeps their records straight, their correspondence in order, and keeps them in touch with the fast moving world of Data Communications and Videotext Services.

SPECIAL OFFER

'Living Letters Package'

The Complete Word Processor with WordStar Pro Pack and DP100 Printer $1995 Inc. Sales Tax

The Software You Need

With the Microbee's now famous Bundled Software and CP/M operating system most routine computer functions are catered for without spending another cent, but it is highly likely that it is in the area of specialist applications software that Microbee scores most points. With so many third party software supplies able to provide specific solutions at realistic costs that don't in themselves create problems (check the prices of software to run on so called Compatibles).

User Friendly Interface.

Every Microbee Small Business System has its own user friendly 'B-Shell" which allows the easy choice of software by simple one finger selection of self explanatory ICONS. A comprehensive Help system is supplied and 'housekeeping' functions are simplified.

Australian Guaranteed

Built to exacting control standards and World class quality the Microbee System is particularly robust remember the Microbee was first developed for use in schools, and in fact the same machine is in extensive use in schools, both in Australia and overseas.

The Complete Business Package

The Microbee Small Business System comprises:

Microbee 128K Computer
Dual 400K 5.25" Disk Drives
High Resolution Monitor
DP100 Dot Matrix Printer
Cables and full set of manuals plus

Bundled Software

worth hundreds of dollars including—WordStar/Mailmerge 3.3, Microsoft Basic, Microsoft Multiplan, MicroWorld Basic, Telcom Communications Package, Full range of support utilities, Comprehensive Training Guides and Tutorials, A complete library of manuals so you can easily and quickly gain the maximum benefit from your system is also included.

The Price

For the complete Small Business System only $2395 including Sales Tax.

As many of the Microbee Systems out there are used extensively for Word Processing with little need for Microsoft Multiplan, the new **'Living Letters Package'** has no Multiplan or Microsoft BASIC. But it does have **The Complete WordStar Package** to bring life to your writing and considerable savings to your pocket.

EXCITING NEW OPTIONS

As part of Microbee's Product Innovation Program, new releases which will shortly be announced include:

The DP100 NLQ or Near Letter Quality Printer.

The MB 7030 High Resolution (0.38 pitch) RGB Colour Monitor.

The MB 3010 Green Screen Monitor.

The ESE Economy RGB Colour Monitor.

microbee computer

Designed and manufactured in Australia by Microbee Systems Limited

PHONE ORDERS ACCEPTED bankcard

Microbee Technology Centres

New South Wales
1 Pattison Avenue,
Waitara, N.S.W. 2077
Phone (02) 487 2711

2/956 Hunter Street,
Newcastle West, N.S.W 2302
Phone (049) 61 1090

Koala Crescent,
West Gosford, N.S.W. 2250
Phone (043) 24 2711

Microbee Education Technology Centre
Unit 2, Eden Park Estate,
31 Waterloo Road,
North Ryde, N.S.W. 2113
Phone (02) 888 9866

Victoria
50-52 Whitehorse Road,
Deepdene, Vic. 3103
Phone (03) 817 1371

South Australia
117-119 Gouger Street,
Adelaide, S.A. 5000
Phone (08) 212 3299

Western Australia
141 Stirling Highway,
Nedlands, W.A. 6009
Phone (09) 386 8289

Queensland
455 Logan Road,
Stones Corner, Qld. 4120
Phone (07) 394 3688

Model Shown
128K Small Business Computer
with Bee Modem

ART PROM 2868

New semiconductor assembly technology

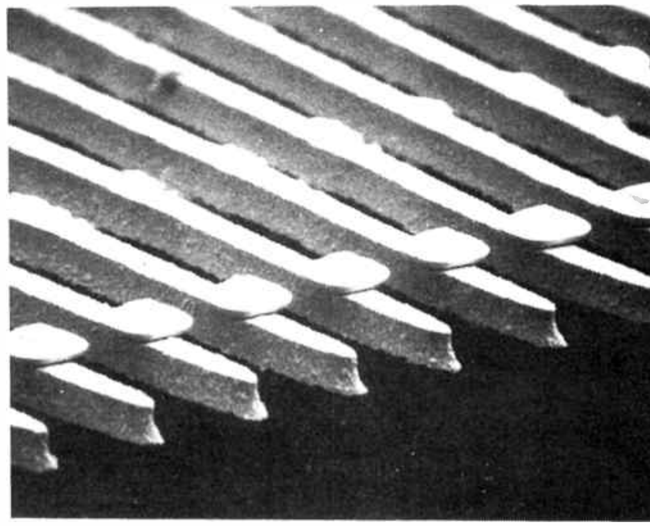
Matsushita Electric Co Ltd, the manufacturer of brands National, Panasonic and Technics, has concluded a licensing agreement with the Shindo Company Ltd, a leading manufacturer of film carriers for semiconductros, for new semiconductor assembly technology called Film Carrier Assembly Technology, "Transferred Bump TAB (Tape Automated Bonding)."

The current film carrier assembly method is effective in making IC chips thinner and smaller, making electronic equipment such as IC cards and liquid crystal displays more compact. Its only drawback is complicated and expensive processes, especially the process of forming electrode bumps which bond leads with an IC chip.

Matsushita claim their new approach to forming bumps is unique. The bumps are formed on the film carrier, rather than on the IC chips as is done in the conventional film carrier method. The bumps are first formed on a glass substrate and then transfered to the film carrier leads. The film carrier is bonded to an IC chip by heat pressing. Bumps can be refabricated on the same substrate.

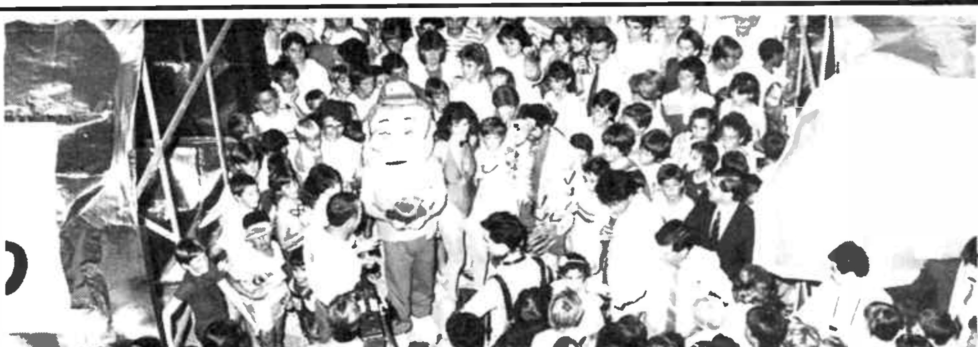
The process of forming bumps on the film carrier is much simpler and much less expensive than forming them on a substrate. The method also allows repeated use of the substrate and flexible selection of chips, reducing assembly costs.

As a result of commercialization of the technology, the use of film carrier type ICs and LSIs is expected to increase, promoting compactness of equipment.



Matsushita is ready to license the new technology to semiconductor and electronics manufacturers throughout the world to meet strong demand for such technology.

The Shindo company will soon begin supplying film carriers assembled by the new technology to semiconductor industry including semiconductor makers and electronic equipment manufacturers.



Little Dick pulls it off at Bankstown Square for the world record bon bon bang.

LITTLE DICK GETS A BIG BANG OUT OF LIFE

'Little Dick,' alter ego of the Dick Smith Electronics organisation, got a lucky break on Friday the 13th last December when he took part in the world-record breaking bon bon bust at Sydney's Bankstown Square along with stars of stage, football, radio and centrefold — comedian Rodney Rude, footballer Ray Price, 2WS's Peter Graham and Playboy Playmate Ali Lynwood.

The giant bon bon, constructed to celebrate Dick Smith's December 'Bon Bon Bonanza' promotion, was 21 metres long and over three metres in diameter. It was stuffed with toys and presents donated by the public which were subsequently distributed by the Variety Club to underpriviliged and handicapped children throughout Australia.

The bon bon pull went off with a big bang and made the Guiness Book of Records. Little Dick spent much of his time in December helping distribute the toys to various children's hospitals. Another, even bigger, bon bon is planned for December this year.

The Little Dick cartoon character has appeared in Dick Smith promotions for the past few years, but the live character first made his appearance the day DSE's Gore Hill store was demolished (see News Review, December AEM, p.9). Cast by DSE as a 'good guy,' the organisation has plans for him to tour throughout Australia, " . . . making life happier and fun for disabled, handicapped and sick children."

Little Dick giving the first of gifts from the bon bon to a child from the NSW Spastic Centre.

Telecom's AXE helps your fingers do the pressing

Pressing buttons is easier than twiddling old fashioned telephone dials and wearing away the guts (yours, not theirs). But exactly what happens when you press those buttons? Usually deafening silence while logic inside your telephone twiddles simulated dials and pulses out the familiar (Strowger) ten pulse per second signal. This crude signalling method makes and breaks the loop to the line, which in turn actuates mechanical switches at the exchange.

The Strowger system was developed in the late 1800s by an American undertaker who became tired of losing business to his competitor across the road via the manual switchboard operator, who, being a relative of the competitor, diverted all calls intended for the victim. Although a sound concept, as witnessed by its survival to the present day, the Strowger system and its later replacement, the crossbar system, are clearly behind the times.

However, if you are lucky and live (or work) in the right place, meaning in an area served by a ▶

ELECTRONICS TOUR TO SINGAPORE

A Sydney specialist tour operator, Torii Tours, is organising a group tour of Singapore for people interested in electronics, either professionally or as a hobby. It will depart on July 13th, 1986.

The nine-day tour will include visits to manufacturers and assemblers of electronic equipment. A visit to an IC producing factory is now being organised. Some local sight-seeing tours will also be available.

Singapore is a major manufacturing centre, with subsidiaries of well known companies such as Philips, Sanyo, NEC, Molex and Matsushita being represented. Duty free shopping is always an attraction of overseas travel, and many take this opportunity to buy videos, cameras or communications gear. Current Singapore prices for Amateur transceivers are a bit below Australian prices but when the full effect of the devaluation of the Australian Dollar flows through to new equipment in the next few months, the difference will be much more marked.

For those people in the trade, the contacts made could be very beneficial. As this is a fact-finding tour, some taxation benefits could apply.

For further information, contact **Paul Rodenhuls, VK2AHB at Torii Tours, 7th Floor, 130 Phillip St, Sydney. (02) 231 2214.**

new AXE exchange, then when you press the buttons on your telephone you will instead hear the somewhat unmusical noise of VF (voice frequency) signalling. Each button generates a unique two-tone standard code which instantly carries out the necessary switching at the exchange.

These electronic exchanges, made by Ericsson, offer more than just the convenience of speedy connection. Telecom's "Easycall" facilities include such features as: abbreviated delayed hotline, where on lifting the receiver and taking no further action a predetermined number (e.g: emergency or relative's) is automatically called; and of great interest to those who do business from home, there are "call waiting", "third party" enquiry and "call diversion" facilities.

With the call waiting facility invoked, the subscriber may carry on a normal conversation with another party, and another caller ringing in will, instead of hearing engaged tone, hear normal ring tone, while the called party hears a distinctive beep as a background to his existing connection. He may now put his first caller on hold and speak to the second, switching between them at will and even connecting them together to make a three-way conference call.

And all this down the single telephone line!

Should said home businessman wish to repair to his local hostelry, provided it is on the same exchange (this facility will be extended to other exchanges later), he may, by keying in a code, automatically divert all calls to wherever he will be

Data on Japanese semiconductors

Looking for data on Japanese semiconductor devices? Arguably the best source is the set of data manuals from Japanese publishers, CQ. Often hard to get, the Melbourne-based company Imark advise they have again secured a limited quantity of the 1985 manuals.

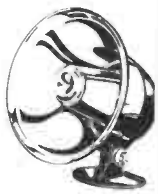
There are thirteen manuals in the set, which comprises: The Transistor Manual, Transistor Substition Manual, The Diode Manual, FET Manual, two Op-Amp manuals, The Linear IC Manula, TTL IC Manual, CMOS IC Manual, Memory IC Manual, Power & Industrial Semiconductor Manual, Interface IC/Device Manual, and an A-D/D-A Converter Manual.

Data from over 30 manufacturers is included, covering thousands of devices. The manuals range in size from around 220 pages to over 400 pages. Each costs $12.50 plus $5.00 post and packing charge for one to 13 manuals. Contact **Imark, 167 Roden St, West Melbourne 3003 Vic. (03) 329 5433.**

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

SUPER SAVINGS ON DSE ALARMS..THEY'RE A STEAL!

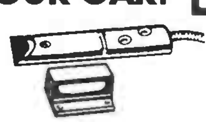
ALARM HORN SPEAKER NOW $4 OFF!



Use on alarm systems with siren (speaker) output. Weather-proof plastic body ideal for outdoor use. 8 ohm impedance.
Cat C-2705

Was $11.95 NOW $7.95

SECURE YOUR GARAGE & PROTECT YOUR CAR!



Reed switches designed for garage roller and overhead doors. Connected to security system provides full property protection.
Cat L-5220 ~~$29.95~~ NOW $14.95

APPLIANCE ALARM

AT $60 OFF IT'S A STEAL!

Brilliant! Plug in TV, VCR, etc. (up to 4 appliances) to control unit ... if an intruder tries to lift them an alarm sounds. Even add security sensors for an affordable home alarm system.
Cat L-5052

Was $129 $69

BOAT ALARM WE'VE SUNK $70 OFF

Cat L-5098

Face it — you're not on your boat 24 hours a day, 7 days a week. Your boat and valuables are vulnerable. But with this DSE alarm system, you're covered. Package features strobe light, electronic siren and magnetic switches. PLUS multiple protection zones allows you to tailor system for individual requirements.

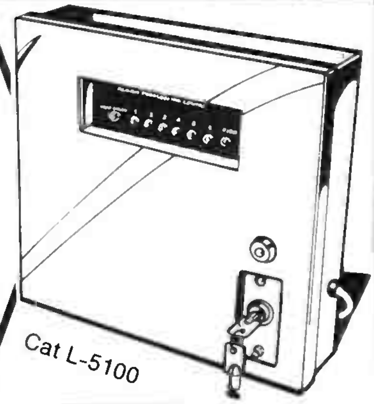
Was $169 NOW $89

VALUE $20 OFF

SECURITY CENTRE ...

Pro quality security for home and commercial use — at a fraction of the cost! Centre suits most popular detection devices: reed switches, etc. Controls 6 sectors — any of which can be isolated — with selectable instant or delay alarms. Steel casing and battery backup provision makes it virtually tamper proof.

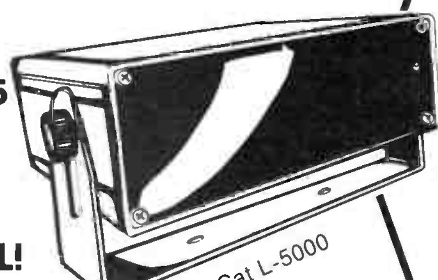
Was $199 NOW $179



Cat L-5100

SAVE $40

MICROWAVE DETECTOR



Cat L-5000

Take the right step towards effective home security. This affordable unit uses discreet microwaves to detect movement — up to 7.5m! Ideal for room surveillance or covering entry/exit points. Works through some plaster walls and ceilings. Adjustable sensitivity.

Was $119 NOW $79

SAVE $20

PASSIVE INFRARED DETECTOR

Top of the line movement detector — used by banks, etc. for reliable protection! Covers broad areas, detecting movement by changes in body temperature — up to 25m. Dual element sensors minimise false alarms, adjustable to compensate for house pets.
Cat L-5010

Was $119 $99

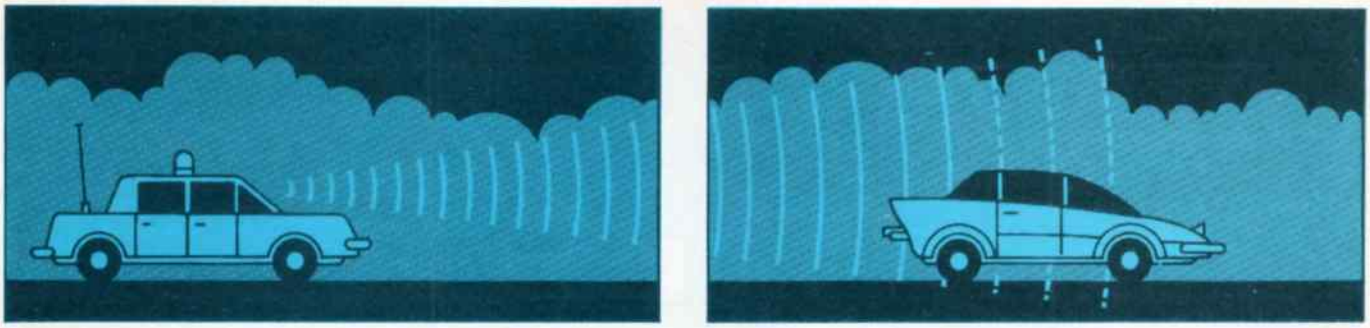
Superb Quality Made in Switzerland

ACCESSORIES? You name it ... DSE has it! A complete range of security peripherals to expand and compliment any security system.

DICK SMITH ELECTRONICS PTY LTD

SEE ADDRESS DETAILS PAGE 88

B.111/CW



Honesty, fallibility and police radar

Jonathan Scott

Are police radars accurate, fair and reliable? Well, that depends entirely on the circumstances. The machines may be reliable and generally accurate, but are operated by people, and people are fallible. Then again, even when correctly deployed, the machines can be 'fooled'. Jonathan Scott reviews the technical and practical questions that still cloud the use of the police radar.

OVER THE YEARS since its introduction there has been a tremendous furore over the use, by Police of Doppler radar for apprehending speeding motorists. The radar system and its mentors have been accused of malpractice, inaccuracy, dishonesty and incompetence. Some cases have been won against it on technical grounds, some on non-technical grounds, and a lot have been lost due to a lack of any concrete evidence from anything but the device itself. Now much of the dust has settled, the boffins on both sides have agreed just what it is capable of, and on the whole there is agreement on just what should go on when one is being used. The instructions for using it are better understood by the teachers, and, in NSW at least, the Police using it are better instructed in how to do it honestly and with legal certainty. Is this the end of the conflict?

This article examines how the beasts "think" and what they can tell in any given situation, described in layman's terms. It describes how the machine is used and when it is used wisely. It also describes what can go wrong, and what to do if you feel that it has unfairly caught you. We discuss how the situation might be improved, and what research is being done towards this.

The operation of radars in general

The scientific principle behind the operation of Doppler radar is well known. The radar bathes the area to be scanned with a radio signal, usually at a frequency either 10 GHz ("X-band") or 22 GHz ("K-band"), because two slots in that part of the radio spectrum have been put aside for this sort of system. Everything " in the beam" returns a signal of some sort — everything.

Jonathan Scott is an engineering specialist in radar technology. He has been involved in investigations into Police radar over the past five years and has extensive court experience as an expert witness.

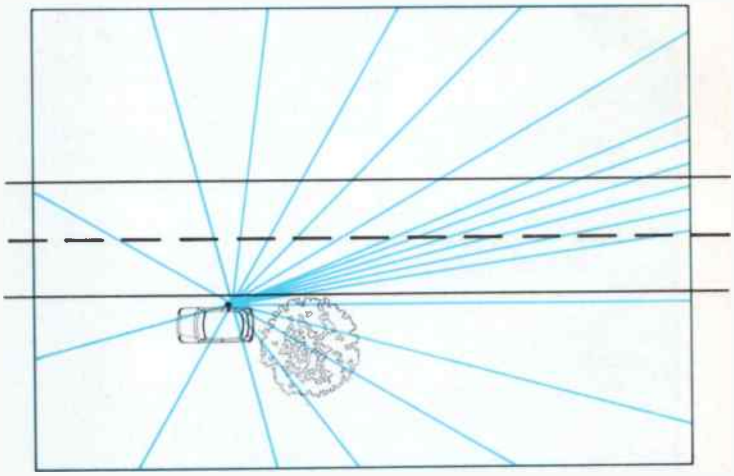


Figure 1. The down-the-road radar beam. The density of lines represents 'strength' of the beam. Remember that the beam is theoretically infinite in length in all directions.

There has been a lot of needless argument in courts over just what area is "illuminated" by the beam. The units have reasonably narrow beamwidths, of the order of 10°. This means that 5° off the centre-line along which the radar points, the illumination is halved. However, this does not mean that there is not a useful amount of illumination beyond that point.

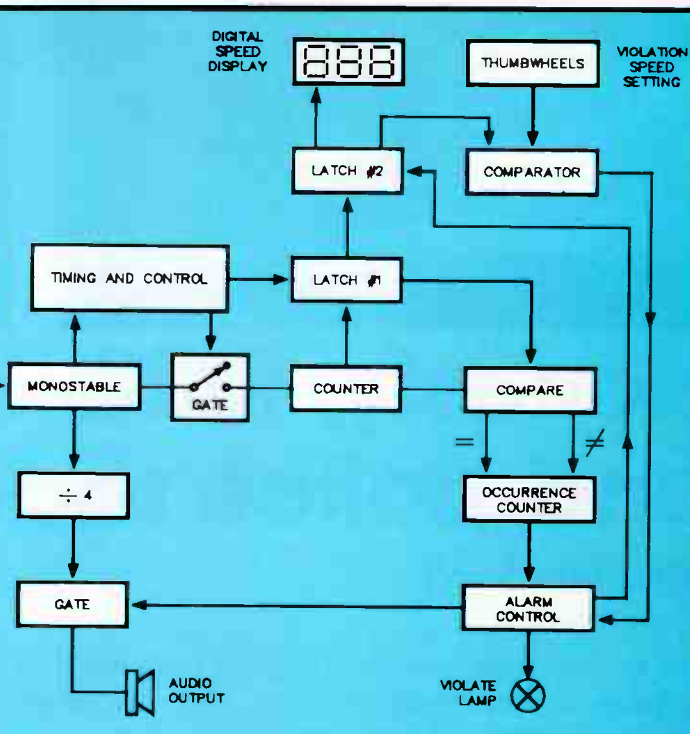
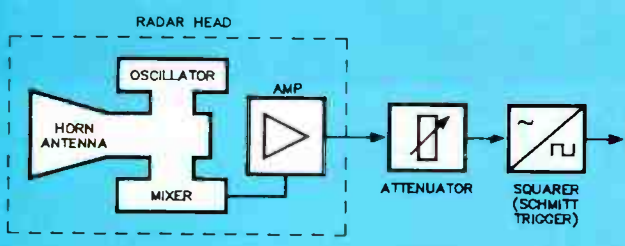
The rate at which the beam weakens as you move sideways is gradual, just as the light from the spotlight in your back garden weakens as you look further aside from where it is pointing. It does not have a totally pencil-like shape like a laser beam. As will be pointed out soon, the signals that the radar 'sees' vary so much in strength (brightness, to continue the spotlight analogy) that even the "light" (radio waves) leaking *backwards* can be enough for the unit to "see" by, in some more extraordinary cases. The halving which occurs at the beamwidth is really a drop in the ocean! ▶

'Illustrations above from Uniden RD9 radar detector manual, courtesy of Dick Smith Electronics.

POLICE RADARS — the technology

The Digidar Unit

The Digidar radar speed monitor was the first used in New South Wales. It has not been made for some years now, and represents very old technology. It is constructed with 741 op-amps and MSI TTL ICs, and came out when the desktop four-function calculator represented a significant engineering feat. It has three basic sections: a Doppler module, an analogue processing circuit, and a digital processing circuit.

The Doppler module is rather different in construction to the cast metal horn and cavity jobs seen in microwave burglar alarms that cost around $40 today, but it has the same electronic function. It generates the radar signal using a single Gunn diode run as an oscillator off a regulated supply, and receives with single Schottky diode acting as a mixer.

The analogue section consists of an audio frequency preamplifier followed by an op-amp connected to act as a zero crossing detector. The output of this comparator circuit is conditioned for TTL levels, and fed to the digital circuit. The resulting squarewave is all the digital circuit knows of the external world.

The digital circuit is basically a counter whose input gate is opened for a specific period of time — just like a digital frequency meter (DFM). The period of time is chosen to allow the counter to accumulate just the right number of pulses to directly hold the speed in kph or mph as required. Since the Doppler frequency at 10 GHz is about 30 Hertz per kilometer per hour, the interval is 1/30 seconds. It has one refinement over the circuits of early DFMs in that it takes six readings of the frequency of the bit stream, and if it gets the same answer six times in a row, it figures that the answer is stable enough to be reliable and displays it, etc. There is provision for sounding an alarm if a preset value is exceeded and to latch the number in the counter if desired when this condition occurs.

Why the information contained in zero crossings acts to select one signal, with the statistical averaging of frequency which the large gate time gives, is better understood these days from digital speech processing technology; in the time of the Digidar unit it was merely observed that most of the time one steady answer was displayed with the interval used. The gain of the preamplifier was made variable and the control labelled 'range', because it effectively set what strength of signal was needed to trip the comparator.

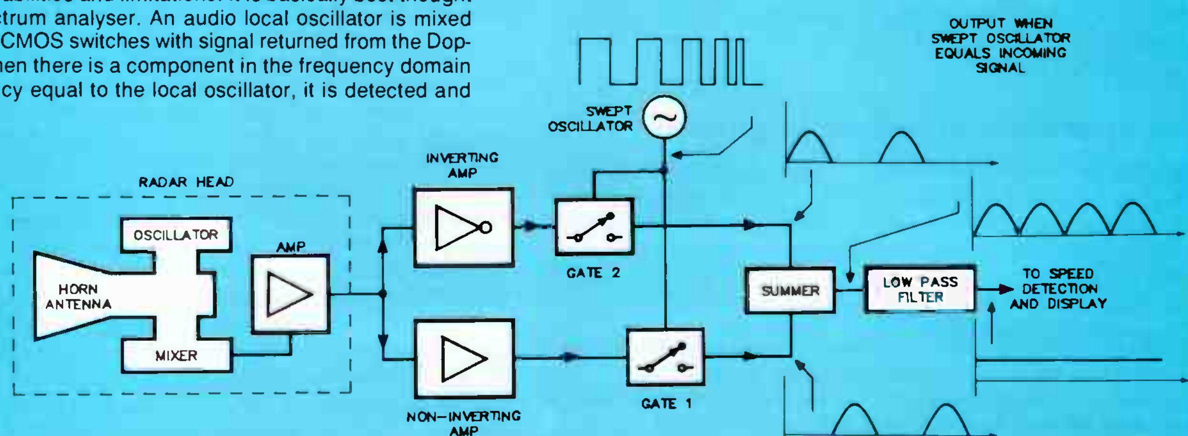
The KR-11 Radar

The KR-11 radar also contains the three functional blocks of Doppler module, analogue section and digital section. However, the digital section is microprocessor-based, the analogue section quite comprehensive, and the Doppler module is compact and operates in K-band. It reflects modern technology throughout, although it is not quite state-of-the-art.

The Doppler module is effectively the same as that in the Digidar (or a burglar alarm for that matter). It operates in the K-band, near 22 GHz, and so is smaller, and has a higher Doppler frequency and a narrower beamwidth for its size. It is otherwise unremarkable.

The analogue section is the crucial part to the understanding of its capabilities and limitations. It is basically best thought of as a spectrum analyser. An audio local oscillator is mixed by means of CMOS switches with signal returned from the Doppler unit. When there is a component in the frequency domain with frequency equal to the local oscillator, it is detected and its strength measured. The machine may then 'view' the spectrum or any part of it by moving the local oscillator suitably. With this power, the digital section can be armed with much more information about the environment in the field of the radar's view.

The digital section handles the 'human interface', which means the controls, as well as managing the analogue section. It can look for the fastest vehicle by seeking the highest frequency component in its range; it can deduct the speed of the vehicle in which it may be mounted from that of the target, allowing it to be used from a moving car. It is rather a shame that the programming does not allow it to search for *other* vehicles, of which it is easily capable, so that it might alert the operator to this situation.



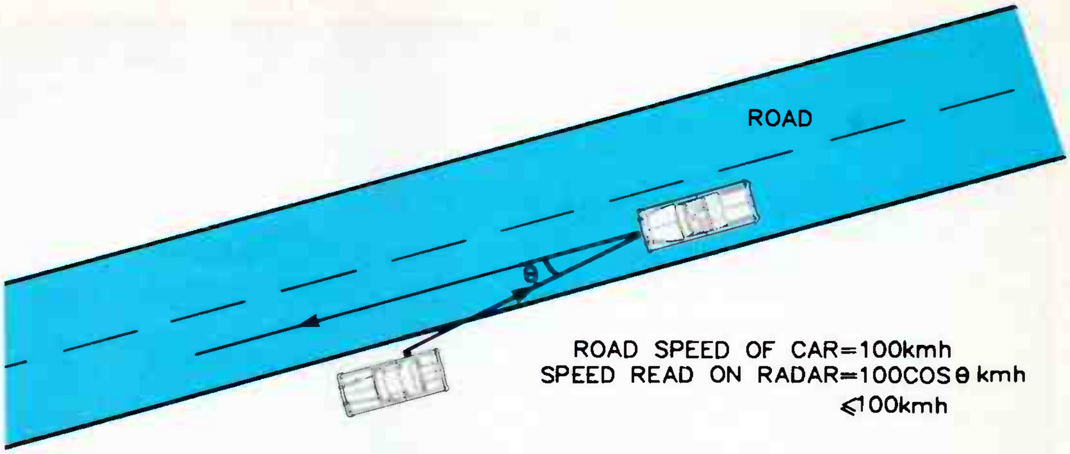


Figure 2. 'Cosine error' results in a reduced speed reading, depending on the angle between the direction of travel of the vehicle and the radar's location.

In the very early days of disputes over radar, it was actually argued in court that the beamwidth limited what the machine could see to the narrow straight ahread view, like a horse with blinkers. This is now pretty universally accepted as an exaggeration; the truth is closer to saying that the radar has a *bias towards what is going on in front of it*, but that the bias is hard to asssess, and not guaranteed anywhere, and so not really useful in court. Recall that a man must be guilty "beyond reasonable doubt".

Now, getting back to the area bathed in the radar's radio wave. Every motionless item in the field of view returns a signal, but these signals are of the same frequency as that sent out, so the radar unit can recognise and ignore them easily. However, it can be shown by high-school level mathematics that for any item that is moving, the radio wave will be bounced back with a slightly different frequency, and also a small amount of distortion. There are three important points:

1) the wave is returned with an increase in frequency if the target approaches, and a decrease if it recedes;

2) the frequency of return is shifted according to the *radial* speed, not the scalar speed of the target, which means that it relates to the rate at which the target is moving directly towards or away from the radar unit, and not at all according to how fast the target is moving perpendicular to the radar;

3) the frequency difference between the returned signal and the one sent is precisely proportional to this radial speed. Radar units all determine the target speed by measuring the *frequency difference* (Doppler shift or Doppler signal) between sent and received waves.

So far this seems a very solid principle for speed measurement. Chronologically, the first matter for debate arose over the second point. There were a lot of courtroom antics based around the so called "cosine error". This is simply a fancy trigonometric name for the fact that the radar perceives only that component of the target's speed which is directly along the line of sight of the beam, as noted in point two above. This is in fact equal to the actual straight line speed times the cosine of the angle between the line of sight of the beam and the line of motion of the target.

Any high school trigonometry student will tell you that the cosine of any real angle is less than or equal to one, so that the radar is going to perceive a speed less than the actual linear speed of the target. Hence, if the radar is supposed to point its beam straight down the road and it isn't, then there will be a small error, but that error is in favour of the motorist. For all down-the-road units, like the Digidar and the KR-11 which are used in NSW, this error is ignored by the Police, and since it is in the motorist's favour no-one is unjustly treated because of it.

Some radar units deliberately point the beam at some angle across the road. The motivation for this will be clearer later on, but it must be realised that these units, because they allow for a cosine less than one, can err in the favour of the Police, and must thus be most carefully handled. This matter will be resumed further on.

The second complication arises from the way that most radar units handle the electronic extraction of the Doppler frequency shifts from the returned signal. They perform a simple mix of the transmitter signal as a local oscillator and pass on only the *difference* frequency. This is an easy and considerably cheaper method than any other. However, it loses the information as to whether the returned signal was more or less than the transmitted one, and thus the radar unit will no longer be able to tell if the vehicle responsible for any signal is travelling towards or away from it. The significance of this will only be fully apparent when the current discussion is complete, but in a nutshell it means the radar unit can just as easily report a receding vehicle's speed as an approaching vehicle's speed.

Recall that I said that *every* target in the field of view returns a signal to the receiver. The third and most serious limitation of speed measuring devices is that they are required to report one speed (usually by putting in a digital display 'window'), and one speed only. Which speed is selected, if there is more than one?

If I put on the table in front of you a pile of cards with numbers written on them, and I ask you to select one, you must use some rule to decide which. Do you choose at random? Do you give me the card with the largest number on it? If that is the rule upon which we agree, then you can pick the card you think I want reliably. If I want the card which is placed on the table nearest to you, irrespective of its number, then this you will be able to discern simply also. I could get more tricky, and ask for the nearest card with a number exceeding 99 on it. No problem, you think. Occasionally there will be a tie for the largest number, and you will not have a rule worked out for this, or you will not be able to discern which is the closer. In the tricky case above the chance of getting equidistant cards of satisfactory number is more remote, but it exists.

A radar is in a similar dilemma when it has to select the detected speed from several. It has two items of information to use — the speed itself, and the strength of the signal corresponding to the speed. *It is in the rule by which the selection is made, that most radars differ.*

There are other things which can upset the Doppler radar mechanism, causing the delivery of false or misleading information. Of course, the unit can malfunction. In New South Wales at least, the units are checked at regular intervals. The setting up and packing up procedures followed by officers using radar both involve putting the unit through a brief test. If a unit is found faulty at regular maintenance, or after use, ▶

DETECTORS — the technology

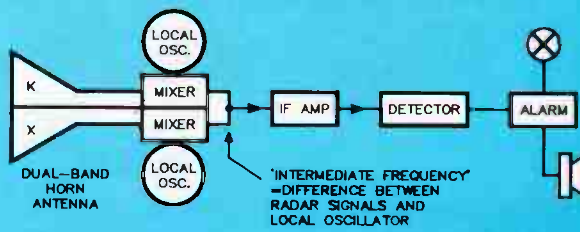
A radar detector is basically a wideband microwave receiver which reports at once if it finds a signal within its working range of frequencies. Like plain radio or TV receivers, there are more and less sensitive types, units with varying coverage, and in differing qualities.

The basic principle upon which they all work is that a Police radar unit emits rather more microwave signal than is usually found in the environment. Thus, if the receiver detects an abnormally strong signal, it is likely to signify that there is a radar unit nearby. There is no way of differentiating between a radar trap and a microwave burglar alarm or a jammer, or any appliance emitting energy in the right frequency range. Thus, there will always be a chance of false alarm from such sources.

Some detectors are very crude, and can be likened to crystal sets. These are pretty useless, because they are so insensitive that they virtually tell you you're about to get 'booked' for speeding (that is, if you are).

Some detectors are equipped with amplification. These are superheterodyne types, just like the tuner in a hi-fi, only designed to work at 10 and 22 GHz, and this provides much better sensitivity. They are usually billed as "Superhet" on the packing because of the obvious advantages this sensitivity can confer. The better ones will fairly easily pick up a radar trap which is not taking special action to avoid detection. As an aside, these units contain a local oscillator (LO) in order to obtain an 'IF' signal from the microwave signal received (see diagram). some "leak" a little of this LO signal out through the receiving antenna, which is why they "detect" another of their own kind.

'SUPERHET' RADAR DETECTOR



Even a good detector can be simply defeated if the trap is appropriately equipped. The simple idea is to suppress the transmitted signal in the radar unit until the operator detects a vehicle whose speed he wishes to measure. At that time he suddenly turns on the microwave signal; even if the detector in a car trips at once, there is not time for the driver to take any action before the trap has taken the reading.

Two notes on detectors should be made. Firstly, each band (X and K) requires a separate receiving system. They can have elements in common, but there is a need to check that a detector covers the bands you require. Secondly, some units claim to be able to detect a radar unit even if it is in the "switched off" mode, where it is trying to conceal its presence as described above. Such claims are made on the basis that there is some residual signal present. This is the case, for example, in the moving mode of the KR-11 where the residual is used to determine the unit's own speed. Rarely, however, is the claim justified in my experience, because of the weakness of this residual signal. There are no detectors which can reliably give early (enough) warning in all cases.

the bookings made with it in the interval since last confirmation of operation are (theoretically) cancelled.

The unit can also be subject to some form of interference from burglar alarms or other radar emitting devices. *'Jammers'* and *'transponders'* (both of which are illegal in Australia, but which nevertheless do find their ways into cars here) emit either random signals onto which the radar can lock in the case of jamming, or sensible signals corresponding to a legal speed in the case of a transponder.

When potentially misleading interference occurs in a location near a stationary radar unit, the effect is pretty obvious — the unit keeps giving a reading even if there are no cars. This has been the case in some reported incidents in the USA. Only a dishonest policeman is going to use this reading, because its continuous nature alerts even the least technical to the fact that something is amiss. Burglar alarms do (very rarely indeed) produce this effect, as do badly adjusted radar motion detectors used to open automatic doors.

Some radar detectors of the super-heterodyne type (see accompanying panel), such as the Super Snooper, emit local oscillator signals. It is for this reason that their importation to some countries is illegal, as well as for the obvious revenue reasons. The emitted signals can produce a reading on a radar trap display. The reading will, however be constant, so if the policeman is careful to check (as he should) that the reading drops as the target car he is about to book slows down, he will see the anomalous behaviour and realise that something is wrong. It is easy to see here that such a check could be overlooked if the operator was in a hurry . . .

The Digidar Radar Unit

The Digidar, the first radar unit used in New South Wales, chooses the largest signal that it sees, provided the signal is strong enough to allow operation. (This probably corresponds to picking the easiest card to reach, continuing the card analogy.) The separation of the maximal signal component, that is the selction of the largest signal from the sum of all signals, occurred more by accident than design. The technique used is to determine the average number of zero crossings in an interval of the sum waveform. This technique is nowadays used in speech processing systems to determine the main formant frequency in a spoken syllable. It was used in the Digidar because it was simply implemented with a single comparator and a few TTL ICs wired up as a frequency counter was probably the first idea the engineer tried. It reliably gave a steady result in the presence of noise and other signals.

The original designer was probably very happy that the unit operated so neatly. The motivation behind keeping this method when the units were used for police service was that it was then thought that the *nearest* vehicle would return the *strongest* signal. Police operators were instructed that the nearest car was the car responsible for any reading they saw.

The fallacy of this is now substantially recognised. Measurements have indicated that different cars have very different "radar cross-sections", or RCSs. That is one car can reflect a much larger amount of the radio wave bathing the area, and so return much more signal for the same conditions than another. In fact, trucks can sometimes reflect 10 000 times more efficiently than certain other vehicles which corresponds to *at least* as much signal when *ten times further away*. The actual signal returned is equal to the beam power (which you recall falls away as we move to the side of its line of sight), times the RCS and divided by the range to the fourth power. For the mathematically minded, this is written:

$$S = B \times RCS/(D)^4$$

where S is the strength of the signal returned,
B is the beam strength for the viewing angle,
RCS is the radar cross section.
and D is the target distance from the radar unit

B is *usually* between ½ and 1, because the car is *usually* in the middle of the beam, that is, roughly on the centre-line. The RCS of two vehicles will typically be within a factor of three of each other if the vehicles are of comparable physical size and construction, but may easily be thousands apart.

The Digidar has a method of indicating "confusion", that is a time between two signals. In such event, it displays two zeroes. Unfortunately it is only confused when the signals are closer than a factor of two in strength or less, so the confusion indication (a double zero display) is not so often useful.

The Digidar unit can easily report a speed for a vehicle which is not the nearest vehicle. The policeman operating the unit, even if he is on the ball, will have to pay attention, and may have some difficulty picking which car his radar unit is tracking.

The KR-11

The KR-11 is the newer of the two basic units used in New South Wales. It has a lot of technical differences which set it apart from the Digidar units. It basically contains a rough analogue circuit for mixing the incoming signal with a variable local oscillator, and searching for the dc output component of the result. This dc component indicates the amplitude of signal at the oscillator frequency which is to be found in the Doppler signal. The unit searches downward in frequency, looking for a signal above a preset level. When it finds one, it knows that *something* out there is going this fast. In addition, since it searched downwards, it grabs the fastest signal that was strong enough to exceed the preset level — the fastest car, presumably.

This is its decision role. It chooses the *fastest* vehicle it perceives from amongst those vehicles returning a preset "substantial" amount of signal. That is, it picks the fastest, once it has discarded signals of lesser strength. (The analogy of cards on a table would be to pick the card with the largest number, from amongst those in easy reach. Clearly this last is rather arbitrary, but that is of no concern so long as you know what is in easy reach.

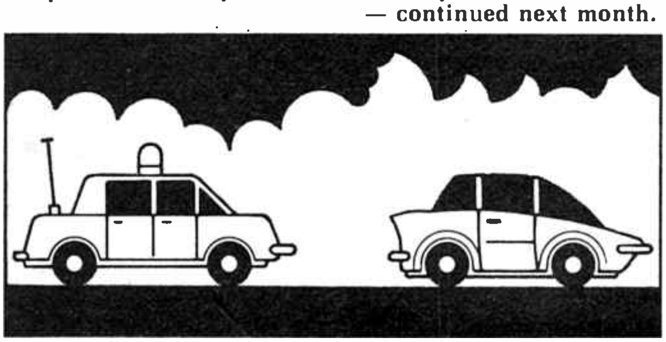
The motivation (presumably) for this is that the Police operator wants to know how fast a speeding vehicle is going, since that tells him whether there is somebody to book. Regrettably, this radar also does not tell who that is, neither does it look any further down the specturm received, to decide if the fastest car is the *only* car.

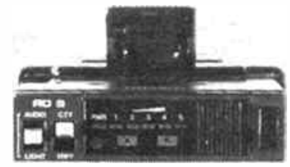
Fewer problems have arisen over the technical aspects of the KR-11 in courtrooms, since it at least has never had any pretence to identifying the vehicle responsible, as did the Digidar.

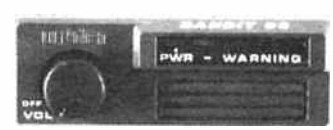
It has two other interesting technical innovations which make it nicer to use. It can operate in a "moving mode", where it will allow for its own speed and deduct this from the reading. This permits it to 'catch' a vehicle's speed from aboard a Police car going the other way. The second innovation is the ability to suppress the transmission of a beam at all until instructed to read, so that radar detectors do not see it coming.

No concrete argument has been proffered to suggest that either innovation directly affects the operation and reliability adversely, to the author's knowledge. This may be because they don't, or because no research has been done to prove the point either way, which is certainly the case.

— continued next month.







Typical of the radar detectors on the market are these three units, manufactured in Asia by the Uniden Corporation of America. All operate off the 12 Vdc car supply. These units were supplied by Dick Smith Electronics.

At top is the RD9, a tiny (described as 'pocket size') dual-conversion superhet unit that receives both X and K band radar. It features the ability to ignore unwanted interference and has a switch to alter sensitivity for 'highway' and 'city' driving — interference from microwave burglar alarms etc is more likely in the city and suburbs. It can be mounted on the dash or sun visor. It measures just 70 mm wide by 18 mm high by 107 mm deep. Dick Smith list it as cat. no. A-8507, priced at $499.

In the centre is the RD-55, also an X and K band detector with similar features to the RD9, but slightly better sensitivity specifications. It may be dash or sun visor mounted too, and measures 131 x 132 x 40 mm. DSE list it as cat. no. A-8501, $399.

The lower unit is the RD-95 'remote' which also employs a dual conversion superhet receiver. The control/indicator unit and the receiver are separate units so that the receiver can be remotely located for optimum performance. The control/indicator unit is quite tiny and can be unobtrusively located on or below the dashboard. It has similar specifications to the RD-55. DSE list it as cat. no. A-8499, $499.

PUT DSE TO THE TEST

DSE'S PICK A BOX ... WE'RE NO.1

ALUMINIUM DIECAST BOXES

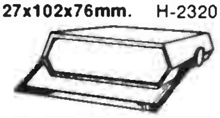
WOW! Precision metal boxes at a price you can afford! These boxes feature channelled walls and withstand extremely high temperatures. Ideal for RF circuits and circuits involving heat.

190x60x110mm.	H-2201	$13.95
150x50x80mm.	H-2206	$9.95
120x40x65mm.	H-2211	$6.95
100x25x50mm.	H-2221	$4.95

ALUMINIUM BOXES

Boxes come in two pieces which slide together: screws hold them for storage. They're versatile and inexpensive.

110x51x70mm.	H-2300	$2.65	133x76x54mm.	H-2325	$3.20
104x60x46mm.	H-2305	$2.30	152x132x103mm.	H-2330	$4.75
127x102x76mm.	H-2320	$3.75	180x158x118mm.	H-2335	$7.75



INSTRUMENT CASES

Great range of plastic instrument case for all your project needs. With slots, ventilation ... the lot!

203x102x254mm.	H-2455	$24.00	200x160x65mm.	H-2505	$12.95
228x76x305mm.	H-2465	$24.00	200x135x95mm.	H-2506	$12.95
95x145x45mm.	H-2503	$10.95	250x190x80mm.	H-2507	$19.95
200x145x75mm.	H-2504	$13.95			

19" RACK ZIP PACK

Storage system for CB, receivers, etc. 358mm deep. Contains all parts.

H-2470 $139

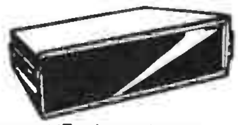
19" RACK MOUNTING CASE

Top quality case. Takes moments to assemble. Heavy-guage metal front/top/bottom. Pre-punched for ventilation.

$49.95 Cat H-2481

PLASTIC INSTRUMENT CASES

No matter what the job, DSE have an instrument case: for communications, power supplies, etc.



Power Supply case. 130x130x75mm.
$7.95 H-2516

Instrument case. 210x27x73mm
$34.95 H-2525

Instrument/Equipment case. 210x175x55mm.
$13.95 H-2520

COMPONENT DRAWS & CABINETS

Great way to organise all your bits 'n pieces ... you'll find them quickly and easily.

16 DRAWER CABINET

Cabinet : 300x180x140mm.
Cat H-2588 **$22.50**

STACKABLE DRAWERS

Flexibility! Vertical or horizontal stacking. With handle, Index card on each drawer.

One drawer. Cat H-2584 **$3.25**
Two drawer. Cat H-2585 **$3.25**

COMPARTMENT CASE

Made of strong plastic. With clear lid, movable internal compartments and 2 tiers of trays. Cat H-2596
$29.50

PLASTIC TOOL BOXES

435x190x180mm. Cat H-2601 $16.95
430x230x200mm. Cat H-2600 $32.95

ZIPPY BOXES

These are it! The original Zippy boxes recommended by magazines because of their versatility. Ribbed sides are ideal for mounting PC boards.

28x54x83mm.	H-2755	$1.95
41x68x130mm.	H-2753	$2.45
50x90x150mm.	H-2751	$2.95
60x113x196mm.	H-2752	$4.45

WE'VE GOT BOOKS COVERED!

Here's just a sample of DSE's large selection of informative, high quality books. They're priced to please and very popular, so get in quick. While you're there why not check out all the other titles available!

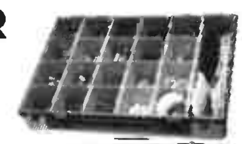
Under I.C. OP AMPS	B-1180	$13.50
OP-AMP Circuit Design	B-1251	$17.95
Basic Electronics Theory	B-1615	$19.50
Basic Electronics Courses	B-1689	$19.50
Funway 1 Into Electronics	B-2600	$4.95
Funway 2 Into Electronics	B-2605	$6.95
Funway 3 Into Electronics	B-2610	$6.95
Electronics A Practical Introduction	B-3005	$9.50
Electronics Dicitionary	B-3610	$9.95
Basic Electronics	B-3620	$4.50
Under D.C. Power Supplies	B-3623	$19.50
Note Book — Starting in TTL	B-3629	$3.50
Note Book — Vol 1	B-3630	$2.40
Note Book — Vol 2	B-3631	$2.60
Note Book — Vol 3	B-3634	$2.80
Introduction Electronics — Sardi	B-3635	$7.95
Encyclopaedia of Electronic CCTS	B-1760	$45.95
Digital I.C.'s and LEDS	B-1785	$22.95
Fibre Optics	B-1865	$22.95

SEE DSE FOR TOOLS BEFORE IT'S TOOLATE!

WOW! 38-PC TOOL KIT WITH MULTIMETER

Excellent value! Carry out auto repairs ... anything. Has all the tools you could want: crimping tool, wire, tape, screwdriver and more!PLUS comes with FREE multimeter.
Cat T-4832 **$29.95**

MORE VALUE! 68-PC KIT WITH CONTINUITY TESTER



What more could you ask ... great variety of handy tools for all types of repairs PLUS a neon tester for 240V equipment.
Cat T4834 **$14.95**

DALO MARKING PEN

Great for precision board marking prior to etching — thanks to unique Press-to-Mark feature.
Cat T-5170 **$3.50**

DON'T 'FRET'

With this handy piercing saw, modellers, hobbyists can cut through plastic, etc. Adjustable universal frame even lets you use broken blades. Comes with 3 blades.
Cat T-4965 **$14.25**

SOLDER SUCKER

Perfect accessory for the handyman, hobbyist! Removes solder in no time. Rugged metal construction takes rough treatment — lasts for years. Features Teflon tip, nozzle sweeper and light thumb release mechanism.
Cat T-2560 **$9.95**

DESOLDERING TOOL

If your job or hobby involves solder then this is a 'must'! It desolders cleanly, quickly and thoroughly. Ideal for PC boards, prototyping and many other applications.
Cat T-1340 **$69**

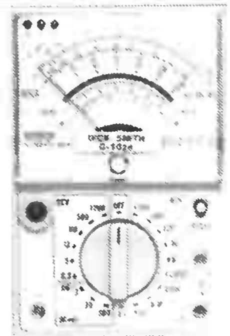
— WE'VE GOT THE LOT!

VALUE! 6.5 MHz OSCILLOSCOPE

An oscilloscope hobbyists can afford! Features retrace blanking, 10mV/div vertical sensitivity and 500mV/div horizontal, 4-range time base and much more. Cat Q-1280 **$299**

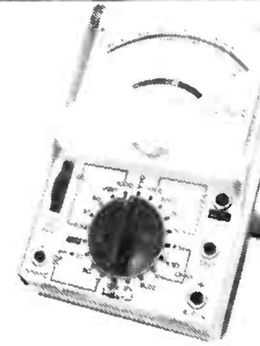
METER/ TRANSISTOR & CAP TESTER ...

Amazing! It's a powerful 100K ohm multimeter PLUS tests transistors and capacitors.
Cat Q-1140 **$85**
$53 each for two!



VERSATILE METER/TESTER!

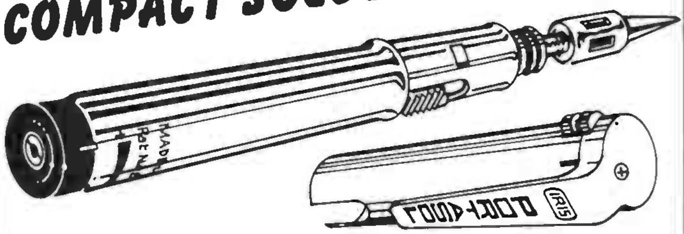
Here's value! Not only do you have a great 20K ohm multimeter, but also a built-in logic tester. That's virtually two instruments. The tester's LEDs give HIGH, LOW & PULSE.
Cat Q-1026 **$34.50**



BUDGET MULTIMETER

WOW! Great DSE value... 20K ohms/volt multimeter with features normally reserved for expensive testers. There's continuity buzzer, 10A DC range PLUS mirrored scale and reliable banana plugs.
Cat Q-1022 **$29.95**

REVOLUTIONARY 'BUTANE' COMPACT SOLDERING IRON!!



This amazing iron is worth a double WOW! It's a powerful, cordless iron the size of a marker pen. Refillable butane provides 'instant' heat for on-the-spot emergencies. Adjustable temperature provides equivalent 10-60 watts ... up to one hour continuous use. Tip temperature 400°C

$69.50

Cat T-1370

'GALAXY' 3.5 DIGIT PANEL METER

Ideal replacement for analogue meters. Provides accurate digital display, is unsusceptible to movement and can be read in daylight. 220mV FSD. Cat Q-2200

$49.95

buy 5 for $44.95 each

DATA SHEET AVAILABLE

SAVINGS! FUNWAY III IC PROJECTS

Auto Minder	Cat K 2660	Was $4.95	**Now $3.95**
Two-Up	Cat -2661	Was $6.95	**Now $5.95**
Pokey	Cat K-2662	Was $14.05	**Now $11.95**
Cricket	Cat K-2663	Was $9.95	**Now $7.95**
Mini Colour Organ	Cat K-2664	Was $6.95	**Now $5.95**
Light and Sound	Cat K-2665	Was $6.95	**Now $4.95**
Combined Timber Lock	Cat K-2666	Was $9.95	**Now $7.95**
Mini Amp	Cat K-2667	Was $14.95	**Now $11.95**
Binary Bingo	Cat K-2668	Was $12.95	**Now $10.95**
Mini Synthesiser	Cat K-2669	Was $12.95	**Now $10.05**
Funway Bonus Pack	Cat K-2670	Was $24.90	**Now $19.95**

'ADCOLA' 12W SOLDERING IRON

What a saving! A reliable iron ideal for hobbyists and general commercial work. Features hi impact plastic handle, Triclad 3mm long life tip. Cat T-1820

Was $27.50 NOW $22.95

FOR HEAVIER JOBS

Adcola's 16 watt iron is ideal ... especially in commercial environments. It's heavier element provides more power and features a 5mm Triclad long life tip.
Cat T- 1825
Was $32.95 NOW $27.50

DICK SMITH ELECTRONICS
PTY LTD
For Address details See P88

B 109

The mindless mouth
— speech synthesis technology

Roger Harrison

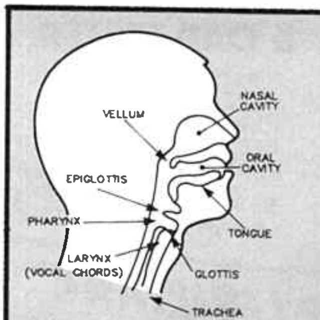
Attempts at making machines that speak date back to the time of the industrial revolution. However, it wasn't until electronics made its appearance that there were any successful machines which could be clearly made to mimic human speech. It was the 'microprocessor revolution', coupled with research into linguistics, that made 'true' speech synthesis possible. The cost of speech synthesis devices has dropped dramatically since their introduction, such that it is now within the reach of the average hobbyist.

THE YEAR CAPTAIN COOK set out to observe the transit of Venus in the South Pacific, a German experimenter called Kranzenstein was awarded a prize by the Imperial Academy of the City of St Petersburg (Leningrad now) for a machine he constructed that could simulate vowel sounds. A relatively simple machine, it comprised a series of resonating cavities. In 1791, some four years after Governor Philip had established a colony in New South Wales, a German inventor name Von Kempelen showed a more elaborate device, later improved by Britain's Sir Charles Wheatstone (renowned for his Wheatstone Bridge resistive measurement technique).

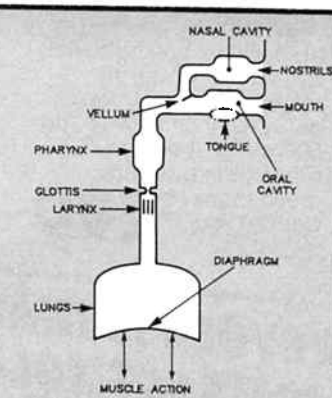
Early experiments in the analysis and synthesis of sound were conducted by the German physicist, Hermann von Helmholtz, in the 1850s. Helmholtz coupled cylindrical cavities to an array of tuning forks, each set between the poles of an electromagnet. Bell, who patented the telephone one hundred and ten years ago in America, followed a similar line of investigation and proposed a similar device, dubbed the *harp telephone*.

This comprised a series of metal reeds placed in a row and magnetically coupled to a long electromagnet. Sounds made near the reeds would make the appropriate reeds vibrate in sympathy with the various pitches making up the sound. (Speech, for example, is a complex sound containing a variety of frequencies, or pitches). A similar device, remotely located and connected via a line, would make the corresponding reeds vibrate from the action of the currents induced, thus reproducing the original sound. Both Helmholtz and Bell recognised that it was the spectral content of speech sounds that was important.

The Victorian era saw many wonderful contraptions arise tha all attempted to mimic speech sounds. 'Singing organs' attempted to 'model' the human vocal tract and, while they could quite well mimic the human voice singing a scale, a facsimile of speech was not achievable.



Cross-section of the human vocal tract.



Schematic diagram of the human vocal tract.

THE VOCAL TRACT

The two diagrams here show the vocal tract in cross-section and its 'mechanical schematic'. The lungs provide an air source that passes a set of semi-rigid flaps called the larynx or vocal chords. These can be allowed to vibrate (to produce 'voiced' sounds) as air from the lungs is forced through the opening between them (called the glottis), or held open (to produce 'unvoiced sounds'). The air flow passing up the throat can be diverted, by a flap called the vellum, wholly or partially through either the nasal cavity or the oral cavity, the latter being a chamber which can be variably shaped by jaw and tongue movements.

Voiced sounds are produced by making the vocal chords vibrate, the pitch being altered by stretching and relaxing the chords. Unvoiced sounds are made when the larynx is held open but the air flow is restricted by the glottal opening or a constriction later in the vocal tract (such as when the upper teeth touch the lower lip). Sharp sounds, called plosives, are produced when the vocal tract is closed off at some point (such as by the lips) and the air pressure from the lungs is suddenly released (such as with p in pull). All the complex sounds of speech are produced in a variety of complex ways and means by this mechanism.

