JUNE 1986 $3.30 NZ$4.50
AUSTRALIA'S TOP ELECTRONICS JOURNAL

The Australian Electronics Monthly

'ULTRA-FIDELITY' MOSFET AMP PROJECT

THE MODERN MULTIMETER

$80 AM stereo tuner — how good?

audio • video • computing • communications • projects • engineering • technology

Fluke. First Family of DMMs.

When accuracy, performance and value are important, professionals the world over look to Fluke — the first family of DMMs.

Reliable Fluke-quality 3½- or 4½-digit DMMs fit every need — from design engineering to industrial troubleshooting.

There's the low-cost 70 Series — the most DMM you can get for the money. The tough 20 Series — totally sealed and built to survive the dirtiest, grimiest, roughest jobs. The reliable 8020B Series — made to withstand the rigors of the field service environment. The precise 8060A Series — the most powerful and complete test and measurement system available in a hand-held package. And, of course, the versatile Bench/Portables that carry on the Fluke tradition for precision and durability in lab-quality bench instruments.

Fluke comes in first again with the world's largest selection of quality accessories to help extend the capabilities of your DMM even further.

There's no need to look anywhere else. Uncompromising Fluke design and leading edge technology are the reasons why attempts at imitation will never fool the millions of professionals that accept nothing less than a Fluke.

FROM THE WORLD LEADER
IN DIGITAL MULTIMETERS.

FLUKE®

ELMEASCO
Instruments Pty. Ltd.

N.S.W. 15 McDonald St, Mortlake. Tel: (02) 736 2888
VIC. 12 Maroondah Hwy, Ringwood. Tel: (03) 879 2322
QLD. 243 Milton Rd, Milton. Tel: (07) 369 8688
S.A. 241 Churchill Rd, Prospect. Tel: (08) 344 9000
W.A. 46-48 Kings Pk Rd, West Perth. Tel: (09) 481 1500

Talk to your local distributor about Fluke

• ***A.C.T.*** Actiec Pty Ltd (062) 80 6576 • George Brown 80 4355 • ***N.S.W.*** Ames Agency 699 4524 • George Brown (02) 519 5855 Newcastle 69 6399 • Bryan Catt Industries 526 2222 • Collier Tools 763 1888 • D G E Systems (049) 69 1625 • Davred Electronics 267 1385 • W F Dixon (049) 61 5628 • Macelec (042) 29 1455 Ebson 707 2111 • Selectro Parts 708 3244 • Geoff Woods 810 6845 • ***N. TERRITORY*** Thew & McCann (089) 84 4999 • ***QUEENSLAND*** L E Boughen 369 1277 • Colourview Wholesale 275 3188 • Fred Hoe & Sons 277 4311 • Nortek (077) 79 8600 • St Lucia Electronics 52 7466 • Selectro Parts (Qld) 394 2422 • ***S. AUSTRALIA*** Protronics 212 3111 • Trio Electrix 212 6235 • Redarc Electronics 278 7488 • A W M Wholesale • ***TASMANIA*** George Harvey (003) 31 6533, (002) 34 2233 • ***VICTORIA*** A W M Electrical Wholesale • Radio Parts 329 7888 • G B Telespares 328 3371 • Browntronics 419 3986 • R K B Agency 82 7704 • A J Ferguson 347 6688 • SIRS Sales (052) 78 1251 • Mektronics 690 4593 • ***W. AUSTRALIA*** Atkins Carlisle 321 0101 • Dobbie Instruments 276 8888 • Cairns Instrument Services 325 3144 • Willis Trading 470 1118

The Australian Electronics Monthly

THE STORY of Sir Clive Sinclair's rise-fall-and-rise-again career over the past two decades, sketched in our lead story in *News Review* this month, probably contains many lessons for us all. Sir Clive's tenacious persistence in pursuing a goal reminds me of the tale of that British folk hero of old, Robert the Bruce who, seemingly hopelessly trapped, took a lesson from a spider he observed who persisted in battling toward his goal, climbing and persistently slipping back, climbing — slipping back, but making progress nonetheless until the creature achieved its goal.

Undaunted by debacles and calamaties that would utterly defeat many businessmen — or maybe just not learning his lesson — Sinclair has walked away from yet another business defeat, the collapse and sale of his computer manufacturing business to a rival, ready yet again with fresh ideas in another area that he's willing to exploit. The amazing thing is, how he still manages to find financial backers ready to fund his latest scheme. Or maybe they're money market vultures ready to rip the still-warm flesh from his corporate carcase as soon as it stumbles along the way. I don't know, but there are those who have certainly profited from his past defeats.

For all his reported faults, one can't but help admiring the tenacity of the man and his ever-willingness to 'have another go'. His example shows us at least two things — how *not* to leave yourself vulnerable in the world of "high-tech" as well as how to maintain the right attitude in seemingly hopeless surroundings.

Roger

Roger Harrison
Editor

CONTENTS →

Roger Harrison VK2ZTB **EDITOR**

David Tilbrook B.Sc. **PROJECT DIRECTOR**

PROJECT ENGINEER
Tony Tilbrook (true!)
ADVERTISING SALES
Steve Collett
PUBLISHER
Adrian Farrow
DRAUGHTING
David Currie
PRODUCTION
Val Harrison
Angelika Koop
Clayton Folkes
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. (Hons.)
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, **Ph:** (02) 487 2700. **Tlx:** AA71460 Sydney Whats New; International AA10101 Whats New.

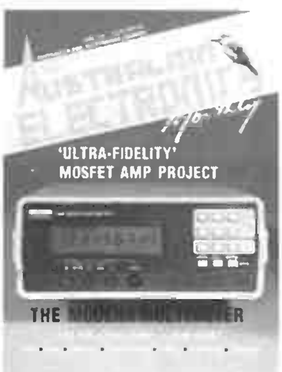
Subscriptions: $39.60 Australia, NZ$57 New Zealand; overseas rates on application.

Australian Electronics Monthly is published the 1st full week each month; printed in 1986 by Offset Alpine, Cnr Wetherill & Derby Sts, Silverwater, NSW, and distributed by Network Distributing Co. *Cover price $3.30 (maximum and recommended Australian retail price only; recommended New Zealand retail price, $4.50). Registered by Australia Post, Publication No. NBP 7435. ISSN No. 0815-5046.