The electronic era

Modelling of the human vocal tract reached its zenith in 1937 when an American named Reisz proposed a mechanical contraption, shown diagrammatically here in Figure 1. It comprised a mouth cavity made from a series of flexible rubber parts, movable 'lips and 'teeth', and valves to control air flow through the system, all 'played' via an assembly of keys and levers.

Bell Telephone Laboratories are reportedly the first group to devise an electronic device that produced intelligible speech. That was in 1939 and the device was called a Voder. Produced by a group headed by Homer Dudley, Reisz was part of the team. Illustrated in Figure 2, it comprised a noise generator for unvoiced sounds and an oscillator for voiced sounds, which could be switched through a series of resonance filters selected in combination by a set of keys to produce a required sound. A pedal was used to change oscillator pitch.

In 1939, Dudley invented the Vocoder (from 'voice coder'), an electronic version of the ideas explored earlier by Helmholtz and Bell. Vocoders have survived and are used these days in pop music production — as can be heard in Stevie Wonder's *I Just Called To Say I Love You*.

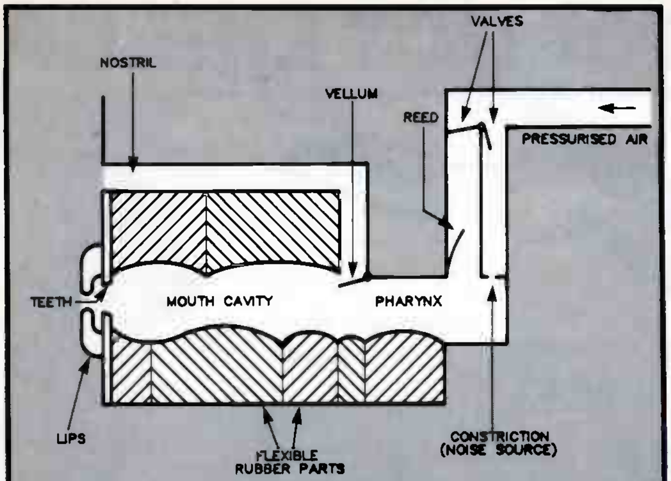


Figure 1. The mechanical vocal tract model proposed by Reisz in 1937. It was supposed to be 'played' by operating the valves with levers varying the flexible cavity parts.

Serious work on voice (or speech) synthesis got into gear in the 1960s, allied to speech processing and speech recognition research. The first method explored attempted to electronically model the vocal tract using transmission line filters made up of a chain of simple filter elements. Called *Articulatory Synthesis*, it was based on an acoustic model of the vocal tract which represented it as a series of connected tubes of differing diameters, the electronic filter variables being changed to simulate the way the vocal tract alters during speech. Complicated — but it worked.

Later, attempts at electronically modelling of the physical structure of the vocal tract were cast aside in favour of modelling the characteristics of speech sounds. Research into speech and linguistics identified a range of characteristics — formants (fundamental voice pitches), nasal resonances, fricatives (noise-based sounds like 'v', 'h' and 'z'), etc. *Terminal Analogue Synthesis* treats the vocal tract as a 'blak box' and generates speech sounds which can be assembled into intelligible speech. J.E. Clark of Macquarie University, Sydney, built a synthesizer of this type, called SID (Speech Imitative Device), shown in Figure 3.

Another method solely employs spectral analysis of speech sounds and assembles speech without attempting to duplicate the fundamental frequencies (formants), in a similar manner to Dudley's Vocoder, employing controlled use of oscillators and filters.

Essentially, these early speech synthesis devices employed analogue electronic techniques. It wasn't until the development of digital electronics, integrated circuits, and then the microprocessor that speech synthesis came out of the laboratories.

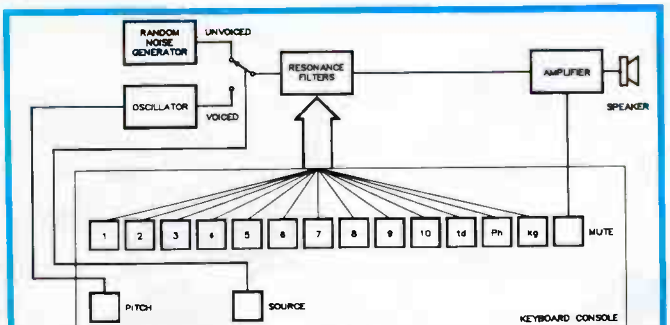


Figure 2. The first electronic speech synthesiser, built by Homer Dudley's team at Bell Labs in the US in 1939. Dubbed the "Voder", it was 'played' by keys and a pitch pedal, producing quite good results when used by a skilled operator. This was the forerunner to the modern-day "Vocoder" occasionally used in music recording.

Micro Speech

Digital sound recording, as you may know, 'samples' the electrical waveform of the sound at intervals and assigns a digital 'value' (or number) to the amplitude of the waveform at each point. This process is called analogue-to-digital (A/D) conversion. The reverse process, digital-to-analogue (D/A) conversion, 'reconstructs' a facsimile of the original waveform by converting the stored 'numbers' into a representative voltage, assembling them in the same time order as they were recorded. Figure 4 show the technique. The 'accuracy' of the reproduced waveform depends on how many samples per cycle you employ.

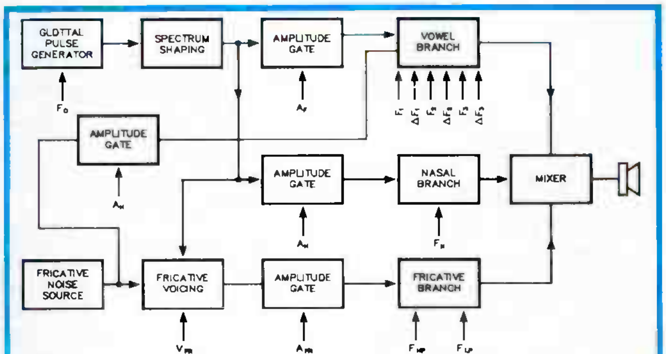


Figure 3. Meet SID. This is J.E. Clark's "Speech Imitative Device", a Terminal Analogue Synthesizer capable of producing speech wholly electronically.

As you may realise, it is possible to actually construct a waveform by making a facsimile of it with a series of digital numbers and sending them to a D/A converter in the right time order. Quite complex waveforms, and thus sounds, can be readily digitally constructed, providing you know the waveform you wish to produce.

The problem, though, is the positively enormous number of digital 'values' (or data) that must be stored in order to generate even short utterances. In order to reproduce a sound by means of digital samples, the sampling rate (the number of samples per second) must be at least twice that of the maximum frequency to be reproduced. Speech generally has an upper limit of 3 kHz, so the sampling rate should be at least 6 kHz (6000 per second). If the amplitude of each sample can be asigned a value between 0 and 127 (that is, 128 possible values), it can be represented by a 6-bit (digital) binary number. One second's worth of speech would require 36 samples. To store those 36 samples would require a total of 36 x 128 = 4608 bits, or 4.5 kilobytes, in electronic (or computer) memory. To store some 20 minutes of speech — the evening news broadcast, for example — would require around *three megabytes* of memory! Given this daunting proposition, it is obviously necessary to find ways of compressing the data.

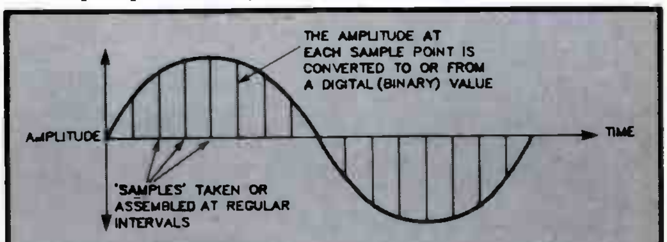


Figure 4. A waveform can be both recorded and constructed digitally by means of 'sampling'.

Speech contains many redundancies and, by removing the redundancies and using appropriate sampling, compressed speech patterns can be stored for later reconstruction, or *synthesis*, of those sounds we recognise as speech. ▶

Three basic methods of digital speech synthesis have been devised. *Waveform digitisation*, more or less as explained above, employs digitally recorded speech, with the redundant sounds removed in order to reduce the memory requirements. Natural Semiconductor's *Digitalker* (DT1050) employs this technique. A limited vocabulary is stored in read-only memory (ROM) chips, the words being accessed as required to string together a sentence. Whilst this technique produces very realistic speech (including the original accent!), the vocabulary is limited to about 600 words maximum because of the (still) enormous memory requirements. This type of synthesizer is also known as a *stored speech* device.

Any periodic waveform, such as a sinewave, or complex waveform which is quasi-periodic, such as speech, behaves in a predictable way. A small, representative segment of such waveforms can be used to make an 'intelligent guess' about what the rest of the waveform will look like. In other words, it is possible to mathematically predict a whole waveform pattern from a part of it. This is called *linear predictive coding* (LPC). It is ideal for digital speech synthesis because, with a high enough sampling rate, the difference between successive samples is quite small and this enables making a good prediction of the value of following samples from the past few. Texas Instruments' TMS-5100 *Speak 'n Spell* employs an electronic model of the vocal tract controlled by a microprocessor as an LPC speech synthesizer.

Yet another method employs *Phoneme reconstruction*. This simply uses an array of stored phonemes — 'building blocks' of speech (see accompanying panel on 'The Elements of Speech'). Any word can be reconstructed from its phonemes according to a set of rules ('synthesis by rule'). As there are only a small number of them (about 45 in English) with a limited spectral content, the sampling rate can be low and memory requirements are thus quite small. The Voltrax *SC-01* employs this technique. As any word can be reconstructed by assembling the phonemes in order, along with pauses, an unlimited vocabulary is available. It is possible to add inflection (steady, rising, or falling tone while the sound is being made) during the D/A conversion process to give the resulting speech some 'life'. Even laughter is possible! Speech quality in second generation devices of this type can be very good.

A now widely used technique for speech synthesis employs linear predictive coding and stored allophones (speech sounds comprised of phonemes). Here too, speech is synthesised by reference to a set of rules. The General Instruments group of *Narrator Speech Processor* (SP0256) devices exploit this combination technique. The sampling rate and memory requirement, as with phoneme reconstruction,is quite low, yet good quality speech synthesis is obtainable. The General Instruments devices have the advantage that stored allophone codes can be employed if a fixed dictionary is required for an application, yet relatively little memory is necessary.

Microprocessors and microcomputers are readily employed to 'drive' these speech synthesis devices. All that's necessary is to program and send the appropriate control codes at a suitable rate — which is, in practice, quite slow.

Some devices produces more acceptable speech sounds than others — but it's all still very 'digital' in character, rather reminiscent of that unforgettable *Star Wars* character — Darth Vader.

ELEMENTS OF SPEECH

Speech is an assembly of fundamental vocal sounds called *phonemes*. Each language has its own set of phonemes which are slightly different from other languages; there are about 45 phonemes in the English language.

Phonemes can be divided into several groups, the most important group being the vowels. Vowels are all voiced sounds. Examples are *a* in 'sat' and 'father', *e* in 'set' and 'fever', *i* in 'sit' and 'kite', etc. Vowel combinations, called *diphthongs* are also found. These are formed by swiftly sliding from one vowel to another — such as *ai* in 'wait'.

Vowels are produced with a relatively open vocal tract and a periodic (a defined pitch) sound source (unless they are whispered) provided by the vibrating vocal chords. Vowels are classified according to whether the front or back of the tongue is high or low, whether they are long or short, and whether the lips are rounded or unrounded. In English, all rounded vowels are produced in or near the back of the mouth.

Consonants can be voiced or unvoiced sounds. There are a whole variety of consonant sounds. *Fricative* consonants employ the lips or teeth, or both together. They can be voiced — *v* in 'voice', *z* in zoom, or unvoiced — *f* in 'form', *s* in 'seen', *sh* in 'sheet'. *Stop* consonants are plosive sounds, which can also be voiced or unvoiced. Examples of voiced plosives include the *b* in 'been' (from the lips), *d* in 'dot' (from the tongue) and *g* in 'gut' (tongue and throat); unvoiced examples include the *p* in 'pot', *t* in 'tip' and *k* in 'keen'. *Affricative* consonants are produced by the swift combination of a stop consonant and a fricative consonant. e.g: the *ch* in 'chip' is a combination of *t* followed by *sh*.

Consonants are produced by creating a constriction in the vocal tract which produces an aperiodic ('all frequencies') sound source. If the vocal chords are vibrating at the same time, as in the case of some voiced fricatives, there are two sound sources: one which is aperiodic and one which is periodic.

Nasal sounds are made when air is diverted through the nasal cavity. Examine the sounds of *n* in 'sin', *m* in 'pump' and *ng* in 'wing'. Some consonants are vowel-like. e.g: *r* in 'root', *y* in 'you'.

Phonemes differ acoustically depending upon their position in a word. Each variant is called an *allophone*, which are the manifestations of phonemes in any speech signal. A discussion of allophones is given in the data sheet on the SP0256 speech processor IC elsewhere in this issue.

Text-to-speech

The next step is to do away with having to program an assembly of control codes and send them to a speech processor. The required 'rules' (or algorithm) can be stored as a computer program and, in response to strings of text sent via a computer printer port for example, the speech processor assembles the text into speech according to the stored rules — viola!, text-to-speech conversion.

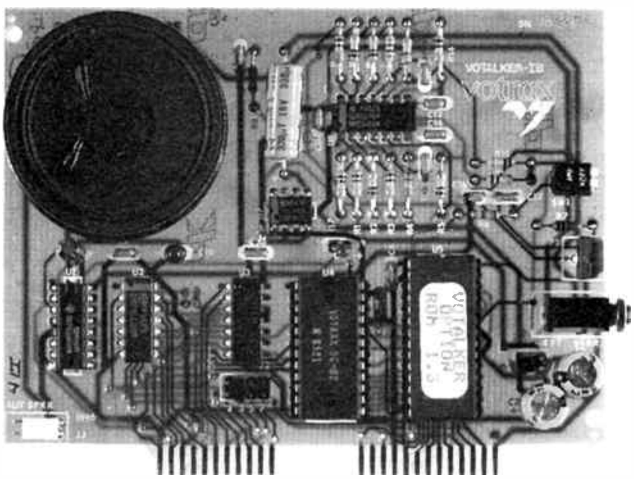
General Instruments released just such a device in February 1985, the CTS256A-AL2, for use with their SP0256A-Al2. This is an 8-bit microcomputer with internal ROM in which is stored a code-to-speech algorithm which converts English text in the form of standard ASCII characters into allophone addresses for the SP0256A-AL2 using letter-to-sound rules.

This plug-in cartridge speech synthesizer for the Commodore 64 'speaks' via the computer's sound channel and employs text-to-speech conversion. It also uses allophone programming and features two different-pitched 'voices', plus the facility to program intonation. It is distributed by Promark in Sydney and Melbourne, (008)22 6226 (toll free).

Applications

Now that the cost of speech synthesis devices has fallen to a level where it's a minor cost component compared to equipment with which it can be employed, applications are spreading rapidly — some serious, some frivolous, admittedly.

Consumer products that use speech synthesis include talking clocks, toy robots (e.g: Elami Jr — see AEM Product Review, Dec. '85 issue, p. 33), vehicle dashboards, burglar alarms etc. Commercial and Industrial applications include arcade video games, talking lifts (but don't see 'The Last Laugh', Jan. '86 issue!), aircraft emergency alarms and special alarms which provide instruction procedures during dangerous or emergency situations.



REVIEW — VOTALKER 1B SPEECH SYNTHESIZER

The Votalker 1B is a single board speech synthesizer suitable for installation in the I/O expansion bus of an IBM PC or PC compatible. The unit is based on the Votrax SC-02 phoneme synthesizer. This IC produces speech sounds from which words are formed and therefore has a virtually unlimited vocabulary and can also produce singing, music and sound effects.

The hardware is contained on a 137 × 106 mm pc board which includes the Votrax IC, an audio amplifer, a choice of two output "voice" filters, an on-board speaker and a socket to facilate connection of an external speaker if required.

The most significant advantage of the Votalker 1B over many other speech synthesizers, however, is the level of software support included. Supplied with the unit is a speech demonstration program which runs under IBM BASICA, a speech-to-text converter and a speech operating system which includes a phonetic speech editor.

The text-to-speech converter is contained in a file called TTS and can be operated directly from DOS level using the SAY command. TTS can also be accessed from programs which provides a very simply means to introduce speech with programs under development.

The TTS program successfully converts written English into speech with remarkable quality. It does this by comparing the typed character string with a set of over 600 rules to generate the correct sequence of phonetic sounds. This is an exceptionally useful feature since the Votrax IC can be difficult and time consuming to program if every word must be formed individually from its phonetic components.

In order to facilitate programming of individual words the software includes a phonetic speech editor which is a menu driven program which provides the functions required to create words as well as other general sounds.

In summary, the Votalker 1B is a good speech synthesizer combining high quality design and construction with an excellent software support package. The unit is available from *Mike Boorne Electronics Pty Ltd, Suite 3, 61A Hill St, Roseville, 2069. Phone (02) 46 3014. Price: $590 inc tax.*

— David Tilbrook

CB SAVINGS...

Emergency Hand-Held

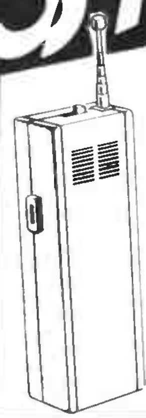
A light, compact go-anywhere CB that's ideal for bushwalkers. Features 'bushwalking' and 'safety' channel 27.620 MHz for instant response to emergency situations. You can't afford not to have one-...and now it's $10 off!!

DOC Approval No. 242H0108

SAVE $10

Was $99 NOW $89

Budget Priced Walkie Talkies



Pocket Com II — effective short-range communicators small enough to fit a pocket. Ideal for kids games ... and Mum can use one to call them for dinner. Yet they're powerful enough to use on construction sites to save time and trouble. At this price, buy a couple. Cat D-1101

Complies with DOC Specification RFME001

$12.95 each

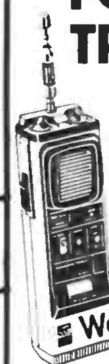
$100 off! Get into the action with a hand-held scanner ...

Tune into news and events as they happen ... all the action up to 525 MHz (including air) with our Regency HX-2000 scanner. Compact hand-held size means you take it anywhere: use it in the car to avoid traffic snarls. It's small, but big on features: priority, scan and search ensures you won't miss a thing. Plus 20 channel memory and more. And now it's even a greater bargain .. SAVE $100! Cat D-2815

Was $449 NOW $349

FOR YOUR OWN SAFETY, MARINE TRANSCEIVER

3W 3-CH CB Transceiver



Save $30 on a handy medium-powered communicator-just in case emergencies. Fitted with one CB channel. Cat D-1106
DOC Approval No. 249A072

Was $129 NOW $99

SAVE $100

Programmable VHF Transceiver

WOW! Now you can have VHF marine without your budget taking a dive! Programmable 12 channel capacity provides access to all local area communications. But if you cruise the coast, then re-program — it's simple. Features switchable 0.5/2.5W power output and very high sensitivity: better than 0.25uV (12dB SINAD). And its compact, hand-held size means you can take it anywhere.
Cat D-1404
DOC Approval No.274C018

Was $399 NOW $299

ACCESSORIES

CB ANTENNAE

Heavy Duty CB Helical — 27MHz

Tough fibreglass antenna for truckies, off-road enthusiasts, etc. Provides that extra range when you need it. Features sealed base with connector for immediate use.
Cat D-4078

$99

UHF Co-ax Base

Mobile base that provides low loss for maximum efficiency. Ideal for use with antenna D-4013 (this page).
Cat D-4516

$6.95

CB UHF 4.5 High Gain Mobile

Great value for this high gain mobile! Gives that 'extra' range when it counts. 4.5 dB gain doubles output.
Cat D-4013

$12.50

CB UHF Base Antenna

High gain antenna covering the 477MHz range with an impressive 4.5dB gain.
Cat D-4012

$49.95

LOOK! NEW CB TRANSCEIVERS

40-CH AM 'Emergency' CB

If you're not into full time CB but appreciate the safety aspect, then this compact 40-Ch mobile CB is ideal. Comes with a carry case: the CB, antenna and accessories stay there until an emergency occurs. The antenna features a magnetic base for instant set up. In no time you'll be on the air calling for assistance.
Cat D-1172

$149

UHF 'Sundowner'

The pick of the crop! UHF FM communication on 40 channels that's as clear as country air. Backed by superior, reliable features: squelch, duplex repeater, RX/TX LEDs and more.
Cat D-1806

$375

Hide-away Mobile CB

Brilliant! Fool thieves by concealing CB almost anywhere — in the boot, glove box. And it's great for crowded dashes — only the hand-set need be mounted. All control functions are located in the hand-set: PTT mic, rocker-switch UP/DOWN channel selection plus volume and squelch controls. Provides access to 40-Ch covering 26.965-27.405MHz range.
Cat D-1441

$299

DICK SMITH ELECTRONICS PTY LTD

For Address details See P88

B.110/RB

Unique appliance security device

A new company, DCB Computer Marketing has developed a unique alarm system for electronic and electrical home appliances which operate via the 240 volt ac mains. The patented system is designed to protect the individual appliances 24 hours a day.

The system consists of a transmitter and receiver. The transmitter generates a frequency modulated RF signal which is sent down the electrical wiring of the building.

The receiver is built into the appliance (such as a VCR, TV, microwave oven, home computer, stereo system, etc). This continuously receives a coded signal from the transmitter via the building's electrical wiring via the appliance's power cord.

The receiver is designed to totally shut down the appliance and set off an ear piercing audio alarm when the signal from the transmitter is interrupted (such as removing the appliance power plug from the wall socket), or the incorrect code is being received.

The transmitter is simply plugged into a normal household electric socket in a place where it cannot be easily found. Other means of concealing the whereabouts of this device can be used, such as building it into a power socket.

The transmitter and receiver have the same pre-set digital code. Any number of appliances with built-in receivers are protected by the one concealed transmitter.

For proper operation, both the transmitter and receiver/s should be operating on the same electrical phase. The system has a self checking capability which activates the alarm for half a second, the moment it is plugged into the electrical system, indicating the system is in working order.

If a protected appliance is removed from the premises, which in turn would set off the internal alarm, and the burglar is silly enough to make his getaway with a screaming appliance, one would assume that all is OK after the built-in rechargeable battery runs down and the appliance is silenced.

Alas, the burglar is in for a big surprise! When he plugs the appliance into his power supply and the unit it totally inoperable, the alarm will immediately activate and the battery is recharged.

This system is inexpensive to produce, but when built into appliances at assembly line level, the cost would become even lower: Note that some 35 000 VCRs are stolen each year in Australia.

DCB claim the following advantages over other security systems:

● Easy installation ● 24 hr protection ● No keys to lose as alarm arms as soon as it is plugged in ● Self-checking system ● Compact ● Low price ● Not easily tampered with.

To move an appliance to another location a keyboard is incorporated into the appliance requiring a predetermined set of numbers to be punched in by the owner to de-activate the alarm. When the appliance is re-located the security system is automatically re-activated and operates normally.

A large manufacture of varied appliances would benefit from this system built into their products, DCB claim.

For further information contact: **DCB Computer Marketing, 81 Kingsclere Avenue, Keysborough 3173 Vic. (03) 798 2323.**

Big bass end for locally-made two-ways

Audiosound Laboratories' model 8035 speakers are a two-way system featuring extended bass performance claimed to be 3 dB down at 38 Hz and only 5 dB down at 30 Hz.

The bass end design was computer-correlated for Audiosound by Mr Neville Thiele, according to his original engineering paper on the subject.

The 8035 speakers employ a newly-developed 200 mm bass driver with aluminium voice coil former and high temperature coil. The top end is provided by Audiosound's HF8 wide dispersion 25 mm dome driver via a phase-corrected third-order (18 dB/octave) filter using air-cored coils and polyester capacitors.

Tonal balance is claimed to be similar to Audiosound's 8033A and 8066 systems (see p.31, Oct. '85 issue about the latter) which are used by the ABC.

The 8035s are supplied with an attractive stand for optimum bass end performance. The speakers stand 1040 mm high (including the stand) by 310 mm wide and 390 mm deep.

Designed and fully manufactured in Australia, the 8035s are obtainable from **Audiosound Laboratories, 148 Pitt Rd, North Curl Curl 2099 NSW. (02)938 2068.**

Concept Audio release CD player by ADC

Concept Audio Pty Ltd of Brookvale NSW, importers of such well respected and sought after products as Rega, Hafler and Mordaunt Short, has finally announced that they have added a compact disc player to their distribution stable.

It is the CD — 100X machine from ADC.

Among its many features, the CD-100X offers: a motorized disc tray; three-beam laser for better tracking; programmable memory for 16 tracks; single track repeat, programmed track repeat and all track repeat and a linear digital-to-analogue converter.

With a retail price point of just $499 Concept Audio believes that this compact disc player will grow in popularity very rapidly. Further information can be obtained directly from **Concept Audio, PO Box 422, Dee Why 2099 NSW. (02) 938 3700.**

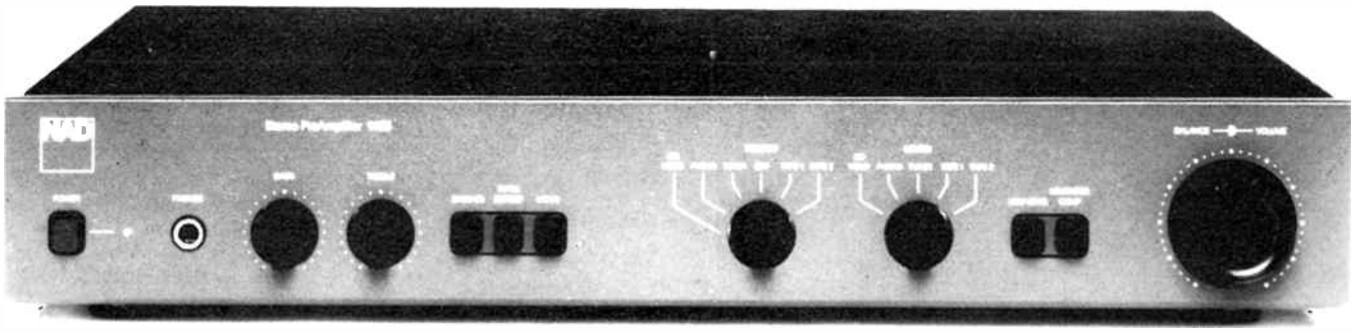
Price rise for TDK video tapes

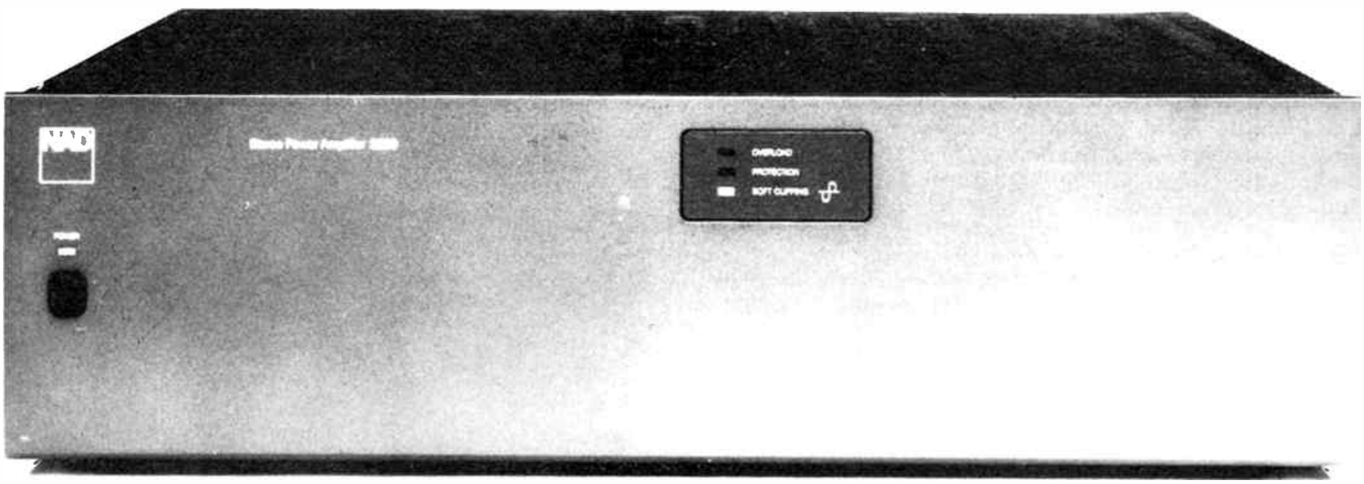
Devaluation of the Australian dollar in 1985 against the Japanese Yen has led to an increase in TDK Australia's price of video tapes. TDK is a major supplier of audio and video tapes to the Australian market.

Mr Ken Kihara, General Manager of TDK Australia, said an increase of approximately 13-15 per cent on most types of TDK video tape will be effective from February 1, 1986.

"Only significant weakening of the Australian dollar during 1985 has necessitated price adjustment for our range of video tapes," he stated.

Elements of a successful marriage —





the NAD 1155 preamp and 2200 power amp with KEF C10 speakers

Systems – comprising source equipment, amps and loudspeakers – have dominated the hi-fi market over the past five years, whereas mix-and-match was the strategy for assembling a domestic hi-fi sound system previously. Is it still possible to mix-and match equipment from different manufacturers to meet today's standards? If these results are any indication, the answer is – certainly! – but you need to do it with care, as before.

Robert Fitzell
AAAC

OVER THE PAST MONTHS we have reviewed a number of component parts of high quality sound systems. One item was the Philips motional feedback loudspeaker system which includes a power amplifier, and we have looked at two excellent input devices, the Nakamichi cassette deck and CD player. Either of the Nakamichis together with the Philips would constitute a sound system. To round off our current review sequence, here we investigate two new products from the traditional equipment which follows the cassette deck/CD player source equipment — separate amplifiers and loudspeakers.

Conflict and compromise

The hi-fi industry has been going through a somewhat muddled phase. Digital sound equipment has become almost commomplace, offering phenomenal performance at prices we all originally only dreamed of (despite a 'slippery dip' dollar). At the same time that other market pressure, nearly always the most influential one, popular opinion, is causing store after store to offer many mini components — all so your friends can listen to music without having to use binoculars over mountainous loudspeakers to see who they're talking to. Clearly, the day of the BIG sound system is not now, and this leads to inevitable conflict or compromise, particularly where digital sound sources are concerned.

While it is a subject we will examine more in later articles, I have said before there is no substitute for power and power handling capacity where digital input sources are concerned. Immense signal strengths may be successfully recorded digitally, so that music with large transients can be auditioned

▲ **The KEF C10 speakers are a two-way pressure-box design measuring just 300 mm high by 205 mm wide by 172 mm deep.**

◀ **The NAD 1155 preamp (above) and 2200 'Power Tracker' power amp (below) make a fine combination in both appearance and performance.**

at a relatively low level, and still have electrical headroom to permit the crashing of cymbals or drums to really take the top off your head if you're silly enough to want that. Even moderate listening levels for some classical and popular music will still require very large amounts of power for transient peaks, and the limit has increasingly become capacity of the loudspeakers.

If one examines simple loudness versus power, the public address system industry has long known the importance of loudspeaker efficiency. If you stack two loudspeakers against one another and one is 3 dB more efficient than the other, at the end of the day the power bill for the less efficient speaker is twice as high. What leads to increased efficiency? . . . either horn loaded drivers or, yes you guessed it, BIG loudspeakers. If we are considering efficiency at low frequencies then efficiency is only achieved using large speakers. If you want to drive your loudspeakers hard, what leads to better power handling capacity? Amongst other things, a large coil (i.e: a large diameter loudspeaker). Again, all this points to large loudspeakers.

Think over the public address or theatre sound systems that have impressed you, and they almost always use large sized loudspeakers. Before leaving this point I will hasten to add an opinion that large loudspeakers are frequently not the best choice for domestic use, particularly where rooms are relatively small. I, for one, would rather listen to a clean loudspeaker with a limited bass end, than one with immense output at low frequencies which is either lost or muddied by being compressed into a room which is simply too small accoustically to accomodate it.

So we are left with the quandary of popular opinion. If you don't want to be humiliated as guests gaze stonily at your bass loudspeakers poorly disguised as a room divider you are likely to greet them at the door with a smile and a KEF C10 loudspeaker clutched hopefully under your arm. As these crass guests glide gracefully into the room you will probably rush furtively to connect the C10 loudspeakers back into the NAD power amp system. If so, all host grovelling aside, they will have the pleasure of listening to an excellent sound system. If the occasion is a party, you would be wise to hide the KEFs in a cupboard, or else Araldite the volume control knob. Otherwise, by the end of the night you may not have any music at all.

The marriage partners

Whilst the NAD 1155/2200 and the KEF C10 are in no way marketed together, both components can be recognised as products of today's market demands and combine to form a 'state-of-the-art' (state-of-the-market really) system. The NAD range of equipment has long been designed with the combination of performance and aesthetics uppermost, and this new amplification chain is no disappointment. Power capacity is very high, and the facilities provided on the NAD are evidence of the dual market sought for the system — domestic hi-fi and commercial sound reinforcing systems.

The name KEF has long been associated with very high performance and state-of-the-art loudspeakers. The C10 is their offering to the domestic market for a compact, high quality loudspeaker, and to other users such as the studio or broadcasting industry as mini-monitors.

We have chosen to review them together, and in doing so have found excellent performance but with a predictable power handling conflict.

NAD 1155/2200 stereo amplifier system

The appearance of the NAD 1155 preamplifier and 2200 power amplifier is typical of the understated quality of past products of this manufacturer. In many respects the system is more properly suited to professional sound systems than domestic use. Being separate units probably restricts the ▶

REVIEW ITEMS:	Composite Sound System
Stereo Preamplifier	
MANUFACTURER:	NAD
MODEL:	1155
FORMAT:	Independent modular
PRICE:	$490.00 rrp.
Power Amplifier:	
MANUFACTURER:	NAD
MODEL:	Model 2200
FORMAT:	Fixed gain
PRICE:	$900.00 rrp
Loudspeakers:	
MANUFACTURER:	KEF
MODEL:	C10
FORMAT:	Mono-amplified two-way acoustic suspension
PRICE:	$399.00 rrp

Distributor: All items from Falk Electrosound, PO Box 234 Rockdale 2216 NSW.

SUMMARY: Clean, uncoloured sound, excellent overall response, but a power conflict between speakers and power amp.

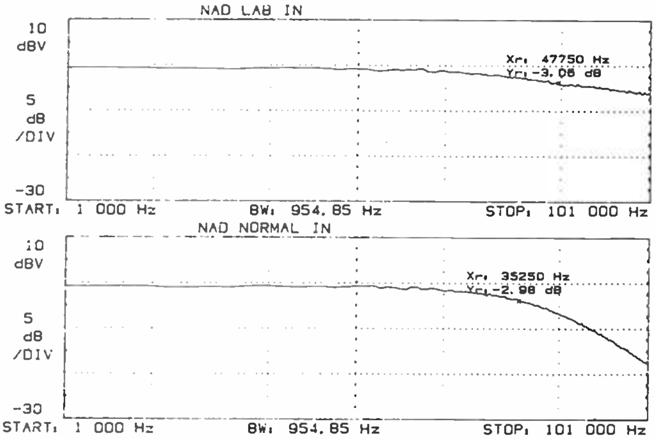


Figure 1 (above) & 2 (below). NAD 2200 power amp frequency responses for the 'lab' and 'normal' inputs.

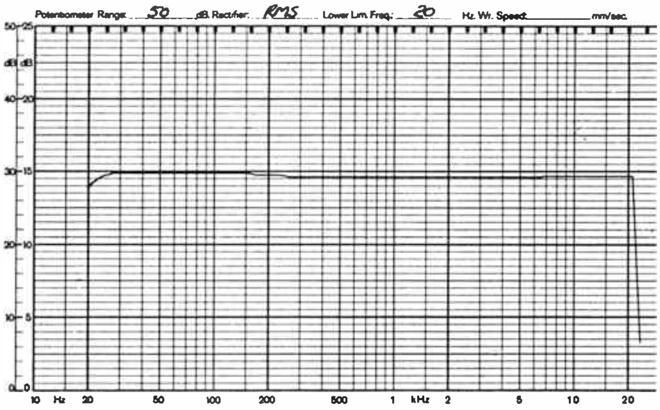


Figure 3. Overall frequency response of the NAD 1155/2200 combination.

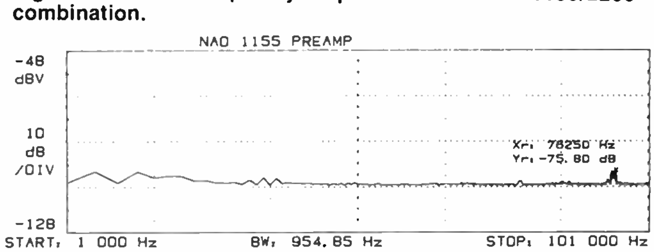


Figure 4. NAD 1155 preamp frequency response.

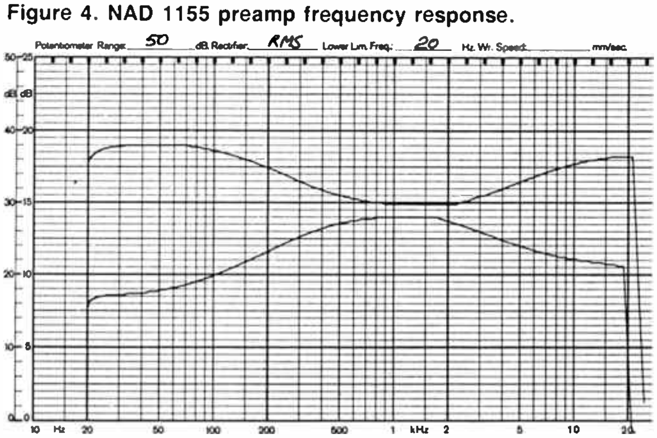


Figure 5. Response of the tone controls on the NAD 1155 preamp.

domestic market in a small way by doubling the number of amplifier components in the system. In professional use the divided system is almost mandatory, since it permits either inclusion of additional signal processing, such as graphic equalisation, or use of the power amplifier alone in conjunction with a microphone mixing console.

The main power amplifier is also a little different from some in that it is fixed gain, i.e: there is no volume control. This is not common yet there is little reason for a main power amplifier gain control since the preamplifier offers total control in any case. An exception is when the power output capacity of the amplifier exceeds the input capacity of the loudspeakers. Then, a power amplifier gain control can be used to limit the maximum power so that the preamplifier volume controls can be used without any concern that power levels might be getting too high.

In integrated amplifiers, that is a single cabinet with all controls on the front and pre and power amplifiers within, the power amplifier stage is usually fixed gain in any case so the NAD system offers nothing new, just the same arrangement but in separate cabinets.

Surprisingly, no technical specifications are given in the literature which accompanies either the 1155 or the 2200. This really is a problem since the power output of the amplifier is condiderable and damage to other components could be done quite unwittingly. Also, if we have just spent our hard earned money on the amps, we all like to read about them. Literature accompanying the 1155 and 2200 comprises instructions for installation and operation and are quite comprehensive.

The 1155 preamplifier offers professional standard facilities:

1. Capacitance adjustment to permit optimum performance for phono cartridges sensitive to input capacitance.
2. Facility for two tape recorders.
3. Separate CD player input.
4. Low output impedance (600 ohm) permitting either long cable runs between the preamp and power amp, as often occurs in a professional theatre public address system, or input to more than one amplifier at a time.
5. Selectable high level output at 220 ohms impedance to permit use with professional studio equipment.

Controls on the 1155 include the usual bass and treble tone controls, and a number of non-standard signal processing controls. These include a bass equalisation circuit, offering a bass boost in a narrower band than can be achieved by the bass tone control alone, and an infrasonic filter removing energy below 20 Hz. A mute button (rather clumsily named 'low level') is included along with loudness and channel balance buttons. Front panel master selectors separately control listen and record functions and take some little while

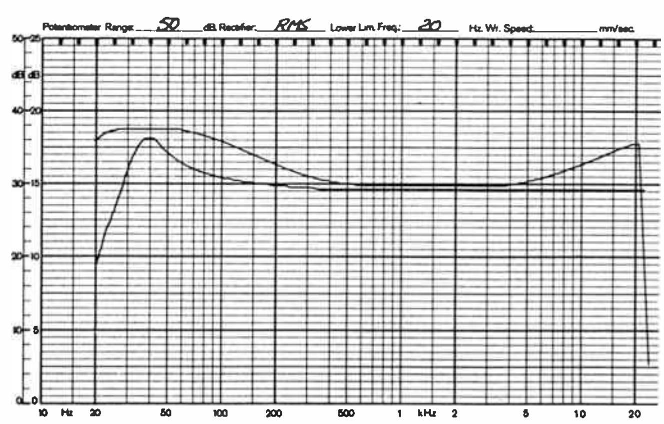


Figure 6. Superimposed curves of the loudness (upper trace) and bass eq (lower trace) switches of the NAD 1155.

to become familiar with, we found.

The 2200 power amplifier has a simple front panel, providing an on-off switch plus overload, protection and soft clipping indicators. The rear panel offers alternative input sockets permitting either a gradual ultra-high frequency roll-off or an extended frequency response, a select switch for soft-clipping, together with the output sockets. The amplifier may be operated in bridged mode whereby a second one may be driven, providing double the voltage or four times the output power. This gives a potential power output of the order of one kilowatt! That sort of power is clearly not for typical domestic hi-fi use.

Amp system test results

To test the amplifier chain we have used a number of input devices whilst driving the power amplifier output into a dummy 8 ohm load. All our tests are therefore applicable to 8 ohm loudspeaker loads.

Initially, we intended to determine the maximum output power rating as the value of 3% total harmonic distortion into an 8 ohm load. However, the output power capacity of the 2200 amp proved to be very high and above the input voltage capacity of our distortion measuring equipment. The output characteristics of transistor amplifiers is such that distortion rises at maximum power output rather like a brick wall and amplifier output voltage increase similarly stops abruptly, so the actual distortion value is rather academic.

Overload indication occured with an input of just over 1 volt, or an output power of 185 watts. For a short term input the RMS output voltage was found to plateau at approximately 43 volts ino 8 ohms, giving a transient output power of 230 watts! So much for the 100 watts we had thought the amp power to be.

Those readers used to testing will realise that without distortion measurement being possible at maximum power we could not quantitatively assess the effect of the 'soft clipping' option on the 2200 power amp. This option is intended to make the amp behave more like a valve amplifier. Amplifier enthusiasts have long complained that the transistor amplifier performs poorly when compared with a valve amplifier, particularly in relation to distortion when driven hard. The valve amplifier offers gradual distortion increase at high levels, and so better, response to high level transients compared with the 'brick wall' distortion of the transistor amplifier.

Using the internal pulse source of our Hewlett-Packard 3561A analyser, we found no appreciable difference between the amplifier response with or without soft clipping at the levels likely to be used for normal listening. In professional

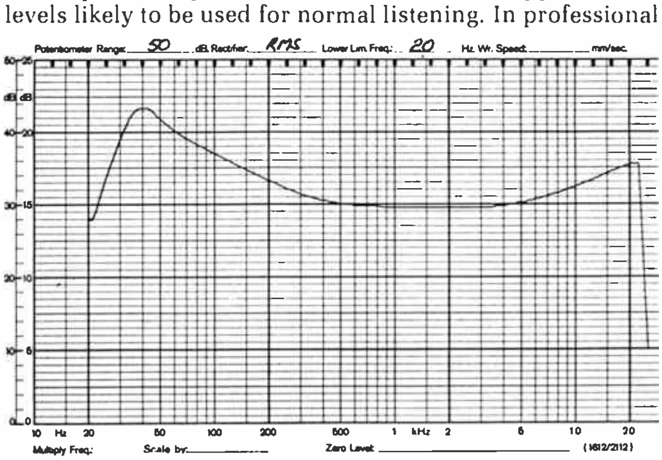


Figure 7. Combined effect of the NAD 1155 loudness and bass eq switches.

public address system use the feature is likely to be of much greater value and may protect both the loudspeakers and the listeners' ears quite considerably.

The voltage gain of the 2200 power amp was found to be 38 to 1, or 31.6 decibels. Harmonic distortion was generally better than -77 dB, although at 10 kHz harmonic distortion clearly existed, at -74 dB for 1 watt output and -77 dB for 20 watt output. All else exceeded our instrument measurement capacity. Signal-to-noise ratio was measured at 105 dB (A).

Frequency response of the 2200 is dependent on the selection of input socket. Figures 1 and 2 show the different responses using the 'normal' and 'lab in' input sockets. Frequency response is rolled off for the 'normal' socket using a 12 dB/octave low pass filter. Relative to 1 kHz, the -3 dB point is not greatly different for the two input sockets being approximately 35 kHz and 48 kHz respectively. At 100 kHz the difference between the two is approximately 12 dB. For the audible frequency band (Figure 3) of 20 kHz to 20 kHz the response is flat within 0.5 dB for either input.

The 1155 preamplifier has multiple input and output choices and hence many configurations for testing. Two output socket pairs are provided, referred to earlier. Output to the power amplifier may be by either 'normal' or 'high' output sockets, with the latter being rated at 13 dB higher output. With this one you need to be careful. For the line input sockets — CD/video, tuner and tape — the gain was found to be 6.6 to 1, or 16 dB. For the phono input, gain was found to be 84 dB using the moving magnet (MM) input option and 107 dB using the moving coil (MC) option.

Distortion for the 1155 was uniformly better than -77 dB, the measurement limit of our equipment. Signal-to-noise was found to be 100 dB (A) for an equivalent 1 watt output using the 2200, or 109 dB(A) at full gain on the 1155! The mute button was found to drop the output by 21 dB.

Frequency response of the 1155 was found to be linear to 100 kHz, although the ripple at 76 KHz seen in Figure 4 has no explanation. This could be a function of the test configuration since cable effects can be significant at very high frequencies. Bass and treble controls gave +9/-12 and +7/-8 respectively, as seen in Figure 5. Figure 6 shows the loudness control superimposed with bass eq control effect, a peak gain of +7 dB at 40 Hz, whilst Figure 7 is the cumulative effect of these two controls. Net boost at low frequencies is 14 dB at 40 Hz and this magnitude of control would rarely be used.

In the equipment literature, the bass eq control is said to be included to assist where room response is restricting loudspeaker output at low frequencies. Whilst this effect is undoubtedly a real one, to which I referred earlier, I would caution against expecting the control to achieve miracles. The reason bass response is missing in small rooms is simply that wavelengths of low frequency room modes simply cannot fit. To pump more power in means that the speaker has to work a lot harder but still cannot efficiently produce the goods. Also, in rooms in which 40 Hz modes are relatively undamped the result could be quite terrible. At low listening levels, however, many will use both the loudness and the bass eq.

In combination, the 1155/2200 can be potentially damaging to even quite powerful loudspeakers if you are not careful. Using the 'normal' output of the preamp at full gain, the combined amplifier gain is 250:1 or 48 dB which will cause the overload protection on the amp to operate for a 0 db tape recorder input. But remember, the amp output at that point is still at least 185 watts. The combined gain on the total system for the high level preamp out is 61 dB. Signal-to-noise at 100 watts was 99 dB (A) and, given the excellent distor- ▶

tion and headroom, the amp would be hard to find trouble within public address or other higher powered applications.

The KEF C10 speakers

Subjectively, the KEF C10 is an excellent loudspeaker. The cabinet is small, being 300 × 205 × 172 mm, and built from woodgrain finish vinyl with a black cloth front. The fabric cloth is supported on a 13 mm deep particle board frame. No real attempt has been made to eliminate high frequency reflection off the frame as is becoming more common practise with higher quality loudspeakers.

The C10 loudspeaker is designed to operate against a wall or on a shelf by including a 'step' in the frequency response at mid frequencies — a logical design for such a small unit. Recommended amplifier power stated in the accompanying literature is not less than 15 watts.

Under laboratory tests we found the C10 to perform right up to specification bar some shortfall at very high frequencies. Figure 8 shows the frequency response on-axis performed in a Q = 2 space; that is, up against a reflective wall to allow for the normal bookshelf mounting. Some evidence of the step in the response is still evident at about 800 Hz. The high frequency limit is not up to the 20 kHz claimed by the manufacturer. Figure 9 is a near-field (50 mm) sweep which shows the crossover is about 2200 Hz. The individual driver response is a little less exciting than some we have seen. However, in combination, the response was found to be good.

High frequency roll-off is shown in Figure 10 where each trace is attenuated 10 dB to achieve separation. At 30° the response above 12 kHz has dropped quite markedly, whilst at 60° the roll-off is smoother with frequency but commences at about 5 kHz.

Vertical roll-off is shown in Figure 11 at 0° and 22.5° down, again 10 dB apart, and two important features are noticeable — phase cancellation at the crossover occurs quite abruptly above 10 kHz. The loudspeaker must therefore be mounted at a correct angle to suit the intended listener head level for the frequency response to be smooth.

Loudspeaker impedance (Figure 12) was found to be a nominal 8 ohm at 250 Hz and the bass driver resonant fre-

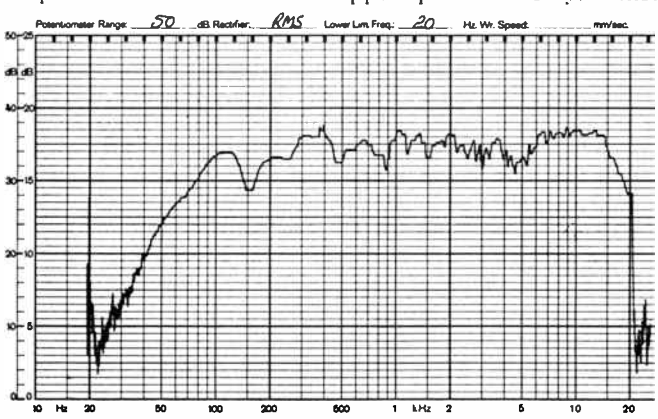


Figure 8. Frequency response of the KEF C10 speaker, measured on-axis.

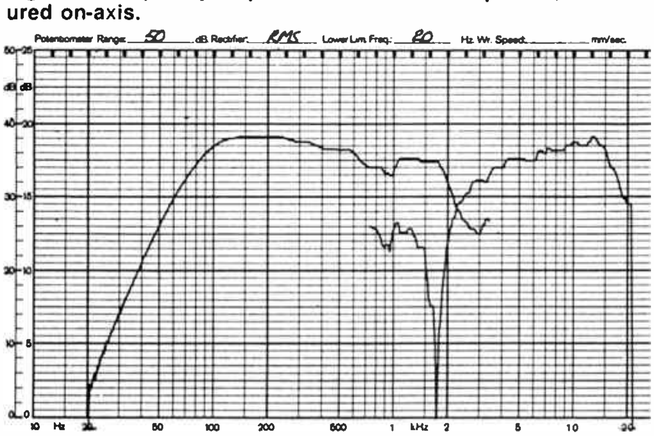


Figure 9. Near field responses of the two drivers in the C10 speaker.

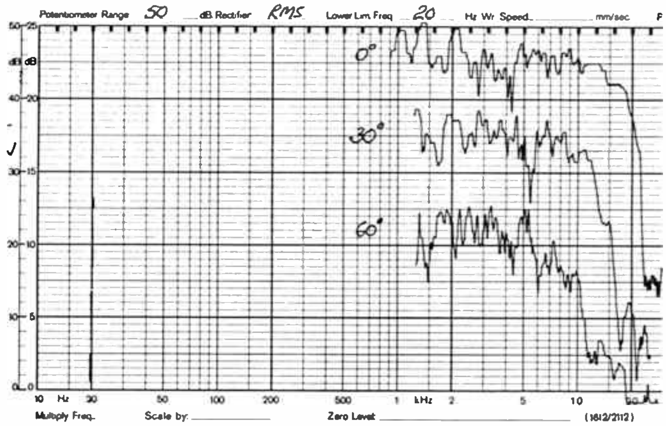


Figure 10. High frequency response of the C10 speaker at three different angles in the horizontal plane. Note — each trace has been separated by 10 dB for clarity. The top trace is on-axis.

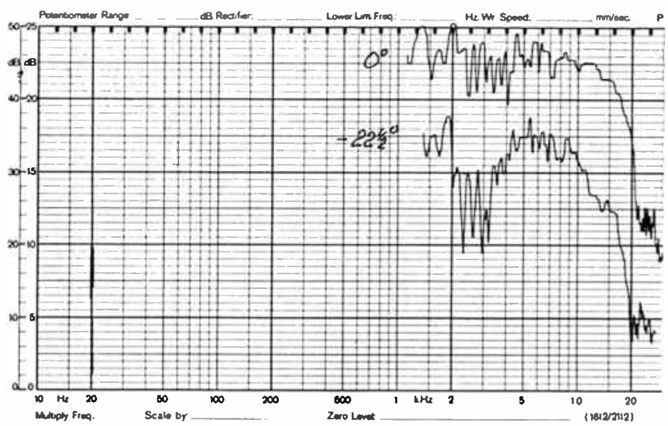


Figure 11. Vertical plane high frequency response of the C10 speaker on-axis (upper trace) and at 22.5 degrees below the horizontal. (Traces separated 10 dB for clarity). Note the phase cancellation around the crossover frequency on the lower trace.

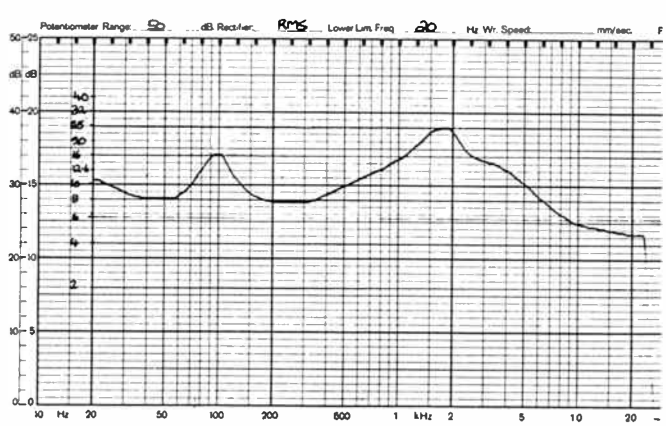


Figure 12. Impedance versus frequency response of the C10 speaker.

quency found to be almost exactly 100 Hz with a Q of 2.53 — quite well damped. At high frequencies the impedance was found to drop to approximately 5 ohms.

Total harmonic distortion for the C10 was found to be excellent at better than -32 dB for all test frequencies at 1 watt. At 10 watts THD dropped to better than -38 dB for 1 kHz and 10 kHz but rose to a still creditable -26 dB at 100 Hz.

Figure 6 is the final test trace, an impulse test of the KEF

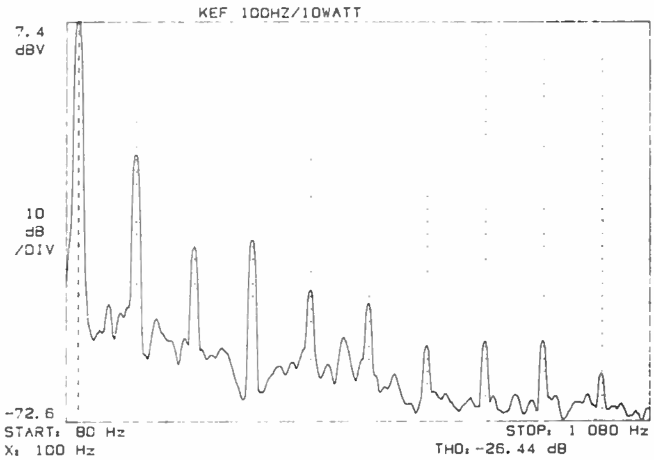


Figure 13. THD of the C10 at 100 Hz and 10 watts (always a critical parameter with bookshelf speakers) is a creditable -26.44 dB.

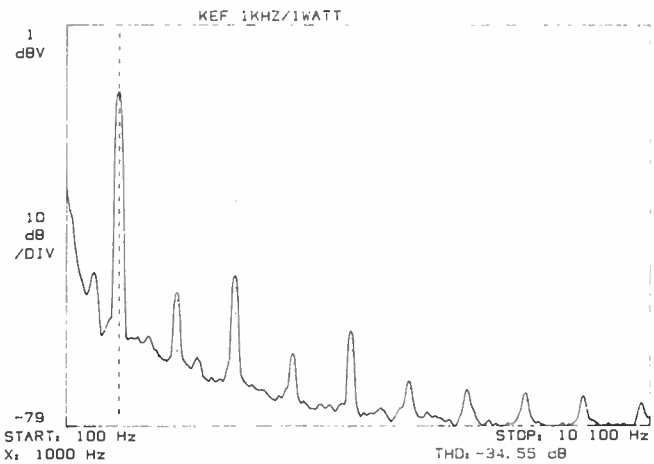


Figure 14. THD of the C10 at 1 kHz and 1 watt is excellent at a little better than -34 dB.

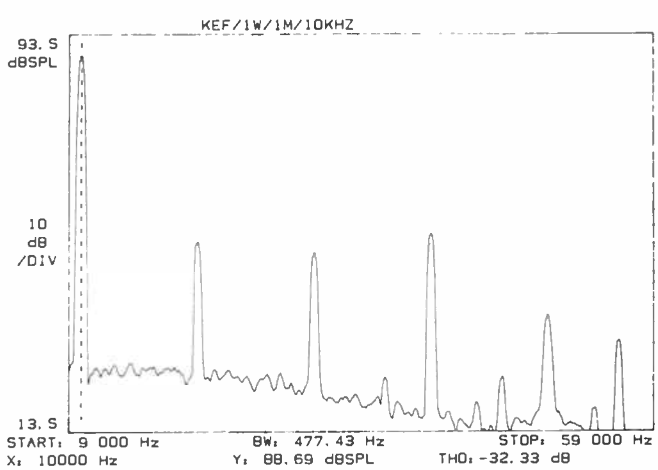


Figure 15. The 10 kHz/1 watt THD of the C10 is also very good, being a little better than -32 dB.

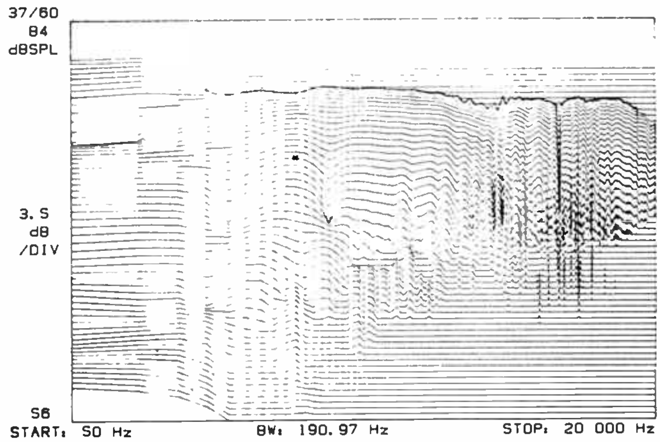


Figure 16. Impulse response of the C10 speaker shows only minor irregularities around 4 kHz and 7.35 kHz.

16 loudspeaker. The impulse is limited at the low frequency end by the analyser's bandwidth of 190 Hz, so little can really be learned about the bass response of the speaker. At higher frequencies however, overall response is remarkably smooth bar one dip at 7350 Hz and two lesser dips at about 4 kHz. Certainly, no problems are evident with the crossover.

Sensitivity of the C10 was tested in free field at 85 dB/watt for a pink noise output. Given the additional 1.5 dB claimed by KEF for the gain through mounting close to a wall, the test results of 86.5 compares very favourably with the manufacturer's specification of 88 dB. Maximum sound pressure level stated by the manufacturer for programme peaks under typical listening conditions is 106 dB, which corresponds from their own sensitivity rating to an input level peak of 63 watts. Given the normal headroom margins applicable for comfort to the loudspeaker rating of 60 watts power handling capacity. Obviously, the NAD has to be used very carefully with this one.

The system

Despite the power conflict outlined above, the NAD amps and the KEF C10s combine very well. I have previously said that in many instances it is the loudspeaker which really determines the sound, and of course the quality of the NAD ▶

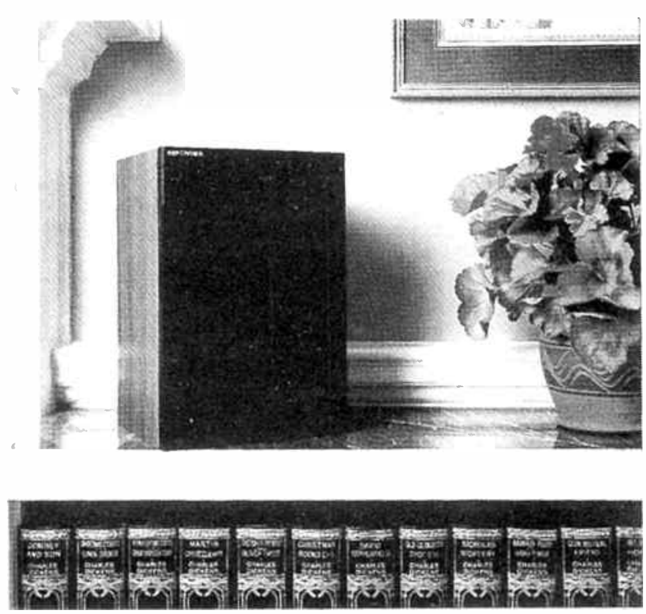


TABLE 1: TEST RESULTS SUMMARY

Item	1155	2200	System	KEF C10
Frequency response (+/-3dB)	-	-	5 - 48 kHz	80 - 17 KHz
High frequency (-3dB rel 1 kHz)	100 kHz	35 kHz	-	17 kHz
	-	48 kHz	-	-
Maximum output power	-	185 watts	-	-
Gain: normal	16 dB	32 dB	48 dB	-
high	29 dB	n/a	61 dB	-
THD 100 Hz 1 watt	< -77 dB	< -77 dB	< -76 dB	-38 dB
10 watt	< -77 dB	< -77 dB	< -77 dB	-26 dB
1 kHz 1 watt	< -77 dB	< -77 dB	< -77 dB	-35 dB
10 watt	< -77 dB	< -77 dB	< -77 dB	-39 dB
10 kHz 1 watt	< -77 dB	-77 dB	-77 dB	-32 dB
10 watt	< -77 dB	-74 dB	-74 dB	-38 dB
Signal-to-noise, dB(A):				
full gain	109	105	104	
100 watts	100	105	99	
Input for 1 watt out at full system gain:				
phono MC	-	-	13 µV	
phono MM	-	-	185 µV	
CD, tape, tuner	-	-	11 mV	
Sensitivity, dB/W @ 1m				
pink noise input	-	-	-	86.5
10 kHz	-	-	-	88.7

is really only heard in that it is inaudible. At no time was I aware of amplifier noise.

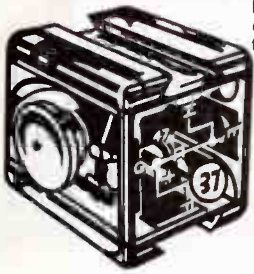
The subjective quality of the KEF C10s is very nice indeed, with quite remarkable presence for such a small loudspeaker. We did not try anything too foolish, such as the 1812 or other hefty classics, but restricted listening tests to lighter classics, some of the Wyndham Hill recordings on both CD and vinyl discs, and pop music. As a mid-range loudspeaker I found it hard to fault. All musical instruments are accomodated with little colouration to marr them. The bass is very 'tight' with the result that the subjective impression is one of quite ample amounts of low frequency output. If you want you can definitely improve the low frequency end with the bass eq control on the preamp. However, I found that I did not really prefer the sound quality and many will opt for the tone controls alone.

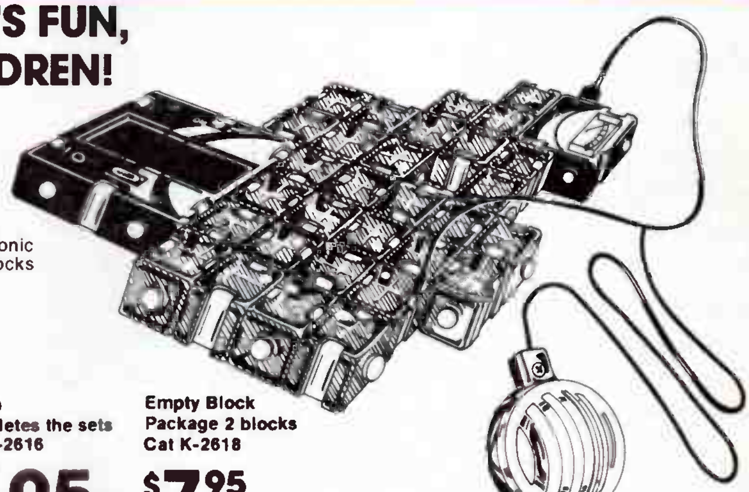
If you are looking for a new high quality system, this is one we can commend to you to evaluate yourself. My own opinion is that the NAD amps should power a larger pair of loudspeakers for main use or for larger rooms, with the C10s being used for either small rooms or for second set use. With little fiddling the NAD power amps could very easily power more than one set of speakers although the facilities on the back of the map do not provide for this. The C10s have the presence to carry listening at low levels so if you have a space problem they are well worth looking at. Perhaps the best asset of the system is remarkably quiet amplifiers, very clean sound, and providing you can keep the preamp volume controls where they should be, the combined equipment has good dynamic range for digital sources. If the volume gets too high though, goodbye C10s.

BLOC-TRONICS IS EASIEST IN LEARNING ELECTRONICS!

IT'S THE NEW STANDARD THAT'S FUN, CREATIVE AND SAFE FOR CHILDREN!

BLOC-TRONICS is a revolutionary method for youngsters to learn electronics and build projects. It's an alternative to soldering, using inter-connecting cubic blocks containing electronic elements with multi-sided contact points. These slot together to form circuits. And by following the BLOC-TRONICS manual, you can build a variety of projects. BLOC-TRONICS is available in 3 configurations. Each builds upon the other with more components. PLUS there are empty BLOCS available for inserting your own electronic elements. BLOC-TRONICS can be the building blocks to your child's future.





KIT A
Starter Set
K-2612
$39.95

SET 1
Builds on Set A
Cat K-2614
$39.95

SET D
Completes the sets
Cat K-2616
$105

Empty Block
Package 2 blocks
Cat K-2618
$7.95

BUILD A 2M UHF TRANSCEIVER

Brilliant! Build it yourself and save $$$. It boasts all the features. +/- 600kHz offsets, anti repeater, 5kHz offset and more. Selectivity is better than 60dB at +/- 25kHz.
Cat K-6308 We export to the USA **$189**

13.8V 2A POWER SUPPLY KIT

A very affordable accessory for UHF/VHF transceivers. Supplies 13.8 volts, regulated at 2 amps continuous. Comes complete with all necessary parts and instructions.
Cat K-6310 **$49.95**

Cat K-6318

RTTY DECODER FOR VZ-200/300 COMPUTER

Fantastic! Low cost entry into teletype. It's easy to build and install ... interfaces straight into expansion port. Features 1K write ahead and WRU buffers, 7 pre-programmed EPROM messages and single letter commands.

Decode news broadcasts or work your local RTTY repeaters! **$69.50**

TRIPLE THE FUN & VALUE

This is it! Funway I, II, III gift box — combines all the fun, excitement and experiments of the Funway series. If you bought the series individually, you'd pay over $70. Now save.
Cat K-2680. **$49.95**

FUNWAY JUMBO BOX

WOW! Talk about value. Contains over 30 fascinating projects PLUS a DSE soldering iron.
Cat K-2690
SAVE $40 **$89.95**

FUNWAY 1 GIFT BOX

Value! There's the great Funway I book and components. PLUS a handy component tray. Contains 20 projects.
Cat K-2605 **$15**

FUNWAY 11 GIFT BOX

It's all here! The Funway 2 book, soldering iron and solder, 9V battery and 'Wireless Mic' kit.
Cat K-2620 **$15**

SAVE NOW ON FUNWAY III

		Save	
Funway III Auto Minder	K-2660	$1	$3.95
Funway III Two-up	K-2661	$1	$5.95
Funway III Pokey	K-2662	$3	$11.95
Funway III Cricket	K-2663	$2	$7.95
Funway III Mini Colour Organ	K-2664	$1	$5.95
Funway III Light and Sound	K-2665	$2	$4.95
Funway III Combined Timer Lock	K-2666	$2	$7.95
Funway III Mini Amp	K-2667	$3	$11.95
Funway III Binary Bingo	K-2668	$2	$10.95
Funway III Mini Synth	K-2669	$2	$10.95
Funway III Bonus Pack	K-2670	Over $4	$19.95

DICK SMITH ELECTRONICS PTY LTD

For Address details See P88

B112/RB

Radical new speaker cabinet design reduces 'cabinet colouration'

Roger Harrison

Danish loudspeaker manufacturer, Jamo, has developed a radical new loudspeaker cabinet design with baffles featuring a unique concrete-like material 'sandwiched' between a polystyrene 'skin' to provide damping that they claim is several times more efficient than conventional materials. Jamo has incorporated this into a range of new loudspeakers housed in asymmetric-design cabinets to counteract internal resonances and with the front baffle angled to obtain 'time coherent' sound radiation.

ONE OF THE MOST COMMON PROBLEMS plaguing traditional loudspeakers is uncontrolled cabinet resonances. Manufacturers have sought solutions to this problem for many years. As drivers have been improved dramatically over the past five years or so, the failings of the traditional loudspeaker box have become more and more apparent. While a rectangular box is simple to design and the best shape for mass production, it has several acoustic problems. The panels will exhibit resonances of their own and internal standing waves, caused by reflection of the sound waves between the panels inside the box, all contribute to distortion produced by the loudspeaker which we perceive as 'colouration'.

In addition, loudspeakers necessarily comprise an assembly of different drivers so as to cover the required frequency range across the audible spectrum. Since these must be mounted at different locations on the front baffle, the output of the various drivers will not add so as to form a recombined signal that is close to the original signal. The listening point position will lie at slightly differing distances from each driver. Now, one driver will be closer than another and there will be a frequency for which the difference in distance is a half wavelength. See Figure 1. At this frequency, the outputs from the two drivers will interfere destructively, one cancelling the other, and a null appears in the frequency response. This is particularly likely around the crossover point between the two drivers in question and will exist for each crossover point in the system. To overcome this, some years ago manufacturers began making cabinets with 'stepped' front baffles such that the drivers were placed acoustically equidistant from the likely listening position, to achieve 'phase coherent' or 'time coherent' reproduction.

A fresh look at stale problems

In 1982, Jamo began a series of experiments with loudspeaker cabinets constructed of non-traditional materials and different shapes. It turned out that they found concrete to be an excellent cabinet material from a sonic point of view (not that Jamo were the first company to learn this, mind you) — but its high production cost in practical speaker cabinet designs ruled out its use at that time. But Jamo's engineers didn't give up.

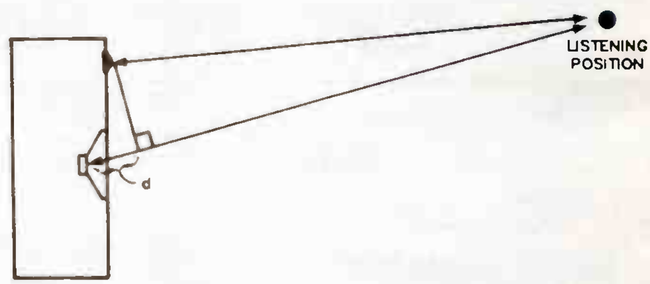


Figure 1. With conventional speaker cabinets the difference in the distances of the drivers to the listening position results in destructive interference of the sound waves producing a dip in the loudspeaker's frequency response where d = ½ wavelength. This is particularly a problem around the crossover frequencies.

Experiments with different cabinet shape designs, using conventional high density chipboard, showed promise in reducing cabinet resonance and standing wave problems and they came up with a cabinet having non-parallel sides.

These two lines of research produced a convergent idea — to combine a non-parallel sided cabinet with concrete material construction.

The biggest problem with cabinet resonances lies in the front panel. By using bracing, these resonances can be reduceed, but not eliminated. Jamo then attempted to make the front baffle of a non-parallel sided cabinet in concrete with the other panels of high density chipboard. The results were very encouraging.

The problem was the finish of the concrete front baffle. For a 'high-tech' product to have a finish like a naked building column (so beloved of modern architects) was felt to be not acceptable. After all, it has to sit in people's living rooms. The solution was to cover it with a skin.

From a start with raw concrete, Jamo's researchers came up with a concrete-like mix having an elastic binder blended in with it, resulting in reduced weight and cost, while retaining the desired acoustic damping characteristics. Jamo has applied for a patent on the material.

The resulting baffle construction comprises two layers of vacuum-formed polystryrene with the concrete-like material injection moulded between to form a sandwich 25 mm thick. The outer polystyrene skin of the baffle incorporates a moulded anti-diffraction pattern to preserve the stereo image at the upper end of the audio range. See Figure 2.

Jamo's new Digital Monitor CBR Series loudspeaker range comprises three floor-standing models and one bookshelf model. From left to right, they are: the CBR 70 (bookshelf), CBR 90, CBR 120 and CBR 200.

Radical approach — radical results

Jamo has dubbed the unique concrete-mix in the sandwich used on the front baffle "non-colouration compound" (NCC). Compared to 20 mm thick high density chipboard commonly employed in loudspeaker construction, it has markedly better damping characteristics, according to Jamo. The Jamo literature shows comparison between these two materials of the time decay spectral response of each to a pulse. Figure 3 illustrates the marked difference between them with the NCC material distinctly better. ▶

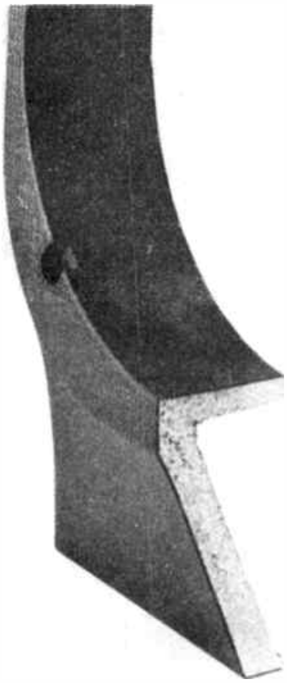
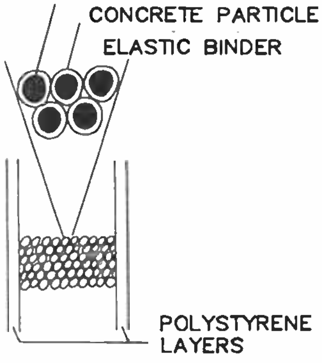


Figure 2. The front baffle of the new Jamo speakers employs a concrete-like mix, having an elastic binder blended into it, sandwiched between a polystyrene skin. Known as 'non-colouration compound', the concrete-like mix is claimed to have superior damping properties compared to the chipboard commonly used. The front surface has an anti-diffraction pattern moulded in it.



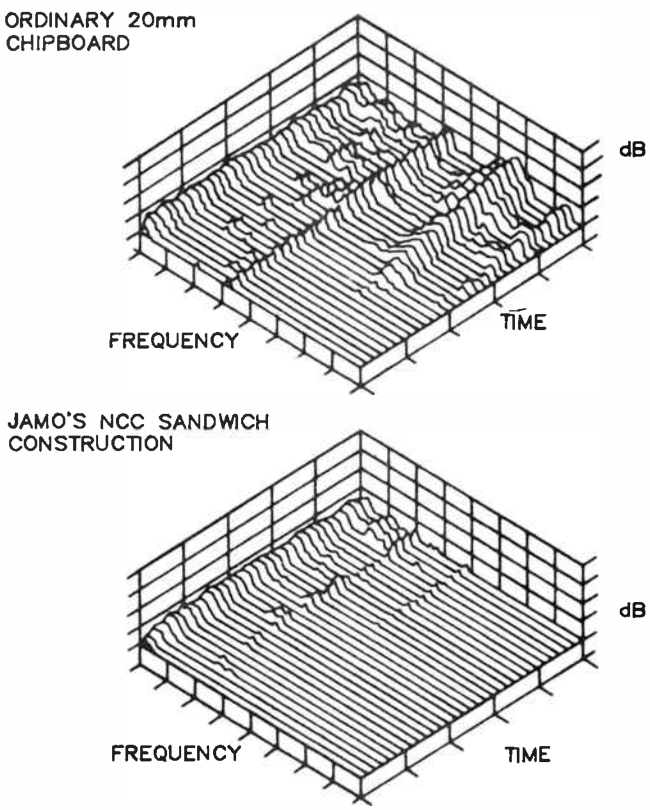
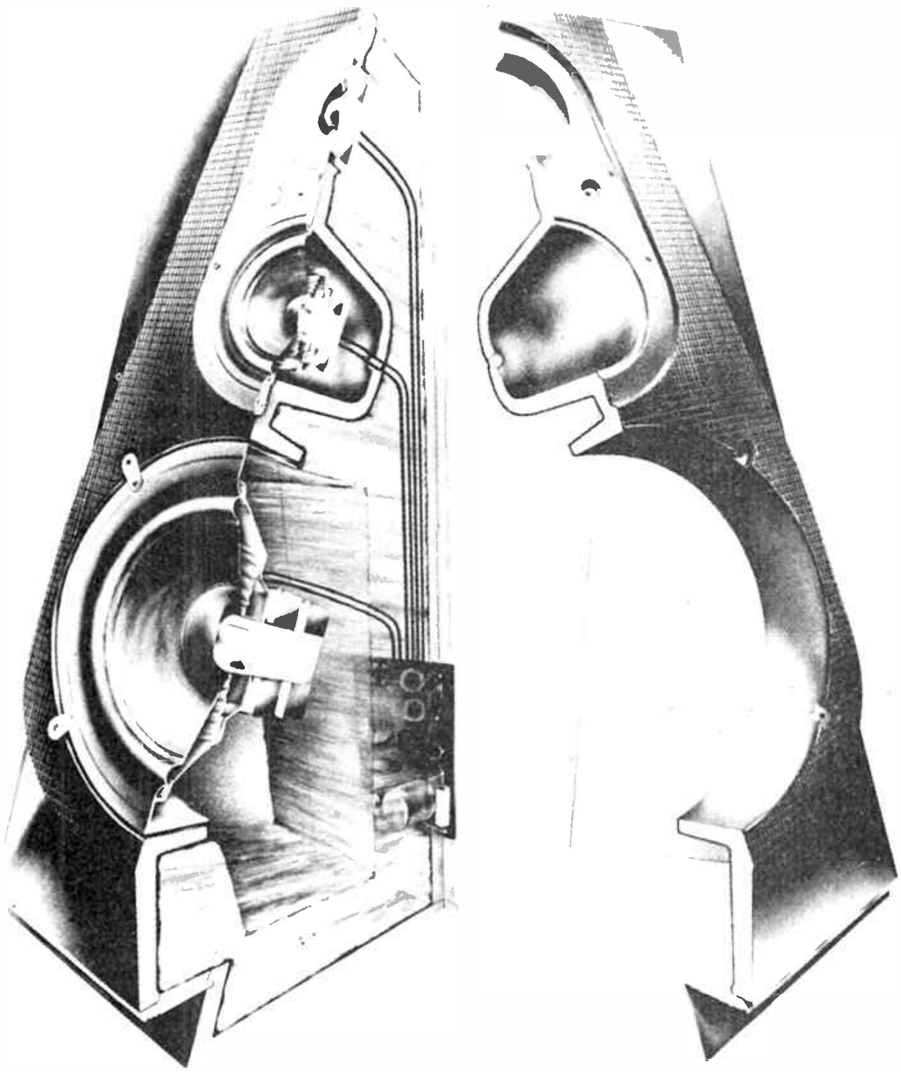


Figure 3. Comparison of the time decay spectral response to a pulse applied to 20 mm chipboard (upper graph) and Jamo's NCC sandwich connstruction (lower graph). Both materials were 'hit' with a pulse containing all frequencies between 20 Hz and 7 kHz. These vibration measurements show the damping characteristics of the two materials. The less 'landscape' there is, the fewer resonances there are, and hence the better the damping.



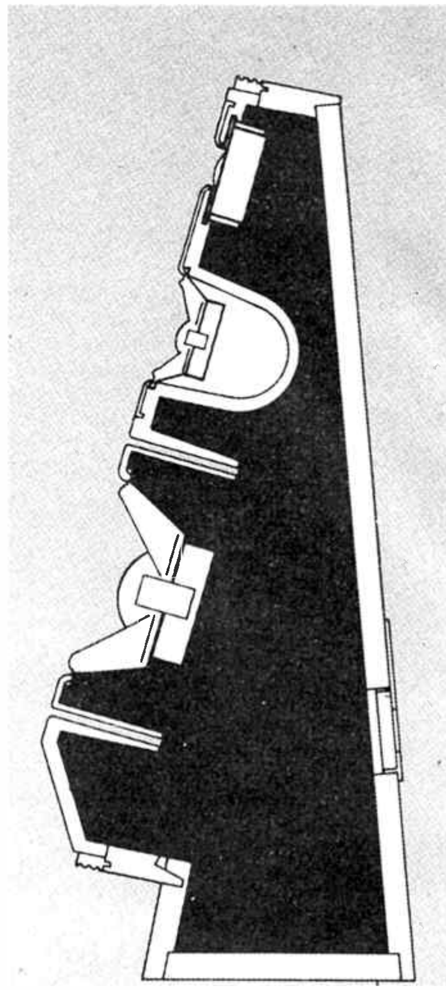
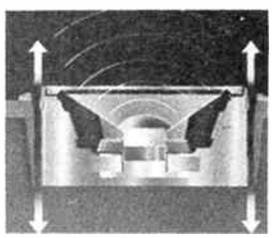


Figure 4. Showing the asymmetric cabinet design of the new Jamo Digital Monitor CBR series speakers. No sides are parallel so as to reduce cabinet internal resonances. The front panel is angled to align the acoustic centres of the drivers to obtain 'time coherent' sound radiation. The photograph shows a cutaway view of the CBR 200.



Jamo's 'centre bass-reflex' (CBR) system suspends the bass driver in the centre of the port which vents around the driver's rim. This is said to provide symmetrical loading of the cone.

Jamo incorporated the new front baffle design in a cabinet designed such that no sides are parallel. High density chipboard was used for the other panels. The front panel was angled to correctly align the 'acoustic centres' of the drivers in the three-way design, assuring equal time delay of the radiated sound from the drivers to the listening position. General construction is illustrated in Figure 4.

New speaker range

A range of four new loudspeakers incorporating these recent developments has been released by Jamo — three floor-standing models and one bookshelf model, known as the 'Digital Monitor CBR' series. All are three-way systems. The floor-standing models incorporate a stand as part of the cabinet design. They can be equipped with tip-toes or spikes. Each speaker in the range employs Jamo's centre-bass-reflex (CBR) system. This patented system mounts the woofer on four rubber suspension points coaxially inside a surrounding port. The air gap surrounding the woofer is said to provide perfect symmetrical loading of the woofer cone, reducing distortion. The tuning of the bass-reflex cabinet is based on the American Schneider theories, and has been aided by Jamo's extensive computer programs.

Top of the new range is the CBR 200. With a rated power handling capacity of 200 watts RMS, it employs a mid-range and woofer featuring carbon fibre diaphragms. This material is light and strong with high internal stiffness. The 254 mm (10") bass driver has a dual magnet assembly for high linearity and efficiency. The dome tweeter used in this system has a polymer diaphragm and ferrofluid injected in the voice coil airgap to give improved damping and power handling capacity. Attenuators are provided on the mid-range and tweeter for individual equalisation where necessary.

The other two floor-standing models are the CBR 120 and CBR 90. The latter has a 200 mm (8") woofer and each has an attenuator for the tweeter only. The bookshelf model is the CBR 70. All four loudspeakers include electronic overload protection for the tweeter.

The new Jamo Digital Monitor CBR series speakers were launched in Australia last month. At time of going to press, prices were expected to range from around $700 to $2000 a pair. Further details can be obtained from the Australian Distributor, Scan Audio Pty Ltd. PO Box 242 Hawthorn 3122 Vic. (03) 429 2199.

Cabinets and crossovers for the AEM 6000-series loudspeakers

Interested in building David Tilbrook's superb two-way or three-way loudspeaker projects (AEM August '85 and January '86, respectively), but don't feel confident about tackling the cabinetwork yourself? Readymade cabinets are now available from Jaycars in Sydney and Brisbane, and Eagle Electronics in Adelaide we are advised.

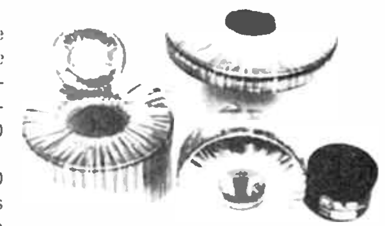
Built from the published plans, the cabinets Jaycar offers are veneered in an attractive black vinyl with a woodgrain texture finish. A grey front baffle screen is included for protection of the drivers.

If you like a 'professional' finish on something you've built yourself, so you can take pride in the finished product, then these cabinets for the AEM6102 and AEM6103 loudspeaker projects are well worth considering.

The two-way cabinets, Jaycar cat. no. CC2810, cost $148 a pair, while the three-way cabinets, cat. no. CC2815, cost $248 a pair. Jaycar has four Sydney stores and one Brisbane store. For mail order, call **(02) 747 1888.** Ready-built crossovers for both the two-way and three-way loudspeakers are also stocked by Jaycar.

Eagle Electronics, 54 Unley Rd, Unley, S.A., (08) 271 2885, have woodgrain veneered cabinets in knock-down form as well as ready-built crossovers.

Full range of toroidal mains transformers available



Electromark Pty Ltd advise they can suppy the *entire* standard range of the well-known British-made 'ILP' toroidal mains transformers, in 240 V primary, ex-stock.

The range includes over 100 types in ten size (VA) ratings with over 15 standard voltage ratings. In addition, Electromark stock a range of sizes of special-application types with, for example, 110 V primary, 120/240 volt dual primaries, 415-240 V and 415-110 V windings.

Electromark also boast 'ultra-thin' models designed for mounting in single unit 19" rack cases.

We recently specified a toroidal transformer for use in the AEM6502 'Bandbox' project (October '85) because of the superior hum and noise induction performance this transformer type offers. Rest assured we'll be recommendinng or specifying the use of toroidal transformers in up-coming audio projects.

For more details on the ILP toroidal transformer range and/or comprehensive specification sheet, contact **Electromark P/L, 43 Anderson Rd, Mortdale NSW, (02) 570-7287.**

10 A bridge rectifier

Melbourne-based All Electronic Components don't make much of a song-and-dance about their range of semiconductors, but it's pretty broad, covering not just the common diodes, transistors and ICs, but some of the 'rarer' beasts as well.

Picking over their inventory, we came across a useful little bridge rectifier rated at 150 Vp and 10 A continuous. It's ideal for those power supply jobs requiring more jolts than usually encountered — such as required in power amps rated at a few hundred watts which need rails of +/- 100 V or so. Even if your job doesn't call for the voltage rating, but you need a 10 A-rated bridge it's a steal at only $2.75.

Call **All Electronic Components, 118-122 Lonsdale St, Melbourne 3000 Vic. (03) 662 3606.**

Tie up those ribbon cables

Flat ribbon cable for use with the popular insulation displacement connectors (IDCs) is being bargained-out at Dick Smith Electronics this month.

They've dropped a buck off the per metre price of their 26-, 27-, 40- and 50-way ribbon cables. Respectively , they now cost $2.50, $2.95, $3.95 and $4.75 per metre.

Ribbon cable is just the thing for use in digital and computer projects, parallel printer cables and suchlike. Rip out and tie up a few metres. Like solder, you know it'll come in handy sometime. Try your local Dick Smith store or dealer.

PROJECT BUYERS GUIDE

This month's feature project, the AEM4504 Speech Synthesizer should be readily constructed at quite low cost. The main component is the General Instruments SPO256A-AL2 speech synthesiser chip. This device is distributed in Australia through Daneva who have offices in Melbourne (03) 598 5622, and Sydney (02)957 2464. You'll find the chip readily available in Tandy stores, blister-packed with a comprehensive 20-page data sheet. Listed as cat. no. 276-1784, it costs $24.95. All the other components are widely stocked by electronics retailers.

The AEM6503 Active Crossover project employs commonly available op-amp types — TL074 and NE5534 — and passive components. However, we should have a word about the frequency determining filter capacitors. While common green-caps may be employed, for the best electronic results and ease of use, metallised polyester capacitors ('MKTs') in a radial-lead package with 5 mm (0.2") pin spacing are recommended. Makes available in Australia include Wima, Roederstein, Thomson-CSF and Seimens. MKTs by Roederstein are distributed by Mayer Krieg in Adelaide and Sydney, Thomson-CSF MKTS by Promark in Sydney and Melbourne and Siemens through Siemens in Melbourne and Sydney. Geoff Wood Electronics in Sydney stocks a range of Roederstein and Wima types.

Printed circuit boards for the above projects will be available through AEM, or over the counter at Protronics in Adelaide, All Electronic Componenets in Melbourne and Geoff Wood Electronics in Sydney.

This month's Star Project, the 13 element 70 cm Yagi for amateurs, is stocked as a complete kit by Dick Smith Electronics, $39.95. See your local Dick Smith store or dealer.

Build this low-cost speech synthesizer add-on for your computer

Mark Bishop

Experimenting with speech synthesis on your computer an be a fascinating pastime. Incorporating speech response into programs really 'brings them to life'! Up till now, though, speech synthesis has been a relatively costly adjunct for computing hobbyists. Ingenious 'bit shuffling' exercises to make the sound output of your computer simulate something akin to synthesised speech, while cheap, are time consuming and not wholly satisfactory. There's no substitute for the real thing! Well, here's the real thing. It can be interfaced to any computer having an 8-bit I/O port. Software given here is for the Microbee, but we'll follow-up with software for other computers in coming issues.

UP TILL NOW, it has been expensive to experiment with speech synthesis on your computer. The 'Rolls-Royce' of available synthesizers is the locally-made *Easy Talker* by Robotron, a stand-alone unit with its own Z80 microprocessor, employing the General Instruments SP0256-AL2 allophone speech processor IC and on-board text-to-speech software. This unit 'speaks' any text output from the serial port and costs about $300. Next is the *Bee Talker*, sold by Microbee Systems (formerly Applied Technology), which is good value at about $100. The Bee Talker uses the Votrax SC-01 phoneme speech synthesiser IC and is sold as a finished unit which connects to the Microbee's parallel port. It includes text/speech software to be loaded in RAM.

The Hobart-based educational robot makers, Flexible Systems, had on offer a while back a ready-built board, designed by Tom Moffat, called the *Chatterbox* for the Microbee. This was for a completed circuit board using the Votrax SC-01, which first sold for $75, then $90. You supplied your own case, speaker, power supply and parallel port connector, and typed-in your own software. A rash of plug-in cartridge type speech synthesisers has appeard in the past year or so, for around $70-$90 (discounted at Christmas!), but like the others mentioned (with the exception of the Robotron), they're computer-specific. If you didn't have that brand of computer, speech synthesis was no go.

The project

This project not only cuts the cost of dabbling in speech synthesis, but you get the satisfation of having built it yourself. It's quite simple to build. There are only three ICs and a handful of components. The speech processor employed is the General Instruments SPO256A-AL2, distributed here by Daneva. Tandy stores stock the device in a handy blister pack (cat. no. 276-1784) complete with a very comprehensive 20-page data manual. The printed circuit board has been laid out to accommodate interfacing to an 8-bit parallel port on almost any computer that has such.

Most application circuits you see for the SP0256 show a quartz crystal employed for the on-chip oscillator. In an effort to keep the cost down, I tried a simple coil-capacitor network. As the oscillator frequency is divided down, any frequency instability is reduced also. In practice, I found it works fine. The actual speech pitch can be set using the trimmer capacitor, CV1. The action is quite 'vernier', and thus non-critical. The variation available ranges from about Kamahl to Joan Sutherland.

This project does not have any text-to-speech conversion software (the algorithm is *fearsome!*). Speech is programmed from strings of individual allophones (word sounds) with this project, after the fashion of the *Chatterbox*. I have included a software 'phrase composer' and 'phrase dictionary' (in Microworld BASIC — for the Microbee), along with a table of the SP0256A-AL2 allophone codes, their ASCII/decimal/hex equivalents, usage examples and allophone duration. Composing your own speech messages is thus relatively easy and you can experiment with allophones and their duration to get a desired effect.

A data sheet on the G.I. SP0256A-AL2 is included elsewhere in this issue.

Interfacing

The 16-pin DIL interfacing socket on the board has been arranged so that, using a 16-pin DIL IDC plug, ribbon cable and 15-pin IDC D-plug, the project can be directly plugged into the Microbee parallel port.

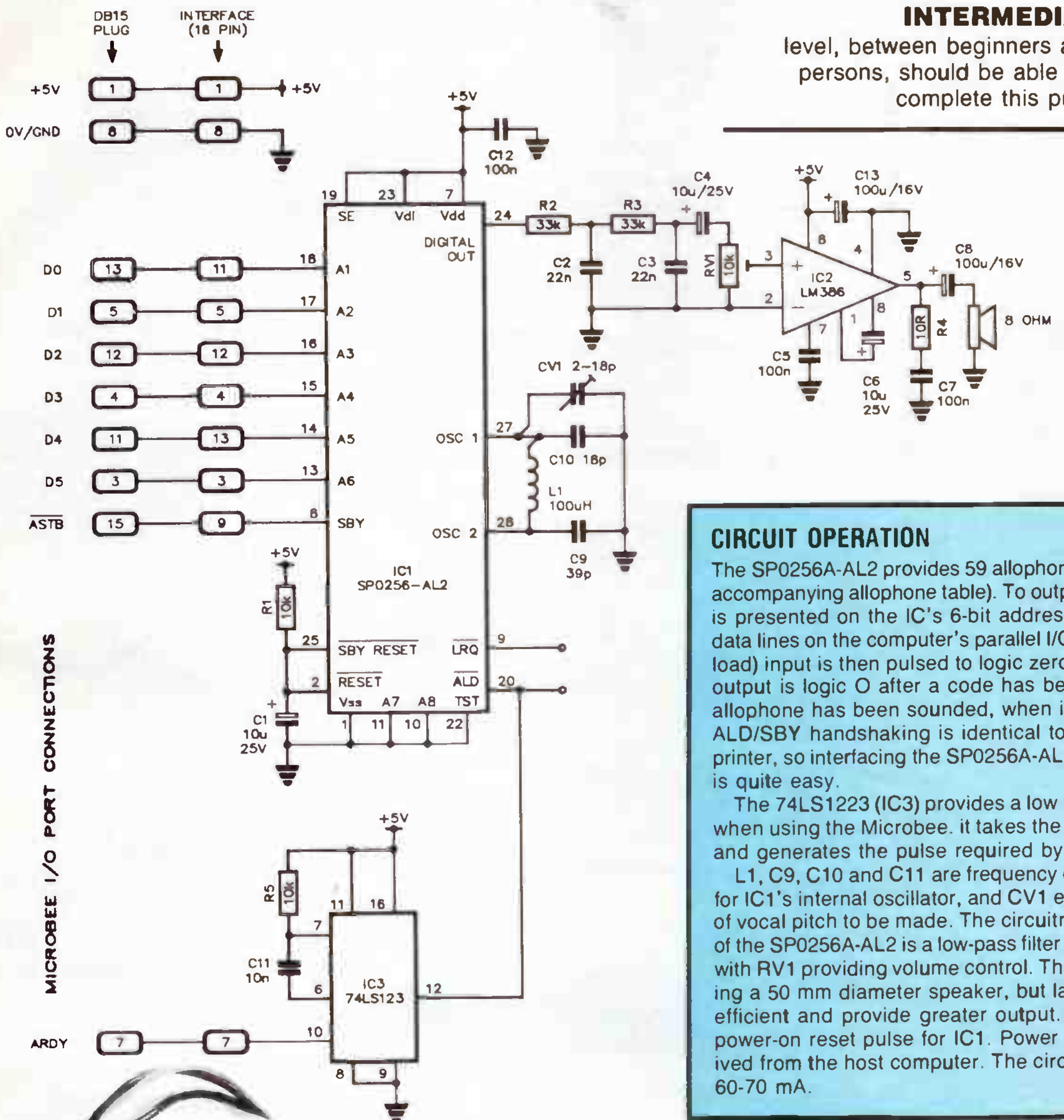
However, that doesn't make it specific to the Microbee. Table 1 shows the interface connections to a variety of popular home computers. Note that, on the pc board, the LRQ and ALD pins of the SP0256 are brought out to 'flying' pads. For those computers requiring access to these pins, simply link them to spare pins on the 16-pin interface socket. Interfacing to your computer can be effected by using a 16-pin (head- ▶

LEVEL

We expect that constructors of an

INTERMEDIATE

level, between beginners and experienced persons, should be able to successfully complete this project.

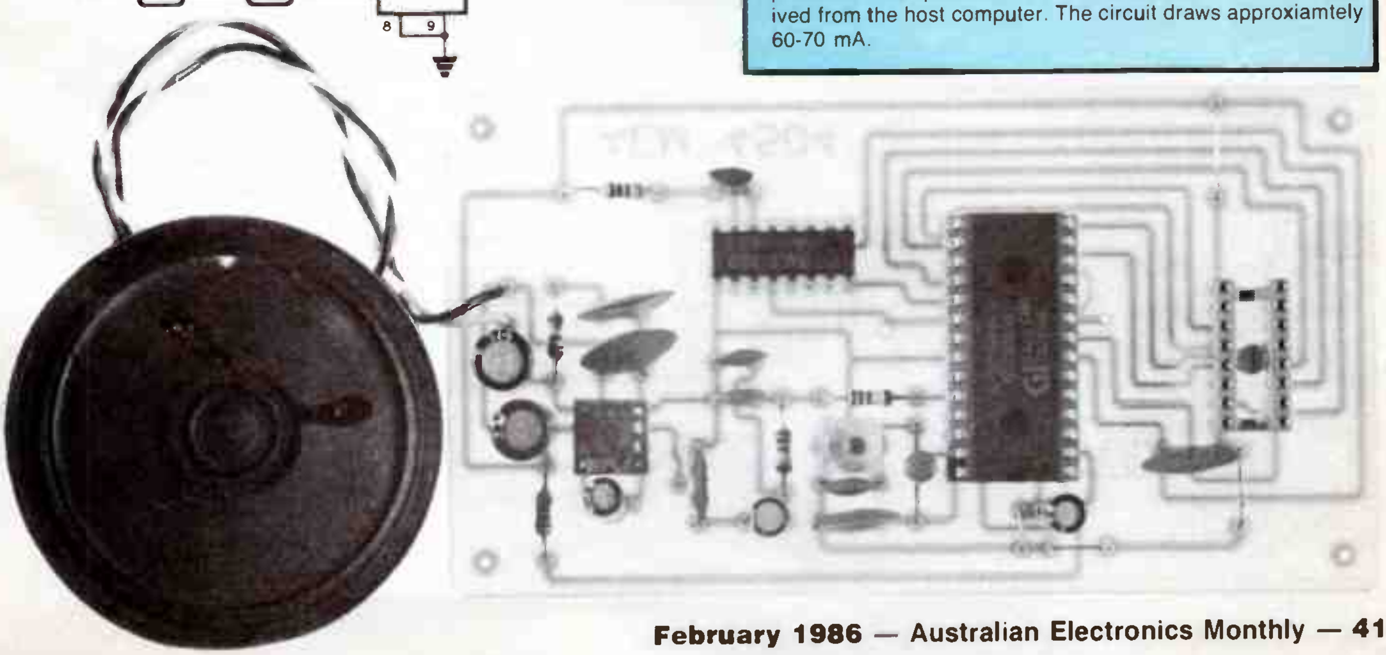


CIRCUIT OPERATION

The SP0256A-AL2 provides 59 allophones and five pauses. (See accompanying allophone table). To output an allophone, its code is presented on the IC's 6-bit address bus via the six lowest data lines on the computer's parallel I/O port. The ALD (address load) input is then pulsed to logic zero (0). The SBY (standby) output is logic O after a code has been loaded and until the allophone has been sounded, when it returns to logic 1. The ALD/SBY handshaking is identical to that used by a parallel printer, so interfacing the SP0256A-AL2 to a personal computer is quite easy.

The 74LS1223 (IC3) provides a low pulse for ICI's ALD input when using the Microbee. it takes the 'Bee's ARDY-high input and generates the pulse required by the SP0256.

L1, C9, C10 and C11 are frequency determining components for IC1's internal oscillator, and CV1 enables some adjustment of vocal pitch to be made. The circuitry connected from pin 24 of the SP0256A-AL2 is a low-pass filter and audio amplifier (IC2), with RV1 providing volume control. The volume is adequate using a 50 mm diameter speaker, but larger speakers are more efficient and provide greater output. R1 and C1 provide the power-on reset pulse for IC1. Power supply is +5 V dc, derived from the host computer. The circuit draws approxiamtely 60-70 mA.



★★★★★★★★★★★★★1986 KIT LINEUP

10″ 3-WAY SPEAKER KIT

AEM6103
Ref Aust Electronic
Monthly Jan '86

We have all components for this system ex-stock. Check details below:

10″ Woofer Cat. CW2136 P25WO $149 ea
3″ Mid-range Dome CM2086 D75MX $89 ea
19mm Tweeter Cat. CT2019 D19TD $38 ea
CX.2634 3-WAY CROSSOVER AS SPECIFIED $119 ea

Introductory Special: Buy the complete stereo system for $750 — save $40

Complete wooden cabinet kit for 3 way system (to AEM specifications). Sides in black vinyl with "woodgrain" texture with matching grey baffle screen, port tube etc.

Cat. CC2815

Only $248 per pair!

NEW KITS FROM "AUSTRALIAN ELECTRONICS MONTHLY"

AEM 6010 Ultra Fidelity Preamp

Ref AEM Oct Nov 1985

We now have stocks of this project in kit form including the original case components etc Nothing else to buy! Chassis is pre punched with original front panel
Cat KM 3030

ONLY $269.00

AEM 4600 Dual Speed Modem

Ref AEM December 1985

This is the ultimate kit modem Dual 1200/300 Baud case etc all included
Cat KM 3040

ONLY $169.00

NEW 145 Watt Mosfet Amp

Ref EA October 1985

This is the high power mono Mosfet amp version of the Playmaster 200 The shortform amp kit includes all parts except the heatsink extrusion/bracket which is available separately
Cat KA 1622

ONLY $89.50

Hands-Free Telephone Adaptor

Ref EA November 1985

Jaycar now has stocks of this superbly designed project Call in and check it out now! Note this unit is ORIGINAL to the design
Cat KA 1640

ONLY $79.00

★★★ SPECIAL

FULLY IMPORTED 'POWERTRAN' MIDI-CONTROLLED SAMPLER
- see review in August 1985 Sonics
KIT VERSION **$800**
BUILT VERSION **$1,000**
UNDER ½ PRICE

NEW CD Attenuator

Ref EA January 1986

This project enables you to dub from a compact disc to a cassette without overloading It attenuates the signal to accomodate the smaller dynamic range of the cassette medium Kit includes case
Cat KA 1624

ONLY $7.95

NEW Video Fader

Ref EA January 1986

Fades video signal to black and up again without loss of sync PCB project Plugpack and box extra
Cat KA 1626

ONLY $19.95

NEW Mini FM Transmitter

Ref ETI

Great stable and compact FM transmitter Tiny!
Cat KE 4711

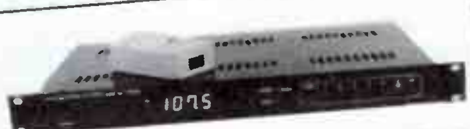
ONLY $8.95

NEW AM-STEREO/FM-STEREO WIDE BAND TUNER

Ref EA Dec/Jan onwards

What can I say - it's a world beater If you want THE BEST at any price We will not have the kit in stock in January (due to metalwork delays over Xmas) but it should be available mid-end Feb
Cat KA 1635 INTRODUCTORY PRICE

$399 COMPLETE *Remote extra*



Bench Type Digital Capacitance Meter

Ref EA August 1985 measure from 1pF to 99 9uF with this handy piece of equipment
Cat KA 1595

ONLY $79.95

"VIFA" 8" 2 WAY SPEAKER KITS

See AEM magazine in August

TWEETER D25TG Cat CT-2020
$59.95 ea $119/pair
WOOFER P21WO Cat CW-2132
$149 ea $298/pair
CROSSOVER NETWORK
Not a kit, now a factory built precision unit
Cat CX 2630
$69.95 ea $139/pair
TOTAL PRICE $557.90
SPECIAL PACKAGE PRICE $499
SAVE $58.90!!

Complete wooden cabinet kit. Black vinyl sides, "woodgrain" texture with matching grey baffle screen, port tube etc.

Cat. CC2810

Only $148 per pair!

☆ ☆ NEW ☆ ☆ Motor/Gearbox Kit

This fantastic new kit enables you to produce a shaft speed between 3 and 2 000 RPM!
It uses a small DC motor with a modular gearbox attached You are supplied with gear wheels spacers etc to configure your gearbox to almost any speed within the 3 2,000 RPM range Measures only 48(H) x 25(W) x 37(D)mm (not including output shaft)
Cat YX 2600

ONLY $14.95

MAIL ORDER HOTLINE (02) 747 1888

"PEST OFF" Ultrasonic Pest Repeller

Ref EA November 1985

A mozzie season special See November EA for more info
Cat KA 1620

ONLY $44.50

— UNBEATABLE!! ★★★★★★★

NEW Low cost Robot Kit

Ref EA January 1986

This is a true 5 axis pick and place robot with substantial payload capability that you can connect direct to your P C ! But the best feature is THE PRICE! You can build the mechanical kit which includes motors, bearings arm components pulleys etc for just $189! The full construction manual is just $10 extra The motor drive electronics computer interface and power supply are also available

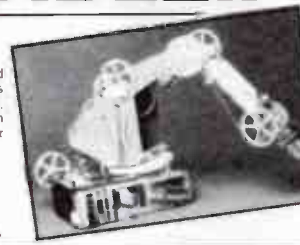
COMPLETE MECHANICAL ROBOT KIT Cat KA 1625

ONLY $189.00

COMPLETE CONSTRUCTION MANUAL Cat BI 8015

ONLY $10.00

Call in to any Jaycar store or watch next months ads for further details



POSITION DETECTOR/ ENCODER Kit.

$29.95

Cat. KA1628

DWELL/TACHOMETER

Ref EA Sept 1985

Tune up your car quickly and easily with this handy piece of gear The Jaycar kit includes case, large meter and Scotchcal meterscale

Cat KA 1612 **ONLY $36.95**

Suits 4-6 or 8 cylinder cars

☆ ☆ NEW ☆ ☆ 300 WATT INVERTER WITH AUTO START

NOT A KIT - BUILT, TESTED & GUARANTEED

This is the built version of the Electronics Australia September 1985 project!

Just think how handy it would be to have 240 volts AC mains power when camping, or for your boat or caravan well this brilliant new design is the answer ● Super compact tough ABS case ● Uses high efficiency toroid transformer which keeps the weight down, battery drain and heat dissipation ● Auto start draws power from your battery on when appliance is plugged in and turned on i e battery can be left permanently connected ● Thermal overload automatically shuts down if/when output stage is overheated (through high ambient temperature and high load or combination thereof automatic reset ● Current regulated inverter ensures the unit is being used within designed overload limits ● Current overload unit self limits LED indicates overload condition

COMPLETE KIT VERSION

Cat KA 1610

ONLY $199.00

FULLY BUILT & TESTED

Cat MI 5000

ONLY $249.00

★ NEW ★ NEW ★ ELECTRIC FENCE CONTROLLER

Ref EA December 1985

High power and lower current drain No auto coil needed Compact and all parts included

Cat KA-1660

ONLY $45.00

WARNING !

ELECTRIC FENCE

ELECTRONICS AUSTRALIA

AEM 3500 'The Listening Post'

Ref July 1985

Decode all that info on your short wave radio to show Morse code, RTTY, weather maps etc Wonderful!!! (A personal computer is required)

Cat KM-3015

ONLY $37.50

8 SECTOR BURGLAR ALARM

Ref EA Jan/Feb 1985

Why buy a commercially made up unit for more when you can buy this kit and SAVE money! A unique feature of this kit is the fact that you can wire N/O and N/C alarm sensors ON THE SAME LINE ★ 8 SECTORS ★ 2 delayed entry sectors ★ steel box ★ includes battery and siren driver in the price ★ variable exit and entry delays

Cat KA 1580

ONLY $149.00

PLAYMASTER SERIES II MOSFET AMP KIT

Ref EA Jan/Feb/March 1985

"... s stereo amplifier that will equal or better just about any integrated commercial amplifier, regardless of price". Leo Simpson, Editor of EA, February 1985.

MAIN FEATURES

- Switchable phono input for MM and MC cartridges
- Electronic signal switching
- Full facilities for dubbing between two cassette decks
- Monitor loop for either of two cassette decks or a signal processor
- Click action pushbutton switches for selection of sources, dubbing and tape monitor with LED status indicators
- Centre detents on bass, treble and balance controls, multiple detents on volume control
- Heavy duty heatsinks
- Power transformer for low hum and noise
- Easy to build all parts except power supply mount directly on the two printed circuit boards, wiring has been kept to an absolute minimum
- 100 watts RMS per channel into 8 ohm load
- Less than 0.01% total harmonic distortion

Cat KA-1500

ONLY $439.00

AEM 6500 - 60/120 WATT UTILITY MOSFET AMP MODULES

Ref AEM July 1985

This is a low cost high performance design using proven MOSFET technology. A single pair of (2SJ49/2SK134) Mosfets will deliver up to 60 watts output. Another pair may be added for 120 watt performance. The module has been designed to fit into a large variety of commonly stocked instrument cases and rack boxes. It features VERY LOW distortion and impeccable transient performance. It is unconditionally stable and virtually blow-up proof. It can be powered from common transformer/rectifier/-capacitor combinations. A Winner!

As usual, the Jaycar kit reflects a quality approach. All specified components for each version are included.

60 WATT MODULE Cat KM-3010

ONLY $55.00

120 WATT MODULE Cat KM 3012

ONLY $65.00

AEM 9500 Beat Triggered Strobe

Ref AEM July 1985

This project provides a very bright stroboscopic effect for parties, discos, etc., but with an ADDITIONAL FEATURE! This strobe will actually flash in synchron isation with the music!

The Jaycar kit includes case, photographic reflector, flash tube etc.

Cat KM 3018

ONLY $59.00

Jaycar ELECTRONICS

Incorporating ELECTRONIC AGENCIES

Carlingford Hurstville Gore Hill Brisbane Mon Fri 9am 5 30pm
Sydney and Concord Mon Fri 8 30am 5 30pm
Sydney Carlingford Hurstville Thursday nights until 8 30pm
Brisbane Thursday night until 8pm
Sydney Carlingford Hurstville, Brisbane Saturdays 9am 12 noon
Gore Hill Saturday 9am 4pm
CONCORD NOT OPEN ON SATURDAYS

NUMBER 1 FOR KITS

N.S.W. SHOWROOMS
SYDNEY: 117 York Street Tel (02) 267 1614
CARLINGFORD: Cnr Carlingford & Pennant Hills Road Tel (02) 872 4444
CONCORD: 115/117 Parramatta Road Tel (02) 745 3077
HURSTVILLE: 121 Forest Road Tel (02) 570 7000
GORE HILL: 188/192 Pacific Highway (Cnr Bellevue Avenue) Tel (02) 439 4799

QUEENSLAND **BURANDA**: 144 Logan Road Tel (07) 393 0777

MAIL ORDERS P O Box 185, CONCORD 2137

HEAD OFFICE 115-117 Parramatta Road, CONCORD 2137
Tel (02) 747 2022 Telex 72293

POST & PACKING

$5 $9 99	$2 00
$10 $24 99	$3 75
$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 $13.50

MasterCard AMERICAN EXPRESS Cards Welcome VISA

MAIL ORDER VIA YOUR PHONE

er) plug with solder pins plus the connector required by your computer's 8-bit user port on the other end of a length of ribbon cable.

Construction

Assembling the project is quite a simple matter. Organise yourself, take it step by step, and you'll be talking in no time!

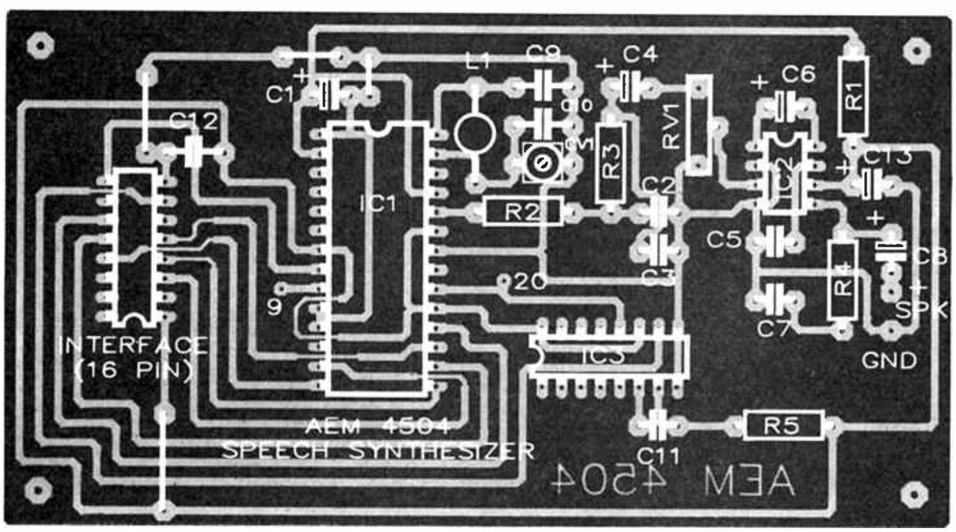
Whether you've purchased a printed circuit board or made your own, give it a thorough visual check before you start. See that all the holes are drilled and the correct diameter. Make sure no small 'bridges' join closely-spaced pads or tracks. See that no tracks are broken anywhere. IC sockets may be used if you wish, but may be dispensed with if you're an experienced project constructor. If you use IC sockets, solder these in place first. Note that a 16-pin DIL socket is necessary for the interface connection.

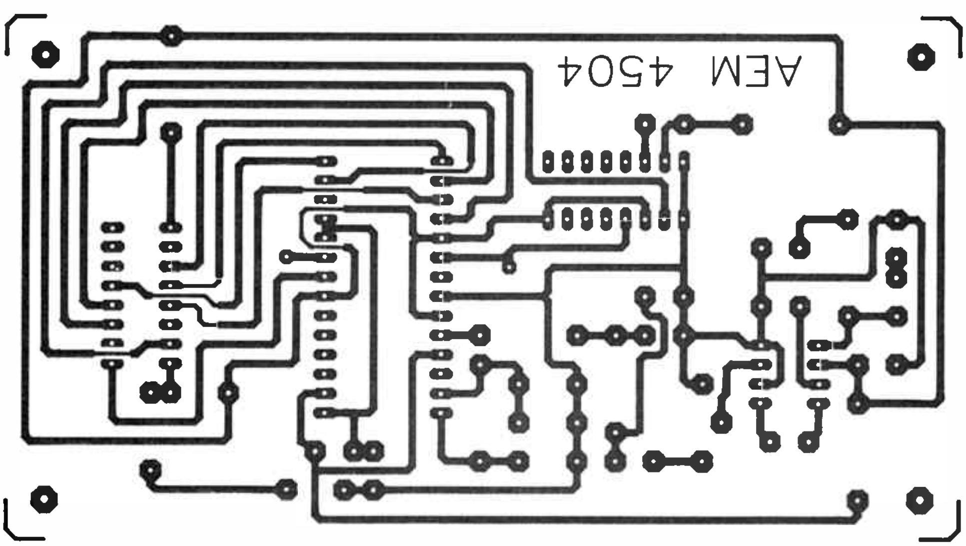
There are four wire links on the board. Using 22 gauge tinned copper wire, solder these in place next. Follow with the trimmer capacitor and trimpot, then the resistors and capacitors. The ICs come last of all. Make sure you orientate them correctly. Handle the SP0256 with care. Only hold the package by the ends and avoid touching the pins. If soldering it in place, solder pin 1 first (Vss), then pin 7 (Vdd), followed by the rest of the pins. Attach the speaker via a short length of twisted-pair hookup wire.