OFFICE:
Fox Valley Centre, Cnr Fox Valley Rd & Kiogle St, Wahroonga NSW.
POSTAL ADDRESS:
PO Box 289, Wahroonga 2076 NSW
ENQUIRIES
Advertising: John Whalen (02) 487 2700.
Editorial: Roger Harrison (02) 487 2700.
Technical: Only after 4.30 pm EAST, David Tilbrook (02) 487 1483.

Melb Correspondent: Ian Boehm c/- Saddleton Cox, (03) 233 7933.
Qld Ad. Sales: Geoff Horne Agencies, PO Box 247, Kenmore Qld 4069; (07) 202 6813, Sue Horne or Rosemary Lergessner
W.A. Ad. Sales: Hugh Scott, 20/415 Charles St, North Perth WA 6006; (09) 444 8587

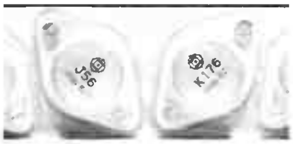
ADVERTISERS INDEX



COVER

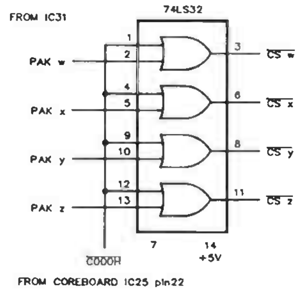
The 'face' of a modern DMM leads into our feature. Photograph courtesy of Tech-Sales. Design and production, Angelika Koop.

PROJECTS TO BUILD

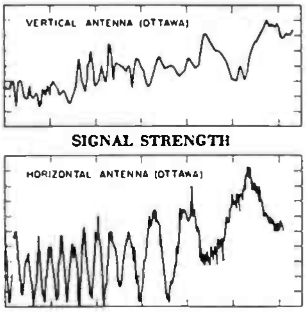


CIRCUITS & TECHNICAL

PRACTICAL COMPUTING



COMMUNICATIONS SCENE



CONSUMER ELECTRONICS

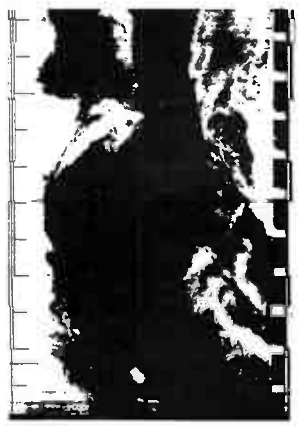
NEWS & GENERAL

SPECIAL OFFERS

NEXT MONTH!

1ST ANNIVERSARY ISSUE!
Who said we wouldn't make it? We're planning some very special treats for our July issue — just to celebrate our first year — and you, wonderful readers, will be the winners! ***Don't miss it!***

BUILD A 1 GHz DIGITAL FREQUENCY COUNTER
Held over from last month, unfortunately, awaiting the availability of some critical components. This project is remarkably simple to assemble and features an 8-digit readout with coverage up to 1000 MHz in three ranges.



SATELLITE FAX DECODER
This project's a sort of Listening Post for weather satellites. If you liked the Listening Post, this gadget will also appeal.

PERTH ELECTRONICS SHOW PREVIEW
The annual Perth Electronics Show is Australia's 'showcase' for the consumer electronics industry. Each year, the industry's 'movers and shakers' launch the next year's products to the trade and 'test public' in Perth — see what's in store for '86-'87.

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

FEATURE

Sir Clive Sinclair rises phoenix-like from yet another company crash

Once hailed as "Mr Microchips" in the British computing industry, and renowned for his string of innovative products produced over the last two decades, Sir Clive Sinclair's once thriving Sinclair Research computer manufacturing business was sold to Amstrad Electronics, run by pragmatist businessman, Alan Sugar.

Sinclair's career has been peppered with booms and busts, but he's inevitably bounced back to launch yet another innovative idea or product. In the 1960s, he had Sinclair Radionics which sold kits by mail order. It grew rapidly, but that became it's downfall for it was said it proved too much for Sinclair to handle as he is more the 'brains behind' than the frontman/manager.

Sinclair conceived a pocket calculator in 1972 and supervised its development and production from go to whoa — a mere nine months. The innovation involved was making the then current-hungry ICs run on very low current. Others saw its potential; the Americans copied it and cut the cost and price;, the Japanese devised more powerful ICs to drive it. They took his bat and ball and ran all round the world with it.

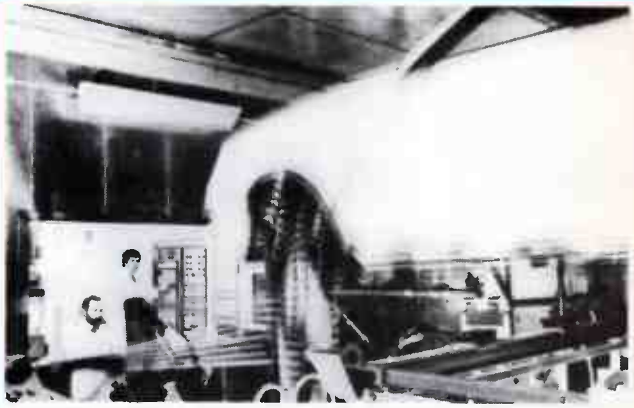
While everybody else got on with making a pile from his calculator idea, Sir Clive devised a revolutionary digital watch. While digital timepieces were not new then, Sinclair's approach, typical of his thinking, was to put all the circuitry on a single chip, reducing manufacturing costs in the process. This project foundered on the shoals of quality control.

Meanwhile, he'd devised a mini television. The rights to his original design were sold off at the end of the digital watch failure, but he had another go at it later. Sir Clive walked away from the digital watch episode with $20 000 and launched Sinclair Research. This time, he and his team came up with a winning low cost computer.

Sinclair's ZX80 and ZX81 home computers, limited as they were, brought very low cost home computing to 'the man in the street', helping to fuel the incredible boom in personal computers during the early '80s. In Britain, they were even sold in newsagents. But fierce competition and a slump in demand, followed by a price-cutting war, saw Sinclair Research in severe trouble early in 1985.

Pressured by banks and trade creditors, the sale of Sinclair's computer manufacturing business, valued at $274 million in 1983, was inevitable. It went to Alan Sugar's Amstrad for $10 million.

Sinclair, seemingly undaunted, is now talking of forming a subsidiary to exploit his work on wafer-scale integration which allows, for example, putting a complete computer system on a single slice of silicon instead of assembling it from individual ICs. The project is slated to cost over $100 million, to be funded by Barclays Bank.



"SHAKE RATTLE AND ROLL" BY COMPUTER

The roughest roads at Ford's You Yangs proving grounds in Victoria are duplicated in the laboratory by the use of computerised test equipment. Controlled hydraulic exciters "drive" the suspended vehicle as demandingly as any test driver. It's all made possible by programs written in DAOS, a language developed in Australia and specifically designed for real time data acquisition and scientific computing.

Originally developed for the PDP-11 family of computers, DAOS has now been posted to the MS-DOS operating system on the IBM-PC and compatibles. DAOS was first used in the field of bio-medicine, but is now widely applied in research and industrial laboratories throughout the world.

For information on DAOS and its applications, contact **David Boldiston, Laboratory Software Associates Pty Ltd, 12/35 Gertrude St, Fitzroy 3065 Vic.**

Australians to feature in sessions at international conference

Australia will make significant contributions at the 8th International Conference for Computer Communication (ICCC '86), to be held in Munich, Federal Republic of Germany, from 15-19 September, 1986.

Four conference sessions will be chaired by Australian delegates, some seven will present papers and one will be a panelist. Theme of the conference is "new Communication Services — A challenge to Computer Technology."

Some of the major issues to be addressed include: ISDN, local area networks, deregulation, electronic funds transfer, satellite and packet radio communications and social and policy aspects. The session on electronic funds transfer (session A8) will be of particular interest to sectors of the Australian community, we are assured.

If you lodge your registration for attendance before 1st August, it costs just DM770 (about A$440), jumping to DM870 (about A$500) after that date.

A 'Call for Registration and Advance Programme' brochure is available from **N.R. Crane, Manager — Public Network Services, Commercial Services Dept, Telecom Australia Headquarters, 18th Floor, 199 William St, Melbourne 3000 vic. (03) 606 5152.**

SBS to become corporation

The Special Broadcasting Service is reportedly delighted with the recent announcement by the Minister for Communications, Mr Michael Duffy, that legislation will be introduced next year making the SBS a broadcasting corporation from July 1st next year.

Executive Director of the SBS, Mr Ron Brown, said the legislation would enable the SBS to look toward a bright future, rather than fighting off negative rumours and amalgamation bids.

The move will free the SBS from a variety of Public Service regulations, providing it with greater financial self-control, and giving it greater powers over its own operations, their press release said.

Since its establishment in 1978, the SBS has been responsible for consolidation of multicultural radio station 2EA Sydney and 3EA Melbourne, plus the setting up of the SBS-TV network, which now operates exclusively on channel 28, Australia's first national UHF-only TV service.

When the SBC is formed in 1987, it will be controlled by a new board of three to seven members, each appointed for a term of up to five years. The current role of Executive Director will be replaced by a board-appointed Managing Director who will also be named for a term up to five years and be eligible for re-appointment.

Hitch a ride to the future

Tom King VK2ATJ

On December 12, 1901 the Atlantic was first bridged by wireless when a faint signal transmitted from the United Kingdom was received in Newfoundland. Nearly 85 years later and on the opposite side of the vast 'continent' of Canada visitors from throughout the world will gather for an exposition of transport, communications and the future which is at least partly a result of those early experiments of Guglielmo Marconi.

The glistening dome of the Expo Centre, Vancouver's newest landmark. Housed in here is the Omnimax theatre, the only one of its kind in Canada and the largest in the world.

IMAGINE being able to decide on the course of your future and then watching a screened performance based on the consequences of that choice. Ponder the possibilities of having your entire range of vision filled with huge images of racing across a lake in a high speed boat or roaring into a tunnel at the front of a speeding train. Consider the practicability of driving a wind-powered vehicle or strapping on a 'jet plant'. And then picture these futuristic-type activities all happening at the same time inside a 17 storey geodesic dome of stainless steel and white steel beams.

Don't dismiss these revolutionary ideas and structures as something that might happen or be developed beyond our lifetime. They are available here and now and for five and a half months they will be major attractions of Expo '86, Vancouver's World Exposition.

More than 15 million visitors are expected to be recorded during the 156 days of Expo '86 between May 2 and October 13. Located on a 70 hectare riverfront site in the heart of downtown Vancouver, British Colombia, Expo '86 is shaping up to be the biggest single event to be staged in Canada between 1986 and the end of the century. It will cost a total of $1.6 billion, of which $190.5 million will be contributed by more than 30 corporate sponsors.

One of the first major expenses was for the construction of the glistening geodesic dome known as the Expo Centre. This unusual building, which will remain as a pavilion of tomorrow, was dedicated on May 2, 1985, exactly one year before the commencement date for the brief opening of a 'window to the future'.

The high-tech domed Expo Centre, the port city's newest landmark, houses major exhibits which interpret the future in three different ways. The most prominent exhibit is the 500 seat Omnimax Theatre, the only theatre of its kind in Canada and the largest in the world. Omnimax has been called "the world's most breathtaking medium". The Canadian exhibition lives up to this rather sweeping description as an enormous 27 metre wide movie screen which engulfs its viewers with gigantic images nine times larger than shown on ordinary screens.

Another exhibit inside the Expo Centre is the 323 seat 'Futures Theatre' where members of the audience have the final word on the future. Visitors are first introduced to a show of dazzling computer graphics and laser illusions dealing with topics ranging from extraterrestial intelligence to brain implants. Fifteen screens, a 16 mm projector and 12 speakers heighten the drama of the presentation. The audience is then introduced to a series of future possibilities and asked to choose from these options. They vote through computer buttons set in the arm of each seat. The vote is then computed and the consequence of the majority vote is revealed through a second audio visual show.

The third exhibit is 'Design 2000', a walk-through exhibition of future technology. On display will be high-tech holography and space gear, a strap-on jet plane and alternative technology creations such as human powered aircraft and a three-wheeled cycle that will do more than 80 kph.