TABLE 1.

AEM4504 INTERFACE	MICROBEE	C64	VIC20
1 (+5 V)	1	2	2
2 —	—	—	—
3 (A6)	3 (D5)	J (PB5)	J (PB5)
4 (A4)	4 (D4)	F (PB3)	F (PB3)
5 (A2)	5 (D1)	D (PB1)	D (PB1)
6 —	6	—	—
7 (ARDY)	7 (ARDY)	—	—
8 (O V)	8 (O V)	1 (GND)	1 (GND)
9 (SBY)	15 (ASTB)	—	—
10 —	—	—	—
11 (A1)	13 (DO)	C (PBO)	C (PBO)
12 (A3)	12 (D2)	E (PB2)	E (PB2)
13 (A5)	11 (D4)	H (PB4)	H (PB4)
14 —	—	—	—
15 —	—	—	—
16 —	—	—	—
* (ALD)	—	K (PB6)	K (PB6)
* (LRQ)	—	L (PB7)	L (PB7)

* *'Flying' pads on-board.*





AEM4504 PARTS LIST

Resistors all ¼W, 5%

R1 .... 10k
R2, R3 .... 33k
R4 .... 10R
R5 .... 10k
RV1 .... 10k min. vert. trimpot

Capacitors

C1 ...... 10u/25 V RB electro.
C2, C3 .... 22n ceramic
C4 ...... 10u/25 V RB electro.
C5 .... 100n ceramic
C6 ...... 10u/25 V RB electro.
C7 .... 100n ceramic
C8 ..... 100u/16 V RB electro.
C9 .... 39p ceramic
C10 .... 18p ceramic
C11 .... 10n greencap
C12 .... 100n ceramic
C13 .... 100u/16 V RB electro.
CV1 .... 2-18p trimmer

Semiconductors

IC1 .... SP0256A-AL2
IC2 .... LM386
IC3 .... 74LS123

Miscellaneous

L1 .... 100 uH RF choke

AEM4504 pc boad; 2 × 16-pin IC sockets; 1 × 28-pin IC socket; 1 × 8-pin IC socket; 8 ohm 50 mm diameter (or larger) speaker; 500 mm of 15-wire ribbon cable; 1 × 16-pin DIP header; connector to suit 8-bit computer interface; short length of 22g tinned copper wire; hookup wire, solder, etc.

Expected cost: $35-$50

Testing

Before attempting to plug-in the project and power it up, give it a thorough visual check. Look for unsoldered or poorly soldered joints, solder 'bridges' between closely-spaced pads, etc. Pay special attention to the links. It's a good idea to check with your multimeter that there are no shorts between the +5 V and 0 V rails (on pins 1 and 8 of the 16-pin interface socket). If you've used IC sockets, leave the ICs out, plug the board into your computer and power up.

Using your multimeter, check that +5 V appears between pins 7/19/23 and 1/10/11/22 of IC1 (also check between pins 6 and 2 of IC2, and pins 11/16 and 8/9 of IC3). If 5 V is not present, or worse — the wrong way round, switch off, unplug the board and check it over. Check your interface wiring first. Also, pay special attention to the on-board links!

If, or when all's well, fit the ICs, set the trimpot RV1 and the trimmer capacitor CV1 both to mid-position, plug it in and power up.

For Microbee owners, here's a simple test routine.

```
10 OUTL#1: LPRINT "@";: REM initialise parallel port, silence TALKER
20 LPRINT "@[GmuDDDFBZPBYzBPF@Hgu@?WWbBMWWAis@";:REM phrase to speak
30 A1$=KEY$: IF A1$="" THEN GOTO 30 ELSE GOTO 20
```

You may need to adjust RV1 for required volume and CV1 for a pitch that sounds OK to you.

Programming the AEM4504

Two programs are provided here — a 'Phrase Composer' and a 'Phrase Dictionary'. When you run the Phrase Composer it utters "testing". Press any key except [ESC] or [P] to repeat 'testing', and to print the allophones for 'testing', on the screen. To edit the allophones press [ESC]. This puts your 'Bee in the edit mode for the line with the 'testing' allophones e.g.:

00150 AO$="TT2 EH SS PA2 TT1 IH NG"

Edit any allophone changes then RUN to hear the result. The allophones must come from the list reproduced here and be separated by one space (no spaces before the first/after the last allophone), or you will get an error message spoken. Press P and the allophones and their ASCII equivalent will be printed on the screen and sent to the parallel port. If you exchange your AEM4504 for your printer, the allophones and their ASCII equivalent will be LPRINTed, otherwise your project will make some interesting noises. No harm, just wait until these have finished, swap the plugs and try again.

To add speech to your programs, first initialise the parallel port and silence the synthesizer by

OUTL#1: LPRINT "@";

then add a line to LPRINT the ASCII string equivalent of the allophones. There must be a silence code at the start and end of the string (e.g: @), and a semi-colon at the end of the LPRINT line. The semi-colon is to inhibit the carriage return which would turn the SP0256 back on with the TT2 code. See the example above. Your first programming efforts can be understood but become much better with a bit of practice. If it doesn't sound right look for an alternative allophone, as there is usually a better one to use.
@PTBvXAhzwwA?SAnLvAy-@

The Phrase Diction allows entry of a sentence, the individual words of which are then looked-up in a dictionary (which is part of the program), and spoken. There are over 300 words in the dictionary, including numbers, days of the week, and months. The program is fairly well error-trapped, with spoken and printed messages to catch typing errors in data statements, for data statements not in ASCII order, and input errors. Plenty of REMs are inserted throughout the listing to aid your understanding of how the program functions.

Get your micro talking!

HOUSING YOUR PROJECT

There are no special housing requirements for the project. However, no matter what sort of speaker is used, it will always produce louder, better quality sound if mounted in some sort of enclosure. Low cost, small diameter speakers will readily fit the lid of a suitably sized jiffy box which will also house the pc board. Or, you might choose a low cost mid-range driver of, say, 150 mm diameter. This could be readily housed in a small, open-backed chipboard enclosure, with the pc board screwed down inside. Such an arrangement will deliver remarkably good speech.

SP0256-AL2 ALLOPHONE CODES v. 19/6/85

PHONEME	CODE	ASCII	EXAMPLE	HEX	DEC	DURATION (ms)	
AA	24	X	hOt	58	88	100	*
AE	26	Z	hAt	5A	90	120	*
AO	23	W	AUght	57	87	100	*
AR	59	{	alARm	7B	123	290	
AW	32	`	dOWn	60	96	370	
AX	15	O	sUcceed	4F	79	100	*
AY	6	F	kIte	46	70	250	
BB1	28	\	riB	5C	92	80	***
BB2	63	?	Beast	3F	63	50	***
CH	50	r	CHurCH	72	114	190	
DD1	21	U	enD	55	85	70	***
DD2	33	a	Down	61	97	160	***
DH1	18	R	THis	52	82	290	
DH2	54	v	baTHe	76	118	240	
EH	7	G	End	47	71	70	*
EL	62	~	angLE	7E	126	190	
ER1	51	s	lettER	73	115	160	
ER2	52	t	fERn	74	116	300	
EY	20	T	trAY	54	84	280	
FF	40	h	Food	68	104	150	**
GG1	36	d	Guest	64	100	80	***
GG2	61	}	Got	7D	125	40	***
GG3	34	b	peG	62	98	140	***
HH1	27	[	He	5B	91	130	**
HH2	57	y	Hoe	79	121	180	**
IH	12	L	sIt	4C	76	70	*
IY	19	S	sEE	53	83	250	
JH	10	J	JudGe	4A	74	140	
KK1	42	j	Can't	6A	106	160	****
KK2	41	i	speaK	69	105	190	****
KK3	8	H	Crane	48	72	120	****
LL	45	m	Like	6D	109	110	
MM	16	P	Milk	50	80	180	
NG	44	l	aNGer	6C	108	220	
NN1	11	K	thiN	4B	75	140	
NN2	56	x	No	78	120	190	
OR	58	z	fORtune	7A	122	330	
OW	53	u	zOne	75	117	240	
OY	5	E	vOIce	45	69	420	
PP	9	I	Pow	49	73	210	****
RR1	14	N	Read	4E	78	170	
RR2	39	g	cRane	67	103	130	
SH	37	e	SHip	65	101	160	**
SS	55	w	veSt	77	119	90	**
TH	29	]	THin	5D	93	180	**
TT1	17	Q	parTs	51	81	100	****
TT2	13	M	To	4D	77	140	****
UH	30	^	bOOk	5E	94	100	*
UW1	22	V	tO	56	86	100	
UW2	31	_	fOOd	5F	95	260	('_'=SHIFT/DEL)
VV	35	c	Vest	63	99	190	
WH	48	p	WHig	70	112	200	**
WW	46	n	We	6E	110	180	
XR	47	o	stARe	6F	111	360	
YR	60	|	hEAr	7C	124	350	
YY1	49	q	cUte	71	113	130	
YY2	25	Y	Yes	59	89	180	
ZH	38	f	pleaSure	66	102	190	
ZZ	43	k	Zoo	6B	107	210	
PA1	0	@	(sil)	40	64	10	
PA2	1	A	(sil)	41	65	30	
PA3	2	B	(sil)	42	66	50	
PA4	3	C	(sil)	43	67	100	
PA5	4	D	(sil)	44	68	200	

* these vowel sounds can be doubled to lengthen them.
** these allophones may be used doubly for initial, or singly for final positions.
*** usually need 10-30ms silence preceeding them.
**** usually need 50-80ms silence preceeding them.

```
00100 REM   AEM4504 PHRASE  COMPOSER
00110 REM    by Mark Bishop  22/7/85
00120 REM
00130 GOSUB 260: REM print title
00140 GOSUB 280: REM init. & read data into arrays RO$,R
00150 WO$="TT2 EH SS PA3 TT1 IH NG"
00160 ON ERROR GOTO 240: REM input error
00170 GOSUB 310: REM search array for allophone ASCII code
00180 IF QO$="N" THEN GOTO 240: REM input error
00190 PRINT WO$: LPRINT AO$;: REM print and speak phrase
00200 KO$=KEY$: IF KO$="" THEN 200
00210 IF KO$=CHR$(27) THEN PRINT: EDIT 150
00220 IF KO$="P" OR KO$="p" THEN GOSUB 440: GOTO 200: REM print
00230 GOTO 190: REM speak again
00240 LPRINT "@LKBI^QCGGg@s@";: EDIT 150: REM input error
00250 LPRINT "aXXAQsCwAQTAQPGKQCGGg@s@";:END
00260 CLS: PRINT TAB(15) "AEM4504 PHRASE<ASE COMPOSER"\\\
00270 RETURN
00280 ON ERROR GOTO 250: REM data statement error
00290 OUTL#1: DIM R0(64),R(64): STRS (1000)
00300 FOR I=1 TO 64: READ RO$(I): READ R(I): NEXT I: RETURN
00310 A=1: B=0: WO$=WO$+" ": AO$=""
00320 C=B: B=SEARCH(WO$," ",A)
00330 IF B=0 THEN 370: REM end of phrase
00340 A=A+1: W1$=WO$(;C+1,B-1): REM W1$=word to search for
00350 GOSUB 380: REM search array RO$(?) for W1$
00360 AO$=AO$+CHR$(R(N)): GOTO 320: REM AO$=ASCII of word
00370 AO$="@"+AO$+"@": RETURN: REM add pause to ends of phrase
00380 L=1: H=64: N=0: REM L=lowest array #, H=highest, N=now
00390 P=N: N=(L+H)/2: REM previous=now, now=(low+high)/2
00400 IF RO$(N)=W1$ THEN LET QO$="Y": RETURN: REM found
00410 IF RO$(N)<W1$ THEN LET L=N+1 ELSE LET H=N-1
00420 IF P<>N THEN GOTO 390: REM keep looking
00430 QO$="N": RETURN : REM not found in array
00440 CLS: OUT#1 ON: REM change to OUT#5 for serial printer
00450 PRINT "PHRASE:": PRINT WO$: PRINT
00460 PRINT "ASCII:": PRINT AO$: PRINT
00470 PRINT: PRINT: PRINT: OUT#1 OFF: RETURN
00480 DATA "AA",38,"AE",90,"AO",87,"AR",123,"AW",96
00490 DATA "AX",79,"AY",70,"BB1",92,"BB2",63,"CH",114
00500 DATA "DD1",85,"DD2",97,"DH1",82,"DH2",118,"EH",71
00510 DATA "EL",126,"ER1",115,"ER2",116,"EY",84,"FF",104
00520 DATA "GG1",100,"GG2",125,"GG3",98,"HH1",91,"HH2",121
00530 DATA "IH",76,"IY",83,"JH",74,"KK1",106,"KK2",105
00540 DATA "KK3",72,"LL",109,"MM",80,"NG",108,"NN1",75
00550 DATA "NN2",120,"OR",122,"OW",117,"OY",69,"PA1",64
00560 DATA "PA2",65,"PA3",66,"PA4",67,"PA5",68,"PP",73
00570 DATA "RR1",78,"RR2",103,"SH",101,"SS",119,"TH",93
00580 DATA "TT1",81,"TT2",77,"UH",94,"UW1",86,"UW2",95
00590 DATA "VV",99,"WH",112,"WW",110,"XR",111,"YR",124
00600 DATA "YY1",113,"YY2",89,"ZH",102,"ZZ",107
00610 REM end of program listing
```

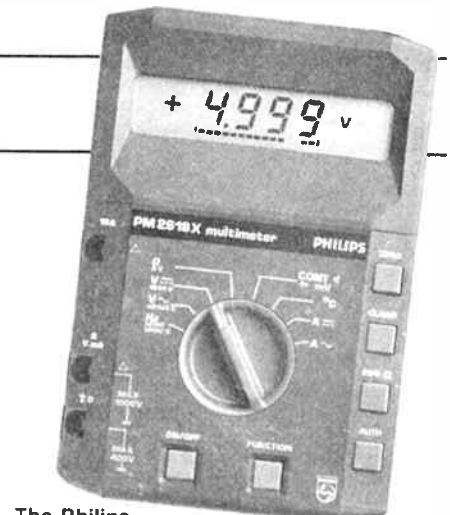
```
00100 REM    AEM4504 PHRASE DICTIONARY
00110 REM    by Mark Bishop  22.7.85
00120 REM
00130 GOSUB 330: REM print title
00140 GOSUB 370: REM init. & read data into arrays RO$, R1$
00150 IF QO$="N" THEN GOTO 300: REM error - not ascii order
00160 GOSUB 470: GOTO 180: REM title 2nd part
00170 CLS:CURS 15,5:PRINT"What would you like me to say next ?'
00180 GOSUB 520: REM enter phrase to speak
00190 GOSUB 590: REM search array for allophone ASCII code
00200 PRINT WO$: LPRINT AO$;:REM print and speak phrase
00210 REM select, edit, print or speak option
00220 POKE 257,0: REM lower case input
00230 KO$=KEY$: IF KO$="" THEN 220
00240 IF KO$=CHR$(27) THEN 170
00250 IF KO$="P" OR KO$="p" THEN GOSUB 760: GOTO 230: REM print
00260 GOTO 200: REM speak
00270 REM error routines
00280 LPRINT "@LKBI^QCGGg@s@";:POKE 257,0: GOTO 170: REM error
00290 PRINT TAB(15) "Data line #";Z+1;: GOTO 310
00300 PRINT "'";RO$(I-1);"' & '";RO$(I);"' NOT in ASCII order";
00310 PRINT " - DATA statement error";:
00311    LPRINT "aXXAQsCwAQTAQPGKQCGGg@s@;:END
00320 REM print title
00330 CLS: UNDERLINE
00340 CURS 15,1: PRINT "AEM4504 PHRASE DICTIONARY"
00350 NORMAL: RETURN
00360 REM init. & read data into arrays RO$, R1$
00370 ON ERROR GOTO 290: REM data statement error
00380 CURS 15,4: PRINT "reading dictionary . . . . ."
00390 READ FO$,F1$: Z=Z+1: IF FO$<>"dataend" THEN 390
00400 ON ERROR GOTO 300: Z=Z-1: RESTORE: REM due 'dataend'
00410 OUTL#1: DIM RO(Z),R1(Z):STRS (10000): RO$(0)="": QO$="Y"
00420 REM for 16k systems change to STRS(5000)
00430 FOR I=1 TO Z: READ RO$(I):READ R1$(I)
00440 IF RO$(I)=< RO$(I-1) THEN LET QO$="N" :NEXT*I RETURN:
00441    REM error, data not in ASCII order
00450 NEXT I: RETURN
00460 REM title part 2
00470 CURS 15,4: PRINT "Hello,  I am your Microbee talker !"
00480 LPRINT"@[GmuDDFBZPBYzDPFABHguA?SBMWWAisDDD@";
00490 CURS 15,5: PRINT "What would you like me to say ?"
00500 LPRINT"@pXMp^adY-MFiPSDM-wT@";: RETURN
00510 REM enter phrase to speak
00520 CURS 5,15: PRINT"lowercase input only please,";
00530 PRINT " separate groups by 1 space"
00540 CURS 0,9: INPUT "";WO$: IF WO$="" THEN 540
00550 CLS: CURS 15,5: PRINT "searching  dictionary . . . ."
00560 RETURN
00570 REM search array for allophone ASCII code
00580 ON ERROR GOTO 280: REM input error
00590 A=1: B=0: WO$=WO$+" ": AO$=""
00600 C=B: B=SEARCH(WO$," ",A)
00610 IF B=0 THEN 670: REM end of phrase
00620 A=A+1: W1$=WO$(;C+1,B-1): REM W1$=word to search for
00630 GOSUB 690: REM search array RO$(?) for W1$
00640 ON ERROR GOTO 280: REM input error
00650 IF QO$="Y" THEN LET
00651 AO$=AO$+R1$(N)+"C":  GOTO 600: REM AO$=ASCII of word
00660 IF QO$="N" THEN LET
00661 AO$=AO$+"    ":  GOTO 600: REM no word, add 'blank'
00670 AO$="@"+AO$+"@": CLS: RETURN: REM add pause phrase ends
00680 REM Binary search S/R for word in array RO$(?)
00690 L=1: H=Z: N=0: REM l=lowest array #, H=highest, N=now
00700 P=N: N=(L+H)/2: REM previous=now, now=(low+high)/2
00710 IF RO$(N)=W1$ THEN LET QO$="Y": RETURN: REM found
```

```
00720 IF RO$(N)<W1$ THEN LET L=N+1 ELSE LET H=N-1
00730 IF P<>N THEN GOTO 700: REM keep looking
00740 QO$="N": RETURN :REM not found
00750 REM print phrase and allophone ASCII equivalent
00760 CLS:OUT#1 ON: REM change to OUT#5 for serial printer
00770 PRINT "PHRASE:": PRINT WO$: PRINT
00780 PRINT "ASCII:": PRINT AO$: PRINT
00790 PRINT: PRINT: PRINT: OUT#1 OFF: RETURN
00800 REM
01000 REM first data items  MUST be in ASCII/alphabetical order
01010 REM and in LOWERCASE.  Word then ASCII equivalent
```

```
01020 DATA ".","IEKQ"
01030 DATA "0","fSgu"
01040 DATA "1","pOK"
01050 DATA "10","MGK"
01060 DATA "11","SmGctK"
01070 DATA "12","MnG~Ac"
01080 DATA "13","]sMSK"
01090 DATA "14","hWgMSK"
01100 DATA "15","hLhMSK"
01110 DATA "16","wLiwMSK"
01120 DATA "17","wwGGcLKMSK"
01130 DATA "18","TQMSK"
01140 DATA "19","xFKMSK"
01150 DATA "2","M--"
01160 DATA "20","MnGKMS"
01170 DATA "21","MnGKMS@pOK"
01180 DATA "22","MnGKMS@M--"
01190 DATA "23","MnGKMS@vgS"
01200 DATA "24","MnGKMS@hWWg"
01210 DATA "25","MnGKMS@hFc"
01220 DATA "26","MnGKMS@wLiw"
01230 DATA "27","MnGKMS@wwGGcLK"
01240 DATA "28","MnGKMS@TQ"
01250 DATA "29","MnGKMS@xFK"
01260 DATA "3","vgS"
01270 DATA "30","]sMS"
01280 DATA "31","]sMS@pOK"
01290 DATA "32","]sMS@M--"
01300 DATA "33","]sMS@vgS"
01310 DATA "34","]sMS@hWWg"
01320 DATA "35","]sMS@hFc"
01330 DATA "36","]sMS@wLiw"
01340 DATA "37","]sMS@wwGGcLK"
01350 DATA "38","]sMS@TQ"
01360 DATA "39","]sMS@xFK"
01370 DATA "4","hWWg"
01380 DATA "40","hWgMS"
01390 DATA "41","hWgMS@pOK"
01400 DATA "42","hWgMS@M--"
01410 DATA "43","hWgMS@vgS"
01420 DATA "44","hWgMS@hWWg"
01430 DATA "45","hWgMS@hFc"
01440 DATA "46","hWgMS@wLiw"
01450 DATA "47","hWgMS@wwGGcLK"
01460 DATA "48","hWgMS@TQ"
01470 DATA "49","hWgMS@xFK"
01480 DATA "5","hFc"
01490 DATA "50","hLhMS"
01500 DATA "51","hLhMS@pOK"
01510 DATA "52","hLhMS@M--"
01520 DATA "53","hLhMS@vgS"
01530 DATA "54","hLhMS@hWWg"
01540 DATA "55","hLhMS@hFc"
01550 DATA "56","hLhMS@wLiw"
01560 DATA "57","hLhMS@wwGGcLK"
01570 DATA "58","hLhMS@TQ"
01580 DATA "59","hLhMS@xFK"
01590 DATA "6","wLiw"
01600 DATA "60","wLiwMS"
01610 DATA "61","wLiwMS@pOK"
01620 DATA "62","wLiwMS@M--"
01630 DATA "63","wLiwMS@vgS"
01640 DATA "64","wLiwMS@hWWg"
01650 DATA "65","wLiwMS@hFc"
01660 DATA "66","wLiwMS@wLiw"
01670 DATA "67","wLiwMS@wwGGcLK"
01680 DATA "68","wLiwMS@TQ"
01690 DATA "69","wLiwMS@xFK"
01700 DATA "7","wwGGcLK"
01710 DATA "70","wwGGcLKMS"
01720 DATA "8","TQ"
01730 DATA "9","xFK"
01740 DATA ":","DDDDDD"
01750 DATA "a","T"
01760 DATA "alarm","Om{P"
01770 DATA "alex","ZmGiw"
01780 DATA "alexandra","ZmGiwZKUgO"
01790 DATA "all","WWm"
01800 DATA "am","ZP"
01810 DATA "amateur","ZPZQqs"
01820 DATA "an","ZK"
01830 DATA "and","ZKU"
01840 DATA "april","TAINLm"
01850 DATA "are","{"
01860 DATA "at","ZM"
01870 DATA "august","W}bOwQ"
01880 DATA "b","?S"
01890 DATA "baby","A?TA?S"
01900 DATA "bath","?Tv"
01910 DATA "bather","?Tvs"
01920 DATA "bathing","?TvL1"
01930 DATA "be","?S"
01940 DATA "becky","?GiS"
01950 DATA "bee","?S"
01960 DATA "beer","?¦"
01970 DATA "beth","A?G]"
01980 DATA "birthday","A?s]AaGT"
01990 DATA "bite","A?FCQ"
02000 DATA "bites","A?FCQk"
02010 DATA "blank","A?mZKBi"
02020 DATA "bob","A?XXA?"
02030 DATA "bread","\gGG@U"
02040 DATA "brett","A?gGCQ"
02050 DATA "brother","A?gO]s"
02060 DATA "buy","?XF"
02070 DATA "by","?XF"
02080 DATA "byte","A?FCQ"
02090 DATA "bytes","A?FCQk"
02100 DATA "c","wwS"
02110 DATA "calender","jZZmGKAas"
02120 DATA "calling","HW~L1"
02130 DATA "cat","jZBM"
02140 DATA "check","rGGBi"
02150 DATA "checked","rGGBiM"
02160 DATA "checker","rGGBjs"
02170 DATA "checkers","rGGBjsk"
02180 DATA "checking","rGGBjL1"
02190 DATA "checks","rGGBjw"
02200 DATA "clock","jmXXBi"
02210 DATA "close","jmuww"
02220 DATA "clown","jm`K"
02230 DATA "collide","HOmFU"
02240 DATA "computer","jOPIqVQs"
02250 DATA "cookie","H^jS"
02260 DATA "correct","jtGGAiAQ"
02270 DATA "corrected","jtGGAiAMLAU"
02280 DATA "correcting","jtGGAiAML1"
02290 DATA "corrects","jtGGAiAQw"
02300 DATA "crane","HgTK"
02310 DATA "crown","jg`K"
02320 DATA "d","aS"
02330 DATA "daniel","aZK@L@G~"
02340 DATA "darren","AaogK"
02350 DATA "data","aXXAQs"
02360 DATA "date","aTBM"
02370 DATA "daughter","aWMs"
02380 DATA "day","AaT"
02390 DATA "december","US@wGp\s"
02400 DATA "dennis","aGKLw"
02410 DATA "disk","aLwwi"
02420 DATA "divided","aLcFAaLAU"
02430 DATA "do","CaV-"
02440 DATA "drive","agFv"
02450 DATA "drives","agFvk"
02460 DATA "e","S"
```

— to page 89 ▶

Meter Magic! – Philips Series 18 DMMs



The Philips Series 18 DMMs feature 4.5-digit LCD readouts and a variety of sohpisticated and useful functions — plus the unique option of automatic display backlighting under dim light conditions. The 2518 is the 'junior burger', the 2618 the 'quarter pounder' and the 2718 the 'big mac'! Range selection is by a single rotary switch, function selection by pushbuttons. Note the test leads and probes insert in the left hand side.

NOTWITHSTANDING the vast range of digital readout multimeters now available to both professional and hobbyist (including that noble band who are both), there is no doubt that many users prefer the old analogue meter. I am one of them — or *was*, I should say.

Starting as a very impecunious schoolboy with a tinplate-clad pocket watch-sized dual voltmeter, 0-10, 0-100 volts, with the two ranges accessible via prods on the bottom and a common flying lead, I worked my way through various cheap multimeters, until at last I achieved the ultimate (on hire purchase) — the beautiful *AVO Model 8*. I would watch for hours the smooth movement of the mirror-backed pointer as I put electrolytics across the ohms range. I do believe I began to understand capacity and time constants at that time.

A surprising number of enthusiasts have this affinity to the analogue meter, and the preference doesn't just reflect an unwillingness to change. A few of the criticisms levelled at digital meters are: hard to read displays, susceptibility to overload, delay in settling down to a reading, distracting "hunting" of the least significant digits, misleading apparent resolution ("this power supply is delivering 5.00001 volts — disgraceful!"), and most important, far less convenience when performing null or peak adjustments.

When I was asked to review the three instruments which comprise the Philips Series 18 DMs, I wondered what the Editor's, or Philips' reaction would be at an article singing the praise of the "traditional" way of measuring. I needn't have worried. These little beauties have converted me, and I do believe I'm coming over all digital . . .

The Series 18

The three instruments marketed under the Series 18 banner are the PM2518, PM2618, and PM2718. Broadly, the 2518 is the economy version (albeit well sprinkled with frills), while the 2618 and 2718 offer progressively more features.

All are housed in enclosures of identical size and styling. Measuring 170 x 55 x 118 mm, and weighing 700 grams, they could not be described as pocket-sized. However, this allows the benefit of a clear 12 mm high 4½-digit display with plenty of room for other display information, a selector knob you can get your fingers on and a number of very positive-action press switches for driving the various functions.

At the same time the meters are definitely portable, being small enough to carry in a toolbox, or more deservingly, in the heavy duty carry case offered as an option. The cases of the meters are robust, verified accidentally in my workshop when one was dropped on the floor and crushed between a castor-borne bench and the workshop wall (no mark or damage to the meter). A handy folding stand is built into the meter and although it looks flimsy enough to break I will accept that this may be an illusion. Not an illusion, however, is the battery cover, which is irritatingly fiddly to open and an excellent finger nail breaker. It's as well that the very low current consumption means the four C-type cells do not have to be replaced often. Removing the battery cover also reveals the current overload fuse and a spare, this latter a nice touch which costs little extra and gives the user so much satisfaction.

With regard to the battery cover, I later discovered that judicious use of a flat screwdriver blade (when I could find one) caused the offending part to spring open. Yes, I should have read the reference card supplied with the instrument (in seven European languages)!

Measuring features common to all three instruments include dc volts to 1000 V with input resistance 10M (makes the AVO 8 pale a bit), ac volts also to 1000 V with input >2M and <20 pF, dc and ac amps to 10 A with voltage drop <25 mV or <250 mV depending on range, and resistance to 100M; all the above fully autoranging, with the exception of the 10 A range accessed through the usual separate test lead receptacle.

The above facilities are common enough, and it suffices to say that readings were quick, clear, and unambiguous, with a generous sprinkling of extra information on the LCD display, including high voltage warning, ac/dc indication, and indication of unit of measurement.

A very handy extra facility is the backlight. Available as an option, and included in one of the meters sent to us, this is not the usual crude pea lamp with attendant glare almost rendering its function useless, but gives a soft green "true" backlight effect which greatly enhances readability in poor ambient light conditions. The backlight automatically switches on when light conditions are poor, and switches off after a few seconds if no new measurement is made.

Notable also is the high accuracy RMS function. Most readers will know that RMS (root mean square) ac values are, broadly speaking, equivalent values to dc in terms of energy (usually referenced to heating effect). In other words 50 Vac RMS will create the same heating effect in a given resistive network as 50 Vdc. However, because the voltage (and current) level is constantly oscillating from pole to pole, and through zero, the peak voltage and current will be considerably in excess of this level. The mathematics are not difficult, but that's only with a true sine wave such as would be expected from the mains or standard oscillator.

Because meters do not work via heat effect these days (they used to — ever heard of a hot wire ammeter?), this effect is irrelevant and reliance must be placed on an internal RMS converter. If considerable distortion is present on the waveform, or if it is a square or triangular wave, the RMS converter can get hopelessly confused.

The Series 18 meters have been designed to overcome this difficulty, and accurate RMS readings up to 100 kHz (1 GHz with optional probe) are claimed, irrespective of the waveform.

Resistance measurement includes continuity, with a useful beep function, giving a high tone for negligible, and low tone for very low resistance. The beep is not your average raucus squeak but a mellow musical note. Diode test facilities are provided.

An extremely useful feature, via optional probe (except on the PM 2718 where it is built in), is the *data hold function*, enabling a measurement to be held on the display, particularly useful when working in cramped conditions.

During tests of the Series 18 meters, I made much use of the relative reference mode. Using this mode, with a press of a switch any given measurement can be established as the reference, and future measurements displayed relative to it.

Also available on all three meters is a temperature reading in degrees Celcius, via an optional probe. This function measures from -20 (English summer's day on Polzeath Beach, Cornwall) to + 100 (Editor, one day after copy date). The temperature probe is connected via an 8-pin DIN socket with neat sliding cover.

All meters are supplied complete with very well-shielded test prods, only a small point being exposed, designed to meet or exceed a number of national and international safety standards, including UL IEC and VDE. However, these prods are very inconvenient when trying to work on equipment, unless of course you are an octopus. During tests on a number of computers and other items I had to resort to my "Dick Tandy" clip-on prods on several occasions.

— to page 97 ▶

KITS THE AFFORDABLE WAY TO GET INTO COMMUNICATIONS

HF Transceiver

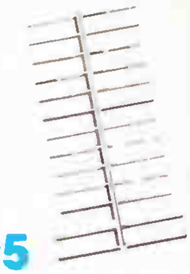
It's fun, challenging and just think of the money you'll save! Being a 'do-it-yourself' job doesn't mean a lack of performance... not by a long shot. Look at these specs! • Covers any 500kHz band from2-30mHz* • switch-able noise blanker • USB, LSB & CW modes • digital frequency display with 100Hz resolution • 30 watts 'pep' output (conservative rating) • RX sensitivity better than 0.3uV for 10dB S+N/N • inbuilt clarifier • 12 volt operation makes It idealfor mobile or portable applications.

$349

Cat K-6330 (80 metre version)

*Some bands require component changes.

UHF CB 'Yagi' Antenna Kit



Fantastic! Really get into the action with our 13 element Yagi antenna. Boosts signal up to 18 times. Impressive 12.5dBi gain.

*Easy to construct. All you need is a screwdriver and solding iron.

$39.95

Cat K-6304

For the serious amateur UHF Yagi antenna kit

Talk about performance! It's just the thing for the serious amateur who wants extra range within the 430-440mHz band. Increases signal strength up to 18 times. Impressive 12.5dBi gain.

$39.95

Cat K-6305

Phasing Harness

Wow! The easy, affordable way to 'stack' a pair of antennae to increase signal range. A 'must' for the serious enthusiast.

$9.95

Cat K-6298 COMING SOON

Build your own UHF Transceiver

Our Explorer 1 UHF transceiver kit is the most affordable way to get into the exciting world of communications. Enjoy access to 40 channels within the 438.025-439MHz range. With just a little time, you can easily assemble this impressive unit that boasts many features found in more expensive commercial units. Cat K-6300

$189

Repeater Up-Grade Kit

WOW! This inexpensive kit gives the Explorer full repeater capability PLUS S-meter and an extra crystal filter. Includes front panel. Cat K-6302

$14.50

Value! UHF Wattmeter

Just the thing for the UHF enthusiast! The ability to check your transceiver's power output PLUS the efficiency of your antenna system. And what a performer this little beauty is ... it's accurate to within 10%! Directivity is greater than 20dB with insertion loss less than 0.3dB. Covers 400-520MHz range.

As seen in QST & 73 magazines in the USA.

$39.95

Cat K-6312

DICK SMITH ELECTRONICS PTY LTD

For Address details See P88

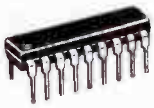
B.108/AC

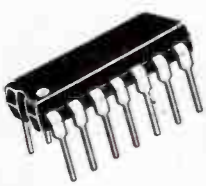
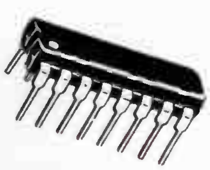
ELECTRONIC FACILITIES

TECHNOLOGY TO MAKE IT HAPPEN

74LS SERIES

PART NUMBER	PRICE EA
74LS00	.55
74LS02	.55
74LS04	.55
74LS05	.55
74LS08	.55
74LS10	.55
74LS11	.55
74LS13	.55
74LS14	.65
74LS20	.55
74LS22	.50
74LS30	.60
74LS32	.60
74LS38	.65
74LS42	.65
74LS74A	.55
74LS83A	.75
74LS86	.50
74LS90	.75
74LS93	.80
74LS109	.75
74LS123	.90
74LS125A	.65
74LS126	.75
74LS132	.90
74LS136	.75
74LS138	.90
74LS139	.85
74LS157	.65
74LS161A	.75
74LS162A	.80
74LS164	.85
74LS165	.90
74LS174	.75
74LS175	.75
74LS190	.95
74LS192	.80
74LS240	1.45
74LS244	1.45
74LS245	1.45
74LS247	.95
74LS251	.85
74LS257A	.90
74LS258A	.90
74LS259	.90
74LS365A	.90
74LS367A	.75
74LS368A	.80
74LS373	1.45
74LS374	1.45
74LS377	1.45
74LS390	1.40
74LS393	.95

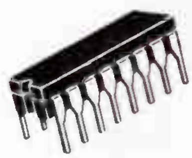
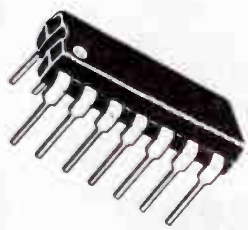
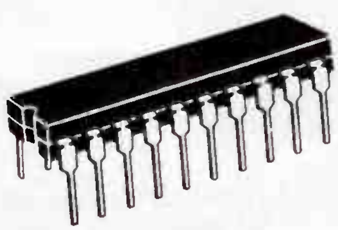


OVER 25 ITEMS OF ANY TYPE
LESS 7½%

4000 SERIES CMOS

PART NUMBER	PRICE EA
4001B	.50
4002B	.50
4006B	.85
4007UB	.50
4008B	.85
4011B	.50
4012B	.50
4013B	.90
4015B	1.20
4016B	.80
4017B	1.40
4020B	1.40
4023B	1.50
4024B	1.10
4025B	.90
4040B	1.60
4044B	.95
4049B	.50
4069UB	.50
4071B	.50
4081B	.50
4085B	.50
4093B	.50
40160B	1.65
40174B	.90
4503B	.65
4510B	1.60
4512B	1.60

OVER 25 ITEMS OF ANY TYPE
LESS 7½%

MICRO & PERIPHERALS

PART NUMBER	PRICE EA
8085A	$3.60
8155	$3.60
8212	$3.00
8216	$3.00
8251	$3.60
8255	$3.00
8039	$3.60
8259	$3.60

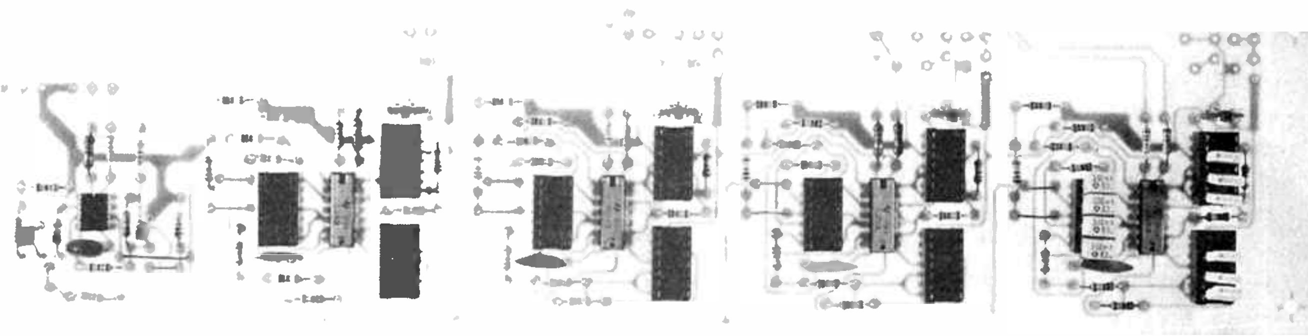
OVER 25 ITEMS OF ANY TYPE
LESS 7½%

MEMORY

PART NUMBER	PRICE EA
2114	3.00
NMC 9817 5V EEPROM 2K × 8	36.50
41256-15	9.00
4164P-15A 150ns 64K DYNAMIC RAM	2.50
6264LP-15 150ns 8K X 8 STATIC CMOS RAM	7.20
2764-25 250ns 8K X 8 EPROM	4.95
6116LP-3 150ns 2K X 8 STATIC CMOS RAM	3.80
2716-45 450ns 2K X 8 EPROM	5.95
2732A 250ns 4K X 8 EPROM	5.60

OVER 25 ITEMS OF ANY TYPE
LESS 7½%

aem project 6503



An active crossover

David Tilbrook

While the idea of active-filter crossovers, and their use in 'active loudspeakers', is not new, they have not come up to performance expectations in the past. But, with proper attention to crossover design, the active loudspeaker is the way of the future.

IN A CONVENTIONAL passive loudspeaker system the audio spectrum is divided into several frequency bands by a passive LCR circuit called the *crossover*. The input of the crossover is connected to the output of the power amplifier while the crossover outputs are connected to the drivers. In this way drivers can be designed for optimum performance over a more restricted frequency range and a greatly improved overall loudspeaker performance obtained. Unfortunately, passive crossovers also introduce a hoard of conceptual and practical problems some of which are extremely difficult, if not impossible, to correct using purely passive techniques.

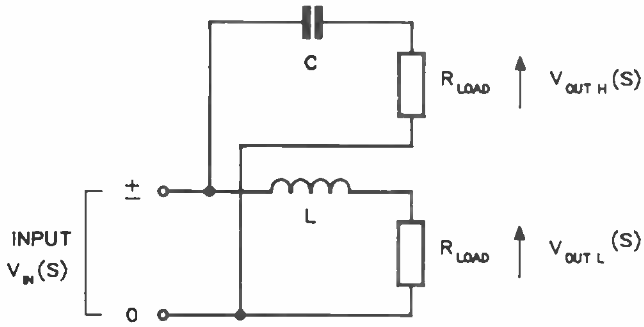
As mentioned above, the purpose of the crossover is to divide the audio spectrum into frequency bands suitable for the drivers employed. The assumption implicit in this is that the complete audio spectrum is once again present after the outputs of all the drivers are added together. We should expect the overall frequency response, the transient characteristics and the phase characteristics of the output signal to be the same, or at least as close as possible, to that of the input signal. Unfortunately, this is not the case. In fact it turns out that it is not even theoretically possible!

The passive crossover consists of a selection of inductors (L), capacitors (C) and resistors (R) arranged to form high-, low- and band-pass filters. In addition, most passive crossovers are also designed to correct for the different sensitivities of the various drivers employed and to correct for the effects of resistances introduced by the crossover components themselves.

The simplest passive filter is called the *first-order filter* and consists simply of an inductor or a capacitor connected in series with the load. Such a crossover is shown in Figure 1 here.

The transfer functions of the filters are also shown together with the resultant transfer function when the outputs of the two filters are summed. Notice that in this case the resultant overall transfer function is equal to one, which is correct. This is, in fact, the only passive crossover with a unity transfer function and makes this crossover extremely attractive for certain specialized applications. In the vast majority of applications, however, the extremely slow roll-off of the first-order filter makes it impractical. Furthermore there is another, less obvious, disadvantage of this type of crossover which is caused by the fact the two outputs are in phase quad-

Figure 1. Conventional 1st-order passive crossover.

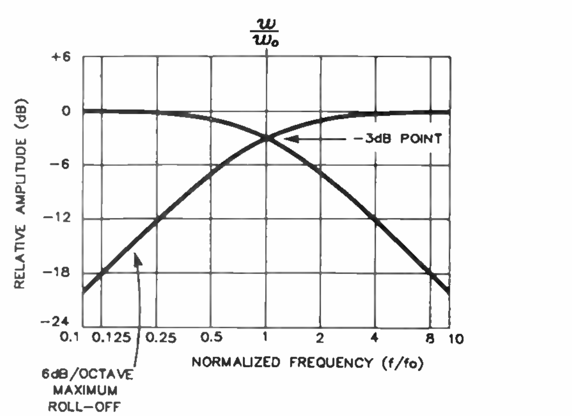


$$F_{LOW}(S) = \frac{1}{S+1}$$

$$F_{HIGH}(S) = \frac{S}{S+1}$$

$$F_{LOW}(S) + F_{HIGH}(S) = \frac{S+1}{S+1} = 1$$

So this type of crossover has a unity transfer function.



N.B: V_{OUTh} and V_{OUTl} are in phase quadrature (i.e: 90° out of phase) which leads to a skewed polar response in the vertical plane in front of the loudspeaker.

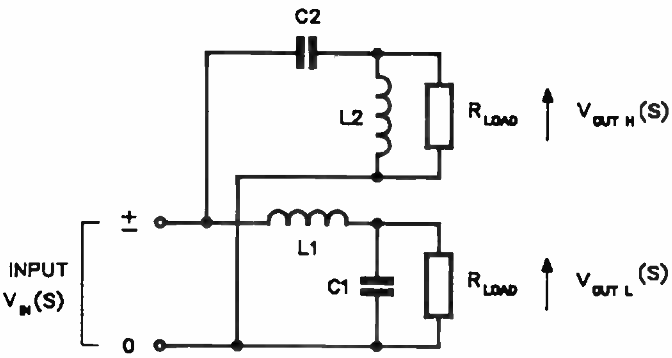
rature (i.e: the two outputs are 90 degrees out of phase to one another). The effect is that, for a sufficiently high crossover point, say that between a typical mid-range and high-frequency driver, the maximum reinforcement of the outputs from the two drivers occurs at an angle below the plane equidistant between the two drivers. This can have an extremely significant effect on the frequency response of the loudspeaker as the listening height is changed.

If an extra inductor and capacitor are added as shown in Figure 2, the second-order crossover results. A quick glance at the transfer functions and resulting overall frequency response shows that this crossover is entirely unsuitable for use in loudspeakers. The overall frequency response shows an infinitely deep hole at the crossover point which is caused by phase cancellation between the outputs of the filter sections.

Since the problem with the second-order filter stems from the out of phase nature of the filter section at the crossover point it is not surprising that reversing the phase of one of the drivers will help to overcome the problem. The result is shown in the curve at the bottom of Figure 2. Notice that the frequency response function now shows a 3 dB peak at the crossover point. This is certainly far from ideal but the filter slopes are now acceptably fast for many applications. Furthermore, the frequency response anomaly inherent with this type of crossover is often hidden by greater frequency response errors in the drivers used.

The second-order crossover with reversed driver phase is the most common type of crossover design and for many years was used by loudspeaker engineers almost without exception. In more recent times with improved driver quality and an increasing emphasis on the importance of phase integrity through the audio chain, an increasing number of loudspeakers are being designed with higher or lower order crossovers depending on which of these characteristics is ▶

Figure 2. Conventional 2nd-order passive crossover.

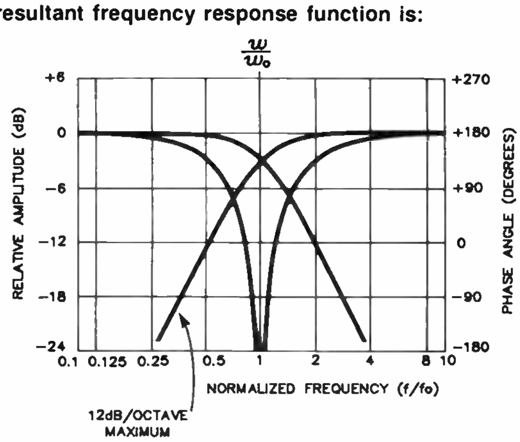


$$F_{LOW}(S) = \frac{1}{S^2 + S\sqrt{2} + 1}$$

$$F_{HIGH}(S) = \frac{S^2}{S^2 + 2\sqrt{S} + 1}$$

$$F_{LOW}(S) + F_{HIGH}(S) = \frac{S^2 + 1}{S^2 + S\sqrt{2} + 1}$$

The resultant frequency response function is:



N.B: An infinitely deep hole results in the frequency response at the crossover point. V_{OUTh} (S) and V_{OUTl} (S) are 180° out of phase. To correct this the phase of one of the drivers is reversed resulting in the following frequency response.

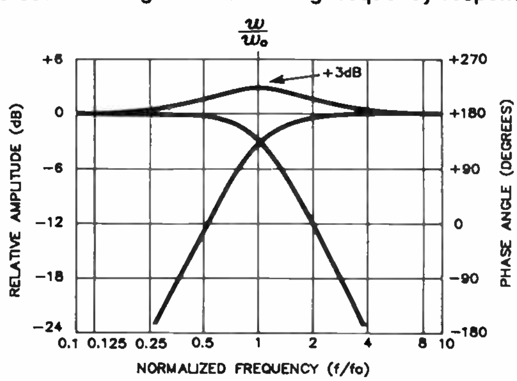
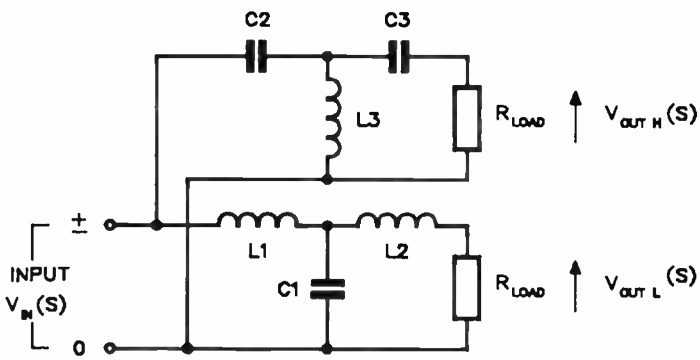


Figure 3. Conventional 3rd-Order passive crossover.

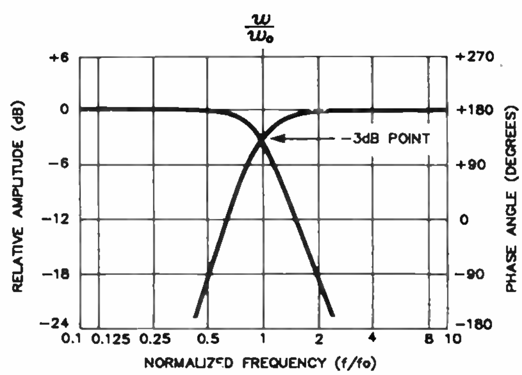


$$F_{LOW}(S) = \frac{1}{S^3 + 2S^2 + 2S + 1}$$

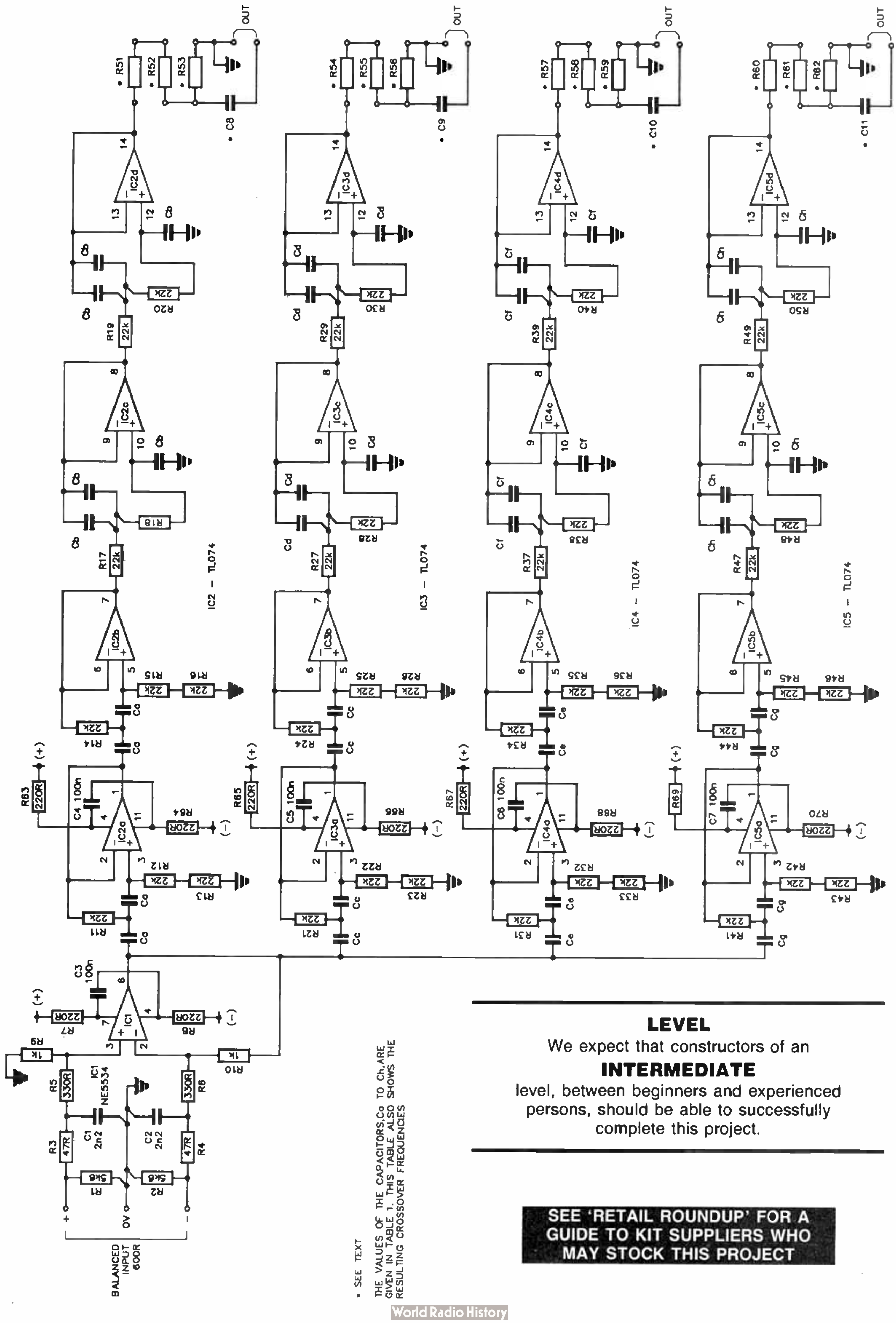
$$F_{HIGH}(S) = \frac{S^3}{S^3 + 2S^2 + 2S + 1}$$

$$F_{LOW}(S) + F_{HIGH}(S) = \frac{S^3 + 1}{S^3 + 2S^2 + 2S + 1}$$

And the resultant frequency response curve is flat.



N.B: V_{OUTl} and V_{OUTh} are in phase quadrature again (as in the 1st-filter).



LEVEL

We expect that constructors of an

INTERMEDIATE

level, between beginners and experienced persons, should be able to successfully complete this project.

SEE 'RETAIL ROUNDUP' FOR A GUIDE TO KIT SUPPLIERS WHO MAY STOCK THIS PROJECT

to be optimised. Generally, the higher the order the more gross the phase errors generated. So audio engineers interested in optimisation of phase performance tend to use the lower order filters. If optimisation of frequency response performance is desired, higher order filters are often adopted such as the *third-order filter* shown in Figure 3.

In the case of the third-order filter, the resultant transfer function results in a flat frequency response characteristic and a very useful fast roll-off outside the crossover point.

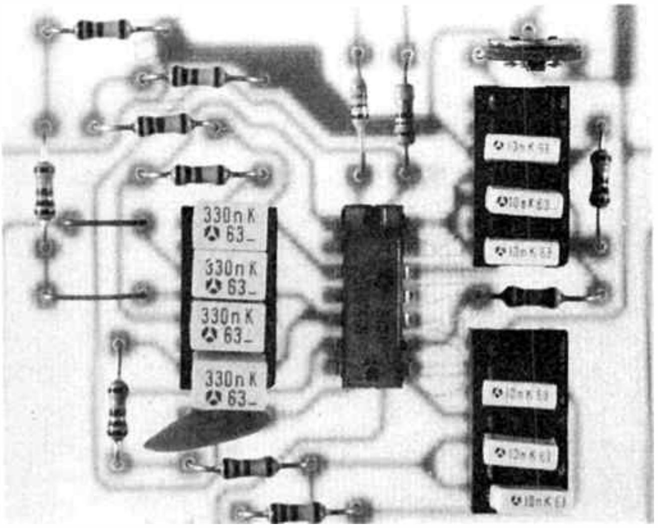
This type of crossover is an extremely useful one for applications requiring the flat frequency response and excellent roll-off performance it provides and is becoming increasingly popular for applications in top quality loudspeakers.

Unfortunately, the outputs of the drivers are again in phase quadrature and the crossover reveals an overall phase characteristic which is dominated by a substantial phase shift for several octaves either side of the crossover point.

The active approach

Given the substantial problems associated with these types of passive crossovers it is surprising that the alternative, that of electronic or active crossovers, has not found more acceptance among loudspeaker designs intended for high fidelity applications. One of the possible reasons is that many of the earlier active crossover designs duplicated most of the problems inherent in the passive devices. Nevertheless the active crossover is an elegant approach and will, in my opinion, be the way of the future for loudspeaker design.

In the active crossover scheme the output of the preamp is connected to the input of an *electronic* crossover the outputs of which are connected to separate power amplifiers that are dedicated to their own drivers. So a total of three power amps are required for a three-way loudspeaker, one for each driver. The most common argument against the idea is usually based on the cost of such a design, but this is often not a valid criticism. Much of the cost of commercial power amplifiers is associated with the power supply, chassis and front panel controls and metering etc, and these costs are removed if the power amps share a common power supply and are mounted in the loudspeaker cabinet itself. The result is an "active loudspeaker" which, if executed correctly, can often yield spectacular results.

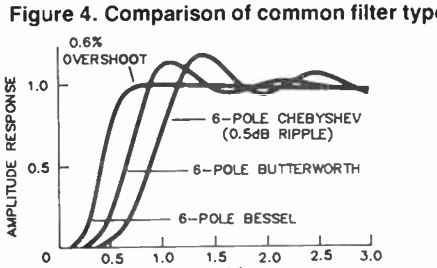


The active crossover has a number of extremely significant advantages over the more common passive designs. Firstly, active crossovers can be designed with much steeper slopes and the frequency response characteristics are much more predictable since there is no interaction between the filter and the highly non-linear load represented by the driver. The resulting well defined passbands help to decrease intermodulation distortion and optimise the frequency response performance.

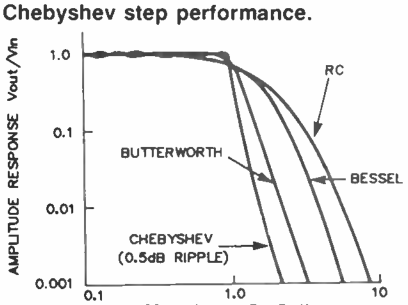
Another major advantage of active loudspeakers is the ease with which the effect of the different sensitivities of the drivers can be corrected. Furthermore, the insertion of the active crossover does not cause a decrease in the efficiency of the system which can occur with the higher order passive crossovers. The fact that the outputs of the power amps are connected directly to the drivers without the series resistance of the passive crossovers also helps to increase driver damping and hence driver control.