Not all the cinematic and technological wonders will be found in the eye catching Expo Centre, however. Described as a "giant leap in film technology" the CN IMAX Theatre will display the state of the future art . . . today. The star attraction of this theatre inside the Canada Pavilion will be the Canada National Film Board's production "Carrying Things", the first ever three-dimensional IMAX movie. Combining 3-D technology with the Canadian-developed IMAX system, 70 mm film is projected on a mammoth screen providing unparalleled quality and undistorted viewing from ▶

Hitch a ride to the future

any seat in the theatre. Polarised glasses are worn by the audience to view the realistic 3-D images.

In a separate theatre in the Canada Pavilion an entirely new film development, Scenography, will make its world debut. Through the complicated coordination of nine 35 mm projectors, nine rectangular screens and a single spinning sphere, 'scenographic' images will move from screen to screen, creating lifelike illusions.

The Australian Pavilion

The "World in Motion — World in Touch" theme will be universally displayed throughout the 80-plus Expo '86 pavilions, including the $6 million Australian exhibit. Commissioner-General for Australia, Mr John Landy and his team who will staff the Australian pavilion, will present Australia as a technologically advanced nation where communications and transport are vitally important in coping with our vast distances.

Many of the 50 000 Australians expected during Expo '86 will probably choose to fly with Canadian Pacific Air Lines, Canada's 44-year old international airline which links the 10 Canadian provinces and the Yukon Territory to five continents. (The Vancouver-based all-jet airline is one of the few carriers in the world to fly over the international dateline, the equator and arctic circle.)

Help from local radio amateurs

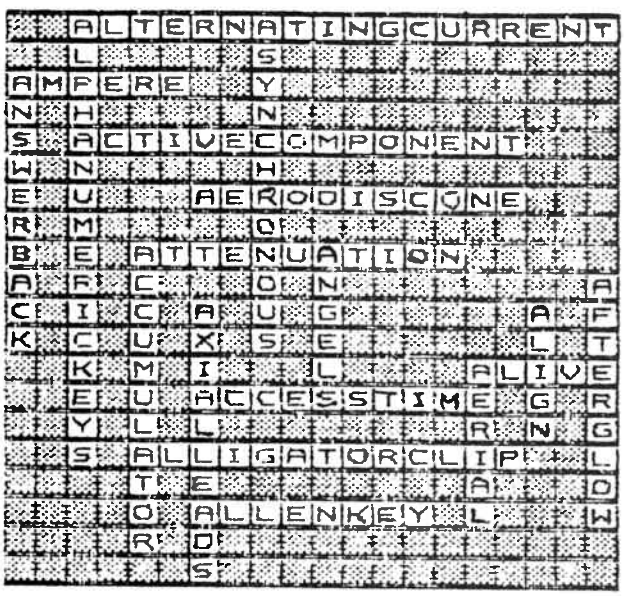
Nothing quite this advanced has yet hit the amateur radio scene in Canada although a number of the 25 000 hams (in the country of 25 million) are active with packet/OSCAR/moonbounce and/or ATV plus, of course, repeater operation.

In Western Canada amateur radio activities are concentrated in the Province of British Colombia where there are about 4300 amateurs. Roughly 2300 of these are situated in the 'lower mainland', in and around Vancouver. With five clubs, three two-metre band repeaters plus repeaters for 220 MHz, 440 MHz and 1.2 GHz FM, and ATV operations, it would seem that Vancouver-based amateurs would be in an ideal position to offer communications support for the 5½ months long Expo '86. They are . . . and coordinated efforts are being made for pavilion-based demonstrations showing the benefits and obligations of amateur radio while behind the scenes volunteers will man amateur radio equipment to provide backup communications at vital points throughout the exposition grounds.

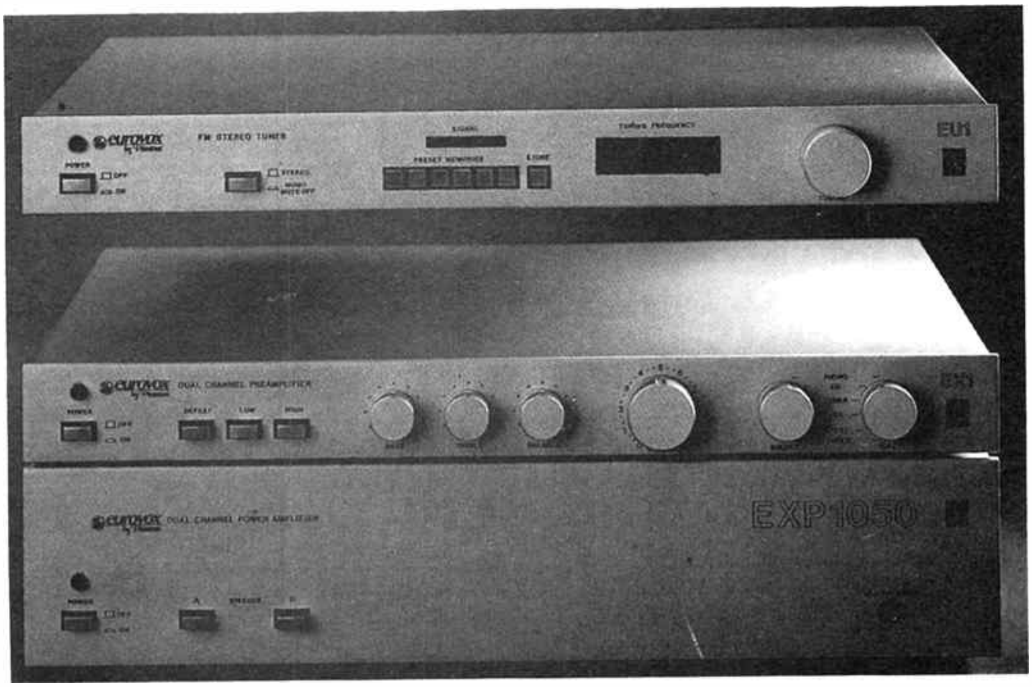
Vancouver amateurs are not newcomers to the public service aspects of amateur radio as they have been called upon — and volunteered — many times before. There's no doubt that the immensity of Expo '86 will be their biggest ever communications challenge but it may not be their most stimulating assignment. Several years ago amateur operators in Vancouver were called upon to provide communications assistance and security for an open house at a local nudist colony!

The Canada Pavilion dominates the port city's waterfront and houses a CN IMAX Theatre where films combining 3-D technology and the Canadian-developed IMAX system will be projected on a mammoth screen to put the audience in the scene with undistorted viewing from any seat in the theatre.

ANSWERS TO THE WELLER CROSSWORD COMPETITION NO.9.



Kangaroo and the Kiwi launch locally-made hi-fi range



The Melbourne-based company Eurovox, best known for their superb range of car sound equipment, has joined forces with New Zealand's Perreaux and developed a range of hi-fi components, marketed under the slogan "Now you don't have to sit in your car to listen to great hi-fi."

Three stereo components have been released — an FM tuner, a 'dual-channel class A' preamp and dual-channel power amp known respectively as the EU1, the EX1 and the EXP1050. All are 17-inch (non-rack) units and will be manufactured by Perreaux under the Eurovox label.

The tuner features a claimed frequency response of 30 Hz to 15 kHz +/- 0.3 dB, a stereo separation of 55 dB, THD of 0.12% in stereo and 0.1% in mono, a sensitivity of 17.5 uV for 50 dB quieting and a S/N ratio of 70 dB in stereo.

The EX1 preamp features both MC and MM input, plus CD, tuner, aux and two tape inputs. Frequency response is claimed to be 20 Hz to 20 kHz +/- 0.25 dB with tone controls defeated. The rated output is given as 1.5 V RMS into 10k or higher load. Distortion is quoted as 0.008% on the phono input across the bandwidth, and less than 0.002% for all other inputs, rising to 0.02% before overload. Noise on the MC input is quoted as -60 dB re rated output, -75 dB for the MM input and -95 dB for all other inputs. Channel separation is given as 60 dB across the bandwidth.

The EXP1050 power amp is rated to deliver 100 watts RMS per channel continuous into 8 ohms (both driven) from 20 Hz to 20 kHz at no more than 0.03% THD from 0.25 W to rated output. Distortion is quoted as typically 0.006% THD, with 0.009% IM. Dynamic headroom is rated at 2 dB, with amplifier saturation given as 300 W per channel into 8 ohms. Claimed bandwidth is -3 dB from 10 Hz to 200 kHz re rated output. Hum and noise is quoted as 100 dB below rated output across 20 Hz to 20 kHz.

Styling is 'plain and simple', eschewing the 'audio Christmas tree approach', according to the company literature.

Apart from their new hi-fi range, Eurovox has released a new range of car sound equipment and accessories and announced they will also be distributing Perreaux hi-fi and pro-sound products in Australia. Eurovox comes from "euro" — being the biological name for the largest species of kangaroo, and "vox" — the Latin for voice.

Further details are available from **Eurovox Australia, 6 University Place, Clayton 3168 Vic. (03) 561 5244.**

Pluck stereo sound from thin air!

Manufactured by MFJ Enterprises of Mississipi USA and distributed in Australia by GFS Electronic Imports in Victoria, the MFJ-1501 stereo synthesizer is designed to provide high quality synthesized stereo from a TV or video recorder.

The unit connects between the audio output of a VCR, or across a TV speaker, and the Aux input of a stereo system. The technique used to derive the stereo is similar to that used by most TV stations when operating from a mono source. It is also the same as record manufacturers use when they produce a stereo LP from an old mono recording.

The MFJ-1501 is equipped with two mono inputs which are switchable and allow for other sources to be used such as a portable electronic organ or AM radio. Operation is from 240 volts ac or 12 volts dc for portable mobile operation.

The unit is furnished in eggshell white with wallnut grain sides and measures 126 × 50 × 152 mm. Price of the MFJ-1501 stereo synthesizer is $305 including postage within Australia. For further information contact the Australian distributors, **GFS Electronic Imports, 17 McKeon Road, Mitcham 3132 Vic.**

New Spectrum speakers to cost less

Hughes Communications has announced the release of three new models from their Spectrum range of loudspeakers. Designated Models One, Two, and Three respectively, the new loudspeakers retain many of the innovative features of the previous series VI.2, VII and VIII.2.

Streamlined production techniques have also allowed a significant price reduction for each new model; for example, the top-of-the-line Model One now sells for a recommended price of only $1349.00.

The Model Two is the redesigned "SP7" which received critical acclaim in the Hi-Fi press last year says Hughes. Its price will be $849.00, while the new Model Three, derived from the famous "Spectrum" bookshelf unit, will sell for just $399.00.

Sole distributor, Hughes Communications, will be pleased to provide interested parties with further details on **(03) 568 0612.**

Welcome to the 1986 PERTH Electronics Show

Make your plans to attend Today!

It's the most important Electrical and Electronic Event in 1986.

P.E.S., the most complete Consumer Electronics Show in Australia. You'll be able to view and preview the latest in home and car audio, home and portable video, personal computer hardware and software, personal electronics, photographic, satellite earth stations, home and kitchen appliances, white goods, brown goods and much, much more.
With over 200 companies represented, it's an ideal time to plan your Christmas buying!

SPECIAL AIRFARE & ACCOMMODATION ARRANGEMENTS

7 night package including Ansett airfares. And staying at the Parmelia Hilton Hotel.

	Per Person Twin Room
Ex Brisbane	$906
Sydney	$868
Melbourne	$798
Adelaide	$722
Launceston	$856
Hobart	$872
Townsville	$886
Mackay	$1,012
Extra Night Per Person	$35

3 night package also available.

Exclusive Trade and Media Only Day Wednesday, July, 30th

- Opening Ceremony and luncheon 11.30am to 1.15pm.
- Trade admitted from 1.30pm until 8pm. By invitation or by suitable identification. Free admission to bona fide members of the industry and media, aged 18 years and over.

PUBLIC ENTRY. Thursday, July 31st — Sunday, August 3rd.

TRADE CONFERENCES AND SEMINARS MEETING ROOMS.