Probably the biggest advantage, however, of active crossovers is the ease with which they allow optimisation of the entire loudspeaker. The choice of drivers is no longer restricted by factors such as the relative driver efficiencies, the phase and frequency response characteristics can be op- ▶

Figure 4. Comparison of common filter types. The comparison is made for six-pole filters to accentuate the differences.



Comparison of the transient performance of the Bessel, Butterworth and Chebyshev step performance.



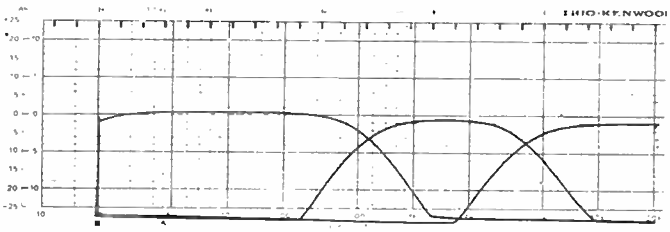
Comparison of sixth order frequency responses.

TABLE

Time-domain performance comparison for low-pass filters

	f_{3dB} (Hz)	Poles	Step rise time (0 to 90%) (s)	Overshoot (%)	Settling time to 1% (s)	Settling time to 0.1% (s)	Stopband $f = 2f_c$ (dB)	Attenuation $f = 10f_c$ (dB)
Bessel (−3.0 dB at f_c = 1.0 Hz)	1.0	2	0.4	0.4	0.6	1.1	10	36
	1.0	4	0.5	0.8	0.7	1.2	13	66
	1.0	6	0.6	0.6	0.7	1.2	14	92
	1.0	8	0.7	0.3	0.8	1.2	14	114
Butterworth (−3.0 dB at f_c = 1.0 Hz)	1.0	2	0.4	4	0.8	1.7	12	40
	1.0	4	0.6	11	1.0	2.8	24	80
	1.0	6	0.9	14	1.3	3.9	36	120
	1.0	8	1.1	16	1.6	5.1	48	160
Chebyshev 0.5 dB ripple (−0.5 dB at f_c = 1.0 Hz)	1.39	2	0.4	11	1.1	1.6	8	37
	1.09	4	0.7	18	3.0	5.4	31	89
	1.04	6	1.1	21	5.9	10.4	54	141
	1.02	8	1.4	23	8.4	16.4	76	193
Chebyshev 2.0 dB ripple (−2.0 dB at f_c = 1.0 Hz)	1.07	2	0.4	21	1.6	2.7	15	44
	1.02	4	0.7	28	4.8	8.4	37	96
	1.01	6	1.1	32	8.2	16.3	60	148
	1.01	8	1.4	34	11.6	24.8	83	200

Figure 5. The frequency response of the AEM6503 active crossover with crossover frequencies set for 15 Hz, 500 Hz and 4.3 kHz.



timised and adjusted to suit the particular concerns of the loudspeaker designer and the overall performance is more accurately predicted and maintained with subsequent driver changes.

There are, of course, a multitude of filter types that can be implemented using the active approach. If characteristics such as phase linearity and minimum overshoot are to be optimised then the Bessel type filter function would be selected (the Bessel filter has the advantage that it introduces a constant time delay for frequencies even well outside the passband). If frequency response performance is regarded as of utmost importance then the choice would normally be for the *Butterworth* function with its optimally flat amplitude performance. This type of filter funciton has inferior phase performance to the Bessel function and considerably more overshoot on transient signals but provides a significantly faster roll-off outside the passband.

Filter designs with even faster stop-band performance are also available but these are usually characterised by significant ripple in the passband frequency response and are usually therefore, not considered appropriate for high fidelity applications. One such filter is the *Chebyshev* which provides an extremely good stop-band performance but poor phase and transient performance. A comparison of the four most common filter slopes is shown in Figure 4.

There are many other filter functions that have been devised which attempt to find compromises between the various performance features mentioned above. The most often used filter type for active crossovers is the *Butterworth* function since it provides optimisation of the passband frequency response. Actually, any of the possible function types with roll-offs slightly slower than the Butterworth can also be used with great success.

The AEM6503 active crossover

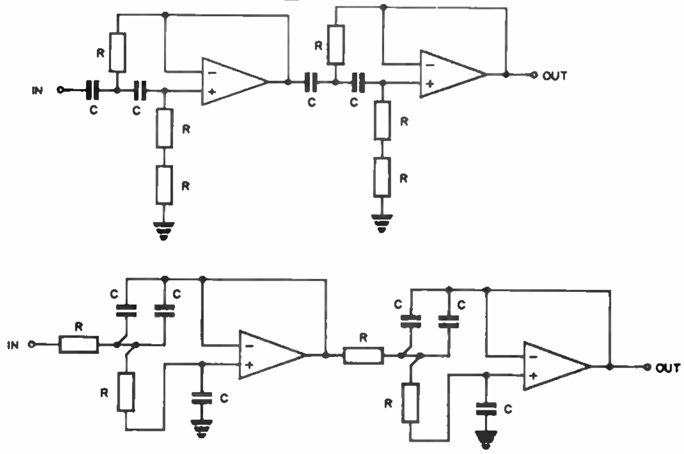
In this design I have chosen a Butterworth filter type and designed a fourth-order crossover (ultimate roll-off around 24 dB/octave). This particular filter has the advantage that *it uses capacitors of all the same value for any particular crossover frequency* and hence allows very easy modification to the crossover point.

TABLE 1: Crossover points available for E12-series capacitors with R = 22k

f (Hz)	C (F)	f (Hz)	C (F)	f (kHz)	C (F)	f (kHz)	C (F)
10.88	470n						
13.12	390n	131.2	39n	1.312	3n9	13.116	390p
15.50	330n	155.0	33n	1.550	3n3	15.501	330p
18.95	270n	189.5	27n	1.895	2n7	18.946	270p
23.25	220n	232.5	22n	2.325	2n2	23.252	220p
28.42	180n	284.2	18n	2.842	1n8	28.419	180p
34.10	150n	341.0	15n	3.410	1n5	34.103	150p
42.63	120n	426.3	12n	4.263	1n2	42.629	120p
51.15	100n	511.5	10n	5.115	1n	51.154	100p
62.38	82n	623.8	8n2	6.238	820p	62.384	82p
75.23	68n	752.3	6n8	7.523	680p	75.228	68p
91.35	56n	913.5	5n6	9.135	560p	91.347	56p
108.8	47n	1088	4n7	10.884	470p	108.84	47p

$$f = \frac{1}{2\pi\sqrt{2}\,RC} \qquad C = \frac{1}{2\pi\sqrt{2}\,fR}$$

Figure 6. Fourth-order crossover filter section used — shown in both high- and low-pass configurations.



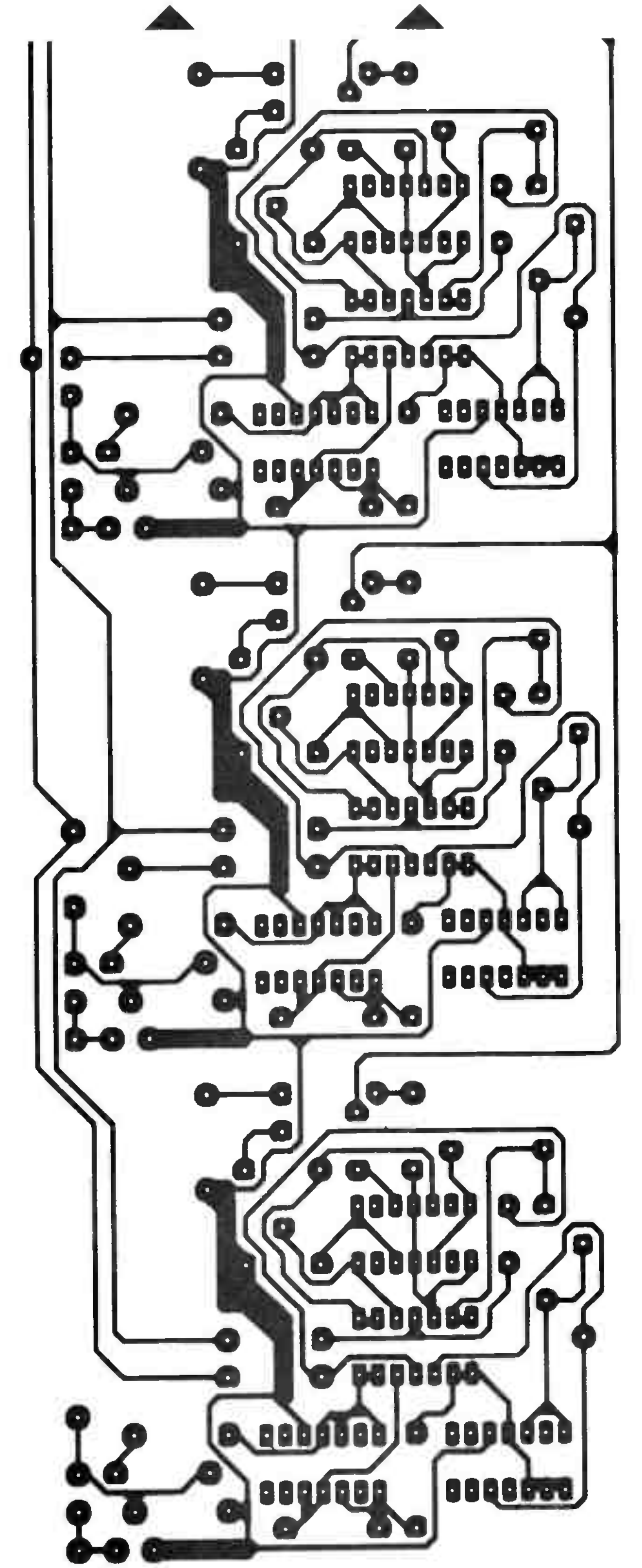
One of the major considerations in the design of this crossover was versatility. The crossover is suitable for use as a stand alone crossover, possibly mounted in its own chassis with a suitable power supply. Alternatively, the crossover might be mounted on the rear of the loudspeaker cabinet in conjunction with power amplifiers to form an "electronic loudspeaker".

This is the direction we will be taking over the next few months as we describe the conversion of the AEM6502 and AEM6503 loudspeakers to active designs. In this configuration relatively long leads must be run from the output of the preamp to the inputs of the active crossovers. To decrease the possibility of hum pick-up in these leads the crossover is provided with a balanced 600 ohm input stage.

The output of this stage is connected to a total of four filter sections each incorporating both a fourth-order low-pass and a fourth-order high-pass filter. The crossover is therefore suitable for use with up to a four-way loudspeaker. If you intend to dedicate the unit for use with a two- or three-way loudspeaker, the redundant section(s) of the pc board can be cut off before commencing construction. Alternatively, simply leave these areas of the pc board unpopulated.

As mentioned above, all four filter sections are identical with both high- and low-pass filter sections provided. This provides the facility to incorporate a low frequency high-pass filter to minimise the effects of subsonic content that might be generated by tone arm resonances etc. Large amounts of subsonic content robs the bass driver of linearity and hence causes a dramatic increase in low-frequency distortion. The incorporation of the additional high-pass function at low frequencies can therefore result in a significant improvement in low-frequency power handling. The top low-pass filter can be set just above the audio spectrum if required or disabled by omitting the capacitors for this section. With these capacitors removed the section becomes a unity gain buffer. Note that this is not possible with the high-pass filter sections. The capacitors for these sections are in the signal line and their removal will disable operation of that filter section completely. A diagram showing the selection of crossover points for a three-way crossover intended for use with the AEM6503 three-way loudspeaker is shown in Figure 6 together with the actual crossover frequency response.

The basis of the active crossovers are the fourth-order active filter sections shown in Figure 6. Both the low- and high-pass sections are shown together with the design equations. This filter provides a fourth-order Butterworth response which has the advantage that although the filter introduces a frequency dependent phase-shift around the cros-

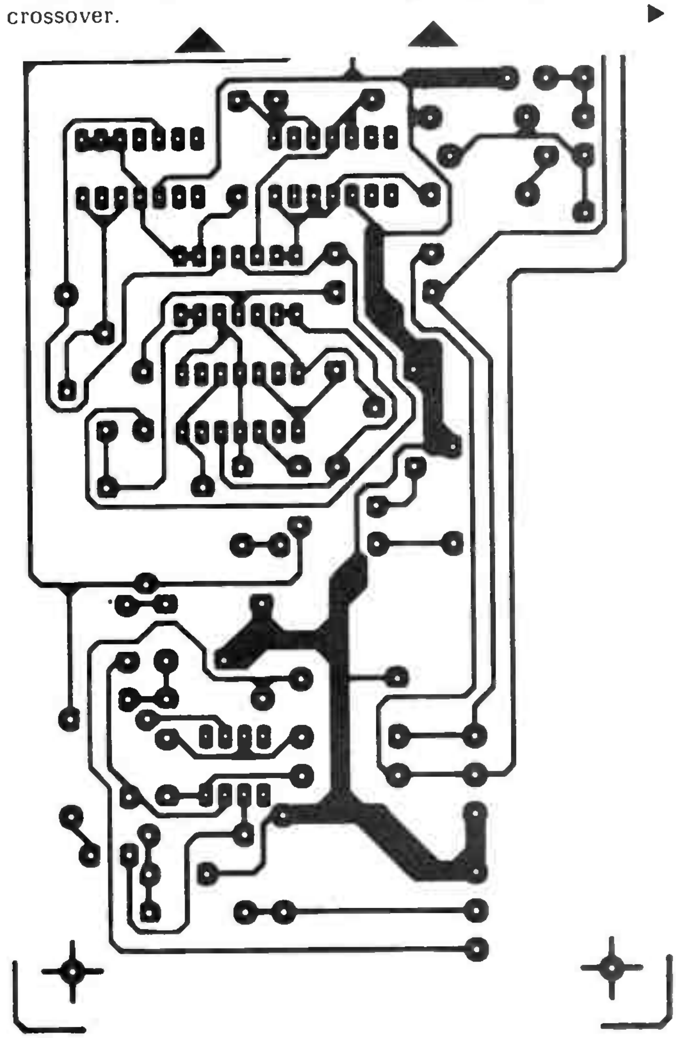


AEM 6503

sover point, the frequency shift is identical for the two sections. So the signal phase from the two drivers will be the same for all frequencies. This is a very important advantage of this type of active filter since the resulting stationary and well defined lobe pattern around the loudspeaker contributes enormously to its superior subjective performance.

Table (1) shows the standard E12 capacitor values and the resulting crossover frequencies obtained when the resistors are all set to 22k. If other crossover frequencies are required then these can be obtained by changing the values of the resistors slightly. However, the range of values shown would probably satisfy most requirements. These resistors are soldered directly to the pc board. The frequency determining capacitors on the other hand, need to be able to be changed with relative ease to facilitate adjustment of the crossover frequency. Accordingly, DIP sockets have been provided which allow the capacitors either to be plugged into these or soldered to DIP plugs which are in turn plugged into the sockets. Alternatively, the capacitors can be soldered directly to the pc board if required, such as for equipment which is likely to be transported regularly.

Another practical feature worthy of mention at this stage is the output attenuator arrangement. This is provided so that the different sensitivities of the drivers can be corrected. In the following months we will be describing the conversion of the AEM6502 and AEM6503 loudspeakers to an active system incorporating this crossover and it is therefore important that the project be designed with sufficient versatility to fill both this role and that of a general purpose active crossover. ▶



aem project 6503

Accordingly we have designed the pc board so that it will accommodate fixed potential dividers, preset potentiometers or flying leads to pots that might be mounted on the front panel of the active crossover unit. The component overlay illustrates the use of the fixed potential dividers while the photograph shows the device with presets fitted. A careful look at the photograph will also reveal that we have left the output coupling capacitors off our prototype. This is because the values of these capacitors, and hence the capacitor types, can be optimised only after the crossover points have been chosen for a particular application. Indeed for many applications no output capacitors will be necessary. If, on the other hand, the crossover is to be constructed as a completely general unit, then a value around 1 uF would be about right.

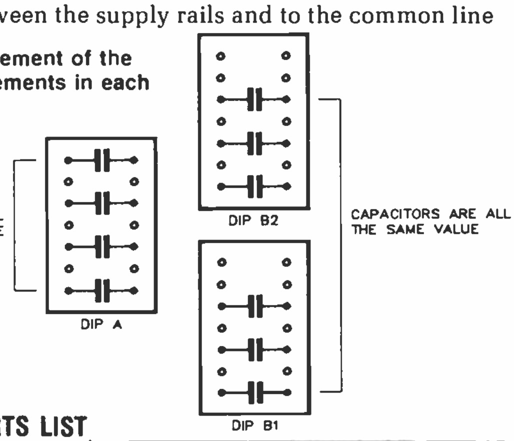
Construction

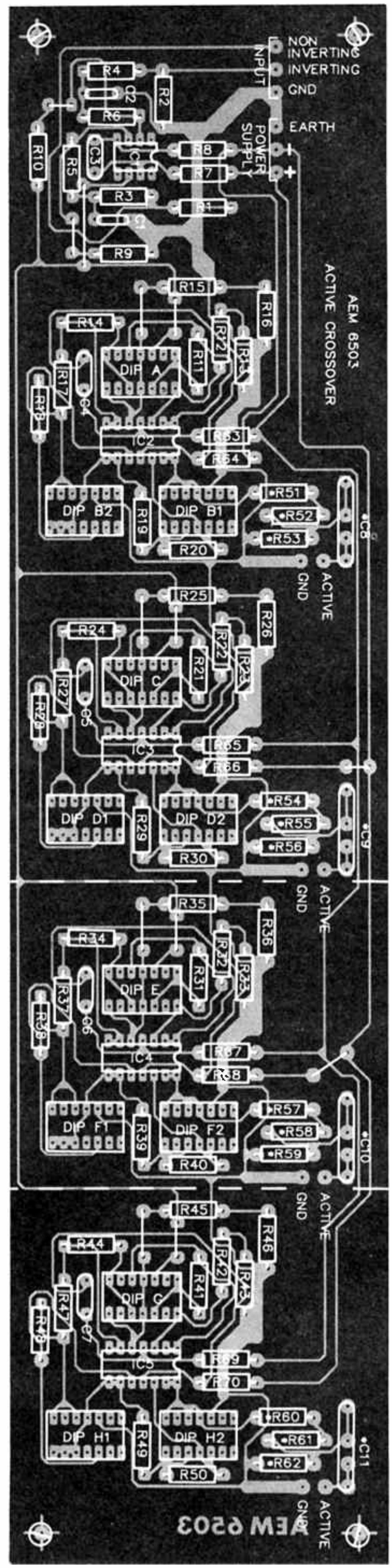
Assembly of the circuit board is quite straightforward. If the unit is to be used in an application where the filter frequencies have been predetermined, then the appropriate capacitors can be soldered directly into place, otherwise 14-pin DIL IC sockets (as seen in the photographs) allow convenient plug-in replacement of the filters' frequency determining capacitors. Although unessential, sockets may be used for the ICs.

Before commencing assembly, first do a visual check of the board. See that all holes are drilled and of the right diameter. Best place to start construction is with the links — there are twelve (12) of them. Use tinned copper wire or cut off component leads. Follow by soldering all the passive components in place next. If you are using trimpots, these should follow, otherwise, solder pc stakes in place so that connections to off-board potentiometers are easily made. If you're using sockets for the filter capacitors, solder these in place now. The ICs should be left till last.

Before attempting to test the unit, do a thorough visual check. You could do a multimeter check to see that there are no shorts between the supply rails and to the common line

General arrangement of the capacitor placements in each active filter.





AEM6503 PARTS LIST

Semiconductors
- IC1 . . . . NE5534N
- IC2, IC3, IC4, IC5 . . . TL074

Resistors all ¼ W, 5%
- R1, R2 . . . . 5k6
- R3, R4 . . . . 47R
- R5, R6 . . . . 330R
- R7, R8 . . . . 220R
- R9, R10 . . . . 1k
- R11-R50 . . . . 22k
- R51-R62 . . . Chosen to suit crossover frequencies, alternatively use four 470n.
- Ca, Cb, Cc, Cd,
- Ce, Cf, Cg, Ch . . chosen to determine required crossover frequencies. See Table 18.

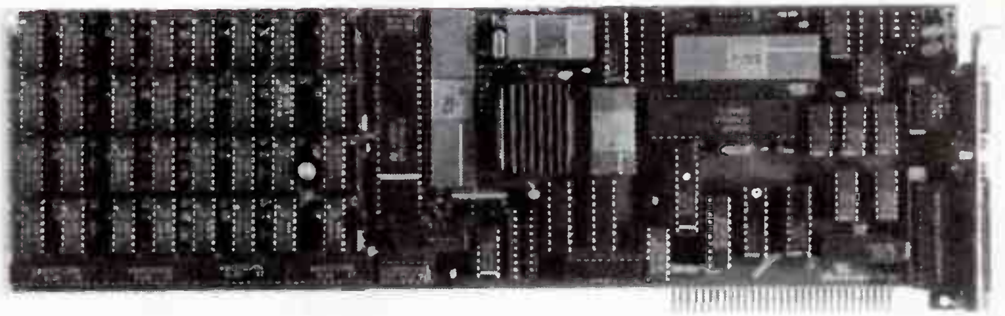
Capacitors
- C1, C2 . . . . 2n2
- C3-C7 . . . . 100n
- C8-C11 . . . . . chosen to suit crossover frequencies, alternatively use four 470n.
- Ca, Cb, Cc, Cd,
- Ce, Cf, Cg, Ch ccchosen to determine required crossover frequencies. See Table 1.

Miscellaneous
AEM6503 printed circuit board; pc board pins (if required); IC sockets for filter capacitors (if required); hookup wire, solder, etc.

Estimated cost: $55-$65

Co-processor board gives 32-bit power and UNIX capability for PCs and compatibles

If you need number crunching power with speed comparable to a VAX, a new board from California-based Definicon Systems to plug into the IBM-PC, XT, AT, Compaq or compatibles, would be the way to go.



The single-slot pc board, to be marketed here by Pepete Pty Ltd with software support from Osiris Technology, features full 32-bit architecture employing National Semiconductor's NS32032 running at 10 MHz and an NS32081 floating point accelerator.

The board will be offered with either 1M or 2M of dynamic RAM. In addition, there are two independent 38 kilobaud asynchronous serial ports and a 16-bit interrupt-driven counter/timer included.

The host machine's 8088 processor has access to the full 32032 memory space and peripherals. The NS32082 memory management unit (MMU) is offered as an option.

The operating environment is either PC DOS or MS DOS and the machine interface uses Definicon's LOAD 32 assembler/linker/loader.

Some expatriate Australian whizz-kid engineers are behind the development of the DSI-32, including Trevor Marshall who assembled and ran Australia's first open-access bulletin board in Perth and designed Australia's first-published direct-connect computer modem project.

A complete hardware and software description of the DSI-32 appeared in *Byte*, August and September 1985 issues, written by Trevor Marshall, George Scolaro, David L. Rand, Tom King and Vincent P. Williams of Definicon Systems.

The DSI-32 will be offered here with UNIX, truly putting the power of a mainframe and its facilities within the reach of PC users. Using a sieve benchmark with n = 40 000 and ten iterations, the DSI-32 compares very favourably with a VAX-11/780 and is faster than a VAX-11/750. Quoted execution times are 10.07 seconds for the DSI-32, 6.38 secs for the 11/780, 13.3 secs for the 11/750, 99.71 secs for an IBM-PC/AT and 351.5 secs for the IBM-PC/XT.

UNIX support will be available here through Osiris Technology of Sydney, a UNIX specialist who has been in the business two years now. Osiris is a licensed UNIX distributor.

The DSI-32 is priced around $6000, which includes UNIX. Enquiries should be directed to

D. Anisimoff, Pepete Pty Ltd, PO Box 417, North Sydney 2060 NSW. (02) 888 3674

68XXX SERIES SINGLE BOARD COMPUTERS

Paris Radio Electronics has announced the availability of the UniQuad Series of 68XXX single board computers from Hazelwood Computer Systems, USA. A UniQuad computer model is available at two performance levels. The UniQuad 1 utilizes a 68008 processor and can have up to 512K of memory. Offering twice the performance, the UniQuad 2 uses a 68000 and will suupport up to 1M of memory.

Major Features of the UniQuad series are:

	UniQuad 1	UniQuad 2
Processor:	68008	680000
Speed:	8 Mhz	10 Mhz
RAM:	128k	512k
ROM:	2K	4K
Serial I/O:	4 ports	4 ports
Parallel I/O:	2 ports	2 ports
Floppy Disk:	2 5.25" DSDD disk drives	4

The UniQuad boards all include a SASI (SCSI) bus compatible interface which allows for the addition of a hard disk drive. Included as a standard part of the UniQuad package is sufficient software to support most common computer applications. The included operating system is OS-9/68000 giving the UniQuad's Multi-user/Multi-tasking abilities, included as well are the following software packages :- BASIC09, DYNACALC spread sheet and the Stylorgraph word processing system.

Other software that is available is the LLOYD I/O Cross Assemblers for all CPU types, Omegasoft Pascal Compiler, INTROL C compilers as well as Microware's Pascal, C and Fortran 77 compilers.

For further technical information please contact **Paris Radio Electronics, PO Box 380, Darlinghurst 2010 NSW. (02) 344 22579**

Bye, bye blurty

Noise on the mains can wreak havoc with sensitive electronic equipment, ranging from unwanted blurts in the middle of your hi-fi listening session to disastrous corrupted bits in a running computer system, it is becoming commonplace for electronic equipment to feature a built-in ac noise filter as either a separate component or part of the mains receptacle.

We hear from JRH Components of Murata's popular five amp, 250 Vac noise filter, type PLF-2V-5RA-501. This low-cost, locally stocked device is supplied with a moulded case and 'quick-connect' or solder terminals.

A noise attenuation of 40 dB is guaranteed, say Murata, over a frequency range of 0.8-30 MHz betweeen leads and 0.7-30 MHz to ground.

AT LAST!

An affordable IBM Software compatible computer for the enthusiast!

DSE Multitech

Only

$1395

128K, Single Drive Model as shown, inc MS-DOS. Monitor not included in price.

Yes: at last the enthusiast can afford a true MS-DOS computer. With the world's best and biggest range of software available (and more coming every day!) the real computer hobbyist now has access to virtually limitless applications. No enthusiast should settle for an 'orphan' computer system — go with the strength. You know the MS-DOS system will be around for years: can you say that about most others? Check out the DSE Multitech at your nearest DSE store now!
Cat X-8000

And two other models with even more features:
256K Twin disks, plus EASY word processing package. Cat X-8001 **$1995**
10Meg hard disk (and one floppy), 512K plus AURA integrated software package. Cat X-8002 **$3995**

B113/MM

VZ-300

THE BEST VALUE IN COLOUR COMPUTERS

Unbelievable! This is DSE's most popular computer ... we've sold thousands to families and small businesses. And now it's yours for under $100. It's so versatile and 'user-friendly', any one can use it. Ideal for experienced programmers and beginners alike. 18K RAM expands up 64K, you can add any number of peripherals and a run of variety of software. This is truly sensational value. Cat X-7300

WAS $149 $99

WOW! CAT COMPUTER FOR UNDER $500!!

This is it! Your chance to enter the arena of powerful computing at a fraction of the price. CAT is the pick of the litter...thousands have been sold. It's 64K RAM stores and executes large amounts of personal and business data. The 81-keyboard boasts a numeric keypad and 8 function keys. Plus there's hi-res graphics, colour and sound. At this price, the Cat is an incredible bargain you can't afford to miss.
Cat X-7500

WAS $699 $499

IDC FLAT RIBBON CABLES

FEBRUARY ONLY!

All prices per metre

27 way. Cat W-2752. Was $3.95. **NOW $2.95**
26 way. Cat W-2750. Was $3.20. **NOW $2.50**
40 way. Cat W-2754. Was $4.95. **NOW $3.95**
50 way. Cat W-2756. Was $5.75. **NOW $4.75**

DICK SMITH ELECTRONICS COMPUTERSTOP

For Address details See P88

CMOS modems

The EF7500 series of communication ICs from CSF Thomson offer significant power dissipation reductions compared to older NMOS devices, they claim.

The family includes asynchronous FSK and DPSK monochip units handling CCITT/V.23, V.22, Bell 202 and Bell 212A protocols.

These products use the same circuit methods as the older 7900 series such as digital sine wave synthesis, on-chip switched-capacitor filters and selectable baud rates. Rather than have four protocols per chip there is one chip per protocol. The result is a substantial reduction in cost and package size.

Details from: **Promark Electronics, PO Box 381, Crows Nest 2065 NSW**

CALL IT A PLOT-BOT

This 'plotting robot', from Penman in the UK, is a portable printer that produces hard copies of designs worked out on a computer. Here it shows its flexibility by sketching a design of the Space Shuttle.

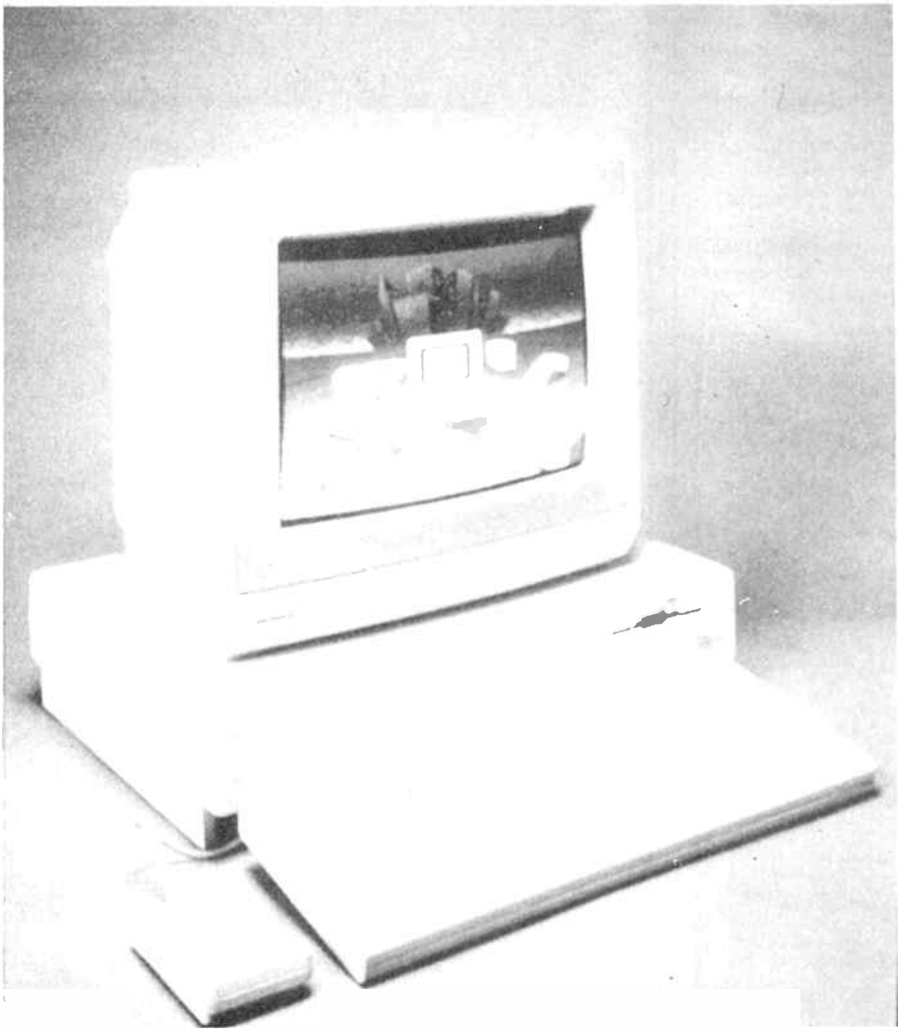
The Equipment consists of two parts — the control box containing the electronics and a 127 mm² robot device which moves around on the paper to produce the graphics.

With only two moving parts, the robot can draw straight lines in any direction and perfect circles without any 'zig-zag' effect, and it can be used on any size paper within the limits of its one metre long umbilical cable, according to Penman.

There are three built-in pen holders which can be different colors or thicknesses of pen. The plotter can change pens in mid-line, matching the old and new lines exactly, it is claimed.

Its British developed claim it is ideal for the home computer enthusiast or for architects and engineers who often need hard copies of computer designs. It is also said to be useful for schools because of its low cost and versatility. It will work with virtually any kind of computer.

The Plotter won the 'Peripheral of the Year' presentation at the 1985 British Microcomputer Awards. Details from **Penman Productions Ltd, 8 Hazlewood Close, Dominion Way, Worthing, West Sussex England BN14 8NP.**



Bonjourno* Amiga!

J. Nathan Cohen

Positioned between the 'MacIntosh-line' and the 'IBM-line' machines, Commodore's new 'flagship' offers speed, power, graphics and sound facilites not previously seen in anything under $3000.

THE PROBLEM with reviewing a machine like the Commodore Amiga is that it doesn't fit into any of the recognised 'slots' that computers nowadays have fallen into. It's not a games machine, but it's not strictly a 'business' machine either. It's not a high-performance workstation, but it's got some of the features you would expect from one. It was designed by a bunch of people in the US who seemed to be saying to themselves "wouldn't it be nice if the machine had . . .", rather than what most manufacturers say to themselves, which is "what will X type of user need".

The Amiga was born in California (where else?) about three years ago by a company called Amiga. In a late stage of development, when each of the big, later-to-be-custom, chips were simulated by a large box of electronics, they showed it to Commodore who were so impressed they bought the whole company, gave it some more money, and told them to get on with it.

A year later (in July last year), it was ready for release in the States. Commodore Australia will launch it here in March-April.

Character

What gives the Amiga its character (and dominates most of the demo programs including the ones you will probably see in shop windows) are its graphics capabilities, these are provided by two of the custom chips that used to be big black boxes — they work together to form a graphics processor capable of moving objects around on the screen, detecting collisions, and a few other tricks, all without intervention by the Amiga's main processor.

This graphics 'coprocessor' means that you can have graphics moving around on the screen (say, for example, in an animated illustration) while the processor is doing nothing but polling the keys, or doing calculations, or whatever.

A similar philosophy is followed for the sound generating part of the machine. Again, once the sound generator has been told what to do, no intervention is needed. In fact, the 'hands off' philosophy has been extended to the whole computer, and is what gives it its muscle. For example, disk access can be performed direct into memory without the processor worrying about it.

In fact, up to 28 devices can use the main memory for DMA (direct memory access) at any one time. That means that, as well as disk, graphics and sound going on all at once, up to 25 other devices can be connected to the machine (via a bus connector at the side of the box) and all be clicking and whirring at once — all while the CPU is doing something else!

Operating system(s)

The problem with selling anything but an 8086-based computer these days is that the first question asked by many people is: "is it IBM compatible". The simple answer for the Amiga is "no". The operating system (OS) supplied with the machine is more like a MacIntosh OS than anything else (although, I think, a little less refined and a lot faster).

But when Commodore saw this they must have had a sudden inrush of breath and ordered Amiga to provide compatibility at all costs. Launched with the original machine (but sold separately for US$99) is a piece of software called 'Transformer' which emu-

J. NATHAN COHEN

J. Nathan Cohen is a freelance technical writer and journalist, proprietor of 'Hard Copy', his own technical writing and documentation company based in Sydney. (02) 264 8166.

He has worked on a number of electronics publications around the world and written a large number of reviews of computers, among other equipment, plus features, etc.

Although his initial background was in chemical engineering, he says he was first fascinated by electronics after sticking his hand into the high tension cage of a TV set an unspecified tender age.

*Italian for "G'day!"

lates the IBM PC's capabilities up to but not including graphics. 'Hercules'-type monochrome graphics are supported, but there's no sign of PC colour compatibility. Pity — it would be in Commodore's favour to be able to claim that the machine was completely software compatible, since they plan to sell it first and foremost as a small business machine. However, at present, colour capabilities remain little-used in the vast majority of business applications.

The Amiga's own operating system (called "Intuition") has a few things to commend it, though, such as true multi-tasking: the ability to run two or more programs at the same time. (The actual limit for the Amiga is around 30). That means that you can be compiling some code in one window, printing from another, editing at another and . . . all at the same time, with the processor's attention split between all windows. 'Windowing' software on other machines lets you turn one task off and work on another, but that's not true multitasking.

The machine as supplied has a copy of the operating sytem, a tutorial (which makes full use of the graphics), a BASIC (called, confusingly, ABasic) which has software for speech synthesis from plain text built-in, and a couple of demos. Not very much for a small business to be going on with.

It's the lack of available software that most worries me, in fact. The only software that has *actually* been released is for things like drawing and painting, playing music, etc. The full 'Enable' range of business software being developed by the "The Software Group" company is still in the 'real soon now' category (at time of review — Ed). Commodore tells me they have a nice video tape with a lot of software company managing directors saying that they're going to release this or that for the Amiga, but you can't run your accounts with a video tape.

I suppose a small business could buy the machine now, along with the PC emulation software, then buy a load of PC software to run on it, then throw out all the PC software later when the Amiga software had been reviewed . . . or maybe Commodore should think again about who they're going to sell it to.

Hardware

Apart from the lack of software, the machine is *very, very impressive*. For around $2500 you will get the main processor unit with 256K of RAM (the operating system sits in a separate 192K of RAM, so you get the whole 256K to play in), one 3.5" 880K (formatted) floppy drive, keyboard and two-button 'opto-mechanical' mouse (I suppose this means that movement of the mouse ball is detected optically). The monitor is extra.

The keyboard is a little light-pressured to my way of thinking, but not bad apart from that. It has a cursor control diamond, a numeric keypad and 10 function keys. Could it be that after years of reviewers panning machines for bad keyboards, makers are actually beginning to get it right?

One very nice feature of the keyboard (especially in a mouse-driven machine) is that it slides under the front of the processor box, taking it completely out of sight. The footprint of the Amiga isn't all that small (around 450 by 340 mm), and with room needed to use the mouse, this feature is welcome.

A curious feature of the keyboard is the appearance to either side of the space bar of two keys with big 'A's on them. Very reminiscent of the MacIntosh.

Memory expansion on-board (well, in a little trapdoor that opens at the front of the machine, actually) will take the non-operating-system RAM up to 512K, and off-board expansion can be up to 8.5 megabytes (!).

There are two mouse ports on the machine, which can be used for paddles or joysticks (see what I mean about it being a business/games I-dunno-what type of machine?), a system bus connector, a nearly Centronics-type port (which, with a little add-on connector, interfaces to a standard IBM PC printer), a disk drive connector, RS232 connector, two audio outputs, monitor sockets and a keyboard socket.

You can add up to four external drives, in either 3.5" or 5.25" sizes (which is what you need to run PC software, of course), and they daisychain together out of the single external drive socket.

The RS232 connector has a power supply and audio outputs, so that it can be used as a telephone answering machine (with the aid of the speech synthesis capabilities of the machine) or whatever.

Although the review machine I saw was built to work with an NTSC monitor, I was told that the Australian version will work with PAL. There are outputs for analogue and TTL RGB video, plus composite video. There are two composite video output sockets — one to fit a standard Commodore modulator, and one RCA socket.

There's even a video input with a feature called 'Genlock': this means that you can bung the video output from your video recorder into the computer, have it displayed on your monitor, and have graphics from the computer synched into it and displayed on the monitor at the same time. Great for doing your accounts while watching the cricket (Ho, ho). Or, more seriously, good for security applications where you want to see graphics and pictures at the same time, or for generating your own titles or animated graphics along with real video signals.

A nice little add-on box will digitise the video picture and put it into RAM (by DMA of course, so it doesn't use any processor time at all) so that you can move it around on-screen, edit it, or whatever. Could be very useful for a small TV or video studio.

Graphics

The graphics themselves (apart from being animated by a coprocessor) have some very nice features. There are four modes: 640 × 400 with 16 colour choices, 640 × 200 with 16, 320 × 400 with 32 and 320 × 200 with 32. Each of the colour choices can be set to one of 4096 colours. Any combination of screen modes can be used on the screen at any one time, all in different windows.

In order to provide realistic shading, there's also a feature called 'hold and modify' (avail-

— to page 91 ▶

The disk operating system — what it's all about

Bill Thomas looks at the functions and features of a disk operating system, in particular PC DOS, used by the IBM PC family and numerous compatible systems.

I ONCE READ in an esteemed journal of personal computing that agonizing over the choice of an operating system was a waste of time. So the article went on, if the application you want to buy can run on the operating system that comes with the computer, all is well. The main question was whether all the applications you wish to run are available for that operating system. As far as it goes, I have to agree with that author. Unless of course you really want to *write* the application, then the choice of operating systems can become a critical matter. If you want to write an application that supports multi-tasking, multi-users, windowing and all the other bells and whistles, then you have two choices. You can use an operating system which provides these features or you can prepare to spend much time, money and many sleepless nights trying to write all the features you require.

From this you can gather that an application which tries to provide some fairly sophisticated services using a basic operating system will take longer to write than if the services were already provided by the operating system. And that means its will cost more in time or money or problems that you really didn't want to fix. To use a more complex operating system will decrease those costs for some applications but the initial cost of the operating system is higher and that cost will be in cash.

The last point is often the deciding factor so we won't go overboard with how the latest super-gee-whiz operating systems are put together, but will look at one of the more common, and basic, operating systems.

MS DOS 2.11 and it's cousin, IBM PC DOS 2.1, are used on a very large number of personal computers. The MS DOS version is designed to run on just about any 808X system while PC DOS has been configured for the IBM PC family. Functionally they are very similar. This article will restrict its scope to those systems which are 'IBM PC compatible' and could run PC DOS. To include all the configurations supported by MS DOS would get so complicated that I'd soon give up.

What is an operating system?

When you take home your brand new PC you really have a collection of hardware which will maybe run BASIC, if you're lucky. To do anything useful, you will have also purchased an operating system. If you have one of the two mentioned back a bit, then you have a disk operating system, or DOS.

The hardware includes read only memory (ROM) chip(s) which provide the instructions that the computer will execute when you power it on. Somewhere in the hardware an address has been pre-defined where the computer will look for the first instruction to execute. That instruction will be in the ROM. The instruction directs the computer to execute program(s) in the ROM to check that the hardware is functioning correctly. The ROM programs initialize all of the hardware devices provided with the system and provide routines which can be used to access these devices. The programs resident in the system ROM have acquired the acronym BIOS, for basic input/output system. The functions provided by the BIOS routines are fairly standarized amongst the 'PC compatibles', but there are differences. These differences will need to be taken into account when writing programs which use the BIOS routines or when running a program which makes use of BIOS routines.

Once initialization is complete, the BIOS executes a routine to check to see if there is a diskette in the disk drive and then looks to see if there is a program on the diskette that should be loaded at power-on. This is known as 'booting' from a disk(ette). The program may be an operating system such as DOS or could be a program which chooses to provide its own interface to BIOS. Many game programs use the latter approach. If there is no 'boot record' on the disk(ette), BIOS will either pass control to another program in ROM (maybe BASIC) or issue a message to place a 'system diskette' in one of the drives. This is the last time that BIOS will 'control' the system until the next boot or power-on.

Once the ROM initialization program finds a 'boot record' on the disk(ette), it will load the program and pass control to it. If the program is 'DOS', this begins the DOS initialization process. DOS provides more complex functions that are not contained in the BIOS routines, but generally make use of BIOS to access the hardware.

The DOS programs' main functions are to provide keyboard command handling, load programs into memory, execute those programs and manage files on either diskette or hard disk. Functions which DOS shares with the BIOS routines are keyboard input, video display output, parallel printer output, diskette input/output and communications adapter input/output. In many cases the DOS function is identical to the BIOS function.

So the operating system is really a two-tiered system. The BIOS provides a direct interface to most of the hardware and DOS allows you to issue the commands that run the system. Both BIOS and DOS facilities can be used by programs to make the hardware perform the necessary functions. BIOS routines generally provide the fundamental operations, while DOS provides control of the entire environment. For example, the routines to read and write a block of data from/to a diskette are provided by BIOS, but DOS will have determined what data is to be kept on the diskette, how the data will be stored and instruct BIOS where to find/put the block data.

A typical system?

To look at the operating system functions pre-supposes that there is some hardware with which to actually do something. A 'typical configuration' of an IBM PC type system might look something like this:

One 8088-based system unit.
One floppy diskette drive controller (FDC).
One or two floppy diskette drive(s) (FDD).
One colour graphics video adapter (CGA).
One colour display monitor.
Alternatively, one B/W graphics monitor.
One serial (communications) adapter.
One parallel (printer) adapter.
One graphics printer.

That may seem like a lot, but prices have dropped a lot over the last few years. Colour is playing an ever more important role and graphics applications certainly warrant a colour display. With the exception of the serial port, most items will be very useful in most program development. Many of the adapters can be obtained on one hardware card, in various combinations. A PC with all the goodies listed can be obtained for as little as $2500 at time of writing, and prices are dropping by the month.

What facilities are provided by BIOS

Since the BIOS routines may vary from one system to another, it is impossible to say that any BIOS will provide certain functions. It should provide them, but this cannot be assumed. The documentation for each particular system should be checked to see if the facility you require is available. There are generally routines in BIOS to handle the devices mentioned in the previous section. BIOS routines are exclusively concerned with the interface between programs (including DOS) and the hardware. They do not manage the programs and know nothing about files. BIOS does not handle commands from the keyboard.

BIOS routines can be divided into two classes. There are routines which respond to requests from the hardware (hardware interrupts) and routines which respond to requests from programs running in the system (software interrupts). In the first class are routines to handle keyboard input, diskette/hard disk status and 'timer pops'. These routines are entered any time the hardware wishes to pass information to the operating system. The second class of routines are used by programs to tell the hardware devices what actions to perform. Table 1 lists most of the functions performed by BIOS. Each line in the OPERATIONS column represents a single request that can be passed to BIOS. Sometimes an operation will require more than one action. In this case, several BIOS requests must be made sequentially.

TABLE 1. BIOS FUNCTIONS

FUNCTIONAL ROUTINES	OPERATIONS
Keyboard Interrupt	Read a keystroke into the buffer and convert it into an ASCII or Extended ASCII character.
Diskette Interrupt	Set the diskette status flag.
Timer Interrupt	Update the system date/time. The timer rate is set to 18.2 Hz by BIOS.
Keyboard Service	Read a character from the keyboard buffer. Test if a character is available from buffer. Test whether the shift key is pressed.
Diskette Service	Reset the Floppy Disk Controller. Read the FDC status. Read sectors from the diskette. Write sectors onto the diskette. Verify sectors on the diskette. Format a track on the diskette.
Video Service	Set the monitor characteristics. Define the cursor size. Set/Read the cursor position. Read the light pen position. Select the display page. Scroll the screen up/down. Read/Write a character from screen buffer. Set the colour pallette (graphics). Read/Write a dot (graphics). Write a character to next free position. Read the current video configuration.
Communications Service	Initialize the communications port. Send/Receive a character. Read the communications port status.
Printer Service	Initialize the printer port. Print a character. Read the printer port schedule.
Time of Day Service	Set/Read the system clock.
Print Screen	Copy the screen image to the printer.
Boot Strap Loader	Re-initialize (boot) the system.
Equipment Check	Read 'installed equipment' switches.
Memory Check	Read 'installed memory' switches.

How BIOS routines are accessed

The mechanism used to access the BIOS routines is the *interrupt*. This is a hardware feature of the 8088. There are 256 interrupts defined to the 8088, numbered 0-255 (0 — FF in hex). For each interrupt, the address of the program to handle the interrupt may be kept in low storage (0 — 3FFh). All the interrupts need not be used. Those which are to be used must be initialized. This means that the address of the program to 'handle' the interrupt can be used. There are two ways in which an interrupt may be initiated. A hardware *interrupt* is invoked in response to a signal generated by another hardware chip. The hardware determines which of the 255 possible interrupt addresses (termed vectors) will be used. The second type of interrupt is the *software interrupt*. This is invoked by issuing one of the INT machine instructions from a program. The format of the INT instruction determines which interrupt vector will be driven. Generally the format is 'INT nnH' where nnH is the hexadecimal number of the interrupt.

BIOS makes use of a number of software interrupts to allow programs to access the I/O routines. The addresses of the BIOS interrupts are loaded into low storage during power-on initialization. The BIOS interrupts/routines also require information describing the request you are about to pass to it. This is done by 'setting up' the registers. The BIOS documentation describes what values must be placed in which registers to perform the function you need. This documentation can be found in the 'hardware technical reference' or 'programmers technical reference' for your system. Table 2 lists the BIOS interrupts and indicate which type of functions they are used for.

The advantage of software interrupts is that the interrupt routine may reside anywhere in storage. When a new version of an interrupt handler is installed it is only necessary to alter the interrupt vector in low storage to make it available to all programs. The new interrupt handler does not have to be at the same address as the one defined by BIOS. This allows the programmer to experiment with a new version without having to replace the ROM.

Loading DOS

DOS consists of three files. MS DOS calls them IO.SYS, MSDOS.SYS and COMMAND.COM. In PC DOS they are called IBMBIO.COM, IBMDOS.COM and COMMAND.COM. The first two files are stored at particular locations on the diskette. When BIOS initialization is complete, the boot record (Sector 1, Track 0, Head 0) is read into storage. The boot record checks that both files exist and then loads the IO.SYS (IBMBIO.COM) file into storage.

IO.SYS is the interface routine between DOS and BIOS. It translates any DOS requests into one or more BIOS requests. This allows the DOS to be transportable across a number of systems with minimum change. If BIOS knows how to access the hardware, DOS need only talk to the ROM routines. Since DOS contains an interface routine to translate ▶

DOS requests to a form understandable by the ROM programs, only the interface program need be modified for DOS to run on a new system. IO.SYS also loads any device drivers specified in the CONFIG.SYS file. Device drivers are programs which control hardware devices and other programs which look like hardware to DOS (eg., a RAM disk). A device driver is necessary for any device not supported by BIOS. Once IO.SYS initialization is complete, MSDOS.SYS (IBMDOS.COM) is loaded.

MSDOS (IBMDOS) provides the fundamental DOS facilities that are used by programs. It initializes the DOS environment to allow programs to be run. MSDOS then loads COMMAND.COM.

COMMAND.COM is the DOS command processor and is the means by which the user can communicate with the system. COMMAND.COM is responsible for the loading of all programs and the execution of programs, batch files and DOS commands. DOS commands can be divided into two groups, 'internal' commands and 'external' commands. The routines to handle internal commands are contained in COMMAND.COM itself. The routines for external commands are contained in files on the diskette. The files usually have the same filename as the name of the command. To execute an external command it is necessary to have the file for that command available to be read.

One other important file used by DOS during initialization is CONFIG.SYS. This file is used to tell DOS what type of configuration you want to set up. There are five options for CONFIG.SYS.

BREAK on/off	determines at what point in program execution you wish the 'CONTROL-BREAK' key to terminate (cancel) the execution of a program. BREAK ON allows DOS to cancel the program anytime a DOS function is requested.
BUFFERS = xx	tells DOS how many buffers to allocate for diskette operation. If many buffers are allocated, DOS may run a bit quicker when running database-type applications. Each buffer is 528 bytes, so when more buffers are allocated there is less room for program storage. These days it seems that the storage on many PCs is approaching the 640 Kbyte maximum, so BUFFER = 10 + is not uncommon.
FILES = xx	specifies the number of files that can be used (opened) concurrently. The recommended value is eight, but some applications require more than this. Again, storage limitations are not so severe as they were a while back, so FILES = 20 seems a reasonable value.
SHELL = name	allows the installation of a command handler other than COMMAND.COM. If you're into that game, you won't be reading this article.
DEVICE = name	tells DOS that you want to install a device driver to handle I/O in a special way. The device driver may use one of the standard hardware adapters or one which is not supported by BIOS. Some of the hard disks use a device driver to make one 20 Mbyte disk look like two 10 Mbyte disks. RAM disks can also use a device driver. One device driver supplied with DOS is ANSI.SYS. This device driver allows additional screen handling functions to be performed by programs running under DOS and allows keys to be assigned special meaning. In this way, for example, the function keys F1-F10 can be redefined.

TABLE 2. BIOS INTERRUPT TABLE

INTERRUPT NUMBER	DEFINED BY	INTERRUPT ADDRESS	DESCRIPTION
0	INTEL	0000	Divide by Zero Error
1	INTEL	0004	Single Step Program Execution
2	INTEL	0008	Non-Maskable Interrupt
3	INTEL	000C	Program Breakpoint
4	INTEL	0010	Interrupt on Overflow
5	BIOS	0014	Copy Screen to Printer
6			reserved
7			reserved
8	BIOS	0020	Timer Interrupt for the Clock
9	BIOS	0024	Keyboard Hardware Interrupt
A			reserved
B			reserved
C			reserved
D			reserved
E	BIOS	0038	Diskette Hardware Interrupt
F			reserved
10	BIOS	0040	Video Output Service Routine
11	BIOS	0044	Test Equipment Switches
12	BIOS	0048	Determine Memory Size
13	BIOS	004C	Diskette I/O Service Routine
14	BIOS	0050	Communications I/O Service Routine
15	BIOS	0054	Cassette I/O Service Routine
16	BIOS	0058	Keyboard Input Service Routine
17	BIOS	005C	Printer Output Service Routine
18	BIOS	0060	Pass Control to ROM BASIC
19	BIOS	0064	Boot Strap Loader Routine
1A	BIOS	0068	Set/Read System Clock
1B	BIOS	006C	User defined Break Routine
1C	BIOS	0070	User defined Timer Routine
1D	BIOS	0074	Video Initialization Table Pointer
1E	BIOS	0078	Diskette Parameter Table Pointer
1F	BIOS	007C	Extended Graphics Character Table
20	DOS	0080	Program terminate
21	DOS	0084	Function Calls
22	DOS	0088	Pointer to termination address
23	DOS	008C	Control-Break routine
24	DOS	0090	Critical error handler
25	DOS	0094	BIOS disk read
26	DOS	0098	BIOS disk write
27	DOS	009C	Terminate but remain in storage

What facilities are provided by DOS?

It's all very fine to have the hardware routines in BIOS, but they are not generally accessable unless you want to write a program. In fact, it would be tedious if only these routines were available. I mean, who wants to work out what sector on the diskette holds the next record in a file.

The disk operating system provides a number of features that make life easier for the programmer and user. The first of these is a 'command handler' which accepts commands from the keyboard. Without this, it is most difficult to get anything running on a PC. The command handler is the program which displays the DOS PROMPT on the screen. This is normally the characters 'A>'. When the prompt is displayed, you can type in any DOS command.

Table 3 lists the DOS commands, grouped by function. As you can see, most of the commands relate to diskette operations, directory management and file manipulation. The filter commands provide a generalised means of tailoring the commands to meet individual requirements. The system commands provide a means of altering the DOS environment after DOS has initialized or to change some of the standard DOS conventions to those more to your liking.

The command type that is the most difficult to describe, but is the easiest to use, is EXECUTE. When used from the keyboard, it is not a command at all. Simply type in the name of an executable program and DOS will find it (hopefully!), load it into storage and set it running. Executable programs must have names which end in '.EXE' or '.COM'. The difference is in the way the program is set up. COM files can have a maximum of 64 Kbytes while EXE files can be as large as you like.

Another type of 'executable program' is the BATCH file. These files all have names ending in '.BAT'. They are not programs in the usual sense but are written in a 'command language' which allows a series of commands to be executed from a file rather than typing them in from the keyboard. The command language consists of all DOS commands (including EXECUTE) plus the BATCH commands listed in Table 3.

The batch commands allow conditional execution of DOS commands. Programs may be started from a batch file. When the program finishes, control is returned to the batch file and an ERRORLEVEL may be set. If so, DOS passes the errorlevel value returned by the program to the batch file so that the batch file can make a decision (IF statement) based upon the value of the 'return code'. Generally errorlevel = 0 indicates that the program was successful in its operation. Higher numbers would indicate an increasingly sever error.

Diskettes, directories and files

Before a file can be used, there has to be some convention to tell DOS how to locate and access the file. First we need to know what physical device to search for the file. This is known as the drive. The drive designator is an alphabetic character followed by a colon (eg, a:, b:, etc.). The hardware manual for the system will tell you which device corresponds to each drive designator. If you don't have a manual, the salesperson should be able to tell you at least that much. DOS uses one of the drives as a 'default drive'. If no drive designator is specified, DOS will look on the drive which was used to boot the system. The default drive can be changed at any time in response to the DOS prompt. The DOS prompt mentioned earlier, 'A>', indicated that the default drive was the A: drive. Entering 'b:' will make the B: drive the default drive. The prompt will now appear as 'B>'.

The standard DOS diskette contains 40 tracks. There are 9 sectors of 512 bytes on each track. The diskettes may be single or double-sided, depending on the type of floppy disk drive. DOS, however, does not calculate in sectors, it uses a thing called *clusters*. Clusters vary in size depending upon the type of diskettes used. For single-sided diskettes, a cluster is one sector. For double-sided diskettes, a cluster is two sectors. For a 10 Mbyte fixed disk, DOS allocates eight sectors per cluster. DOS maintains information about files in terms of clusters. The minimum disk space allocated to a file is one cluster. If you put a 200 byte file on a fixed disk, DOS will use up 4096 bytes to store it. What a waste!

Beginning on track 0, head 0, DOS creates three entries. If the diskette is to be a system disk, a boot record is created in sector 1. A *File Allocation Table* (FAT) is then created. The FAT is used to identify which clusters on the diskette are used by what file and the order in which they are used. The FAT begins in sector 2. The number of sectors used by the FAT varies depending upon the type of disk(ette). For diskettes, two sectors are used. For a 10 Mbyte hard disk, eight sectors are used.