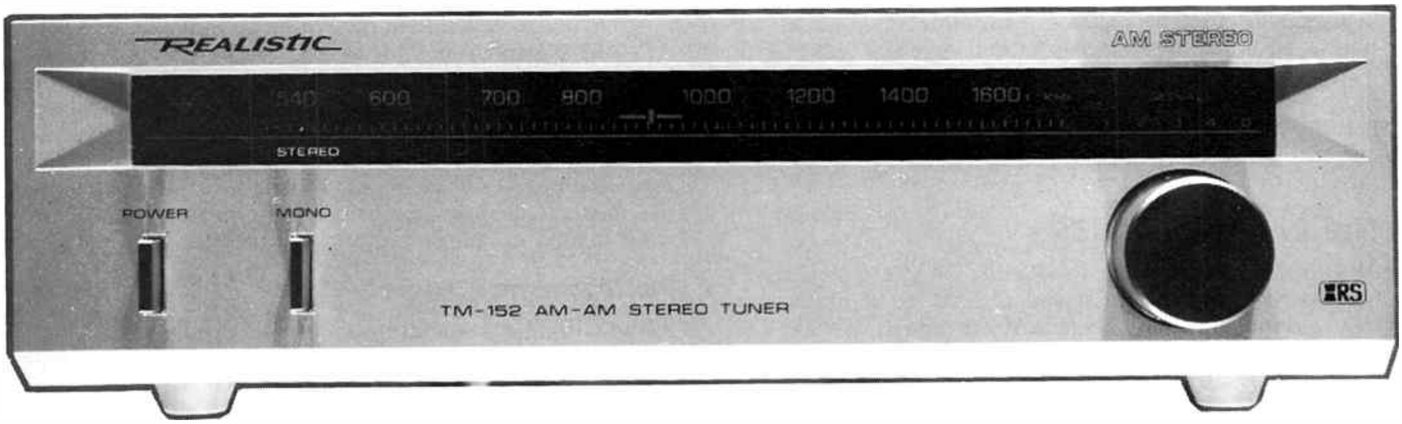
This year's seminars will cover a wider range of topics — full programme to be published later.
Separate meeting and conference areas are also available on request.

LOCAL RETAILER INVOLVEMENT

W.A. retailers will be encouraged to mount electronic show window displays. Starter kits will be issued, free of charge, upon request from exhibitors, who can then distribute to their retailers.

All bookings and enquiries must be made through the offices of Jebsens Travel P/L.
4th Floor, 231 Miller Street,
North Sydney, NSW 2060
Telex 70284 JEBRED. Telephone (02) 922 4300

For further information on the Perth Electronic Show contact The Manager, Chris Gulland.
Perth Electronic Show
PO Box 745
West Perth 6005
Telex 92952. Telephone (09) 382 3122



Tandy's low-cost AM stereo tuner

Robert Fitzell AAAC

This month's review item is a budget stereo AM tuner, the Realistic TM-152. The tuner is a little unusual in that it provides for AM only and is therefore of interest to AM enthusiasts, as well as those already having FM tuners but without stereo AM capability.

FOR MANY YEARS stereo AM broadcasting has been theoretically possible. However, due to combined effects of apparent apathy of the industry, together with the growth of the home hi-fi where the public accepted (even preferred) that if you wanted high quality sound you got it from your record player, stereo AM broadcasting remained in the realm of the theoretical. FM broadcasting has, however, changed that complacency. With high quality stereo programmes of great variety now being available, the pressure for technical improvements for the AM band to maintain competitiveness has resulted in demand of broadcasters for stereo.

Stereo AM broadcasting is now widespread, at least in the capital cities. One of the ironies is, however, that few of us can receive and appreciate the stereo option. It takes little business acumen to realise that electronic equipment manufacturers have had little reason to develop and produce stereo AM receivers to date, so few of us will have a stereo AM receiver. The Realistic (Tandy) TM-152 is an economical way to add stereo AM reception to your home hi-fi. You'd be hard pressed to build a unit like this for yourself at the price.

Big Brother is watching

One of the reasons that good ideas can take a long while to reach the public market is government control/intervention. In case you have ever wondered why government regulation of broadcasting is necessary, imagine what would happen if broadcasters could transmit at any frequency or strength. That would be a situation rather like driving in traffic where cars could be any width, travel in any direction and at any speed. I think the arguments would be frequent.

Before stereo AM could be introduced it was necessary for the transmission coding method to be agreed upon — rather like deciding that if two-way roads were to be introduced we had better all know which side to drive on. In the case of AM stereo it was necessary to agree on a system which enabled 'old-fashioned' mono AM receiver equipment to still receive the new stereo broadcast signal (in mono), as well as the new stereo receivers being able to receive mono signal from those transmitters operating in mono only. The last thing we would all want is a situation like that which existed with computers where nobody could read anything but their own software (still rampant! — Ed.)

The C-QUAM system

The stereo system adopted for Australia is the Motorola C-QUAM (*compatible quadrature amplitude modulation*). Briefly, this method achieves stereo transmission by transmitting separately modulated carriers at the same frequency but with phase 90 degrees apart. The method is similar to that used in colour television transmission. Without wanting to become too involved in the details of C-QUAM, audio matrixing of the two stereo channels provides the exciter with a left-plus-right channel (L + R) and left-minus-right (L - R) channel audio signal. The L + R information is used to produce an in-phase AM signal, while the L - R information is used to ▶

REVIEW ITEM:	AM Stereo Tuner
MANUFACTURER:	Realistic (Tandy)
MODEL:	TM-152
FORMAT:	Free-standing mini-size component
PRICE:	$119.95 catalogue list price, on sale price $79.
SUMMARY:	What can one say?

generate a 90 degree phase-shifted double sideband suppressed carrier signal. Summing both these signals results in a signal that is both phase and amplitude modulated, permitting two separate channels to be decoded by the receiver.

A major advantage of the Motorola C-QUAM system over those with which it competed for the AM stereo market is that the L + R information is standard mono AM material, permitting its reception by existing sets without added distortion.

The Realistic TM-152

As you will have guessed, the Realistic TM-152 used the C-QUAM system. Simply dissected, the TM-152 comprises two main circuit chips, one being the Matsushita RF/IF stage with associated station tuning, and the second the Motorola MC13020P C-QUAM chip used for stereo decoding. The rest of the circuit comprises two output drive stage circuits for left and right channels, power regulation circuitry, and a LED drive chip for the panel display. Electronically, it's quite a simple unit. There is an in-built ferrite bar antenna with rear terminals for connection of an external antenna. The unit is a tuner only, not a receiver, and needs to be connected via RCA sockets on the rear to a preamplifier/amplifier for anything to be heard.

The TM-152 is quite attractive, having an aluminium (plastic) finish front panel with the cabinet fabricated from plastic woodgrain finished hardboard. The front panel layout is simple and clear, with a linear dial covering the full reception range of 520 to 1620 kilohertz. Signal strength is monitored on a 5-LED display enabling easy tuning, while stereo reception is indicated on a single LED. Power-on and stereo/mono are the two front panel buttons, mounted opposite the large tuning knob.

Functionally the unit works well, except that the tuning knob is slippery and annoyingly variable in stiffness, If you like one or two stations this will be no problem, but if you want to station jump, the knob will be a little annoying.

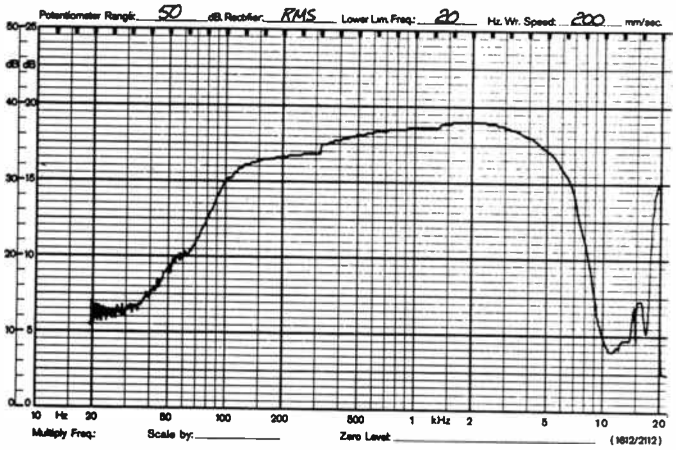


Figure 1. Frequency response, mono reception, 100% modulation level.

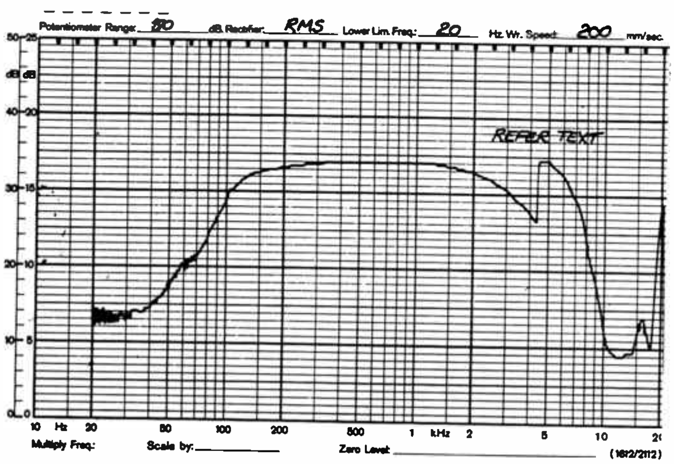


Figure 2. Frequency response, stereo reception, 100% modulation level. The stereo decoder 'lost lock' at around 4 kHz — see the main text.

Performance tests

Along with most new things comes the problem of what or how to test. Much of our standard testing could not be done since we could not transmit the analysis test signals, being instead restricted to those available on the exciter and synthesizer used for the tests. As a result some aspects of performance of normal interest have not been tested, although the testing has still given a reasonably good indication of the TM-152 performance.

For those interested in the test sequence, the program was:

Equipment: *Exciter* — Delta Electronics Model ASE-1.
Synthesizer — Delta Electronics Model CQS-3
Signal Analyser — Hewlett Packard Model 3561A
Level Recorder — Bruel & Kjaer Type 2305
Oscillator — Bruel & Kjaer Type 1022

The CQS-3 synthesizer was converted to a transmitter frequency of 945 kHz whilst the ASE-1 exciter transmitted at 1080 kHz. These frequencies were uncomfortably close to 2UE and 2UW at 954 and 1071 kHz and meant that particular care was needed to ensure that tuning of the broadcast station was nulled. To ensure that proper coupling of the transmission signal was achieved the tuner cabinet was removed, the output of the synthesizer was driven into a 50 ohm load and coupled into the ferrite antenna of the tuner.

Frequency response was measured using both swept tone and random noise sources input to the exciter, although the swept tone proved more informative.

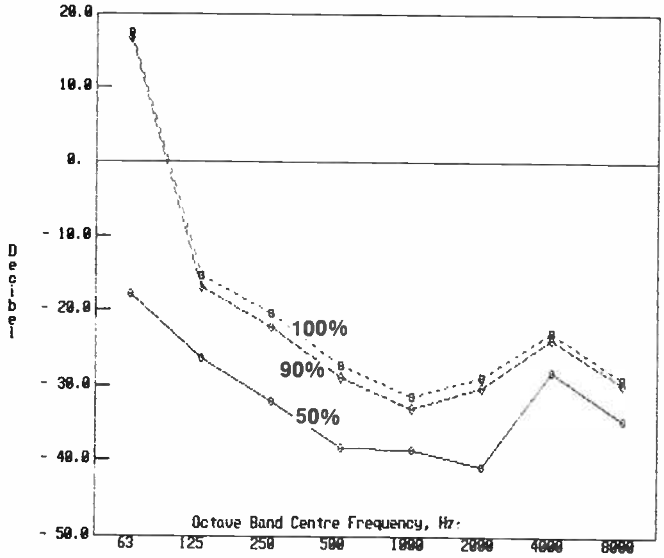


Figure 3. Distortion performance of the L-R (phase modulated) channel in stereo operation at three modulation levels.

Distortion was measured at octave centre frequencies with the standard four percent 25 Hz pilot tone for various levels of signal modulation. Amplitude modulation distortion performance was measured from L + R distortion tests, while phase modulation distortion performance was measured from L - R distortion tests. Distortion in AM tuners is very sensitive to tuning accuracy. We found the resolution of the 5-LED tuning indicator to be inadequate for the distortion tests, and instead tuned the unit manually for the lowest distortion results for each test condition.

Test results

Figure 1 shows the swept tone frequency response of the TM-152 operated in mono for a 100 percent modulation signal. Performance is approximately 125Hz - 6 kHz for a +/-3 dB envelope, which is far from stunning but 'par for the course' with many AM tuners available.