The FAT is a very, very important bit of information. Therefore, the FAT is duplicated so that file recovery is possible should one of the tables become corrupted. If both are corrupted, pray that you backed the disk(ette) recently! A directory is created immediately following the FAT and contains the names of all the files on the diskette and a bit of information about them. This information includes the size, the date the file was last modified, the file attributes, and the cluster in which the file begins.

The directory that DOS creates can hold information concerning a limited number of files. For single-sided diskettes, only 64 entries are allowed. For double-sided diskettes the number of directory entries increases to 112. Two problems arise with these 'root' directories. One, it is possible to fit more than 112 files on a single diskette. Second, it is quite difficult to create a meaningful naming convention when only eight characters are allowed in a filename and you wish ▶

TABLE 3. DOS COMMANDS

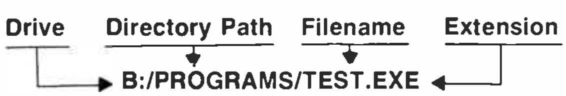
COMMAND TYPES	FUNCTIONS PERFORMED
EXECUTE	Enter the name of a program or .BAT file and DOS will load that program from disk(ette) and start its execution.
DISK(ETTE)	FORMAT a disk(ette) so that DOS can use it.
	CHKDSK checks for errors on the disk(ette).
	RECOVERs a corrupted file or directory.
	DISKCOPY copies one diskette to another.
	DISKCOMP is used to verify the Diskcopy.
	VOL displays the volume label of a disk(ette).
	FDISK defines a DOS partition on a disk.
	BACKUP a fixed disk to diskettes.
	RESTORE a file from diskette to fixed disk.
DIRECTORIES	DIR lists the files in a (sub-) directory.
	MKDIR creates a sub-directory.
	RMDIR deltes a sub-directory.
	CHDIR specifies which (sub-) directory to use.
	TREE displays the structure of all the sub-directories on a disk(ette).
	PATH specifies the order in which to search (sub-) directories for DOS commands.
FILES	COPY a file to another disk(ette) or file.
	COMP compares two files.
	VERIFY instructs DOS to verify that a copy is correct by reading the output file.
	ERASE a file.
	RENAME a file.
	PRINT copies a file to the printer.
	TYPE copies a file to the screen.
FILTERS	FIND searches through one or more files trying to find a match for a a character string.
	MORE causes the screen output to pause when the screen has filled.
	SORT sorts the output of a command or a file beginning at the specified column.
BATCH COMMANDS	ECHO determines whether batch commands are to be display on the screen.
	FOR-DO allows a command to be repeated for a list of %%n parameters.
	GOTO transfers control to a different place in the batch file.
	IF allows conditicn execution of a command.
	PAUSE displays a message and waits for a key to be pressed before resuming execution.
	REM displays a message on the screen, but does not wait for a response.
	SHIFT increases the number of parameters that may be passed to a batch file.
	%N is the Nth parameter passed to the batch file.
	%%N is the Nth paramter in a FOR-DO command.
SYSTEM	ASSIGN re-assigns drive designator to a different drive.
	BREAK selects CONTROL-BREAK processing.
	CLS clears the screen.
	CTTY selects the console device.
	DATE displays/sets the system date.
	EXE2BIN converts an .EXE file to a .COM file.
	GRAPHICS installs graphics print-screen.
	KEYBUK installs UK character set.
	KEYBGR installs German character set.
	KEYBFR installs French character set.
	KEYBIT installs Italian character set.
	KEYBSP installs Spanish character set.
	MODE assigns characteristics to the printer, video display or communications adapter.
	PROMPT sets DOS prompt character.
	SET sets a DOS environment command.
	SYS copies system files to a diskette.
	TIME displays/sets the system time.
	VER displays the version of DOS now running.

to group all the files concerning a particular application so that they are display together.

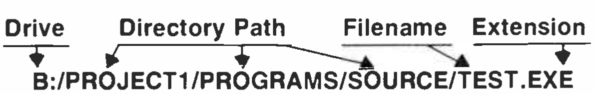
A solution adopted by DOS in Version 2 is the sub-directory. A sub-directory has an entry in the root directory that points to another file on the diskette. That file holds the directory information for more files. The number of entries in a sub-directory is not limited. And, of course, a sub-directory can point to yet another sub-directory, ad infinitum. Since there are now a number of directories, how does DOS know how to find a file? There are two ways, depending upon the type of file DOS is looking for. If the search is a result of an EXECUTE command, DOS provides the facility to nominate the order in which directories will be searched. This is done via the PATH command. For other types of files, DOS uses the CHDIR command. This simply defines which directory will be searched when a program (such as a word processor) tries to find a file on a disk(ette). Most current programs can also accept the inclusion of the directory path in the file name. More on file names later.

The file structure under DOS is fairly straight-forward. DOS will write into a file anything that you tell it without the need for special control information. If you are not programming, the whole process will be taken care of by the word processor or compiler that you are using. The general convention for text files in the DOS environment is that each line ends with a CR-LF (0D0Ah) and that the file ends with 1A00h. Line numbering is the responsibility of the editor or word processor. The conventions for executable programs is defined by the DOS LINKER. Files created by an assembler or compiler will be in a form that the linker can read. The linker, in turn, will create files that the DOS execute command can load into memory.

That leaves the question of how files are named. Files are known by their FILESPEC. This consists of the *drive designator*, the *path*, the *filename* and the *extension*. The drive is the alphabetic character telling DOS which device to access. The path is the chain of sub-directories, starting from the root directory, to follow to get to the directory that contains the netry for the file. The filename is an eight character name you give to the file. It doesn't have to be the full eight characters, though. The filename is followed by a period. Finally there is the extension. This is a three character name that describes what kind of file it is. Four extensions have been mentioned so far, SYS, COM, EXE and BAT. You can use any three characters for the extension, but DOS assigns a special significance to a few. A simple filespec would look something like this:



A more more complicated filespec could look like:



Running DOS commands

When a command is entered, two facilities can be used to alter the way the DOS handles the command. The first is RE-DIRECTION. Normally, the responses to a command are displayed on the screen. But, say you would like the output to go to a file so you can have a chance to look at it later. A couple of instances where this could be useful would be to get a directory listing or to trap the output from a program. Typing in the command followed by '>filespec' will send the output from the command to the file. If you have a program which requires a lot of responses from the keyboard, you can re-direct the source from the keyboard to a file. This way, the program reads the file rather than asking you to type all the information in again and again and again. To re-direct the input, just type in '<filespec' after the program name.

The *filter commands* also come in handy when running commands or programs. If there is a large amount of output from a program, and you don't want to save it in a file, but do want to see ALL of it, PIPE the output through the MORE filter. This will cause the screen to stop scrolling when all 25 lines have been refreshed. The information will remain on the screen until you strike a key. The program will stop as well! The SORT filter is very useful when displaying directory listings. DIR displays the files in the order that they appear in the directory. This is usually not too helpful. By piping the directory listing through SORT it is often easier to find out what you really want to know. Pity it isn't the default for DIR. You can pipe output through more than one filter as well. If you want to list a large directory use both MORE and SORT. It would look something like this:

```
DIR c:/utils/*.* | sort | more
```

SORT and FIND can be used on files when redirection is specified. Re-direct the input to a file and also re-direct the output to a file. It might save buying (or writing) a sort program. FIND is useful when you can't remember which file you stored the data in.

Running programs under DOS

Now that DOS is able to find a file, what types of things happen when an execute command is typed in from the keyboard. If the full filespec was entered, DOS simply goes to the drive you told it to look at, looks in the directory you specified and reads in the file. If only the filename was entered, DOS looks up the path that was defined in the last PATH command. If one was defined, DOS begins by searching the first directory in the list and continues until the program or batch file is found. If no path command has been issued, DOS searches the current directory on the default drive. If no CHDIR command has been entered to set a current directory, DOS searches the root directory on the default drive. Once the file has been found, the DOS loader creates a *Program Segment Prefix* that describes the program. The PSP is 256 bytes long and contains information used by DOS and by the program. Immediately following the PSP the machine code for the program is loaded. Control is passed to the starting (entry) point of the program and off it goes.

A program is able to make use of DOS facilities via software interrupts, just as it can make use of the BIOS functions mentioned earlier. Interrupt 21H is used for DOS 'function calls'. There are something like 87 function calls provided by DOS. The function calls provide most of the facilities available from DOS commands as well as other routines for memory management, altering files, device management and program execution. DOS provides other software interrupts to aid program execution. Table 2 lists the DOS interrupts as well as those from BIOS. Details of the DOS facilities available to programs requires an article (maybe even a book) in its own right.

What else comes with DOS?

DOS doesn't come by itself. In addition to the internal and external commands, DOS provides a few *utilities* that add to the usefulness of your system. The first is the LINK program. Assemblers and compilers create programs in what is called OBJECT format. Sometimes a program is so large that it is divided into segments that have to be combined to form one program. The linker takes one or more object modules and combines them into a file that the DOS loader can read.

EDLIN is a line editor that allows you to create or alter text files. These days line editors are not exactly in vogue, but it's free, and it will let you edit files until the time comes to buy a full-screen editor or word processor.

Another utility that can be very useful to programmers is DEBUG. This utility allows you to get down to the basics of what your program is doing and watch it as it executes, step by step. It's also useful when you have to edit a file that uses non-printing character input or when a file has been corrupted and you need to restore it. Debug will even allow you to assemble a simple program and save the output for later execution. If you want a cheap introduction to assembly language programming it's worth a try. There's a chapter devoted to Debug in your *DOS User's Guide*.

What reference books are available?

If you intend to buy all your programs, all you probably need is the DOS Users' Guide. But if you intend to play with the system, a few additions to your technical library are essential. Start off with an 8088/6 *Hardware Reference* and *Programmer's Reference* from Intel. These describe how the 8088 and 8086 function. Most assemblers for DOS use the same mnemonics as Intel, so it's probably the best guide to the 8088 instruction set. The hardware reference for your system tells you what you have installed and, hopefully, describes the functions available in the BIOS. It may even describe how to program the hardware devices. In order to use DOS facilities at a program level, you'll need the DOS programmer's guide or technical reference. This documents the way in which DOS manages the system and lists all the parameters necessary to use the DOS interrupts and function calls.

PC DOS may be a basic operating system, but it does offer quite a few facilities. So many copies have been sold that it is essential for most software packages to have a PC DOS version. This alone will ensure that it stays around for quite a while. Besides, there's all those little improvements you can make . . .

The Australian Electronics Monthly

SUBSCRIBE NOW AND RECEIVE A SPECIAL FREE GIFT

When you subscribe to Australian Electronics Monthly, not only do you receive the brightest, most informative and most useful magazine around, but we'll give you a free gift of your choice!
Fill in the subscription form here, post it to us and we'll start your subscription from the next issue and send you your free gift.

GIFT CHOICE 1 **$10 Gift Voucher**

If you elect to take our Subscribers' Gift Voucher, you can use it to get a $10 discount when you purchase any item or items by mail order or in-store from any of your favourite electronics or computer retailers honouring the voucher when you make a purchase in excess of $20. This offer is currently available from Jaycar, All Electronic Components, Applied Technology and Magraths.

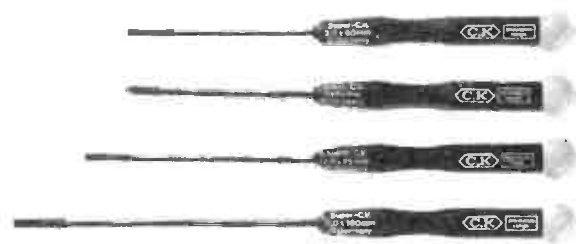
GIFT CHOICE 2

A set of C. K. Allen Keys. Top West German quality. These little beauties are always in need and come in nine different sizes. They're ideal for anyone with an interest in electronics.

Not actual size

GIFT CHOICE 3

Best quality West German screwdrivers from C.K.
We use these in our laboratory and consider them excellent as they are specifically designed for eletronics requirements.



GIFT CHOICE 4

A pack of 23 selected 74LS ICs to the value of approx. $27. This super pack contains the most common ICs, and are ideal for design, servicing, project construction, etc.

Please forward me 12 issues of Australian Electronics Monthly and the gift GIFT CHOICE 1 ☐ GIFT CHOICE 2 ☐ GIFT CHOICE 3 ☐ GIFT CHOICE 4 ☐

All cheques or money orders should be made payable to Australian Electronics Monthly.

Price for subscription is $31.20 N.Z. $A52.80 airmail

Please tick payment method Cheque/money order ☐ Bankcard ☐ Visa ☐ Mastercard ☐ American Express ☐

Card No. .... Expiration ....

Signature .... (Note Unsigned credit card orders cannot be accepted)

Name ....

Address ....

.... Post Code ....

Allow a minimum of 4 weeks delivery of your gift

R

Cheap-&-easy hard copy for the C64

Ian Jellings
17 Kimba Rd, Para Hills 5096 S.A.

Can't afford a printer for your Commodore 64, or don't want to pay the price? Here's a cheap and easy method of getting hard copy – using an old teleprinter machine, a little electronics and some trick software.

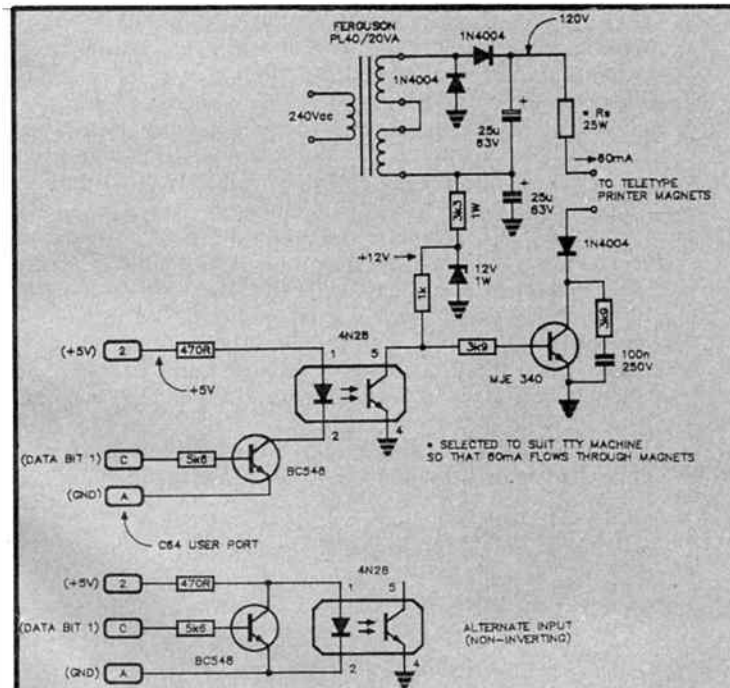
SOME TIME AGO, a friend purchased a second-hand Siemens teleprinter to provide him with an economical hard copy facility. Buying one, of course, is easy (around $30.00 or so will do the trick). Communicating with the fool thing is something else again! After some searching he came across an electronics buff who, suffering a little persuasion, made up a current loop interface for him. That was 50% of the problem solved, but how to get the computer to talk to it? That was where I came in.

There were several parameters established before I sat down to write it.

1) It needed to be as simple as possible to use.
2) It would have to be machine language, since BASIC would be too slow to generate the 50 baud needed.
3) It would need to stay out of harm's way as far as BASIC was concerned.

Taking these parameters into consideration, I decided to make the teleprinter seem like a normal printer to the user, since this is what it would be used under normal circumstances.

I have substituted the C64's "device number 6" for "device number 4", because someone somewhere may want to use the routine with printer(s) connected (like me for argument's sake!!) ▶



SUGGESTED CIRCUIT FOR TELEPRINTER INTERFACE

Here is a *suggested* circuit for interfacing a teleprinter (TTY) to the Commodore 64. The components are all widely stocked by electronics retailers, so little difficulty should be experienced in obtaining the parts.

A teleprinter or 'Teletype' (which is really a brand name but has become synonymous with the machines as a generic term) has electromagnets which drive the printing mechanism. These require some 60 mA current to 'pull in' at a relatively high voltage. Here, a transformer with two 20 volt secondary windings connected in series drives a full-wave voltage doubler rectifier to provide the required voltage. The various machines have differing requirements in this regard, but the 60 mA magnet drive current seems pretty universal. A series resistor, Rs, is required to set the printer magnet current to 60 mA. Of necessity, this must be set by actual measurement with the particular model of teleprinter you use.

The MJE340 is a high voltage transistor and is used here to switch the printer magnet current on and off. Base current to the MJE340 is turned on and off by the transistor in the output of the 4N28 optocoupler. Supply for this part of the circuit is derived from the 12 V zener, sourced from the lower capacitor in the power supply. The 1N4004 in series with the collector of the MJE340, plus the 3k9/100n series RC circuit across the transistor's collector-emitter serve to suppress switching spikes from the printer magnets, preventing possible breakdown of the MJE340.

The 4N28 optocoupler provides full electrical isolation between the computer, the teleprinter drive circuitry and the teleprinter itself. The LED in the optocoupler is turned on and off by the BC548, the base of which is driven by the Baudot data output from data bit 1 of the C64 (pin C on the user port). Note: the software annotation mentions the data is output on 'pin 1'. This means "data pin 1", which is PB0 on the C64 user port. Supply for the optocoupler input circuitry is obtained from the C64 via pin 2 on the user port (+5 V).

The circuit gives 'mark low' sense for the teleprinter, which some units employ, while others work on 'mark high'. The latter require a non-inverting interface, in which case the alternate input circuit should be used.

All circuitry, with the exception of the rectifier, could be readily constructed on matrix board. The rectifier components should be mounted on tagstrip, this includes the 25 W resistor, Rs. Take care with proximity of high voltage connections. In addition, as the voltages involved are possibly lethal, the whole unit should be carefully housed to avoid accidental contact.

— **AEM staff**

The way the routine works is as follows: As some of you will know (and it is a fair bet that most will not), the Commodore 64 has what is known as a "Vector Table" in its memory (locations 785 to 819). For those not familiar with vectors, a vector is nothing more than the address of a certain routine.

By changing the appropriate 'vectors' we can change the way the computer 'talks' to its peripherals (i.e: disk drive, printer etc.). Since several vectors need to be changed for this program to work properly, I will explain what each does, so you may understand better why they were changed (or so you can adapt the routine to suit your own requirements). Table 1 lists the seven vectors involved.

TABLE 1.

Name	Address	Description
Open	794/795	Open a communications channel between computer and peripheral
Close	796/797	Close the communications channel
Chkin	798/799	Prepare to receive data from peripheral
Chkout	800/801	Prepare to send data to peripheral
Basin	804/805	Input a character
Bsout	806/807	Output a character
Get	810/811	Get a character

(See also page 199, The Anatomy of Commodore 64)

Clearly, we would need at least Open, Close, Chkout and Bsout to send data to the teleprinter. But what if someone used 'INPUT#6,A$' in their program? We would like to print an error message like 'sorry, no *can* do' or something similar, since this program does not facilitate serial backchat! Therefore we will also need to 'trap' Chkin, Chrin and Get.

Now that this is all as clear as the editor's editorials, let us proceed with the actual code itself.

INSTALL NEW VECTORS
This routine changes the abovementioned vectors to our routines (see 'newvec').

PRINT INIT INFORMATION
This routine prints the welcome message and displays the program requirements.

HANDLE OPEN STATEMENT
When you execute an open statement (i.e: open 4,4,7), the Open vector is used, and will therefore fall into our routine. This routine ensures that the file number is not '0' (i.e: open 0,4,7), that the file is not already open (i.e: file open error), and that no more than 10 files are open at any one time.

If the open statement passes these tests, the number of files if incremented by one and the file is marked as open by putting the number into the 'file open table'. The secondary address and device numbers are also put in their respective 'open tables'.

Our routine then checks to see if the device number is '6' (line number 1070), and if it is, we take over, otherwise the operating system finishes the task. Our Open routine merely sets bit 1 of the userport to output, puts the teleprinter into alphabetical mode, prints two carriage returns to tighten the paper roll and returns to the operating system.

HANDLE CLOSE STATEMENT
This routine checks to see if the file is open, otherwise it ignores the Close statement (try close4:close4 . . . see, no error!). Again, the routine looks if the device number is 6, and if it is, it executes the interpreter routine at $f2f1 (which reverses the effects of the table entries Open creates).

HANDLE CHKIN ROUTINE
This routine safeguards against Chkin being used with device 6 (illegal).

HANDLE CHKOUT ROUTINE
This routine checks if device 6 is to be accessed, and if so, sets current output device to 6, and passes control back to the interpreter.

HANDLE BASIN ROUTINE
Like HANDLE CHKIN routine.

HANDLE BSOUT ROUTINE
This routine does most of the work, as it is the routine sends the character to the peripheral(s) or for display on the screen. If device 6 is detected, our own serial output routine is engaged (see OUR BSOUT ROUTINE).

OUR BSOUT ROUTINE
This routine saves the registers to the stack (not the flags) and saves the character to be printed into 'asave' which is the 'communications register'. NOTE: A communications register is a memory location which holds a character of information so it may be passed from one routine to another.

The printer routine is called as a subroutine, the registers are restored and command passed back to the intrepreter.

HANDLE GET ROUTINE
Like the HANDLE CHKIN routine.

OUR OUTPUT ROUTINE
Here we come to do the work!

Fetching the character to be output to the teleprinter from the communications register, it is compared with the ACSII value of 90. If the value of the character to be printed is higher than 90 (not displayable on a teleprinter), a space is substituted instead (line 2380). If the value is less than the letter 'a' (line 2420/2430) then the teleprinter must be in the 'numeric mode' to display it!

In line 2480 the current 'mode' is compared to the one used last, and if not the same, the new 'mode' command is issued to the teleprinter. Line 2540 converts the ACSII value to its corresponding Baudot value (well . . . not all of them, but what you cannot display, you cannot display). Line 2570 puts the value of 6 into the 'Y' register for six shifts (Baudot is basically six bits wide, not eight), and in line 2610 the first bit (bit 1) is written to the port.

If you are using any of the other bits of the user port, you will need to modify this somewhat. Maybe something like . . .

```
 STA TEMP ;save original
OUTLOOP

LDA TEMP ;get byte
AND #%00000001 ;mask bit 1
ORA PORT ;or bit into port value
STA PORT ;and write it back
ROR TEMP ;rotate 1 bit right
DEY ;decrement counting register
BNE OUTLOOP ;continue until done
LDA #%00000001 ;set stop bit
ORA PORT ;or stop bit into port value
STA PORT ;write it back
```

These lines could be used to replace lines 2610 up to and including 2690, don't forget to declare *temp*, and change the port initialisation to:

LDA #DDR.MASK ;get bit mask
ORA DDR ;or into data direction register
STA DDR ;write it back

I will not explain the delay subroutine, as this is explained in the printout itself.

The last parts of the program concern themselves with converting ASCII to Baudot.

In CONVERT ASCII TO BAUDOT the ASCII value is compared to $0d (13) which is the ASCII value for a carriage return. Since the teleprinter only returns the carriage upon this command, and does not generate a linefeed, we need to send a linefeed as well. In essence, the ASCII value is transferred into the 'y' register, from where it is used as an index into the conversion table (CONVTBL).

Last but not least is the conversion table. The first column holds the binary form of the 6-bit Baudot code corresponding with the ASCII value in the second column. This routine can be used in various applications.

One possible use is to connect a serial-to-parallel chip to the user port, which will then allow you to write a parallel word to a (say) Centronics printer using just two bits of the user port! The first bit could be used to clock the chip, and the second bit could be used for data. Don't forget to change the lookup table to ASCII!

If you get stuck with a new application for the program, write to me and I will do what I can to help.

HOW TO USE THE SOFTWARE

To use the machine code driver, either type the source code into a decent assembler (you may have to rename some of my labels as some assemblers will only allow six characters) and assemble it.

For those of you who do not possess either an assembler or the inclination to type in the source, I have enclosed a BASIC loader which will set the routine in its proper place.

CHECK YOUR ROUTINE FOR TYPING ERRORS, and save your efforts before running it as machine code is very unforgiving!

If you use the BASIC loader, there is no need to do anything, the loader will fire the routine up when it is finished.

If you happen to use run/stop restore, you will need to type 'sys 49152' to re-install the vectors, or you can disable your run/stop key (not a good idea!).

```
          ;---------------------------------

          ;Author        : I.Jellings
          ;Date written: 20.04.1985
          ;Development
          ;Hardware      : Commodore 64
          ;              : 1541 Drive
          ;              : BMC 80 printer
          ;              : XETEC GPI interface
          ;Development
          ;Software      : MAE Assembler System

          ;References    : The anatomy of C64
          ;              : (Abacus software)
          ;              : 2nd English Edition
          ;---------------------------------
          ; <><>  Serial driver data   <><>
          ;---------------------------------
          ;Data output on pin 1 of user port
          ; Data rate:    50 Baud
          ; Stop bit :    1
          ; Duration :    30 ms.
          ; Encoding :    Baudot
          ;---------------------------------
          ;<><> File handling commands <><>
          ;---------------------------------

          ;nu 0 10

          ;dc "s0:teletype$ctrl"

          ;pu "teletype$ctrl"

          ;---------------------------------
          ;     <><> Assignments <><>
          ;---------------------------------

          ddr        .de $dd03
          port       .de $dd01
          ddr.out    .de %00000001        ;bit 0 = output

                     .ba $fb

00FB-     char       .ds 1
00FC-     asave      .ds 1
00FD-     xsave      .ds 1
00FE-     ysave      .ds 1
00FF-     lastcmd    .ds 1

          outputdev  .de $ba              ;fa
          tablen     .de xnewvec-newvec

                     .ba $c000            ;org
                     .ct                  ;designate control file
                     .os                  ;store object code direct

                     .FI "TELETYPE$MAIN"


1886  34D2-4D58  TELETYPE$MAIN

          ;---------------------------------
          ;---------- BEGIN ----------------
          ;---------------------------------

          ;<><> INSTALL NEW VECTORS <><>
          ;     -------------------
          install
C000- A0 14          ldy #tablen
          instloop
C002- B9 46 C1       lda newvec,y
C005- 99 1A 03       sta $031a,y
C008- 88             dey
C009- 10 F7          bpl instloop

          ;<><> PRINT INIT INFORMATION <><>
          ;     ----------------------
C00B- A0 00          ldy #$00
          printwelcome
C00D- B9 5A C1       lda welcome,y
C010- F0 06          beq goodbye
C012- 20 D2 FF       jsr $ffd2
C015- C8             iny
C016- D0 F5          bne printwelcome
          goodbye
C018- 60             rts                  ;wait for (vector)

          ;<><> HANDLE OPEN STATEMENT <><>
          ;     ----------------------
          open
C019- A6 B8          ldx $b8
C01B- D0 03          bne notzero
C01D- 4C 0A F7       jmp $f70a            ;a '0' file is illegal
          notzero
C020- 20 0F F3       jsr $f30f            ;look for lfn
C023- D0 03          bne notfound         ;not in open table
C025- 4C FE F6       jmp $f6fe            ;file open error
          notfound
C028- A6 98          ldx $98              ;number of open files
C02A- E0 0A          cpx #10              ;max # of entries
C02C- 90 03          bcc notfull          ;less so ok
C02E- 4C FB F6       jmp $f6fb            ;too many files open
          notfull
C031- E6 98          inc $98              ;add 1 to # open files
C033- A5 B8          lda $b8              ;reget file number
C035- 9D 59 02       sta $0259,x          ;put in open table
C038- A5 B9          lda $b9              ;secondary address
C03A- 09 60          ora #%01100000       ;ieee requirement
C03C- 85 B9          sta $b9              ;now valid
C03E- 9D 6D 02       sta $026d,x          ;write in sa table
C041- A5 BA          lda $ba              ;device number
C043- 9D 63 02       sta $0263,x          ;in device open table
C046- C9 06          cmp #6               ;device 6?
C048- F0 03          beq siemensopen      ;yes, its ours
C04A- 4C 72 F3       jmp $f372            ;else do os routine

          ;<><>     OUR OPEN ROUTINE     <><>
          ;         ----------------
          siemensopen
C04D- A9 01          lda #ddr.out         ;get output mask
C04F- 0D 03 DD       ora ddr              ;log'or into ddr
C052- 8D 03 DD       sta ddr              ;write bit 0 to output
C055- A9 3E          lda #%00111110       ;teletype alpha mode
C057- 85 FF          sta lastcmd          ;save for compare
C059- 20 03 C1       jsr output           ;to teletype
C05C- A9 0D          lda #$0d             ;cr + lf
C05E- 85 FC          sta asave            ;communications register
C060- 20 E4 C0       jsr printer          ;print 2*cr to
C063- 20 E4 C0       jsr printer          ;tighten paper !
C066- 18             clc                  ;signal os job completed o
C067- 60             rts                  ;to where we came from

          ;<><> HANDLE CLOSE STATEMENT <><>
          ;     -----------------------
          close
C068- 20 14 F3       jsr $f314            ;leave status alone!
C06B- F0 02          beq found            ;yes it is open
C06D- 18             clc                  ;else ignore it!
C06E- 60             rts                  ;to caller
          found
C06F- 20 1F F3       jsr $f31f            ;set file parms
C072- 8A             txa                  ;save index
C073- 48             pha                  ;to stack
C074- A5 BA          lda $ba              ;device number
C076- C9 06          cmp #6               ;ours again
C078- F0 03          beq siemensclose     ;if this is true
C07A- 4C 9D F2       jmp $f29d            ;else do os close

          ; <><>  OUR CLOSING ROUTINE  <><>
          ;       -------------------
          siemensclose
C07D- 4C F1 F2       jmp $f2f1            ;os does the work!

          ;<><> HANDLE CHKIN ROUTINE <><>
          ;     --------------------
          chkin
```

▶

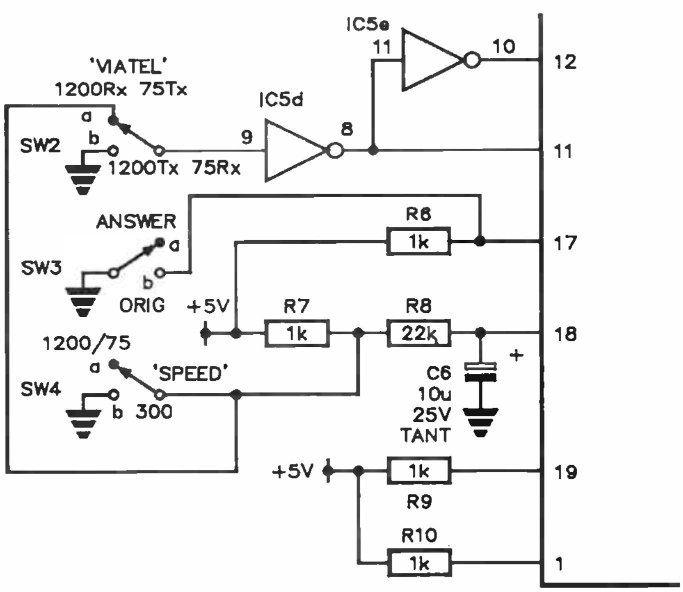
```
C080- 20 0F F3  1510          jsr $f30f           ;look for file in 'x'
C083- F0 03     1520          beq foundin         ;found him (her?)
C085- 4C 01 F7  1530          jmp $f701           ;not found
                1540 foundin
C088- 20 1F F3  1550          jsr $f31f           ;set file parms
C08B- A5 BA     1560          lda $ba             ;device number
C08D- C9 06     1570          cmp #6              ;ours?
C08F- F0 03     1580          beq siemensckin     ;yep !
C091- 4C 19 F2  1590          jmp $f219           ;else not our problem
                1600 siemensckin
C094- 4C 0A F7  1610          jmp $f70a           ;no way!
                1620
                1630 ;<><> HANDLE CHKOUT ROUTINE <><>
                1640 ; .   --------------------
                1650 ckout
C097- 20 0F F3  1660          jsr $f30f           ;still don't know?
C09A- F0 03     1670          beq foundout        ;yes it it there
C09C- 4C 01 F7  1680          jmp $f701           ;error
                1690 foundout
C09F- 20 1F F3  1700          jsr $f31f           ;set file parms
C0A2- A5 BA     1710          lda $ba             ;device number
C0A4- C9 06     1720          cmp #6              ;teletype?
C0A6- F0 03     1730          beq siemensckot     ;yes so process it
C0A8- 4C 5B F2  1740          jmp $f25b           ;not ours
                1750 siemensckot
C0AB- 85 9A     1760          sta $9a             ;show output device
C0AD- 18        1770          clc                 ;no errors
C0AE- 60        1780          rts                 ;from where thou cometh
                1790
                1800 ;<><> HANDLE BASIN ROUTINE <><>
                1810 ;    -------------------
                1820 basin
C0AF- A5 99     1830          lda $99             ;input device number
C0B1- C9 06     1840          cmp #6              ;teletype?
C0B3- F0 03     1850          beq siemensbsin     ;yes
C0B5- 4C 57 F1  1860          jmp $f157           ;interesting routine!
                1870 siemensbsin
C0B8- 4C 0A F7  1880          jmp $f70a           ;sorry, no talkback implem
                1890
                1900 ;<><> HANDLE BASOUT ROUTINE <><>
                1910 ;    ---------------------
                1920 bsout
C0BB- 48        1930          pha                 ;save for later
C0BC- A5 9A     1940          lda $9a             ;output device number
C0BE- C9 06     1950          cmp #6              ;check for device 6
C0C0- F0 04     1960          beq siemensbsot     ;its a 6er
C0C2- 68        1970          pla                 ;else reget char
C0C3- 4C CA F1  1980          jmp $f1ca           ;and let os do it
                1990
                2000 ;<><>    OUR BSOUT ROUTINE    <><>
                2010 ;        -----------------
                2020
                2030 siemensbsot
C0C6- 68        2040          pla                 ;save working registers
C0C7- 48        2050          pha                 ;resave
C0C8- 85 FC     2060          sta asave
C0CA- 8A        2070          txa
C0CB- 48        2080          pha
C0CC- 98        2090          tya
C0CD- 48        2100          pha
                2110
C0CE- 20 E4 C0  2120          jsr printer         ;call output routine
                2130 ;
C0D1- 68        2140          pla                 ;reget registers
C0D2- A8        2150          tay
C0D3- 68        2160          pla
C0D4- AA        2170          tax
C0D5- 68        2180          pla
C0D6- 18        2190          clc                 ;show ok
C0D7- 60        2200          rts                 ;return to caller
                2210
                2220 ;<><>    HANDLE GET ROUTINE    <><>
                2230 ;       -----------------
                2240 get
C0D8- A5 99     2250          lda $99             ;input device number
C0DA- C9 06     2260          cmp #6              ;teletype?
C0DC- F0 03     2270          beq siemensget      ;yes so its ours
C0DE- 4C 3E F1  2280          jmp $f13e           ;else os problem!
                2290 siemensget
C0E1- 4C 0A F7  2300          jmp $f70a           ;pass the buck
                2310
                2320 ;<><>    OUR OUTPUT ROUTINE    <><>
                2330 ;       -----------------
                2340 printer
C0E4- A5 FC     2350          lda asave           ;fetch char from com reg
C0E6- C9 5B     2360          cmp #91             ;max + 1
C0E8- 90 02     2370          bcc validchar       ;pass it
C0EA- A9 20     2380          lda #$20            ;space it instead
                2390
                2400 validchar
C0EC- 48        2410          pha                 ;save to stack
C0ED- C9 40     2420          cmp #64             ;'a'
C0EF- 90 03     2430          bcc noletter        ;ltn 'a' ?
C0F1- A9 3E     2440          lda #%111110        ;else set alpha
C0F3- 2C        2450          .by $2c             ;bit instruction code
                2460 noletter
C0F4- A9 36     2470          lda #%110110        ;set numeric
C0F6- C5 FF     2480          cmp lastcmd         ;same as last time?
C0F8- F0 05     2490          beq noupdate        ;yes leave it alone
C0FA- 85 FF     2500          sta lastcmd         ;else set teletype
C0FC- 20 03 C1  2510          jsr output          ;to proper mode
                2520 noupdate
C0FF- 68        2530          pla                 ;reget original character
C100- 20 34 C1  2540          jsr convert         ;to baudot
                2550
                2560 output
C103- A0 06     2570          ldy #6              ;6 bits to rotate
                2580
                2590 output.byte
C105- 8D 01 DD  2610          sta port            ;output bit
C108- 20 21 C1  2620          jsr delay           ;  10 ms
C10B- 20 21 C1  2630          jsr delay           ;+ 10 ms = 20 ms data puls
C10E- 6A        2640          ror a               ;rotate char 1 bit right
C10F- 88        2650          dey                 ;no of bits to go
C110- D0 F3     2660          bne output.byte     ;next bit if <> 0
C112- A9 01     2670          lda #%00000001      ;set bit 0
C114- 8D 01 DD  2690          sta port            ;output stop bit (high)
C117- 20 21 C1  2700          jsr delay           ;  10 ms
C11A- 20 21 C1  2710          jsr delay           ;+ 10 ms
                2720
                2730 ;the following jsr delay/rts are optional
                2740 ;but are included for documentation
                2750 ;purposes.
                2760
C11D- 20 21 C1  2770          jsr delay           ;+ 10 ms = 30 ms stop bit
C120- 60        2780          rts                 ;to caller
                2790 ;-----------------------------------------------------
                2800 ;delay subroutine timing calculations:
                2810
                2820 ;cpu clock speed: 985,250 cps (pal)
                2830 ;time delay reqd: 10ms
                2840 ;routine overhead: 26cycles (first loop) + 48cycles for in
                2850 ;cycles to complete: 9852.5 - 74  =9777.5 cycles
                2860 ;-----------------------------------------------------
                2870 delay
                2880
C121- 86 FD     2890          stx xsave           ;stack registers used
C123- 84 FE     2900          sty ysave
                2910
C125- A2 9F     2920          ldx #159            ;158 @ 5 cycles    =  790c
C127- A0 08     2930          ldy #8              ;  7 @ 1284 cycles = 8988c
                2940 loop
C129- CA        2950          dex
C12A- D0 FD     2960          bne loop
C12C- 88        2970          dey
C12D- D0 FA     2980          bne loop
                2990
C12F- A6 FD     3000          ldx xsave
C131- A4 FE     3010          ldy ysave
C133- 60        3020          rts
                3030
                3040 ;<><> CONVERT ASCII TO BAUDOT <><>
                3050
                3060 convert
C134- C9 0D     3070          cmp #$0d            ;cr ?
C136- D0 07     3080          bne continue        ;no so process
                3090 ;cr so issue 2 cmds
C138- A9 10     3100          lda #%00010000      ;carriage return
C13A- 20 03 C1  3110          jsr output          ;output it
C13D- A9 0D     3120          lda #$0d            ;reload cr for lf index
                3130 continue
C13F- A8        3140          tay                 ;make ascii index
C140- B9 0D C2  3150          lda convtbl,y       ;get baudot equiv.
C143- 60        3160          rts                 ;'a' is converted
                3170
C144-           3180 oldout   .ds 2
                3190
                3200 newvec
C146- 19 C0     3210          .se open
C148- 68 C0     3220          .se close
C14A- 80 C0     3230          .se chkin
C14C- 97 C0     3240          .se ckout
C14E- 33 F3     3250          .se $f333
C150- AF C0     3260          .se basin
C152- BB C0     3270          .se bsout
C154- ED F6     3280          .se $f6ed
C156- D8 C0     3290          .se get
C158- 2F F3     3300          .se $f32f
                3310 xnewvec
                3320
                3330
                3340 welcome
C15A- 0D        3350          .by $0d
C15B- 3C 3E 3C  3360          .by '<><> SOFTWARE INTERFACE FOR SIEMENS <><>'
C15E- 3E 20 53
C161- 4F 46 54
C164- 57 41 52
C167- 45 20 49
C16A- 4E 54 45
C16D- 52 46 41
C170- 43 45 20
C173- 46 4F 52
C176- 20 53 49
C179- 45 4D 45
C17C- 4E 53 20
C17F- 3C 3E 3C
C182- 3E
C183- 3C 3E 3C  3370          .by '<><> TELETYPEWRITER          <><>'
C186- 3E 20 54
C189- 45 4C 45
C18C- 54 59 50
C18F- 45 57 52
C192- 49 54 45
C195- 52 20 20
C198- 20 20 20
C19B- 20 20 20
C19E- 20 3C 3E
C1A1- 3C 3E
C1A3- 0D        3380          .by $0d
C1A4- 0D        3390          .by $0d
C1A5- 0D        3400          .by $0d
C1A6- 3C 3E 3C  3410          .by '<><> AUTHOR:   I.JELLINGS          <><>'
C1A9- 3E 20 41
C1AC- 55 54 48
C1AF- 4F 52 3A
C1B2- 20 20 20
C1B5- 49 2E 4A
C1B8- 45 4C 4C
C1BB- 49 4E 47
C1BE- 53 20 20
C1C1- 20 20 20
C1C4- 20 20 20
C1C7- 20 20 20
C1CA- 3C 3E 3C
C1CD- 3E
C1CE- 0D        3420          .by $0d
C1CF- 0D        3430          .by $0d
C1D0- 0D        3440          .by $0d
C1D1- 54 4F 20  3450          .by 'TO USE FOLLOW NORMAL PRINTER'
C1D4- 55 53 45
C1D7- 20 46 4F
C1DA- 4C 4C 4F
C1DD- 57 20 4E
C1E0- 4F 52 4D
C1E3- 41 4C 20
C1E6- 50 52 49
C1E9- 4E 54 45
C1EC- 52
C1ED- 0D 50 52  3460          .by $0d 'PROCEDURES. (DEVICE NUMBER 6)'
C1F0- 4F 43 45
C1F3- 44 55 52
C1F6- 45 53 2E
C1F9- 20 28 44
C1FC- 45 56 49
C1FF- 43 45 20
C202- 4E 55 4D
```

```
C205- 42 45 52
C208- 20 36 29
C20B- 0D        3470            .by $0d
C20C- 00        3480            .by $00          ;terminator
                3490
                3500 convtbl
                3520
                0580            .FI "CONVTBL"


0622  34D2-3AF4  CONVTBL

                0010 ;---------------------------------
                0020 ;conversion data ascii to baudot
                0030 ;---------------------------------
C20D- 00        0040            .by 0            ;0
C20E- 00        0050            .by 0            ;1
C20F- 00        0060            .by 0            ;2
C210- 00        0070            .by 0            ;3
C211- 00        0080            .by 0            ;4
C212- 00        0090            .by 0            ;5
C213- 00        0100            .by 0            ;6
C214- 00        0110            .by 0            ;7
C215- 00        0120            .by 0            ;8
C216- 00        0130            .by 0            ;9
C217- 00        0140            .by 0            ;10
C218- 00        0150            .by 0            ;11
C219- 00        0160            .by 0            ;12
C21A- 04        0170            .by %000100      ;cr (= 14 )
C21B- 00        0180            .by 0            ;14
C21C- 00        0190            .by 0            ;15
C21D- 00        0200            .by 0            ;16
C21E- 04        0210            .by %000100      ;14
C21F- 00        0220            .by 0            ;18
C220- 00        0230            .by 0            ;19
C221- 00        0240            .by 0            ;20
C222- 00        0250            .by 0            ;21
C223- 00        0260            .by 0            ;22
C224- 00        0270            .by 0            ;23
C225- 00        0280            .by 0            ;24
C226- 00        0290            .by 0            ;25
C227- 00        0300            .by 0            ;26
C228- 00        0310            .by 0            ;27
C229- 00        0320            .by 0            ;28
C22A- 08        0330            .by %001000      ;spce
C22B- 00        0340            .by 0            ;30
C22C- 00        0350            .by 0            ;31
C22D- 08        0360            .by %001000      ;32
C22E- 08        0370            .by %001000      ;33
C22F- 0A        0380            .by %001010      ;34
C230- 28        0390            .by %101000      ;35
C231- 34        0400            .by %110100      ;36
C232- 1A        0410            .by %011010      ;37
C233- 16        0420            .by %010110      ;38
C234- 0A        0430            .by %001010      ;39
C235- 1E        0440            .by %011110      ;40
C236- 24        0450            .by %100100      ;41
C237- 3A        0460            .by %111010      ;42
C238- 22        0470            .by %100010      ;43
C239- 18        0480            .by %011000      ;44
C23A- 06        0490            .by %000110      ;45
C23B- 38        0500            .by %111000      ;46
C23C- 3A        0510            .by %111010      ;47
C23D- 2C        0520            .by %101100      ;48
C23E- 2E        0530            .b, %101110      ;49
C23F- 26        0540            .b, %100110      ;50
C240- 02        0550            .by %000010      ;51
C241- 14        0560            .by %010100      ;52
C242- 20        0570            .b, %100000      ;53
C243- 2A        0580            .by %101010      ;54
C244- 0E        0590            .by %001110      ;55
C245- 0C        0600            .by %001100      ;56
C246- 30        0610            .by %110000      ;57
C247- 1C        0620            .by %011100      ;58
C248- 1C        0630            .by %011100      ;59
C249- 08        0640            .by %001000      ;60
C24A- 3C        0650            .by %111100      ;61
C24B- 08        0660            .by %001000      ;62
C24C- 32        0670            .by %110010      ;63
C24D- 08        0680            .by %001000      ;64
C24E- 06        0690            .by %000110      ;65
C24F- 32        0700            .by %110010      ;66
C250- 1C        0710            .by %011100      ;67
C251- 12        0720            .by %010010      ;68
C252- 02        0730            .by %000010      ;69
C253- 1A        0740            .by %011010      ;70
C254- 34        0750            .by %110100      ;71
C255- 28        0760            .by %101000      ;72
C256- 0C        0770            .by %001100      ;73
C257- 16        0780            .by %010110      ;74
C258- 1E        0790            .by %011110      ;75
C259- 24        0800            .by %100100      ;76
C25A- 38        0810            .by %111000      ;77
C25B- 18        0820            .by %011000      ;78
C25C- 30        0830            .by %110000      ;79
C25D- 2C        0840            .by %101100      ;80
C25E- 2E        0850            .by %101110      ;81
C25F- 14        0860            .by %010100      ;82
C260- 0A        0870            .by %001010      ;83
C261- 20        0880            .by %100000      ;84
C262- 0E        0890            .by %001110      ;85
C263- 3C        0900            .by %111100      ;86
C264- 26        0910            .by %100110      ;87
C265- 3A        0920            .by %111010      ;88
C266- 2A        0930            .by %101010      ;89
C267- 22        0940            .by %100010      ;90
                0590
                0600            .en

 ---  LABEL FILE:  ---

asave =00FC              basin =C0AF              bsout =C0BB
char =00FB               chkin =C080              ckout =C097
close =C068              continue =C13F           convert =C134
convtbl =C20D            ddr =DD03                ddr.out =0001
delay =C121              found =C06F              foundin =C088
foundout =C09F           get =C0DE                goodbye =C018
install =C000            instloop =C002           lastcmd =00FF
loop =C129               newvec =C146             noletter =C0F4
notfound =C028           notfull =C031            notzero =C020
noupdate =C0FF           oldout =C144             open =C019
output =C103             output.byte =C105        outputdev =00BA
port =DD01               printer =C0E4            printwelcome =C00D
siemensbsin =C0B8        siemensbsot =C0C6        siemensckin =C094
siemensckot =C0AB        siemensclose =C07D       siemensget =C0E1
siemensopen =C04D        tablen =0014             validchar =C0EC
welcome =C15A            xnewvec =C15A            xsave =00FD
ysave =00FE
//0000,C268,C268
```

```
00000 REM PRINT"[cls]":OPEN15,8,15,"s0:basic":CLOSE15:SAVE"basic":
      VERIFY"*",8
00001 REM
00010 I=0
00020 READA$
00030 IFA$<>"end"THENGOTO60
00040 SYS49152
00050 END
00060 B$=A$
00070 GOSUB150
00080 B$=RIGHT$(A$,1)
00090 T1=T*16
00100 GOSUB150
00110 T1=T1+T
00120 POKE49152+I,T1
00130 I=I+1
00140 GOTO20
00149 REM -------------------------------------------------
00150 REM SUBROUTINE TO CALCULATE DECIMAL VALUE OF HEX CHARACTER
00151 REM -------------------------------------------------
00160 T=ASC(B$)-48+7*(ASC(B$)>64)
00170 RETURN
00179 REM ----------------------------------------
00180 REM DATA STATEMENTS REPRESENTING ASSEMBLY @ $C000
00181 REM ----------------------------------------
00190 DATA A0,14
00200 DATA B9,46,C1
00210 DATA 99,1A,03
00220 DATA 88
00230 DATA 10,F7
00240 DATA A0,00
00250 DATA B9,5A,C1
00260 DATA F0,06
00270 DATA 20,D2,FF
00280 DATA C8
00290 DATA D0,F5
00300 DATA 60
00310 DATA A6,B8
00320 DATA D0,03
00330 DATA 4C,0A,F7
00340 DATA 20,0F,F3
00350 DATA D0,03
00360 DATA 4C,FE,F6
00370 DATA A6,98
00380 DATA E0,0A
00390 DATA 90,03
00400 DATA 4C,FB,F6
00410 DATA E6,98
00420 DATA A5,B8
00430 DATA 9D,59,02
00440 DATA A5,B9
00450 DATA 09,60
00460 DATA 85,B9
00470 DATA 9D,6D,02
00480 DATA A5,BA
00490 DATA 9D,63,02
00500 DATA C9,06
00510 DATA F0,03
00520 DATA 4C,72,F3
00530 DATA A9,01
00540 DATA 0D,03,DD
00550 DATA 8D,03,DD
00560 DATA A9,3E
00570 DATA 85,FF
00580 DATA 20,03,C1
00590 DATA A9,0D
00600 DATA 85,FC
00610 DATA 20,E4,C0
00620 DATA 20,E4,C0
00630 DATA 18
00640 DATA 60
00650 DATA 20,14,F3
00660 DATA F0,02
00670 DATA 18
00680 DATA 60
00690 DATA 20,1F,F3
00700 DATA 8A
00710 DATA 48
00720 DATA A5,BA
00730 DATA C9,06
00740 DATA F0,03
00750 DATA 4C,9D,F2
00760 DATA 4C,F1,F2
00770 DATA 20,0F,F3
00780 DATA F0,03
00790 DATA 4C,01,F7
00800 DATA 20,1F,F3
00810 DATA A5,BA
00820 DATA C9,06
00830 DATA F0,03
00840 DATA 4C,19,F2
00850 DATA 4C,0A,F7
00860 DATA 20,0F,F3
00870 DATA F0,03
00880 DATA 4C,01,F7
00890 DATA 20,1F,F3
00900 DATA A5,BA
00910 DATA C9,06
00920 DATA F0,03
00930 DATA 4C,5B,F2
00940 DATA 85,9A
00950 DATA 18
00960 DATA 60
00970 DATA A5,99
00980 DATA C9,06
00990 DATA F0,03
01000 DATA 4C,57,F1
01010 DATA 4C,0A,F7
```

Commodore Codex

```
01020 DATA 48
01030 DATA A5,9A
01040 DATA C9,06
01050 DATA F0,04
01060 DATA 68
01070 DATA 4C,CA,F1
01080 DATA 68
01090 DATA 48
01100 DATA 85,FC
01110 DATA 8A
01120 DATA 48
01130 DATA 98
01140 DATA 48
01150 DATA 20,E4,C0
01160 DATA 68
01170 DATA A8
01180 DATA 68
01190 DATA AA
01200 DATA 68
01210 DATA 18
01220 DATA 60
01230 DATA A5,99
01240 DATA C9,06
01250 DATA F0,03
01260 DATA 4C,3E,F1
01270 DATA 4C,0A,F7
01280 DATA A5,FC
01290 DATA C9,5B
01300 DATA 90,02
01310 DATA A9,20
01320 DATA 48
01330 DATA C9,40
01340 DATA 90,03
01350 DATA A9,3E
01360 DATA 2C
01370 DATA A9,36
01380 DATA C5,FF
01390 DATA F0,05
01400 DATA 85,FF
01410 DATA 20,03,C1
01420 DATA 68
01430 DATA 20,34,C1
01440 DATA A0,06
01450 DATA 8D,01,DD
01460 DATA 20,21,C1
01470 DATA 20,21,C1
01480 DATA 6A
01490 DATA 88
01500 DATA D0,F3
01510 DATA A9,01
01520 DATA 8D,01,DD
01530 DATA 20,21,C1
01540 DATA 20,21,C1
01550 DATA 20,21,C1
01560 DATA 60
01570 DATA 86,FD
01580 DATA 84,FE
01590 DATA A2,9F
01600 DATA A0,08
01610 DATA CA
01620 DATA D0,FD
01630 DATA 88
01640 DATA D0,FA
01650 DATA A6,FD
01660 DATA A4,FE
01670 DATA 60
01680 DATA C9,0D
01690 DATA D0,07
01700 DATA A9,10
01710 DATA 20,03,C1
01720 DATA A9,0D
01730 DATA A8
01740 DATA B9,0D,C2
01750 DATA 60
01751 DATA 00,00
01760 DATA 19,C0
01770 DATA 68,C0
01780 DATA 80,C0
01790 DATA 97,C0
01800 DATA 33,F3
01810 DATA AF,C0
01820 DATA BB,C0
01830 DATA ED,F6
01840 DATA D8,C0
01850 DATA 2F,F3
01860 DATA 0D
01870 DATA 3C,3E,3C
01880 DATA 3E,20,53
01890 DATA 4F,46,54
01900 DATA 57,41,52
01910 DATA 45,20,49
01920 DATA 4E,54,45
01930 DATA 52,46,41
01940 DATA 43,45,20
01950 DATA 46,4F,52
01960 DATA 20,53,49
01970 DATA 45,4D,45
01980 DATA 4E,53,20
01990 DATA 3C,3E,3C
02000 DATA 3E
02010 DATA 3C,3E,3C
02020 DATA 3E,20,54
02030 DATA 45,4C,45
02040 DATA 54,59,50
02050 DATA 45,57,52
02060 DATA 49,54,45
02070 DATA 52,20,20
02080 DATA 20,20,20
02090 DATA 20,20,20
02100 DATA 20,3C,3E
02110 DATA 3C,3E
02120 DATA 0D
02130 DATA 0D
02140 DATA 0D
02150 DATA 3C,3E,3C
02160 DATA 3E,20,41
02170 DATA 55,54,48
02180 DATA 4F,52,3A
02190 DATA 20,20,20
02200 DATA 49,2E,4A
02210 DATA 45,4C,4C
02220 DATA 49,4E,47
02230 DATA 53,20,20
02240 DATA 20,20,20
02250 DATA 20,20,20
02260 DATA 20,20,20
02270 DATA 3C,3E,3C
02280 DATA 3E
02290 DATA 0D
02300 DATA 0D
02310 DATA 0D
02320 DATA 54,4F,20
02330 DATA 55,53,45
02340 DATA 20,46,4F
02350 DATA 4C,4C,4F
02360 DATA 57,20,4E
02370 DATA 4F,52,4D
02380 DATA 41,4C,20
02390 DATA 50,52,49
02400 DATA 4E,54,45
02410 DATA 52
02420 DATA 0D,50,52
02430 DATA 4F,43,45
02440 DATA 44,55,52
02450 DATA 45,53,2E
02460 DATA 20,28,44
02470 DATA 45,56,49
02480 DATA 43,45,20
02490 DATA 4E,55,4D
02500 DATA 42,45,52
02510 DATA 20,36,29
02520 DATA 0D
02530 DATA 00
02540 DATA 00
02550 DATA 00
02560 DATA 00
02570 DATA 00
02580 DATA 00
02590 DATA 00
02600 DATA 00
02610 DATA 00
02620 DATA 00
02630 DATA 00
02640 DATA 00
02650 DATA 00
02660 DATA 00
02670 DATA 04
02680 DATA 00
02690 DATA 00
02700 DATA 00
02710 DATA 04
02720 DATA 00
02730 DATA 00
02731 DATA 00
02740 DATA 00
02750 DATA 00
02760 DATA 00
02770 DATA 00
02780 DATA 00
02790 DATA 00
02800 DATA 00
02810 DATA 00
02820 DATA 08
02830 DATA 00
02840 DATA 00
02850 DATA 08
02860 DATA 08
02870 DATA 0A
02880 DATA 28
02890 DATA 34
02900 DATA 1A
02910 DATA 16
02920 DATA 0A
02930 DATA 1E
02940 DATA 24
02950 DATA 3A
02960 DATA 22
02970 DATA 18
02980 DATA 06
02990 DATA 38
03000 DATA 3A
03010 DATA 2C
03020 DATA 2E
03030 DATA 26
03040 DATA 02
03050 DATA 14
03060 DATA 20
03070 DATA 2A
03080 DATA 0E
03090 DATA 0C
03100 DATA 30
03110 DATA 1C
03120 DATA 1C
03130 DATA 08
03140 DATA 3C
03150 DATA 08
03160 DATA 32
03170 DATA 08
03180 DATA 06
03190 DATA 32
03200 DATA 1C
03210 DATA 12
03220 DATA 02
03230 DATA 1A
03240 DATA 34
03250 DATA 28
03260 DATA 0C
03270 DATA 16
03280 DATA 1E
03290 DATA 24
03300 DATA 38
03310 DATA 18
03320 DATA 30
03330 DATA 2C
03340 DATA 2E
03350 DATA 14
03360 DATA 0A
03370 DATA 20
03380 DATA 0E
03390 DATA 3C
03400 DATA 26
03410 DATA 3A
03420 DATA 2A
03430 DATA 22
03440 DATA END
03450 REM PHEW
```



NOTES & ERRATA

AEM4600 'Dual Speed' Modem, Dec. '85. The missing pc board track advised on p.99 of the January issue is, in fact, not the correct 'fix' owing to an ommission on the part of the author in supplying us the prototype. While this fix will allow the modem to work, the 1200Tx/75Rx mode cannot be selected (fortunately, it's rarely used — one reason we missed the problem). The **correct** circuitry for the 'speed' and 1200/75 switching is given here, as confirmed on several built-up units. Isolate the poles (centre pins) of SW2 and SW4, along with pins **a** and **b** on each. Link pin b on SW2 and SW4 both to the common line (GND). Link pin a on SW2 to the pole of SW4. Link the pole of SW4 to the junction of R7/R8. Link the pole of SW2 to pin 9 of IC5.

The Data System/1 PC compatible

IT IS VERY SELDOM among PC compatibles that one encounters a machine that really shines. The Data System/1, manufactured and distributed by Science and Computing Applications, however, is one of the exceptions and proved to be a delight to review.

The test machine was supplied with a 256K eight slot PC/XT motherboard, power supply, PC compatible keyboard and two disk drives. The unit is housed in an attractive compatible style chassis with the additional unique, and extremely useful, feature of a flip-up lid that is hinged at the rear and opens to provide complete access to the inside of the unit without having to resort to a screwdriver. This feature should be of particular interest to hackers and I found it a real bonus when changing boards on the I/O expansion bus.

A careful look inside the Data System/1 reveals a very high quality multi-layer motherboard fitted with space for up to 256K of RAM and the full complement of eight ROM sockets only one of which is used to house the BIOS. Also provided is an additional socket to accommodate an 8087 maths co-processor if required and the usual array of dip switches provided to set up system status. The operation of these switches is fully described in the motherboard instruction booklet which, although being fairly pedestrian, consisting of a set of photocopied sheets in our case, contained all the necessary information.

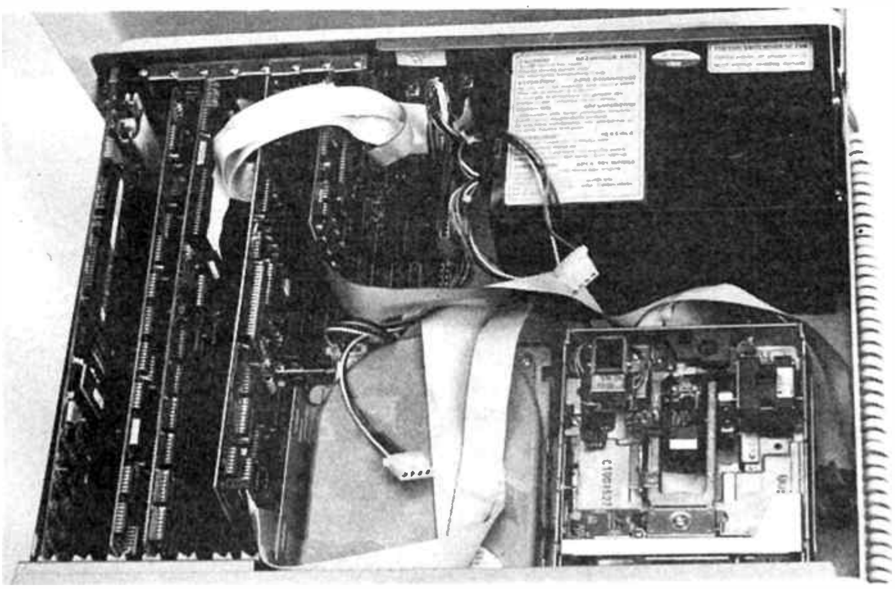
Also supplied with the test machine was the disk controller board, the MF384K multifunction card and a colour graphics adapter. We used the system with a Taxan Super Vision III colour monitor and therefore had the opportunity to put the colour graphics to the test. All of these boards showed the same high quality of construction as the mother board and the multifunction card and colour graphics card were supplied with their own instruction booklets.

The real test of any PC compatible is of course compatability. To test this aspect of the performance I started with the IBM advanced diagnostics program which ran perfectly, except of course for the error-warning regarding the lack of an installed ROM BASIC. The next test was to try a copy of flight simulator which again ran perfectly. This is in general a good test of any machines compatibility because this program appears to address hardware directly without going through DOS. So if the computer does not have the same hardware at the same address locations etc, the program will not run correctly, if at all.

I also tested the machine using Autocad, Lotus, GW Basic, Framework, the Microsoft Macro Assembler, Smartwork, Night Mission Pinball, the Votalker 1B speech synthesizer, and a host of custom written scientific and electronic analysis software. In every case the correct keys on the keyboard produced the correct response and this is one of the few compatibles I have used for which this has been the case. In most other machines one is continually annoyed by "minor" incompatibles such as can be caused by the use of incorrect keyboard scan codes or subtle incompatibilities with the ROM BIOS.

— to page 97 ▶

The DataSystem/1 PC compatible looks much as you'd expect. It features a flip-up lid hinged at the rear for convenient access to the eight-slot motherboard.



Inside the DataSystem/1. The review unit was fitted with a single floppy disk drive and hard disk. Review unit kindly supplied by Science & Computing Applications, PO Box 251, Kensington NSW 2033. (02) 622 4255.

Call to restructure amateur licences to attract beginners, computer hobbyists

The authors of a currently circulating discussion paper, titled "Amateur Radio — Future Direction", propose the creation of two new licence classes and the enhancement of the three existing licences.

A 'new novice' licence to provide telephony (voice)-only operation on a segment of the 70 cm UHF band (and possibly 144 MHz) is proposed, to be awarded to candidates who successfully complete an elementary theory paper and the standard regulations exam. This would allow 'raw beginners' to gain on-air experience and motivation to progress to another licence grade. The authors claim such a licence would easily fit into the school curriculum as an elective subject, or could be readily tackled by mature-age enthusiasts. They say it would be " . . . ideal as an 'achievement badge' for scouts, guides and other youth groups."

In addition, the paper proposes the introduction of an 'intermediate (digital) licence' with Novice-type privileges on VHF/UHF. Such a licence, the paper proposes, would attract computer hobbyists seeking further outlet for their interests. The authors propose the intermediate licence could have a theory syllabus at the current Novice level, with the addition of relevant elementary theory areas covering digital communications, modulation techniques, etc. It would give access to VHF and UHF bands with limitations on modes and power levels and encourage the exploitation of digital communication techniques (radioteletype, ASCII, packet radio, etc.)

Along with the introduction of two new licence grades, the paper proposes that the existing three grades — the Novice (NAOCP), Limited (LAOCP) and Full (AOCP) licences — be enhanced. They propose that Novices should be allowed to operate on VHF and UHF bands and be permitted data communication modes (RTTY, ASCII, etc). Also, for holders of the AOCP and LAOCP, they propose removal of the 'defined mode' restrictions to permit experimental freedom with 'new' transmission modes, increase of the power output limit and permission for unattended operation.

The proposals are aimed at revitalising the hobby of amateur radio, making it more relevant and attractive to the broad scope of today's electronics and computing enthusiasts, and technically stimulated people. The addition of more 'entry points' and enhancement of existing priviliges to afford more opportunity for experimentation in more fields, is seen as the way to achieve this goal.

Once over the initial 'hurdle' and following on-air experience, many Novice and Limited licences 'upgrade' to the AOCP. The paper notes that an estimated 70% of Novices have upgraded to the AOCP and argues that lower 'entry level' licences provide a 'stepping stone' to the AOCP. Hence, the proposed new licences.

Compiled and jointly authored by Jim Linton VK3PC (President and PR Officer of the Victorian Division of the Wireless Institute of Australia for three years) and Roger Harrison VK2ZTB (Editor AEM, etc), copies of the 3000 word discussion paper, *Amateur Radio — Future Direction*, can be obtained by sending a stamped, self-addressed envelope to **A.R. Discussion Paper, Roger Harrison, AEM, PO Box 289 Wahroonga 2076 NSW.**

Pocket pagers fire imagination

GFS Electronic Imports of Mitcham, Victoria, has announced the availability of a low-cost two-tone type talk-through paging receiver, the Model Firepage FRP-501. Not just "BEEEP — (dinner is in the oven)" but "Mother was right; I should have listened, etc. etc. . . ."

An obvious application of the unit is use with volunteer bushfire brigades as a fire call-alert unit. In this role it operates in conjunction with the GFS automatic encoder, the firestation's bell or siren circuitry and base transceiver. Activation of the fire siren or bell provides automatic paging to the receivers.

Talk-through capabilities allow the fire station operator to pass further verbal instructions to the firemen via the paging receivers if necessary. The Firepage is also ideally suited to a wide range of other applications in the VHF highband or UHF frequencies, including operation with other emergency services, says GFS.

The unit is supplied complete with rechargeable batteries and is ruggedly constructed from high impact resistant Lexon. To further increase its range it has provision for an external antenna. Battery life extends to 15 hours between recharges using the optional CH-1502 ac charg-

GFS/AEM 'WIN A SCANNER' CONTEST JULY-SEPTEMBER 1985

There was no shortage of keen enthusiasts to enter this contest. And that presented us with quite a considerable problem in the judging — there were so many entrants who managed to get all the answers correct! The effort expended in finding the answers showed just how keen entrants were to win the Microcomm SX-155 handheld scanner. Here are all the answers.

Q1: Armig Kandoian designed the discone antenna.
Q2. The discone operates over a very wide frequency range and has omnidirectional coverage.
Q3. The upper frequency limit of the SX-155 was given as 512 MHz, but was advertised elsewhere as 514 MHz, so we accepted either answer.
Q4. The frequency limits of the two metre amateur band are 144 MHz and 148 MHz.
Q5. The two top-storey rooms which Marconi used to experiment with radio in his parent's home previously had silkworm trays stored in them. We caught a few on that one!

Some answers required a little 'digging' — that for Q5 in particular. The winner, John Bayley of Surry Hills, Victoria, asked his Italian mate — every Italian boy worthy of his nationality knows Marconi's history! John's short essay on what he found useful or interesting about scanning clinched the prize for him. Here's what he said:

"I consider scanning an absorbing interest which, day or night, provides a window on the diverse world of VHF/UHF communications and, in particular, the fascinating activities of amateur radio."

er, which will charge both the Firepager's internal battery as well as an additional spare battery at the same time. The pager can also be operated while in the charger.

GFS advise that the FRP-501 is priced at $229 plus sales tax, while the CH-1502 battery charger is $45 plus sales tax.

For further details contact **GFS Electronic Imports, 17 McKeon Road, Mitcham Vic 3132. (03)873 3777.**

Amateur Radio courses for 1986

An interest in joining the hobby of Amateur Radio or upgrading from the Novice Licence needs to be followed up with an appropriate course of study. You can join others like yourself at the highly successful Victorian Wireless Institute theory and Morse code classes.

Instruction is programmed to cover the official DOC theory syllabus and required Morse code sending/receiving proficiency. Classes are held one evening a week for six months, ending in time for the DOC examinations.

Novice theory and Morse classes being Tuesday, 25th February 1986. AOCP theory class starts Monday, 24th February 1986. AOCP Morse commences Tuesday, 25th February, 1986.

To enrol in the theory or morse classes, and/or the revision weekends, or to make enquiries, contact **The Education Officer, Wireless Institute, 412 Brunswick Street, Fitzroy 3065 Vic. (03) 417 3535.**

Also available on request, is a free information leaflet "Amateur Radio — The Hobby for Everyone".

Goodies from Vicom

Vicom has released a range of RF test instruments from Fujisoku of Japan which includes videband and narrowband power meters, through-line power meters and RF power peripherals including coaxial switches and dummy loads. Contact **Vicom on 03) 62 6931.**

PEP RF wattmeter features LED bargraph

Roger Harrison VK2ZTB

MONITORING YOUR TRANSMITTER power output while on-air is always a good idea, but leaving your shack SWR/power meter in-line permanently ties up a handy and relatively expensive item of test gear. Monitoring your RF output always provides you with a visual check that all is well and, with single sideband operation, a 'peak envelope power' monitor ensure you don't "talk-up" the rig so that it clips on peaks, causing 'splatter'.

This circuit employs an old LED display technique that is simple to implement without requiring 'fancy' display driver ICs. It's cheap, too. Even if you bought everything, you should be able to lash this up for $20 or less. The circuit here has been adapted from a project described by David Beard WA4QGA in the August 1983 issue of CQ.

A simple peak rectifier tapped directly across the antenna feedline derives a dc output to drive the 'totem pole' display. The halfware peak rectifier (D1 and surrounding components) is housed in a thru-line 'RF head' inserted somewhere in the coax to the antenna. With about a volt or so output from D1, Q1 will turn on, forward biasing the base of Q2 which will turn on, lighting LED1. As the rectifier output rises with increasing RF power delivered to the line, each 1N914 diode, commencing with D2, turns on in turn, turning on the next transistor in the totem pole (Q3-Q11). Each LED thus turns on at a discrete power level, providing a bargraph display.

Input to the peak RF rectifier is via a voltage divider, RV1 providing a means of calibration. The value of resistor R1 will determine the peak RF indicated by LED10. Table 1 gives the corresponding (approximate) power levels for each LED for three useful maximum power levels.

The RF head should be constructed in a metal box. The two coax sockets should either by mounted close together or linked with coax, especially if VHF performance is required. Keep all leads short. RV1 should be a cermet type for best results. LEDs 1-10 could be a common 10-LED display (e.g: Jaycar ZD1700). The display electronics is easily assembled on matrix board. Supply may be derived from any convenient source delivering around 12-15 V at up to 250 mA.

The unit may be calibrated with 50 Hz, an audio signal generator or a dc power supply, and multimeter. Just apply 14.2 Vac peak, or 14.2 Vdc, to the point marked 'T' and set RV1 so that LED10 just lights. (All the other LEDs will be lit).

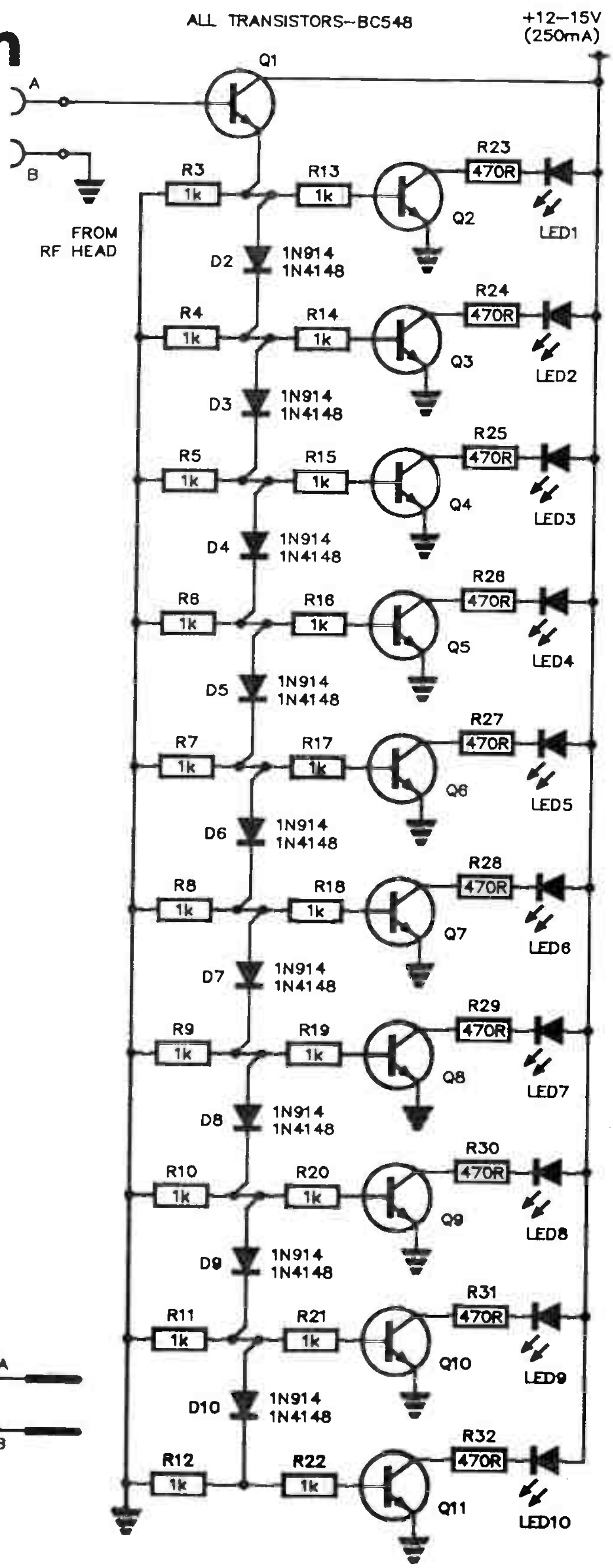
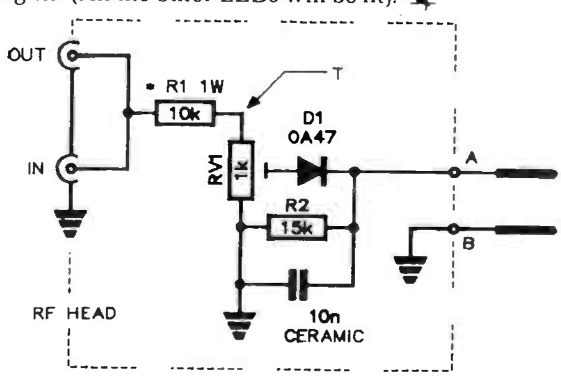


TABLE 1

LED	PEAK RF POWER		
10	400	100	30
9	320	80	24
8	255	64	19
7	188	50	15
6	138	36	11
5	97	27	7.5
4	62	17	5
3	36	10	2.7
2	15	4	1.2
1	4	1	0.3
R1	10k	5k1	2k7



ADMARKET

Readers' free adverts

READERS-CLUBS-ASSOCIATIONS

WE'LL PUBLISH your advertisement of up to 32 words (maximum), totally free of charge.

WANTED: TELEQUIPMENT OSCILLOSCOPE type S51 for spare parts. Phone after 7.00 pm. (045) 79 6176.

COMPUTER USERS: ATARI 520ST 6800-based bit-mapped 512K RAM computer user support and magazine available from Eric Lindsay, 6 Hillcrest Ave, Faulconbridge 2776 NSW. Send SASE.

ATTENTION: CB RADIO enthusiasts! Are you interested in joining Australia's fastest-growing CB club? then write to Trans-World CB Radio Club, c/- 90 Crozier Ave., Daw Park, SA 5041 or 'phone (08) 276 8809 for details.

SELL: FOR APPLE IIs, STARCARD: 6 MHz Z80b + 64K + CPM software + manuals $40.00; Essential Data Duplicator III $40.00; Disk Drive Analyser $20.00; include $2.00 postage. Write to: John, 107 Gilbert Rd, West Preston Vic 3072.

A lightweight, simple-to-build beam for the 70 cm amateur band

Garry Crapp
Technical Products Department
Dick Smith Electronics

Here's a simple, low-cost 13 element Yagi that comes as a kit and requires no adjustment. It delivers good gain and can be used for vertical or horizontal polarisation.

THE POPULARITY and population of the amateur '70 centimetre' band, which spans 420-450 MHz, has grown appreciably in recent years. A number of factors have contributed to this, including the ready availability of reasonably-priced commercial equipment and the variety of activities one can pursue, ranging from mobile operation to satellites and amateur TV.

Mobile operation is popular, with narrowband FM the principal transmission mode. A network of repeaters spread around the major population areas provides reliable coverage over considerable areas for mobile operators.

Satellite operation is another popular activity. These amateur satellites carry 'transponders' which receive signals from stations on Earth on a small band of frequencies within one amateur band and retransmit them to Earth within a small band of frequencies on another amateur band. The 70 cm amateur band satellite allocation is 435-438 MHz.

The relatively low, polar-orbiting series of satellites provide access several times through the day with ranges up to several thousand kilometres between stations. Oscar 10 (Orbiting Satellite Carrying Amateur Radio) is in an elliptical orbit that carries it far out from Earth, providing access for long periods between stations that may be tens of thousands of kilometres apart (Australia to Europe, Australia to USA, for example). Single sideband (SSB) and CW (Morse) are the principal transmission modes used on the satellites.

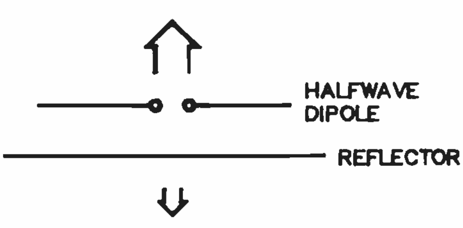


Figure 1. The dipole with parasitic reflector was the forerunner to the Yagi. There is more radiation in the direction away from the reflector and less in the direction of the reflector.

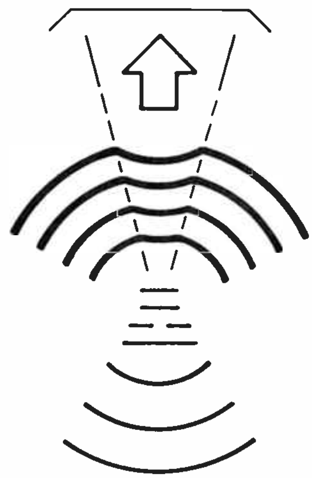


Figure 2. Adding a structure on the side of the dipole opposite the reflector slows down the waves and narrows the beam in this direction.

Amateur television, with many stations capable of full PAL colour transmission, is popular in some areas. Amateur TV repeaters are located in Victoria, Tasmania, South Australia and New South Wales.

The 'traditional activities' near 432 MHz — cross-town chatting, chasing DX via anomolous propagation and tropospheric scatter — are alive and well, SSB and CW being the popular modes.

But joining in the fun is not as simple as buying a 'rig'. On 70 cm you can't hang up 'a bit of wire', as you can on the HF bands, and expect to get too many contacts. UHF is very unforgiving of lossy feedlines and inefficient antennas. However, on the plus side, antennas with substantial gain are small, light and relatively easily fabricated.

Antenna considerations

The 70 cm amateur band is segmented by 'gentlemen's agreement' to avoid clashes between the various activities and modes employed.

Mobile operation is predominantly FM and vertical polarisation is employed. There are technical advantages to both — FM provides clear signals free from ignition and other electrically generated interference and freedom from fading effects (except on weak signals). Vertically polarised antennas provide substantially omnidirectional coverage, are more easily installed on a vehicle and are less influenced by vehicle structure than horizontally polarised types.

Omnidirectional, vertically polarised antennas with substantial gain (e.g. 10 dB or greater) are quite large and

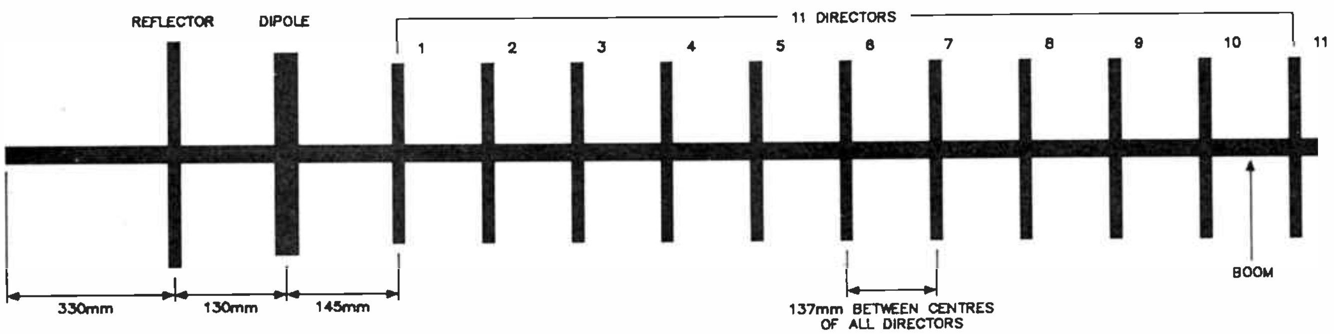


Figure 4. General assembly details and dimensions.

NOTE: DIPOLE,PC BOARD DSE ZA1659
REFLECTOR—10x3x330mm ALUMINIUM STRIP—1 OFF
DIRECTORS—10x3x270mm ALUMINIUM STRIPS—11 OFF
BOOM—19x19x2000mm SQUARE SECTION ALUMINIUM—1 OFF

hence never found on vehicles, but sometimes at home station sites. If substantial gain is required, then a beam and rotator combination is called for.

For other terrestrial operations, horizontally polarised antennas are the 'norm'. For satellite work, circular polarisation is often employed to reduce fading effects — but that's not a consideration here. Two linearly polarised antennas are arranged at right angles (there being no 'horizontal' or 'vertical' in space) and connected so as to receive signals that may have a variety of polarisations.

By far the most popular beam antenna type employed on the amateur VHF and UHF bands is the *Yagi*, named after Hidetsu Yagi, one of its co-inventors. Its popularity derives from its ability to provide the most gain for the least amount of materials used in construction.

The Yagi is an outgrowth of the dipole with parasitic reflector, see Figure 1. The reflector is a little longer than the halfwave dipole and is placed about a quarter of a wavelength away from it. Note that it's not connected to the dipole, hence the term 'parasitic'. It picks up the wave radiated from the dipole and re-radiates it. Now this re-radiated wave, in travelling past the dipole, adds in-phase to the wave from the dipole, increasing the power radiated in the reflector-to-dipole direction (as shown by the large arrow). In the other direction, the re-radiated wave from the reflector and the wave from the dipole tend to be out of phase and one cancels the other, reducing the power radiated (as shown by the small arrow).

What Mr Yagi did with this was to add a simple structure on the other side of the dipole (opposite the reflector), that *slowed down* the wave radiating away from the dipole. The effect is to compress more energy into the space immediately in front of the antenna, making a narrower beam. Figure 2 illustrates.

The simplest structure is just another element, like the reflector, only this time slighter shorter than the halfwave dipole. Again, there is no electrical connection between this element and the dipole. Only the dipole is 'driven' with the RF energy, hence it is often referred to as the *driven element*. The added element 'in front' of the dipole is referred to as a *director*. An assembly of directors may be added in front of the driven element to further narrow the beam — and that's just what we've got here. The general form of a multi-element Yagi is shown in Figure 3.

The design of Yagi antennas is not simple, there being complex mathematical interrelations between the dimensions of the elements and their spacings etc to produce the desired results. In years gone by, there was a lot of 'cut-and-try'. Modern mathematical analysis and computer number-crunching has been able to make Yagi antenna design more of an engineering exercise.

This month's ★ Star Project ★ is from Dick Smith Electronics who will be marketing kits through their stores and dealers; cat. no. K6305, $39.95. Mail order enquiries to PO Box 321, North Ryde 2113 NSW. (02) 888 3200.

Design details

The design of this antenna is similar to the K6304 UHF CB band beam (Star Project in the January 1986 issue of *Australian Electronics Monthly*), the first major requirement of which was simplicity of construction. Thus, a simple element spacing scheme was settled on and the antenna designed around that criterion, with the directors all being set at the same length and spacing. This design, like the K6304, has a total of 13 elements, resulting in a boom length of two metres, allowing for some 330 mm of boom behind the reflector for mounting by 'cantilevering' the antenna from the mast.

The boom is cut from a length of 19 x 19 mm square section aluminium tubing, while the elements are all cut from 10 mm wide by 3 mm thick aluminium strip, as employed in the K6304. The reflector to driven element spacing is 130 mm and driven element to first director 145 mm. The spacing between all the directors is constant, being 137 mm centre-to-centre. All the directors are the same length, which is 270 mm. The mechanical details are given in Figure 4. ▶

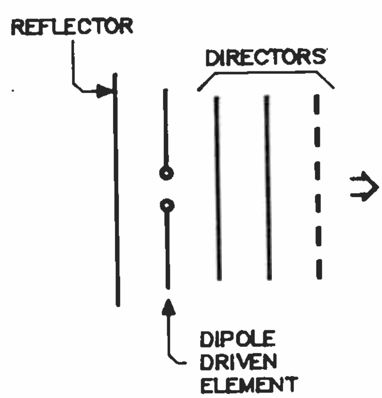


Figure 3. General form of the Yagi antenna. A halfwave dipole is the driven element. The reflector is a few per cent longer, directors a few per cent shorter. The reflector is spaced about one-fifth to one-quarter wavelength behind the driven element. The directors are spaced between about one-tenth and one-fifth wavelength apart.

The driven element is a gamma-matched dipole (as in the K6304), so familiarly used with Yagis designed for the lower frequency bands. The general form of a gamma match is shown in Figure 5. The impedance at the centre of the driven element in a multi-element Yagi is quite low. To feed it with unbalanced coaxial cable, the cable outer conductor is connected to the centre of the dipole (which is continuous) and the cable centre conductor 'tapped out' along one side of the dipole driven element to give a match to 50 ohms. The tapping arrangement is called the 'gamma arm'. However, the gamma arm introduces some inductance in series with the cable centre conductor, so a small capacitance is used to 'tune out' this inductance.

However, at UHF, the physical dimensions of practical gamma match devices unbalances the dipole driven element and the beam does not perform properly. The solution is to shorten that arm of the dipole to which the gamma match is attached.

Practical, weatherproof capacitors for the small capacitance values required at 70 cm are impossible to obtain and can be difficult to fabricate, which is why many UHF antenna designs published in the amateur literature shy away from gamma matching, apart from the problem just mentioned. This problem was overcome by fabricating the driven element from double-sided, fibreglass substrate printed circuit board. A disc at the end of the gamma arm forms the required capacitance with a disc on the opposite side of the pc board to which the inner conductor of the coax feedline is connected. The arrangement is shown in Figure 6.

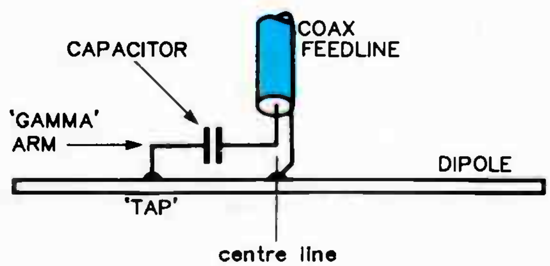


Figure 5. General form of the 'gamma match'. The tap provides an impedance match to the coaxial cable, but the gamma arm introduces a small inductance. This is tuned-out by the capacitor in series.

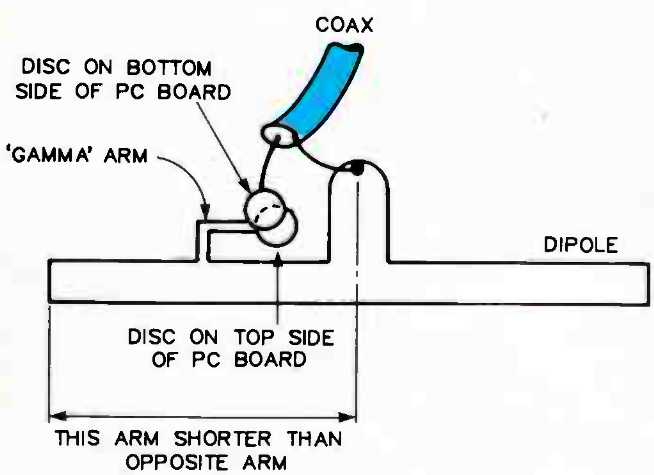


Figure 6. General arrangement of the driven element employed in this project. The effect of the gamma match on the operation of the dipole is compensated for by shortening that side of the dipole.

Performance

The design centre frequency is 438 MHz and the bandwidth, while probably restricted somewhat by the gamma match, should ensure good performance over the popular segments of the 70 cm amateur band.

Gain was measured at 12.5 dBi (compared to an isotropic antenna), which equates to a little over 10 dB compared to a dipole. Beamwidth in the E-plane (horizontal beamwidth when horizontally polarised) was measured at about 15°, H-plane beamwidth at about 20° (horizontal beamwidth when vertically polarised).

Assembly

As all the elements and boom are precut and drilled, assembly is straightforward. No measuring, cutting or drilling is required! First, identify all the directors and the reflector.

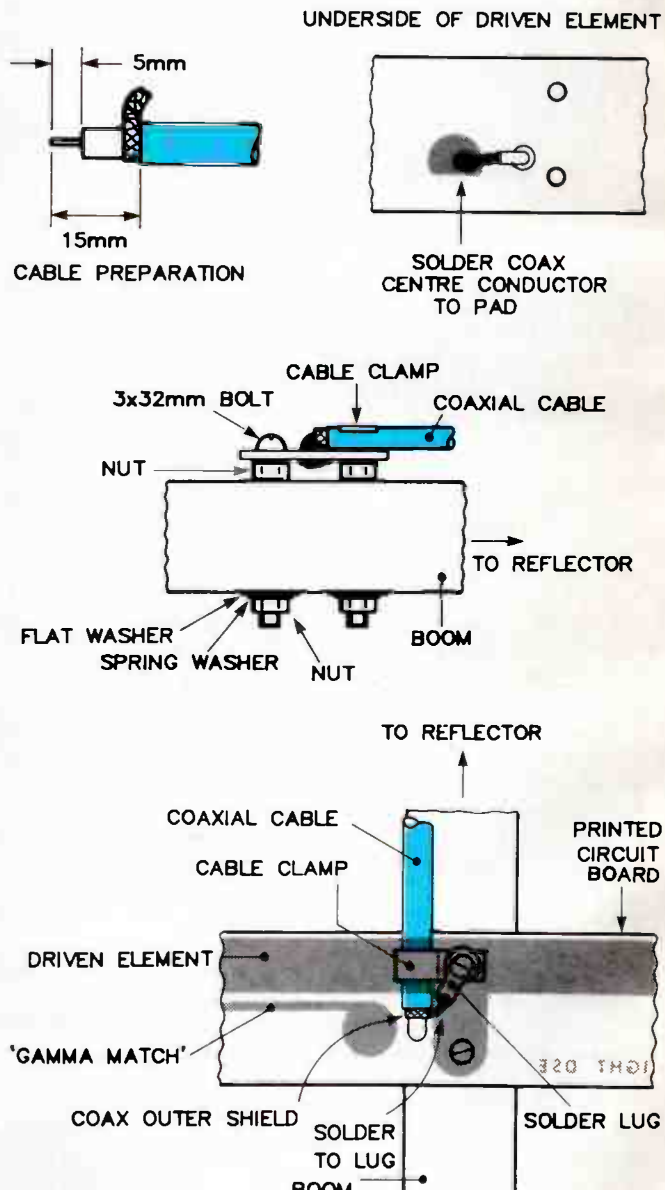


Figure 7. How the feedline connection is terminated and the driven element assembled.

The reflector will be the longest 10 x 3 mm aluminium strip. Next, identify which end of the boom is which. The foremost director is mounted right at one end. The reflector and 11 directors are screwed to the boom using PK screws.

To assemble the dipole driven element, a short length of 6.5 mm diameter coax needs to be attached. This should be a high quality, relatively low loss type, such as RG223/U. You'll need only 200-300 mm. The other end should be terminated in a suitable connector, such as a BNC type. Figure 7 shows how it's done. To prepare the cable, expose about 12-15 mm of the inner conductor and insulation. Undo the braid, twist it around and lay it to one side. Don't leave any stray braid wires hanging around loose. The centre conductor passes through the hole adjacent to the pad at the end of the gamma arm and is soldered to the lone pad on the underside of the board.

The driven element assembles to the boom as shown (Figure 7), with the driven element track on the pc board uppermost. Secure the cable with the cable clamp beneath the rearward bolt, and solder the braid to the solder lug right up close to the cable. This is achieved more easily if you 'tin' both the braid and the solder first. Use a hot iron with medium diameter tip and work quickly. Try and avoid melting the coax's insulation. After you've completed this, seal the coax and the joints against the ravages of the weather by coating them liberally with a silicone sealant, such as Selley's 'Silastic'. The copper track dipole can be protected by spraying with clear lacquer.

The short length of coax passes over the reflector and should be secured to the boom with either insulation tape or a plastic 'zip-up' cable clamp. Your feedline to the rig should be terminated in a suitable connector and plugged into the coax from the dipole via a suitable coupling joint.

Mounting options

This antenna may be mounted by 'cantilevering' it from the mast by the end of the boom protruding beyond the reflector, as mentioned earlier. Alternatively, it may be secured to the mast near the boom's balance point (between directors four and five if the full boom is retained, between five and six if the overhang is cut off).

Vertical polarisation is employed in those segments of the 70 cm band where channelised, FM operation predominates (433-435 MHz and 438-440 MHz). So, if you intend to use this antenna for vertically polarised operation and mount it from a metal mast, it should be cantilevered, as illustrated in Figure 8a. This avoids the mast interfering with the operation of the antenna. However, if you use a non-metallic top section on your mast at least 0.5-1 m tall, then the antenna may be mounted to it at the boom balance point, as shown in Figure 8b.

For horizontal polarisation, the antenna may either be cantilevered, as in Figure 9a, or mounted at the boom balance point, as in Figure 9b.▶

SPECIFICATIONS AS MEASURED ON PROTOTYPE

Centre frequency	438 Mhz
No. of elements	13
Gain	12.5 dbi*
Front-to-back ratio	16 dB
Beamwidth (E-plane)	15° approx.
(H-plane)	20° approx.
Feedpoint impedance	50 ohms

** Gain compared to isotropic antenna.*

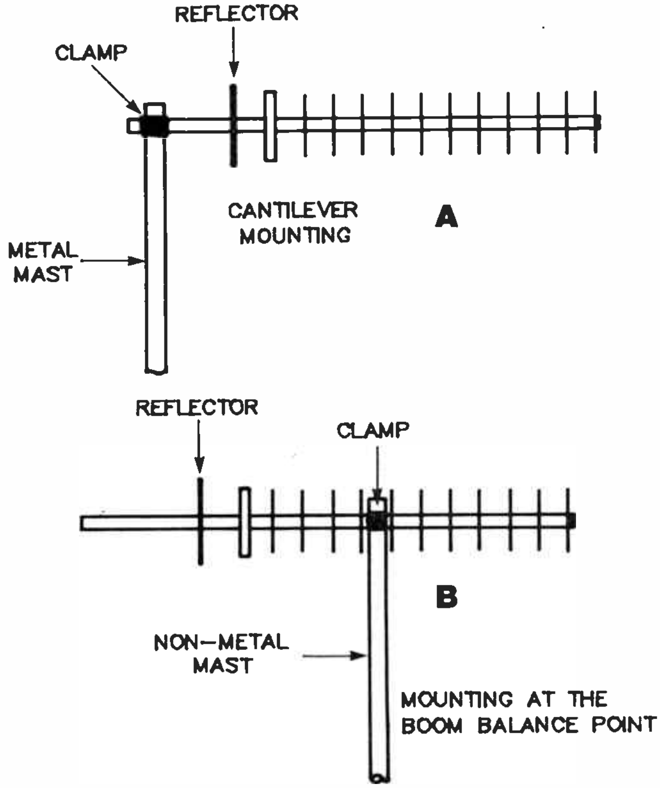


Figure 8. Vertical polarisation mounting arrangement — (a) shows cantilever mounting where a metal mast is employed, (b) shows mounting at the boom balance point, but here a non-metallic mast must be used.

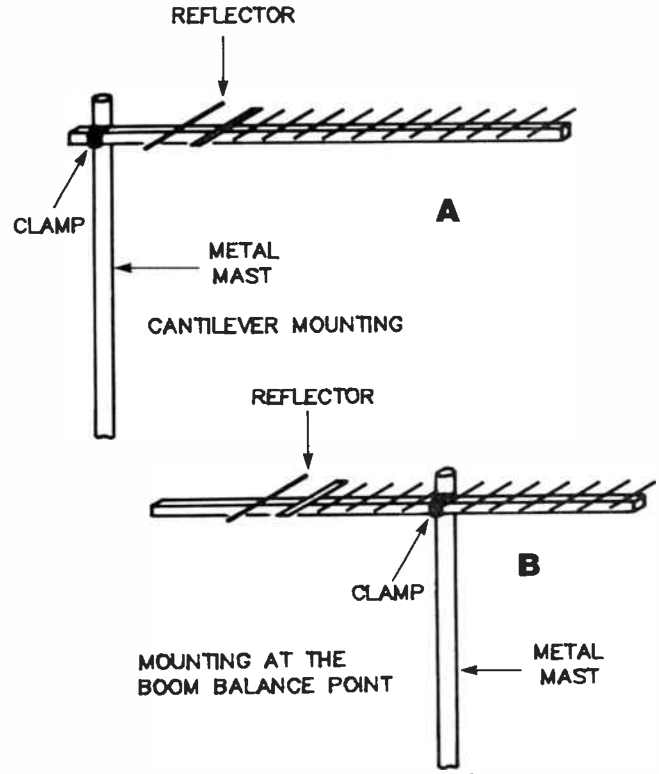


Figure 9. Horizontal polarisation mounting arrangements — (a) shows cantilever mounting, while (b) shows mounting at the boom balance point. In both instances, a metal mast may be used.

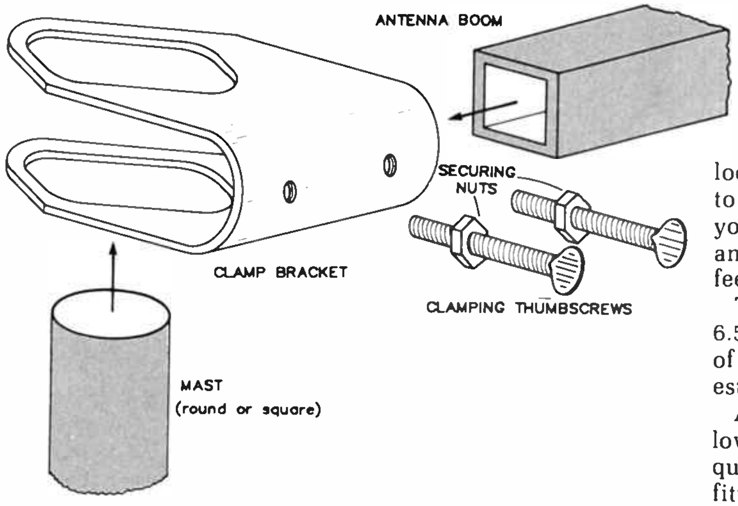


Figure 10. The beam is secured to the mast with this specially-designed U-clamp. Note that either round or square-section mast may be employed.

For mounting the antenna, a specially designed U-clamp is supplied with the kit, as shown in Figure 10. This will fit 40 mm diameter round-section or 40 x 40 mm square section mast (i.e: dressed timber). The two thumb screws securely clamp the boom and mast together, while holding them at a right angle. The thumb screws are secured by locking nuts. This U-clamp requires no drilling of either the antenna boom (which weakens it) or the mast.

See that the antenna boom sits horizontal once it's secured.

Note that extra gain may be obtained by 'stacking' two of these antennas and connecting them via a 'phasing harness', but that should be the subject of another article.

Feedline considerations

The range any VHF/UHF station can reliably achieve without 'external' assistance from repeaters or propagation phenomena is entirely determined by what is called 'station system performance'. A station system comprises:

1) the antenna
2) the feedline
3) the receiver, and
4) the transmitter

The 'height of the antenna above average terrain' (termed the HAAT), also matters. Either you buy a home on top of the biggest hill for miles around, or you put your antenna as high as you can (on top of the biggest tower you can afford)!

The performance of the receiver and transmitter is a matter of personal preference and depth of pocket, and as this is an antenna project, let's just stick to what can be done with the antenna and feedline.

Having chosen your antenna configuration then, and having settled on where and how high it's to be mounted, consider the feedline. As you know, all feedlines exhibit loss. What point is there in putting up a gain antenna if you throw away the gain with loss in the feedline? Not only that, lossy feedlines affect receiver noise figures and thus, sensitivity. Hence, the best quality low-loss coax you can afford is recommended. In addition, you should keep the line length as short as possible, consistent with getting the antenna as high as practicable.

Don't put the antenna mast 100 metres away from the rig's location if you can at all avoid it. Put it closer, even if it has to be lower, in order to keep those feedline losses down. If you have a substantial run of feedline between the antenna and the rig, you'll have to spend proportionately more on the feedline to keep the losses down.

The larger diameter cables have less loss than the common 6.5 mm cables (such as RG58). If you have to use any length of 6.5 mm cable, get a good low-loss type and use the shortest possible length — preferably less than 300 mm.

Andrews FHJ4 is a solid (i.e: not flexible) line with very low loss at 440 MHz and relatively high cost as a consequence. Special connectors are required and are not easily fitted. Consider FHJ4 as the 'Rolls Royce' of cables. Belden 9913 is a semi-flexible coax that comes highly recommended and standard 'Type N' connectors can be fitted. If you have a run of less than ten metres, then RG213 may be used as it's quite economical, but 9913 would be better.

Rotating it

Any light to medium duty rotator may be used for aiming this antenna. If you cantilever it, the height of unsupported mast above the rotator should be no longer than about a metre (for 40 mm diameter mast), depending on the make and construction of the rotator.

If you install a solid or semi-flexible feedline, a length of flexible cable such as RG213, should be run between the antenna connection and the main feedline with some slack to permit rotation without straining it, as illustrated in Figure 11.

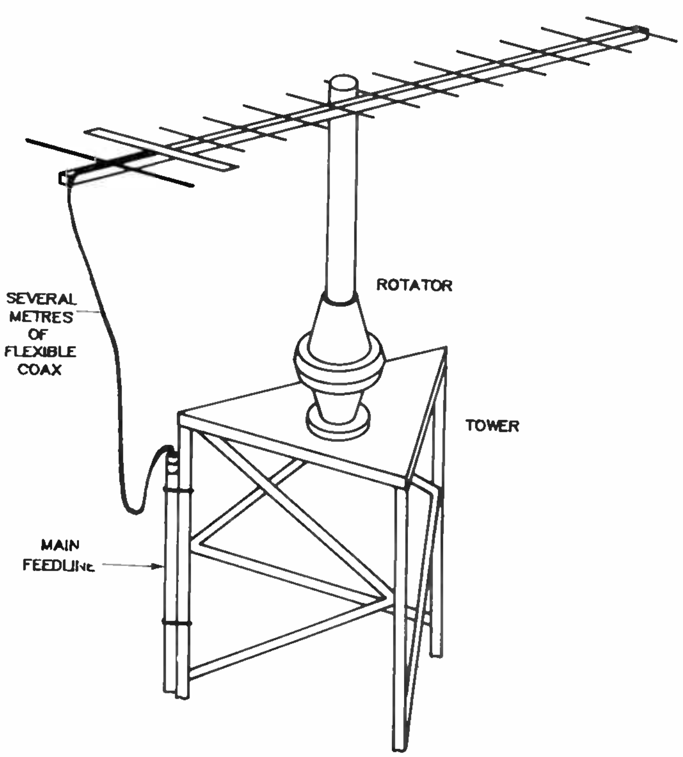


Figure 11. Several metres of flexible coax must be run between the antenna connection and the main feedline, sufficient to allow rotation without straining the cable.

40 MHz digital storage 'scope

Bell-IRH has released a new digital oscilloscope from Hitachi, the VC6041 with GP-IB interface. It features a 40 MHz bandwidth in convential and digital mode, plus a large memory capacity of 4000 words/channel in each of the input, data save and display memories.

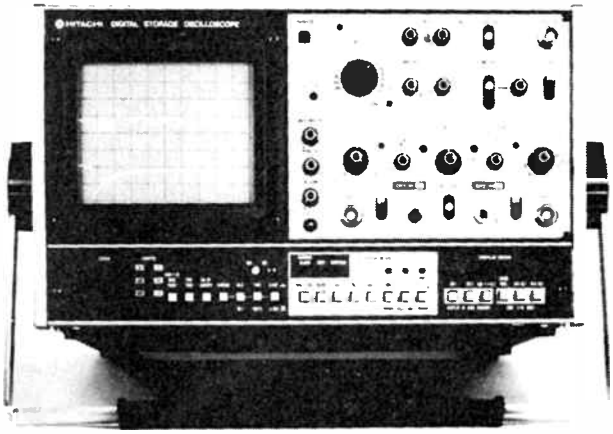
Horizontal axis resolution of 400 words/div with X 100 magnification is quoted. The dual save memories enable display of newly stored and saved memory comparisons. Roll mode allows observation by scrolling low frequency events. Cursor functions display time and voltage information on the LED and annunciation panels.

The VC6041 offers time axis averaging for noise elimination of up to 256 input waveforms. The pre-trigger display gives 0 - 9.9 divisions. The unit also offers ground reference display on screen and x-y phase operation.

A plot switch allows analogue recording output and the GP-IB/IEEE-488 interface enables off-line analysis of stored waveforms using a computer or other systems.

For simplicity of use most features are selected by single pushbutton operation. The unit is backed by a two year warranty.

For further information please contact: **IRH Components, 32 Parramatta Road, Lidcombe 2141 NSW. (02) 648 5455.**



High speed CMOS data book

We hear from Protronics Pty Ltd in Adelaide (a member of the George Brown Electronics Group) of the IDT High Speed CMOS Data Book.

Integrated Device Technology Inc (IDT) who started with what was claimed to be the industry's fastest CMOS 2K x 8 SRAM, now is a company with three divisions producing a wide range of high-speed CMOS circuits, committed to providing you with "CEMOS" (tm) with gate lengths down to 1.2 microns.

Speed is dramatically improved, and, claim IDT, this reflects the continuous R & D effort expended to maintain leadership in high speed CMOS technology.

We reproduce here a table showing IDT's evolution from their original CEMOS 1 through CEMOS 11 and 111. Now you've seen the story, get the book. Contact **Protronics, GPO Box 537, Adelaide 5001 S.A. (08) 212 3111.**

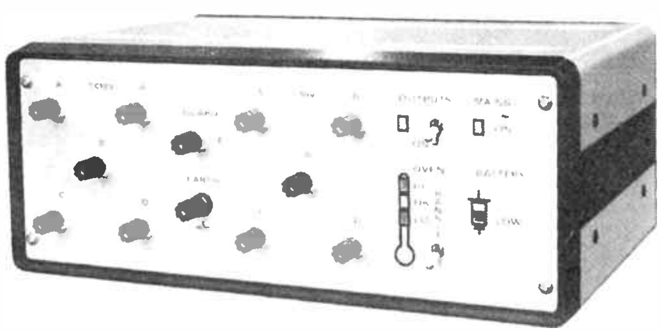
CEMOS TECHNOLOGY	MINIMUM(1) FEATURE SIZE (MICRONS)	FASTEST SPEED 4Kx4 SRAM COM'L ACCESS TIME (ns)	PRODUCT AVAILABILITY
I	2.5	45	Since 1982
IIA	2.0	35	NOW
IIB	1.5	30	NOW
IIC	1.2	25	NOW
IIIA	1.0	SUB 20	FUTURE

A Volt from the blue

The next time you squint myopically at your multimeter on the volts range and announce "She'll be right", spare a thought for those who have to measure the volt to extremely fine tolerances.

"What's the point of that?" you may ask. To start with, if you are a large producer, such as an electricity generating authority, or large wholesaler or retailer of electricity, (not your corner electricity deli but the SCC for example), you would want to be sure exactly how much electricity you were charging for or paying for as the case may be. What does that mean? It means you must have a basic reference of high accuracy.

Traditionally, this has been provided by the "Weston Standard Cell". However, such cells are now only manufactured in very small quantities and are difficult to get. The alternative is a very high stability electronic voltage standard calibrated by reference to national or international standards. These instruments don't come cheaply and the market is not exactly crowded.



However, from Hornsby comes the announcement of a very exciting development. Statronics Power Supplies, in collaboration with the National Measurement Laboratory, CSIRO Division of Applied Physics, have, over a considerable period been developing under the auspices of APIP (Applied Physics Industrial Program), a revolutionary voltage standard.

Available at under $6000, this instrument, known as the VS4, provides not one high stability standard but four! This greatly increases the integrity of the measurement system. As several pages of closely packed mathematics in the extremely comprehensive manual indicate, the improved accuracy resulting from the four independent outputs is not as simple as a factor of four!

Each instrument is certified by the National Measurement Laboratory before delivery, and comes, with its manual, in a sturdy transportation case.

Although probably not an absolute necessity in every hobbyist's den, at this price the Statronics VS4 will rapidly find a place in every large laboratory where numerous DVMs and other equipment are calibrated with reference to external standards on a regular basis, previously a costly and time-consuming procedure.

Apart from its obvious value to Australian laboratories, the VS4 has excellent export prospects, another example of Australian ingenuity and entrepreneurial endeavour.

We hope to run a full article on the development of this instrument in a later issue. In the meantime, for further details contact **Rod Tuson at Statronics Power Supplies, (02) 476 5714.**

— from page 47


```
02470 DATA "east","SwQ"
02480 DATA "eight","TQ"
02490 DATA "eighteen","TQMSK"
02500 DATA "eighty","TQMS"
02510 DATA "eleven","SmGctK"
02520 DATA "emergency","SPsJGKwS"
02530 DATA "engagement","GG@KdTAJPGGKABM"
02540 DATA "engages","GG@KdTAJLk"
02550 DATA "engaging","GG@KdTAJLl"
02560 DATA "enrage","GKNTAJ"
02570 DATA "enraged","GKNTAJAU"
02580 DATA "enrages","GKNTAJLk"
02590 DATA "enraging","GKNTAJLl"
02600 DATA "error","GGg@s"
02610 DATA "extent","GjwMGGKM"
02620 DATA "exterminate","GiwMsPLxTM"
02630 DATA "f","GGhh"
02640 DATA "father","h{Rs"
02650 DATA "february","hG\@Y_tS"
02660 DATA "fifteen","hLhMSK"
02670 DATA "fifty","hLhMS"
02680 DATA "fir","ht"
02690 DATA "five","hFc"
02700 DATA "fool","h^^m"
02710 DATA "fools","h^^mf"
02720 DATA "force","hzww"
02730 DATA "four","hWWg"
02740 DATA "fourteen","hWgMSK"
02750 DATA "fourty","hWgMS"
02760 DATA "freeze","hhNSk"
02770 DATA "freezer","hhNSks"
02780 DATA "freezers","hhNSksk"
02790 DATA "friday","hgFAaT"
02800 DATA "from","hgXP"
02810 DATA "frozen","hhNukGK"
02820 DATA "g","JS"
02830 DATA "gemini","JGPLxF"
02840 DATA "glenn","AbmGl"
02850 DATA "h","TABr"
02860 DATA "happy","yZIS"
02870 DATA "has","[[Zk"
02880 DATA "have","[[Zc"
02890 DATA "hello","[Gmu"
02900 DATA "hertz","yytQk"
02910 DATA "how","y`"
02920 DATA "hundred","yOOKAagLL@U"
02930 DATA "i","F"
02940 DATA "idiot","LAaLLLOQ"
02950 DATA "in","LK"
02960 DATA "input","LKBI^Q"
02970 DATA "is","Lk"
02980 DATA "it","LCQ"
02990 DATA "j","JGT"
03000 DATA "january","JZK_qtS"
03010 DATA "john","JXK"
03020 DATA "julie","Jq~S"
03030 DATA "july","J_mF"
03040 DATA "june","J_K"
03050 DATA "k","jGT"
03060 DATA "karen","jZg@GK"
03070 DATA "kilo","jLmu"
03080 DATA "know","xu"
03090 DATA "kristy","HgLwQS"
03100 DATA "l","GG~"
03110 DATA "live","mlc"
03120 DATA "m","GGP"
03130 DATA "march","P{r"
03140 DATA "mark","P{i"
03150 DATA "may","PT"
03160 DATA "mega","PGdO"
03170 DATA "memory","PGPXgS"
03180 DATA "mhz","PGdOyytQk"
03190 DATA "microbee","PFABHguA?S"
03200 DATA "microbug","PFABHgu@?WWb"
03210 DATA "minute","PLKLBM"
03220 DATA "minutes","PLKLBMk"
03230 DATA "modem","PuAaGP"
03240 DATA "monday","POOKAaT"
03250 DATA "month","POK]]"
03260 DATA "mother","POvs"
03270 DATA "my","PF"
03280 DATA "n","GGK"
03290 DATA "name","xTP"
03300 DATA "naughty","xWWBQS"
03310 DATA "nine","xFK"
03320 DATA "nineteen","xFKMSK"
03330 DATA "ninety","xFKMS"
03340 DATA "no","xu"
03350 DATA "november","xu@cGP\s"
03360 DATA "o","u"
03370 DATA "october","Xi@Qu\s"
03380 DATA "of","Xc"
03390 DATA "on","XK"
03400 DATA "one","pOK"
03410 DATA "or","z"
03420 DATA "our","`s"
03430 DATA "p","IS"
03440 DATA "past","I{wM"
03450 DATA "penelope","ABIGKGmuIS"
03460 DATA "penny","ABIGKS"
03470 DATA "point","IEKQ"
03480 DATA "q","jq_"
03490 DATA "r","{"
03500 DATA "ram","gAZZP"
03510 DATA "rebecca","Ns?GBH{"
03520 DATA "ross","NXww"
03530 DATA "s","GGww"
03540 DATA "saturday","wwZBMsaT"
03550 DATA "september","wGIQGP\s"
03560 DATA "seven","wwGGcLK"
03570 DATA "seventeen","wwGGcLKMSK"
03580 DATA "seventy","wwGGcLKMS"
```

— to page 91

ELECTRONIC FACILITIES

SPECIAL OFFER
TO ALL
AUSTRALIAN ELECTRONICS MONTHLY READERS.

A SEMICONDUCTOR SPECIAL.

This pack of selected 74LS IC's is ideal for any hobbyist or professional alike. The pack contains the most common IC's that are used for your designs, projects or servicing.

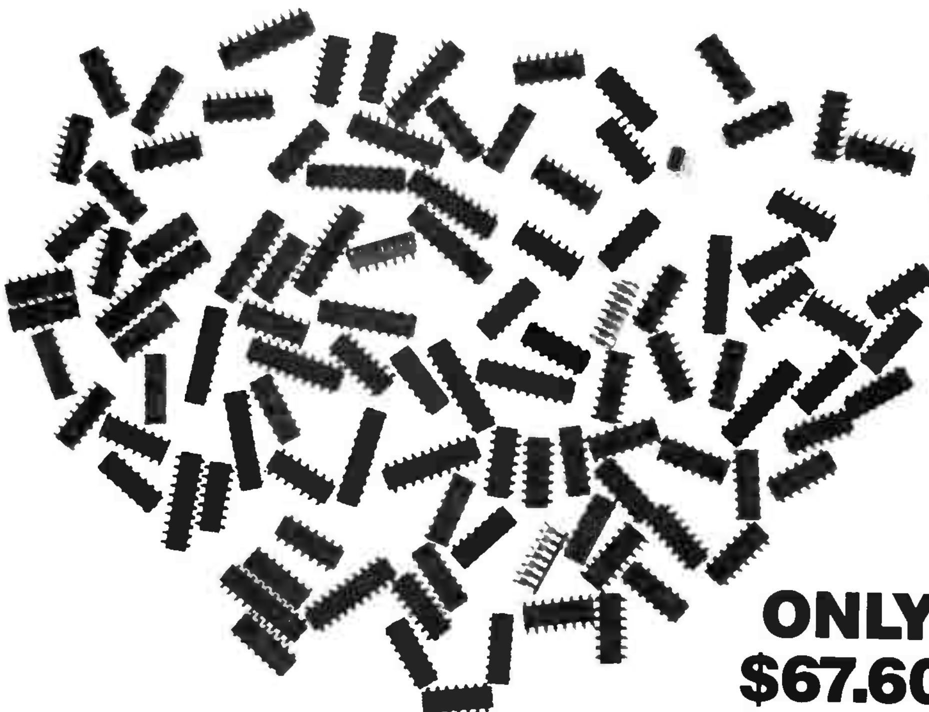
All IC's in this special offer are top quality NATIONAL PANASONIC brand.

A ONCE IN A LIFETIME SPECIAL.

5 of Each

74LS00
74LS02
74LS04
74LS08
74LS10
74LS123
74LS132
74LS138
74LS139
74LS14
74LS164
74LS165
74LS175
74LS20
74LS22
74LS240
74LS244
74LS245
74LS57A
74LS30
74LS32
74LS373
74LS374
74LS393
74LS74A
74LS86

130 IC's FROM NATIONAL PANASONIC.



ONLY
$67.60
Plus $2.50 P&P

Would normally retail about $140.00

THIS IS AN OFFER THAT YOU CANNOT MISS OUT ON.

PLEASE SEND your mail order to: **ELECTRONIC FACILITIES** Pty Ltd
PO BOX 351
Artarmon N.S.W. 2064

67 Dickson Avenue, Artarmon
Sydney NSW 2064 Australia
Telephone: 439 3786
Telex AA177084

TOLL FREE (008) 22 6385

National

MONEY ORDER ☐ CHEQUE ☐

NAME ....

ADDRESS ....

....

— from page 47


```
02470 DATA "east","SwQ"
02480 DATA "eight","TQ"
02490 DATA "eighteen","TQMSK"
02500 DATA "eighty","TQMS"
02510 DATA "eleven","SmGctK"
02520 DATA "emergency","SPsJGKwS"
02530 DATA "engagement","GG@KdTAJPGGKABM"
02540 DATA "engages","GG@KdTAJLk"
02550 DATA "engaging","GG@KdTAJL1"
02560 DATA "enrage","GKNTAJ"
02570 DATA "enraged","GKNTAJAU"
02580 DATA "enrages","GKNTAJLk"
02590 DATA "enraging","GKNTAJL1"
02600 DATA "error","GGg@s"
02610 DATA "extent","GjwMGGKM"
02620 DATA "exterminate","GiwMsPLxTM"
02630 DATA "f","GGhh"
02640 DATA "father","h{Rs"
02650 DATA "february","hG\@Y_tS"
02660 DATA "fifteen","hLhMSK"
02670 DATA "fifty","hLhMS"
02680 DATA "fir","ht"
02690 DATA "five","hFc"
02700 DATA "fool","h^^m"
02710 DATA "fools","h^^mf"
02720 DATA "force","hzww"
02730 DATA "four","hWWg"
02740 DATA "fourteen","hWgMSK"
02750 DATA "fourty","hWgMS"
02760 DATA "freeze","hhNSk"
02770 DATA "freezer","hhNSks"
02780 DATA "freezers","hhNSksk"
02790 DATA "friday","hgFAaT"
02800 DATA "from","hgXP"
02810 DATA "frozen","hhNukGK"
02820 DATA "g","JS"
02830 DATA "gemini","JGPLxF"
02840 DATA "glenn","AbmGl"
02850 DATA "h","TABr"
02860 DATA "happy","yZIS"
02870 DATA "has","[[Zk"
02880 DATA "have","[[Zc"
02890 DATA "hello","[Gmu"
02900 DATA "hertz","yytQk"
02910 DATA "how","y`"
02920 DATA "hundred","yOOKAagLL@U"
02930 DATA "i","F"
02940 DATA "idiot","LAaLLLOQ"
02950 DATA "in","LK"
02960 DATA "input","LKBI^Q"
02970 DATA "is","Lk"
02980 DATA "it","LCQ"
02990 DATA "j","JGT"
03000 DATA "january","JZK_qtS"
03010 DATA "john","JXK"
03020 DATA "julie","Jq~S"
03030 DATA "july","J_mF"
03040 DATA "june","J_K"
03050 DATA "k","jGT"
03060 DATA "karen","jZg@GK"
03070 DATA "kilo","jLmu"
03080 DATA "know","xu"
03090 DATA "kristy","HgLwQS"
03100 DATA "l","GG~"
03110 DATA "live","mlc"
03120 DATA "m","GGP"
03130 DATA "march","P{r"
03140 DATA "mark","P{i"
03150 DATA "may","PT"
03160 DATA "mega","PGdO"
03170 DATA "memory","PGPXgS"
03180 DATA "mhz","PGdOyytQk"
03190 DATA "microbee","PFABHguA?S"
03200 DATA "microbug","PFABHgu@?WWb"
03210 DATA "minute","PLKLBM"
03220 DATA "minutes","PLKLBMk"
03230 DATA "modem","PuAaGP"
03240 DATA "monday","POOKAaT"
03250 DATA "month","POK]]"
03260 DATA "mother","POvs"
03270 DATA "my","PF"
03280 DATA "n","GGK"
03290 DATA "name","xTP"
03300 DATA "naughty","xWWBQS"
03310 DATA "nine","xFK"
03320 DATA "nineteen","xFKMSK"
03330 DATA "ninety","xFKMS"
03340 DATA "no","xu"
03350 DATA "november","xu@cGP\s"
03360 DATA "o","u"
03370 DATA "october","Xi@Qu\s"
03380 DATA "of","Xc"
03390 DATA "on","XK"
03400 DATA "one","pOK"
03410 DATA "or","z"
03420 DATA "our","`s"
03430 DATA "p","IS"
03440 DATA "past","I{wM"
03450 DATA "penelope","ABIGKGmuIS"
03460 DATA "penny","ABIGKS"
03470 DATA "point","IEKQ"
03480 DATA "q","jq_"
03490 DATA "r","{"
03500 DATA "ram","gAZZP"
03510 DATA "rebecca","Ns?GBH{"
03520 DATA "ross","NXww"
03530 DATA "s","GGww"
03540 DATA "saturday","wwZBMsaT"
03550 DATA "september","wGIQGP\s"
03560 DATA "seven","wwGGcLK"
03570 DATA "seventeen","wwGGcLKMSK"
03580 DATA "seventy","wwGGcLKMS"
```

— to page 91

— from page 89 **4504**

```
03590 DATA "sister","wwLwMs"
03600 DATA "six","wLiw"
03610 DATA "sixteen","wLiwMSK"
03620 DATA "sixty","wLiwMS"
03630 DATA "son","wOK"
03640 DATA "sound","w`KU"
03650 DATA "south","ww`]"
03660 DATA "space","wITw"
03670 DATA "statement","wAQTAQPGKQ"
03680 DATA "sunday","wwOOKBaT"
03690 DATA "suz","wOk"
03700 DATA "suzanne","w-kZZK"
03710 DATA "t","MS"
03720 DATA "talker","MWWAis"
03730 DATA "television","MGmLcLwLXK"
03740 DATA "ten","MGK"
03750 DATA "test","MGwAQ"
03760 DATA "testing","MGwAQL1"
03770 DATA "the","vX"
03780 DATA "their","]GGGo"
03790 DATA "there","]GGGo"
03800 DATA "thirteen","]sMSK"
03810 DATA "thirty","]sMS"
03820 DATA "this","RLw"
03830 DATA "thousand","]`kZKU"
03840 DATA "three","vgS"
03850 DATA "thursday","]tkAaT"
03860 DATA "tim","M\P"
03870 DATA "time","MFP"
03880 DATA "to","M--"
03890 DATA "today","M-aT"
03900 DATA "tuesday","MqkAaT"
03910 DATA "twelve","MnG~Ac"
03920 DATA "twenty","MnGKMS"
03930 DATA "two","M--"
03940 DATA "u","q_"
03950 DATA "v","cS"
03960 DATA "vision","cLfLLXK"
03970 DATA "w","aDA?~_"
03980 DATA "want","nXKBQ"
03990 DATA "wednesday","nGGKkAaT"
04000 DATA "what","pXBQ"
04010 DATA "who","yy^-"
04020 DATA "with","nLv"
04030 DATA "x","GGBiww"
04040 DATA "y","nF"
04050 DATA "year","Y;"
04060 DATA "yes","YGww"
04070 DATA "you","Y_"
04080 DATA "your","Yz"
04090 DATA "z","kGBU"
04100 DATA "zero","fSgu"
04110 DATA "dataend","zzzz"
04120 REM data line "dataend",
         "zzzz" must be last data line
04130 END OF PROGRAM LISTING
```

— from page 63

able on all graphics modes) in which the CPU tells the graphics processor what colour a particular pixel is to be and the required change in colour over the rest of that line. This means that you can have all 4096 colours shown on-screen at the same time, and (more usefully) can shade graphics objects so subtly that they look a bit more like 'live' images.

Audio is reasonably well-supported, with the audio coprocessor able to handle four simultaneous channels, each with its own attack-delay-sustain-repeat (ADSR) envelope and each selectable for right, left or both of the output channels. There's a nice piece of software called Musicraft which allows you to draw a waveform on the screen using the mouse, modify its envelope, add vibrato and whatever, and then 'play' it using the keyboard. The Amiga's operating system can tell when you press, and when you release, up to three keys at a time, so polyphony is no problem. Yet another add-on hardware box gives the machine a 'MIDI' interface, which is an industry standard way of connecting computers to electronic musical instruments (e.g: a synthesiser).

One curiosity with the audio is that there is no loudspeaker built in. This means that, unless you connect an audio amp and external speaker, or use the Amiga monitor (which has an amp and speaker in it), you will get no beeps from your software when you make a blooper.

Manuals

The documentation that comes with the Amiga is (to the best of my knowledge) an industry first. It's printed with colour pictures throughout, and it's well-written. It's all a manual should be (apart from a preponderance of errata sheets which, I guess, Commodore will fix). The technical manuals (totalling around 150 mm of paper!) are also well-written, clear, concise and honest. Why can't everyone do it this way?

All in all, the Amiga is a nice, clean friendly machine, designed by well-meaing engineers somewhere in California. How well it does out in the cold hard world of the marketplace (or the hot hard world of the Australian marketplace) is another story. I can only assume that Commodore, which is no stranger to the hard world, knows what it's doing and will provide the backup and software to support the machine before the gloss wears off it.

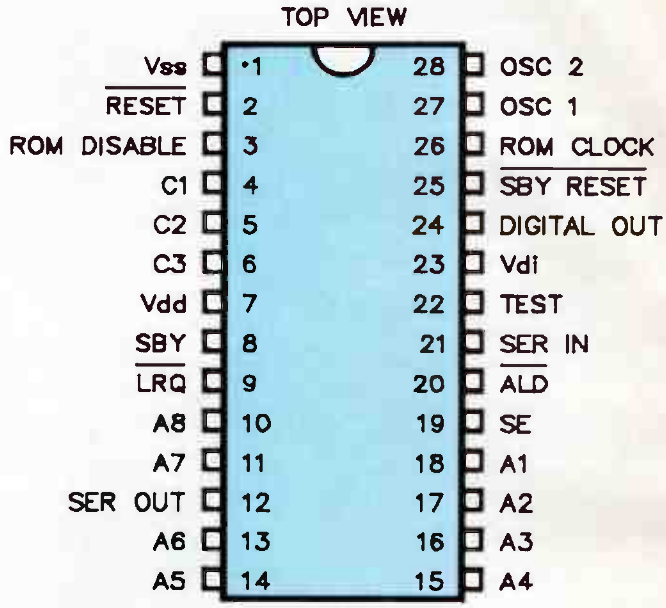
Recommendation?

My recommendation: *fantastic* for serious hackers, technical people who want to play with C and windows, TV stations, video production houses and ad agencies who want their own animated logos, etc at low cost, video games manufacturers and AEM readers heavily into graphics, sound and sophisticated programs. I can't advise on the Amiga's usefulness to small businessmen because I haven't seen the business software.

GENERAL INSTRUMENTS SP0256-AL2 SPEECH PROCESSOR

Features

- Natural Speech
- Stand Alone Operation with Inexpensive Support Components
- Wide Operating Voltage
- Word, Phrase, or Sentence Library, ROM Expandable
- Expandable to 491K of ROM Directly
- Simple Interface to Most Microcomputers or Microprocessors



PINOUT

GENERAL DESCRIPTION

The SP0256 Speech Processor is a single chip N-Channel MOS LSI device that is able, using its stored program, to synthesize speech or complex sounds.

The achievable output provides a flat frequency response to 5 kHz, a dynamic range of 42 dB, and a signal-to-noise ratio of approximately 35 dB.

The SP0256 incorporates four basic functions:

- A software programmable digital filter that can be made to model a vocal tract.
- A 16K ROM which stores both data and instructions (the program).
- A microcontroller which controls the data flow from the ROM to the digital filter, the assembly of the "word strings" necessary for linking speech elements together, and the amplitude and pitch information to excite the digital filter.
- A pulse-width modulator that creates a digital output which is converted to an analogue signal when filtered by an external low pass filter.

One example of a preprogramed SP0256 is the AL2 pattern.

ALLOPHONE SPEECH SYNTHESIS

The allophone speech synthesis technique provides the user with the ability to synthesise an unlimited vocabulary at a very low bit rate. Fifty-nine discrete speech sounds (called allophones) and five pauses are stored at different addresses in the SP0256 internal ROM. Each speech sound was excised from a word and analyzed using linear predictive coding (LPC).

Any English word or phrase can be created by addressing the appropriate combination of allophanes and pauses. Since there is a total of 64 address locations each requires a 6-bit address. Assuming that speech contains 10 to 12 sounds per second, allophone synthesis requires addressing less than 100 bits per second.

LINGUISTICS

A few basic linguistic concepts will help you start your own library of "allophone words".

First, there is no one-to-one correspondence between written letters and speech sounds; secondly, speech sounds are acoustically different depending upon their position within a word; and lastly, the human ear may perceive the same acoustic signal differently in the context of different sounds.

The first point compares to the problem that a child encounters when learning to read. Each sound in a language may be represented by more than one letter and, conversely each letter may represent more than one sound. (See the examples in Table 2.) Because of these spelling irregularities it is necessary to think in terms of *sounds,* not letters, when using allophones.

The second, and equally important point to understand, is that the acoustic signal of a speech sound may differ depending on its position within a word. For example, the initial *K* sounds in *coop* will be acoustically different from the *K's* in *keep* and *speak.* The *K's* in *coop* and *keep* differ due to the influence of the vowels which follow them, and the final K in speak is usually not as loud as initial *Ks.*

ELECTRICAL CHARACTERISTICS

Maximum Ratings*

All pins with respect to VSS .... -0.3 to 8.0V
Storage Temperature .... -25°C to 125°C

Standard Conditions

Clock — Crystal Frequency .... 3.120 MHz
Operating Temperature (TA) .... 0°C to 70°C

* Exceeding these ratings could cause permanent damage to the device. This is a stress rating only and functional operation of this device at these conditions is not implied. Operating ranges are specified in Standard Conditions. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Data labeled "typical" is presented for design guidance only and is not guaranteed.

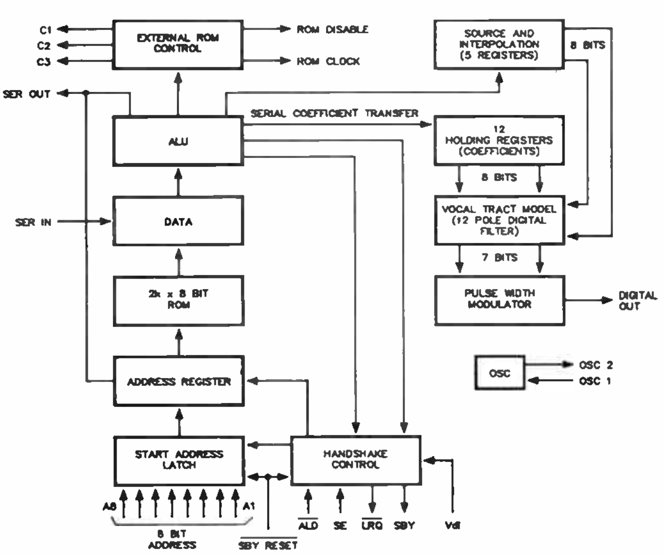
DC CHARACTERISTICS

Characteristics	Sym	Min	Typ	Max	Units	Conditions
Primary Supply Voltage	V_{DD}	4.6	—	7	V	
Standby Supply Voltage	V_{D1}	4.6	—	7	V	
Primary Supply Current	I_{DD}	—	—	90	mA	V_{D1}, V_{DD} = 7.0V
Standby Supply Current	I_{D1}	—	—		mA	V_{SS} = 0.0V.
Inputs A1-A8, $\overline{ALD}$, SER IN, TEST, SE Logic 0	V_{IL}	0	—	0.8	V	
Logic 1	V_{IH}	2.4	—	V_{D1}	V	
Capacitance	C_{IN}	—	—	10	pf	
Leakage	I_{LC}	—	—	±10	μA	
RESET, SBY $\overline{RESET}$ Logic 0	V_{IL1}	0	—	0.6	V	
Logic 1	V_{IH1}	3.6	—	V_{D1}	V	
Oscillator Leakage OSC 1	—	1.0	—	10	μA	No Load, OSC1 = 7.0V
Outputs SBY, DIGITAL OUT, C1, C2, C3, $\overline{LRQ}$, ROM DISABLE, ROM CLOCK, SER OUT Logic 0	V_{OL}	0	—	0.6	V	0.72mA (2 LS TTL Loads)
Logic 1	V_{OH}	3.5	—	V_{D1}	V	−50μA (2 LS TTL Loads)

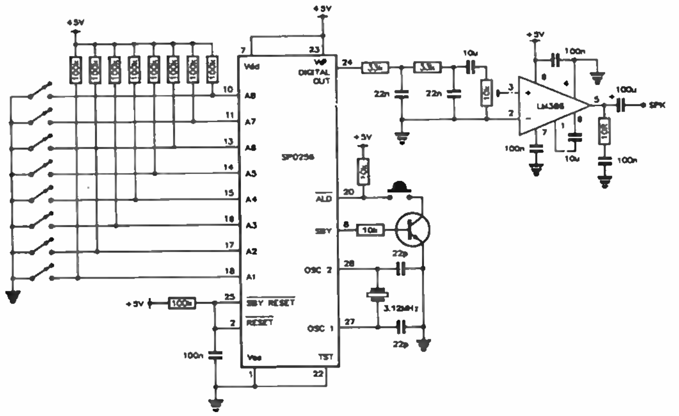
AC CHARACTERISTICS

Characteristics	Sym	Min	Typ	Max	Units	Conditions
Clock Frequency	—	—	3.120	—	MHz	Crystal
Reset SBY Reset	t_{pw1}	100	—	—	μs	
ALD (<800ns)	t_{pw2}	200	—	800	ns	
A1-A8 Set Up	t_{s2}	160	—	—	ns	
A1-A8 Hold	t_{h2}	160	—	—	ns	
ALD (≥800ns)	t_{pw3}	800	—	—	ns	
A1-A8 Set Up	t_{s3}	0	—	—	ns	
A1-A8 Hold	t_{h3}	1200	—	—	ns	
LRQ	t_{pd0}	—	—	840	ns	
SBY	t_{pd}	—	—	840	ns	

SP0256A—AL2 BLOCK DIAGRAM



APPLICATIONS CIRCUIT



PIN NUMBER	NAME	FUNCTION
1	VSS	Ground
2	RESET	A logic 0 resets that portion of the SP powered by VDD. Must be returned to a logic 1 for normal operation.
3	ROM DISABLE	For use with an external serial speech ROM, a logic 1 disables the external ROM.
4, 5, 6	C1, C2, C3	Output control lines for use with an external serial speech ROM.
7	VDD	Power supply for all portions of the SP except the microprocessor interface logic.
8	SBY	STANDBY. A logic 1 output indicates that the SP is inactive and VDD can be powered down externally to conserve power. When the SP is reactivated by an address being loaded, SBY will go to logic 0.
9	LRQ	LOAD REQUEST. LRQ is a logic 1 output whenever the input buffer is full. When LRQ goes to a logic 0, the input port may be loaded by placing the 8 address bits on A1-A8 and pulsing the ALD output.
10,11,13,14, 15, 16, 17, 18	A8, A7, A6, A5, A4, A3, A2, A1	8-bit address which defines any one of 256 speech entry points.
12	SER OUT	SERIAL ADDRESS OUT. This output transfers a 16-bit address serially to an external speech ROM.
19	SE	STROBE ENABLE. Normally held in a logic 1 state. When tied to ground, ALD is disabled and the SP will automatically latch in the address on the input bus approximately 1 μs after detecting a logic 1 on any address line.
20	ALD	ADDRESS LOAD. A negative pulse on this input loads the 8 address bits into the input port. The negative edge of this pulse causes LRQ to go high.
21	SER IN	SERIAL IN. This is an 8-bit serial data input from an external speech ROM.
22	TEST	This pin should be grounded for normal operation.
23	VDI	Power supply for the microprocessor interface logic and controller.
24	DIGITAL OUT	Pulse-width modulated digital speech output which, when filtered by a 5 kHz low pass filter and amplified, will drive a loudspeaker.
25	SBY RESET	STANDBY RESET. A logic 0 resets the microprocessor interface logic and the address latches. Must be returned to a logic 1 for normal operation.
26	ROM CLOCK	This is a 1.56 MHz clock output used to drive an external serial speech ROM.
27	OSC1	XTAL IN. 'Input' connection for 3.12 MHz crystal.
28	OSC2	XTAL OUT. 'Output' connection for 3.12 MHz crystal.

Finally, a listener may identify the same acoustic signal differently depending on the context in which it is perceived. Don't be surprised, therefore, if an allophone word sounds slightly different when used in various phrases.

PHONEMES OF ENGLISH

The sounds of a language are called phonemes, and each language has a set which is slightly different from that of other languages. Table 3 contains a chart of all the consonant phonemes of English, Table 4 all the vowel phonemes.

Consonants are produced by creating an occlusion or constriction in the vocal tract which produces an aperiodic sound source. If the vocal cords are vibrating at the same time, as in the case of the voiced fricatives VV, DH, ZZ, and ZH, (see Table 5) there are two sound sources: one which is aperiodic and one which is periodic.

Vowels are usually produced with a relatively open vocal tract and a periodic sound source provided by the vibrating vocal cords. They are classified according to whether the front or back of the tongue is high or low (see Table 4) whether they are long or short, and whether the lips are rounded or unrounded. In English all rounded vowels are produced in or near the back of the mouth (UW, UH, OW, AO, OR, AW).

Speech sounds which have features in common behave in similar ways. For example, the voiceless stop consonants PP, TT, and KK (See Table 3) should be preceded by 50-80 msec of silence, and the voice stop consonants BB, DD, and GG by 10-30 msec of silence.

ALLOPHONES

Phoneme is the name given to a group of similar sounds in a language. Recall that a phoneme is acoustically different depending upon its position within a word. Each of these positional variants is an allophone of the same phoneme. An allophone, therefore, is the manifestation of a phoneme in true speech signal. It is for this reason that our inventory of English speech sounds is called an allophone set.

ALLOPHONE USAGE WITH A MICROPROCESSOR

The SP0256-AL2 requires the use of a processor to concatenate (link together) the speech sounds to form words. The SP0256 is controlled using the address pins (A1-A8), ALD (Address Load), and SE (Strobe Enable). The object for controlling the chip is to load an address into it which contains the desired allophone. The speech data for the allophone set is contained within the internal 16K ROM. This particular application requires only six address pins (A1-A6) to address all the 59 allophones plus five pauses, a total of 64 locations. For simplicity, since only six address pins are needed to address the 64 locations, pins A7 and A8 can be tied low (to ground) and any further reference to the address bus will include A1-A6 and A7 = A8 = 0.

There are two modes available for loading an address into the chip. SE (Strobe Enable) controls the mode that will be used.

Mode 0 (SE = 0) will latch in an address when any one or more of the address pins makes a low to high transition. For example, to load the address one (1), A2 to A6 = 0 and A1 is pulsed high. To load the address twelve (12 octal), A1 = A3 = A5 = A6 = 0, A2 and A4 are pulsed high simultaneously. (Note that an address of zero cannot be loaded using this mode). ▶

Mode 1 (SE = 1) will latch in an address using the ALD pin. First, setup the desired address on the address bus (A1-A6) and then pulse ALD low. Any address can be loaded using this mode, but certain setup and hold times are required (refer to the timing diagrams).

Two microprocessor interface pins are available for quick loading of addresses. They are LRQ and SBY. LRQ (Load Request) tells the processor when the input buffer is full. SBY (Standby) tells the processor that the chip has stopped talking and no new address has been loaded. Either interface pin can be used when concatenating allophones. LRQ is an active low signal, when LRQ goes low it is time to load a new address to the chip. If LRQ is high, then simply wait for it to go low before loading the address. SBY will stay high until an address is loaded, then it will go low and stay low until all the internal instructions (Speech Code) from that one address are completed. Once this signal goes high, it is time to load a new address. Since speech does not require very fast address loading, it would be acceptable to use SBY to interface to the processor.

To end a word using allophones, it is necessary to load a pause to complete the word. For example, the word "TWO" can be implemented using the following allophanes: TT2-VW2-PAI. PAI is actually not an allophone but a pause which is needed to end the word.

HOW TO USE THE ALLOPHONE SET

The allophone set (refer to Table 5) contains two or three versions of some phonemes. It may be necessary to use one allophone of a particular phoneme for word-or-syllable-final position. A detailed set of guidelines for using the allophones is given in Table 5. Note that these are suggestions, not rules.

For example , DD2 sounds good in initial position and DD1 sounds good in final position, as in "daughter" and "collide". One of the differences between the initial and the final versions of a consonant is that an initial version may be longer than the final version. Therefore, to create an initial SS, you can use two SSs instead of the usual single SS at the end of a word or syllable, as in "sister". Note that this can be done with TH, and FF, and the inherently short vowels (to be discussed later), but with no other consonants.

You will want to experiment with some consonants, such as *str and cl*, to discover which version works best in the cluster. For example, KK1 sounds good before LL as in "clown", and KK2 sounds good before WW as in "square".

One allophone of a particular phoneme may sound better before or after back vowels and another before or after front vowels. KK3 sounds good before UH and KK1 sounds good before IY, as in "cookie".

Some sounds (PP, BB, TT, DD, KK, GG, CH, and JH) require a brief duration of silence before them. For most of these, the silence has already been added but you may decide you want to add more. Therefore there are several pauses included in the allophone set varying from 10-200 ms. To create the final sounds in the words "letter" and "little" use the allophones ER and EL.

Remember that you must always think about how a word *sounds*, not how it is spelled. For example, the NG sound is represented by the letter N in "uncle". And remember that some sounds may not even be represented by any letters, as the YY in "computer".

As mentioned earlier there are some vowels which can be doubled to make longer versions for stressed syllables. These are the inherently short vowels IH, EH, AE, AX, AA, and UH. For example, in the word "extent" use one EH in the first syllable, which is unstressed and two EHs in the second syllable which is stressed.

Of the inherently long vowels there is one, UW, which has a long and short version. The short one, UW1, sounds good after YY in computer. The long version, UW2, sounds good in monosyllabic words like "two".

Included in the vowel set is a group called R-colored vowels. These are vowel + R combinations. For example, the AR in "alarm" and the OR in "score". Of the R-colored vowels there is one, ER, which has a long and short version. The short version is good for polysyllabic words with final ER sounds like "letter", and the long version is good for monosyllabic words like "fir".

One final suggestion is that you may need to add a pause of 30-50 msec between words, when creating sentences, and a pause of 100-200 msec between clauses.

Note: Every utterance must be followed by a pause in order to make the chip stop talking the last allophone.

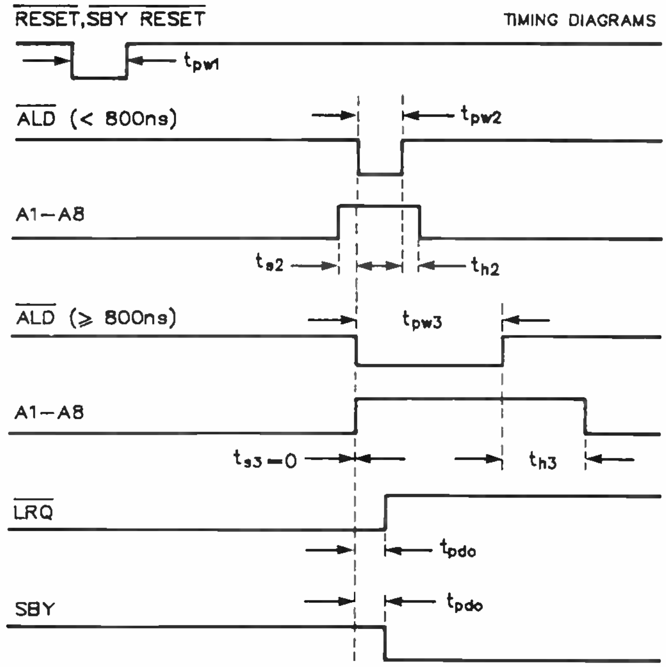


Table 1:

EXAMPLES OF WORDS MADE FROM ALLOPHONES

DD2-AO-TT2-ER1	"daughter"
KK3-AX-LL-AY-DD1	"collide"
SS-SS-IH-SS-TT2-ER1	"sister"
KK1-LL-AW-NN1	"clown"
KK3-UH-KK1-IY	"cookie"
LL-EH-TT2-ER	"letter"
LL-IH-TT2-EL	"little"
AX-NG-KK3-EL	"uncle"
KK1-AX-MM-PP1-YY1-UW1-TT2-ER	"computer"
EH-KK1-SS-TT2-EH-EH-NN1-TT2	"extent"
TT2-UW2	"two"
AX-LL-AR-MM	"alarm"
SS-KK3-OR	"score"
FF-ER2	"fir"

TABLE 2 — EXAMPLES OF SPELLING IRREGULARITIES

	Same sound represented by different letters	Different sounds represented by the same letters
Vowels	mEAt fEEt pEte pEOple pennY	vEIn forEIgn gEIsha
Consonants	SHip tenSIon preCIous naTIon	althouGH GHastly couGH

We gratefully acknowledge the assistance of Daneva Australia Pty Ltd in providing data used to prepare this data sheet. More information on General Instruments' devices is obtainable from **Daneva Australia Pty Ltd, PO Box 114, Sandringham 3191 Vic. (03) 598 5622.**

TABLE 3 — CONSONANT PHONEMES OF ENGLISH

		LABIAL	LABIO DENTAL	INTER-DENTAL	ALVEOLAR	PALATAL	VELAR	GLOTTAL
Stops:	Voiceless	PP			TT		KK	
	Voiced	BB			DD		GG	
Fricatives:	Voiceless	WH	FF	TH	SS	SH		HH
	Voiced		VV	DH	ZZ	ZH*		
Affricates:	Voiceless					CH		
	Voiced					JH		
Nasals	Voiced	MM			NN		NG*	
Resonants	Voiced	WW			RR, LL	YY		

* *These do not occur in word-initial position in English.*

Labial: Upper and lower lips touch or approximate
Labio-Dental: Upper teeth and lower lip touch
Inter-Dental: Tongue between teeth
Alveolar: Tip of tongue touches or approximates alveolar ridge (just behind upper teeth)
Palatal: Body of tongue approximates palate (roof of mouth)
Velar: Body of tongue touches velum (posterior portion of roof of mouth)
Glottal: Glottis (opening between vocal cords)

TABLE 4 — VOWEL PHONEMES OF ENGLISH

	FRONT	CENTRAL	BACK
High	YR IY IH*		UW# UH*#
Mid	EY EH* XR	ER AX*	OW# OY#
Low	AE*	AW# AY AR AA*	AO*# OR#

* *Short Vowels* # *Rounded Vowels*

TABLE 6 — ALLOPHONE ADDRESS TABLE

Octal Address	Allophone	Sample Word	Duration	Octal Address	Allophone	Sample Word	Duration
000	PA1	PAUSE	10ms	040	/AW/	Out	250ms
001	PA2	PAUSE	30ms	041	/DD2/	Do	80ms
002	PA3	PAUSE	50ms	042	/GG3	Wig	120ms
003	PA4	PAUSE	100ms	043	/VV/	Vest	130ms.
004	PA5	PAUSE	200ms	044	/GG1/	Guest	80ms
005	/OY/	Boy	290ms	045	/SH/	Ship	120ms
006	/AY/	Sky	170ms	046	/ZH/	Azure	130ms
007	/EH/	End	50ms	047	/RR2/	Brain	80ms
010	/KK3/	Comb	80ms	050	/FF/	Food	110ms
011	/PP/	Pow	150ms	051	/KK2/	Sky	140ms
012	/JH/	Dodge	100ms	052	/KK1/	Can't	120ms
013	/NN1/	Thin	170ms	053	/ZZ/	Zoo	150ms
014	/IH/	Sit	50ms	054	/NG	Anchor	200ms
015	/TT2/	To	100ms	055	/LL/	Lake	80ms
016	/RR1/	Rural	130ms	056	/WW/	Wool	140ms
017	/AX/	Succeed	50ms	057	/XR/	Repair	250ms
020	/MM/	Milk	180ms	060	/WH/	Whig	150ms
021	/TT1/	Part	80ms	061	/YY1/	Yes	90ms
022	/DH1/	They	140ms	062	/CH/	Church	150ms
023	/IY/	See	170ms	063	/ER1/	Fir	110ms
024	/EY/	Beige	200ms	064	/ER2/	Fir	210ms
025	/DD1/	Could	50ms	065	/OW/	Beau	170ms
026	/UW1/	To	60ms	066	/DH2/	They	180ms
027	/AO/	Aught	70ms	067	/SS/	Vest	60ms
030	/AA/	Hot	60ms	070	/NN2/	No	140ms
031	/YY2/	Yes	130ms	071	/HH2/	Hoe	130ms
032	/AE/	Hat	80ms	072	/OR/	Store	240ms
033	/HH1/	He	90ms	073	/AR/	Alarm	200ms
034	/BB1/	Business	40ms	074	/YR/	Clear	250ms
035	/TH/	Thin	130ms	075	/GG2/	Got	80ms
036	/UH/	Book	70ms	076	/EL/	Saddle	140ms
037	/UW2/	Food	170ms	077	/BB2/	Business	60ms

TABLE 5 — GUIDELINES FOR USING THE ALLOPHONES

Silence

PA1 (10 ms) — before BB, DD, GG, and JH
PA2 (30 ms) — before BB, DD, GG, and JH
PA3 (50 ms) — before PP, TT, KK, and CH, and between words.
PA4 (100 ms) — between clauses and sentences.
PA5 (200 ms) — between clauses and sentences.

Short vowels

*/IH/ — sitting, stranded
*/EH/ — extent, gentlemen
*/AE/ — extract, acting
*/UH/ — cookie, full
*/AO/ — talking, song
*/AX/ — lapel, instruct
*/AA/ — pottery, cotton

Long vowels

/IY/ — treat, people, penny
/EY/ — great, statement, tray
/AY/ — kite, sky, mighty
/OY/ — noise, toy, voice
/UW/ — after clusters with YY: computer
/UW2/ — in monosyllabic words: two, food
/OW/ — zone, close, snow
/AW/ — sound, mouse, down
/EL/ — little, angle, gentlemen

R-Colored vowels

/ER1/ — letter, furniture, interrupt
/ER2/ — monosyllables: bird, fern, burn
/OR/ — fortune, adorn, store
/AR/ — farm, alarm, garment
/YR/ — hear, earring, irresponsible
/XR/ — hair, declare, stare

Resonants

/WW/ — we, warrant, linguist
/RR1/ — initial position: read, write, x-ray
/RR2/ — initial clusters: brown, crane, grease
/LL/ — like, hello, steel
/YY1/ — clusters: cute, beauty, computer
/YY2/ — initial position: yes, yarn, yo-yo

Voiceless fricatives

*/FF/ —) These may be doubled for
*/TH/ —) initial position and used
*/SS/ —) singly in final position
/SH/ — shirt, leash, nation
/HH1/ — before front vowels: YR, IR, IH, EY, EH, XR, AE
/HH2/ — before back vowels: UW, UH, OW, OY, AO, OR, AR
/WH/ — white, whim, twenty

Voiced fricatives

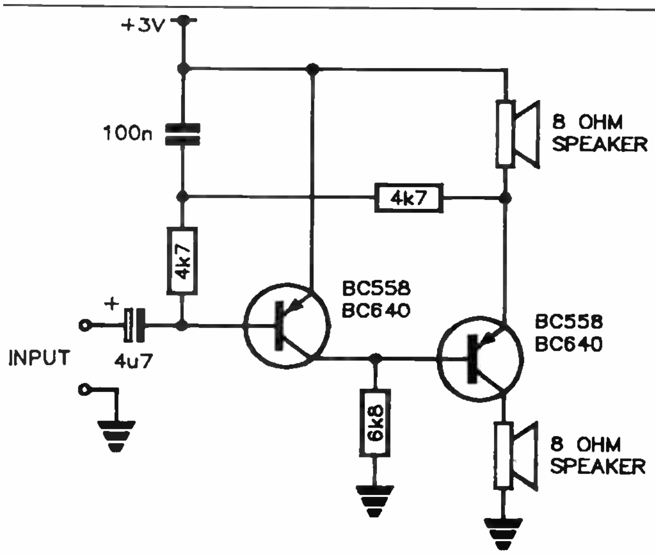
/VV/ — vest, prove, even
/DH1/ — word-initial position: this, then, they
/DH2/ — word-final and between vowels: bathe, bathing
/ZZ/ — zoo, phase
/ZH/ — beige, pleasure

Affricates

/CH/ — church, feature
/JH/ — judge, injure

Voiced stops

/BB1/ — final position: rib; Between vowels: fibber; In clusters: bleed, brown
/BB2/ — initial position before a vowel: beast
/DD1/ — final position: played, end
/DD2/ — initial position: down; Clusters: drain
/GG1/ — before high front vowels: YR, IY, IH, EY, EH, XR
/GG2/ — before high back vowels: UW, UH, OW, OY, AX; And clusters: green, glue
/GG3/ — before low vowels: AE, AW, AY, AR, AA, AO, OR, ER; And medial clusters: anger; And final position: peg

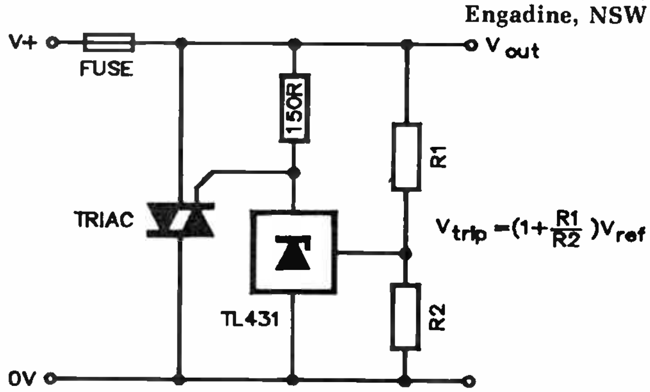


Just about the simplest push-pull audio output amp

It would be hard to find an audio output stage with fewer components — even though it does use a pair of speakers! This circuit delivers around 50 mW total output, but the two speakers ensure it is efficiently delivered. Mount them on a baffle or in an open-backed box to get maximum loudness.

The two transistors are direct-coupled with dc and ac feedback via the two 4k7 resistors. There must be equal voltage drops of about ¾ volt across each loudspeaker. Adjust the 6k3 resistor to achieve this, if necessary. Note that either BC558 or BC640 transistors may be used. Input impedance is around several thousand ohms. Note that a higher supply rail voltage may be used, with consequent more output, but the output stage quiescent current flows through the speakers and this must be kept down to avoid distortion.

C. Twiss,
Engadine, NSW



Bencnbook is a column for circuit designs and ideas, workshop hints and tips from technical sources of the staff or you — the reader. If you've found a certain circuit useful or devised an interesting circuit, most likely other readers would be interested in knowing about it. If you've got a new technique for cutting elliptical holes in zippy boxes or a different use for used solder, undoubtedly there's someone — or some hundreds — out there who could benefit from you knowledge.

We'll pay from $10 to $100 for each item published. Send your gems to **'Benchbook', Australian Electronics Monthly, PO Box 289, Wahroonga NSW 2076.** Please include your postal address for publication with your item(s).

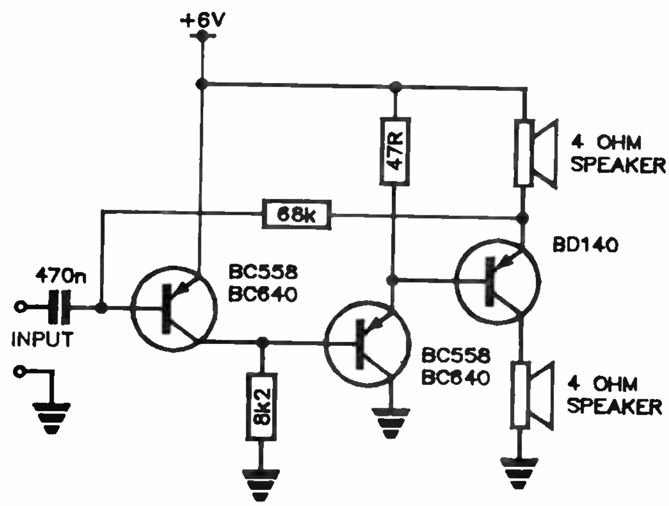
As far as reasonably possible, material published in Benchbook has been checked for accuracy and feasibility etc, but has not necessarily been built and tested in our laboratory. We cannot provide constructional details or conduct correspondence or technical enquiries.

More output from the simplest audio output stage

It's possible to beef up the audio output of the "simplest push-pull audio output amp" to around one watt without raising the supply voltage and output stage quiescent current beyond practicable limits.

An additional drive stage is added and a pair of 4 ohm speakers used (or two pairs of 8 ohm speakers, each pair in parallel). The BD140 output stage should be mounted on a small heatsink. The 8k2 resistor may need to be adjusted to obtain about 1.5 V drop across each speaker. Eight ohm speakers could be used, with a consequent reduction in power output.

C. Twiss,
Engadine, NSW



Power supply over-voltage protection

Fixed voltage regulated power supplies, such as the common 13.8 V 'battery eliminators' used to power mobile communications equipment (marine, CB or amateur transceivers) generally employ a series-pass type regulator with a power transistor between the rectifier and the output terminals. If, for any reason, this series-pass transistor should fail, the full output voltage of the rectifier is applied to the connected equipment. The results can be devastating.

This circuit, from the Motorola Linear ICs databook, prevents more than the rated voltage being applied to equipment connected to the output of a fixed regulated supply, protecting it in the event of regulator failure. A TL431 'precision zener' is employed, biased to turn on at a voltage slightly above the rated output of the fixed regulated supply, applying a bias to the gate of the triac which then turns on, shorting the supply output and blowing the fuse.

The voltage at which the TL431 'trips' depends on the ratio of resistors R1 and R2 and can be determined from the equation with the circuit. Vref. here is 2.5 volts. Typical values for R1 and R2 would be in the thousands to tens of thousands of ohms range. Note that the triac should be rated to withstand the short circuit current capability of the fixed regulated supply.

— from page 77

computer review

Showing the rear-hinged flip-up lid and the general internal arrangement.

The BIOS is, of course, one of the major areas of incompatibilities in most machines. This is the area in which a great deal of work and expense must be incurred if the machine is ever to be expected to work properly. The Data System/1 shines in this respect and the BIOS supplied with the machine is by far the best I have encountered in any PC compatible. It seems to be free from the usual bugs which seem to plague some other machines.

Immediately after power-up the machine carries out basic diagnostics including a complete memory check then lists the current configuration of the system i.e: lists all boards plugged into the I/O expansion bus and then hands control to DOS. The BIOS also provides some of the more subtle features that are invariably omitted from other machines. As an example, depressing the "alt" key while typing in the decimal value of any ASCII character will result in the character being typed on the screen when the "alt" key is released. This is a useful feature that allows control and graphics characters to be checked without having to look them up and is a feature often omitted from compatibles.

Another useful feature is the operation of the cursor-up and cursor-down keys which in conjunction with the "alt" key allow a queue to be formed under DOS of any DOS commands or file names that might be in constant use at a particular time. The cursor-up and cursor-down keys allow scrolling through the queue until the desired command is found.

In summary, the Data System/1 is a particularly good PC compatible. It is well built and well supported and features an excellent BIOS. The system is available in a variety of configurations. One configuration that might be of particular interest to hackers consists of the base system (i.e: mother board, power supply, case and keyboard) and a single TEAC double density disk drive for a price of $1295 inc tax.

If you have been considering the purchase of a PC compatible but have been put off by concerns of possible incompatibility problems, then wait no longer. At a retail price of $1295 for the system outlined above plus the cost of your choice of video adapter and monitor, the Data System/1 represents real value for money.

— **David Tilbrook**

— from page 48

product review

PRICING

MODEL NO.	without backlight	with backlight
2518X-01	$368	
2518X-11		$491
2618X-01	$491	
2618X-11*		$613
2718X-01	$552	
2718X-11		$675

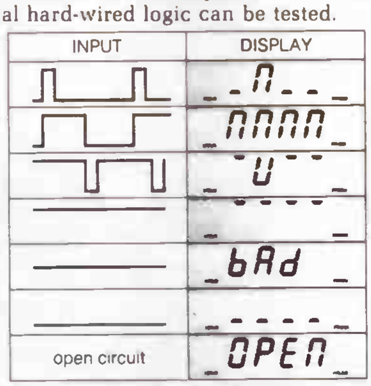
** A special 'medical applications' version is available providing mAs measurements. ($1073).*

Icing on the cake

It is in the differing special features available amongst these three instruments that the icing appears on the cake, so to speak.

The PM 2518 gives direct dB measurements on ac volts and at HF to 100 MHz, the latter feature again via optional probe.

The PM 2618 offers a logic display to show digitial activity at speeds up to 10 MHz. Duty cycle, bad levels, and open circuits are clearly shown, and levels up to 100 V can be accommodated so both microprocessor and industrial hard-wired logic can be tested.



This meter includes a frequency counter with a range of 1 Hz-200 kHz, and an analogue bargraph display. The display shows trend by movement of a gap: movement to the right shows a measured value is increasing, and to the left if decreasing. The bargraph can also be used to adjust to a set value, where a resolution of 0.3% is provided. Finally, this version of the Series 18 provides for dB measurements at 50 ohms and 600 ohms.

The PM 2718 has all the features of the PM 2618 plus Max/Min readout and built-in *data capture and hold* without external probe.

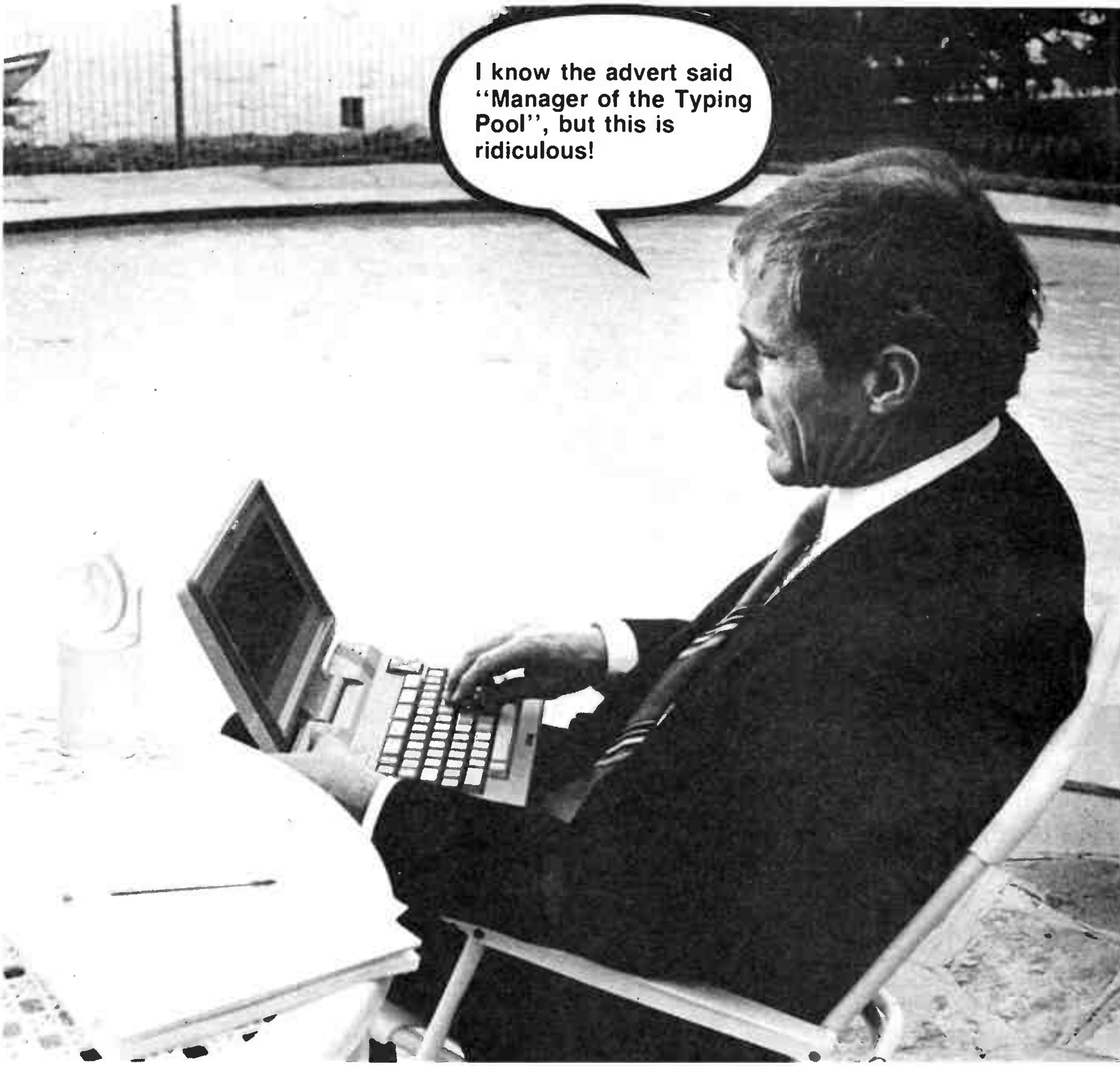
With the appropriate bus control unit all three instruments may be connected to computer equipment via the IEEE 488 bus, which allows automatic calibration (except on the PM 2518) as well as transfer of measured values.

There just isn't room to deal with all the features available on the Philips Series 18 DMMs, but the above may be enough to send you rushing round to **Philips, Test and Measurement, Box 119 North Ryde 2113, NSW, (02) 888 8222,** who kindly provided the meters for review. The accompanying table shows prices.

Whatever your choice, a Series 18 DMM will undoubtedly be a handsome and useful addition to your workshop.

— **Alan Ford**

The Last Laugh



WE HEAR of a new theory of electronics. A radical new theory. So radical, in fact, that not only is the electronics engineering fraternity having difficulty wrestling with it, but the physics community as well.

An esteemed colleague of ours spent many years in the servicing game. The stories he has to tell . . . ! But, most servicemen have their fund of amusing anecdotes, just like fishermen and motor mechanics, etc. However, said colleague's best yarn concerns a certain gentleman who aspired to be an electronics hobbyist — perhaps 'buff' would be a better term — who never quite got around to actually learning any of the fundamental physical precepts of electricity and electronics.

This fellow's penchant was to purchase secondhand radios, radiograms, TV sets etc. in various states of disrepair, and attempt to refurbish then, by the "eclectic empiricist" technique (— trial and error!). More often than not he'd get himself into deep water and appear on colleague serviceman's doorstep with a confused, sorry tale and beg aid in sorting out the mess.

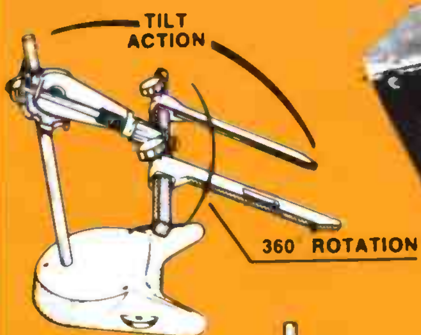
Being a patient man (a prime virtue of all servicemen) he'd sift the symptoms from the fantasies and, time permitting, go through the step-by-step deductive process of finding the fault, explaining it as he went — in the (vain) hope something might sink in.

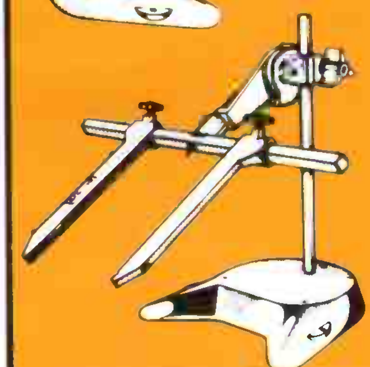
After some years, he felt he was making progress with this fellow. Alas, his dream was shattered the day he called in and announced that he'd finally worked out " . . . how electronic components work!"

"It came to me the other night as I watched a fault," he said excitedly. " . . . the parts are filled with smoke. That's what makes them work. When the smoke escapes, they work no longer!"

INDEXING P.C.B. HOLDER

LOCKS IN 32 POSITIONS





SCOPE
Model 333

TILT AND TURN ACTION – The New Panavise Model 333 rotates the P.C.B. and locks in any of 8 positions in 45° increments. It also Tilts and Locks at 4 angles - 0° (vertical) 45°, 90°, 120° and offers 200mm of vertical adjustment to the work height.

This design is for medium volume production of P.C. Boards and complements the Model 315 P.C.B. Holder which is more suited to the service and repair workshop.

HEAVY BASE – Heavy cast iron base is dedicated to this Model and provides excellent stability and has three mounting holes which permits permanent attachment to a work bench.

QUICK RELEASE ARMS – Spring loaded arms hold boards securely, and provide rapid loading and removal of similar sized P.C.B.'s.

Cross bars are available to 750 (30″) for working on large boards or multiple board work, using extra sets of arms.

AVAILABLE FROM

N.S.W.

Geo. Brown & Co	(02) 519 5855
Pauls Merchants	(02) 709 2311
Scruttons P/L	(02) 667 0511
D.J. Coulter	(049) 67 1455
J. Blackwood	(02) 609 0030
A.E. Baker	(02) 621 0044
Sheridon	(02) 699 6912
Martin Delannay	(02) 267 1055
Promark Electronics	(02) 439 6477

WESTERN AUSTRALIA

Atkins Carlyle	(09) 321 0101

VICTORIA

Radio Parts Group	(03) 329 7888
	(03) 211 8122
Geo. Brown & Co	(03) 419 3986
Ellistronics	(03) 602 3499
Ames Agency	(03) 328 3001
McGraths	(03) 347 1122
Ballarat Electronics	(053) 31 1947

SOUTH AUSTRALIA

Gerard & Goodman	(08) 223 2222
Protronics	(08) 212 3111
A.J.F. Electrical Dist.	(08) 269 1244
Graphic Electronics	(08) 42 6655

QUEENSLAND

Dunlop IBC	(07) 892 0011
St. Lucia	(07) 527 466
L.E. Boughen & Co	(07) 369 1277
Fred Hoe	(07) 277 4311
ECQ	(07) 376 5677
Magraths	(07) 832 3944

TASMANIA

G.H.E Electronics	Hobart	34 2233
	L'ton	31 6533

FOR A FREE CATALOGUE SEND YOUR NAME AND ADDRESS TO:
FREEPOST No.2
SCOPE LABORATORIES
P.O. BOX 63, NIDDRIE.
VICTORIA, 3042
AUSTRALIA
No Stamp Required

SCOPE
BOX 63 NIDDRIE
VIC 3042
TEL (03) 338 1566
TLX AA38318

Fulfilling the Promise of Digital, Monster Cable Introduces

INTERLINK® CD

Super High Resolution Compact Disc Interconnect Cables. Conventional cables run out of breath when trying to cope with today's sound. The incredible sonic capabilities of the compact disc player push all your components to their limit ... including your connecting cables. The detailed resolution, awesome dynamic range, and powerful bottom end available from your compact disc player are not fully reproduced when you use ordinary interconnect cables.

Why a Special Cable for Compact Disc? Interlink CD is specially designed to compensate for the transient and phase distortions of the digital process as well as minimizing some of the "harshness" found in some CD program material. Using our revolutionary "Bandwidth Balanced™" technology, we can control high frequency phase shift to produce a more enjoyable, musical sound; the bass is tighter, transients are quicker, and there's a greater 3-dimensional depth to the music.

If you listen to compact discs, let them sound their Monsterous best with Interlink CD. Please write for our free brochure.

MONSTER CABLE

Distributed by:
Convoy International Pty. Ltd.,
400 Botany Road, Alexandria,
NSW, 2015.
Telephone 698 7300.
Telex AA23111.