Figure 2 shows an interesting problem, experienced during testing, where the tuner could not hold stereo reception for the swept tone beyond about 4.25 kHz and switched to mono reception. Immediately apparent is the considerable increase in sensitivity for monaural operation, as well as the slightly flatter frequency response for stereo mode. The response is, however, only 100 Hz - 4 kHz for a +/- 3 dB envelope, which is hardly exciting. Careful comparison of Figures 1 and 2 will show that the low frequency response, or sensitivity, for the TM-152 is identical for both mono and stereo, and whilst the stereo response remains relatively flat above about 200 Hz, the mono response departs quite abruptly at about 320 Hz with a presence lift centred on 2 kHz. I have not been able to explain the cause of the very substantial increase in signal at 20 kHz apparent in both Figures 1 and 2.

Figure 3 shows the results of numerous distortion tests for the phase modulated L - R channel information. Figure 3 shows distortion to be a function of both frequency and modulation, much as one might expect. Mid-frequency levels are in the order of minus 30 dB and nowhere near as good as distortion performance of magnetic recording tapes.

The MC13020P data sheet shows that the chip has a distortion specification of 1% (-40 dB) in stereo mode, but does not say at what modulation level or audio frequency. In this respect, it seems the TM-152's performance is primarily determined by the detector specifications.

Figure 4 we cannot explain, perhaps a reader can. Shown are the results of distortion tests for Left and then Right channels separately, at three modulations. Distortion is again seen to be a function of frequency and modulation, although why the right channel is almost unbelievably higher than the left channel we do not know. We can only assume that our test configuration was in fact testing at an over-modulated state, and the results for the right channel therefore should be viewed cautiously.

Figure 5 shows the results of distortion testing for L + R, or monaural, at various modulations. Again, distortion is clearly a function of frequency and modulation. The high values for 63 Hz should be ignored, as the frequency response results of Figures 1 and 2 show that the response at low frequencies is well down and the apparent distortion is due to poor signal-to-noise ratio. Typical distortion may be seen to be in the order of minus 25 to 35 dB, again well below that of recording tape. Note that increased distortion was found at 1 kHz for low modulation levels.

Here again, it seems the distortion performance in mono reception is determined primarily by the MC13020P detector specifications. The data sheet quotes 0.5% (-46 dB), but ▶

TABLE 1: Test results summary, Realistic TM-152

Frequency response:		
mono, 100% modulation		125 — 6 kHz +/- 3 dB.
stereo, 100% modulation		100 — 4 kHz +/- dB.
Total harmonic distortion @ 1 kHz:		
Phase modulated, L - R,	50%	-39 dB
	90%	-33 dB
	100%	-31 dB
Amplitude mod., L,	25%	-37 dB
	50%	-36 dB
	75%	-23 dB
Amplitude mod., L + R,	25%	-35 dB
	50%	-39 dB
	75%	-42 dB
	95%	-39 dB
	100%	-31 dB
	125%	-18 dB
Carrier frequency drift capacity:		**+/- 250 Hz**

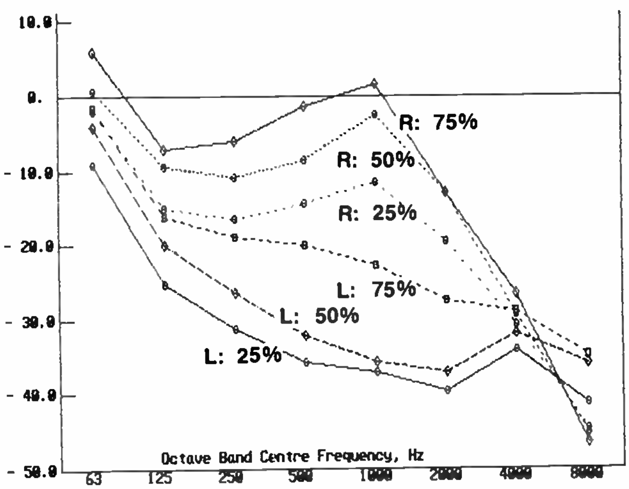


Figure 4. Distortion performance of the left and right channels in stereo operation at three modulation levels. For some reason the right channel distortion is substantially higher than the left channel.

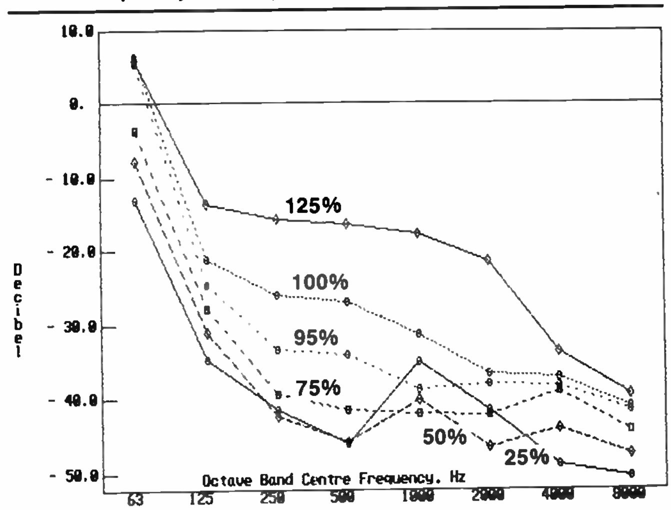


Figure 5. Distortion performance, AM reception (L+R) at modulation levels from 25% to 125% (over-modulated). Note the increase in distortion at 1 kHz at the lower modulation levels.

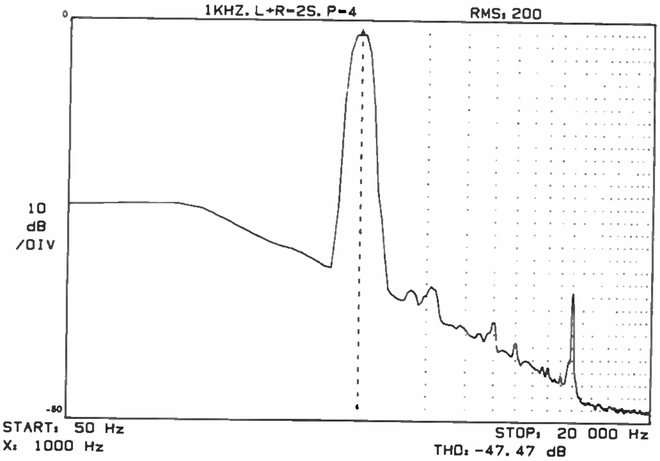


Figure 6. Spectral analysis of 1 kHz distortion at 25% modulation, L + R (AM reception).

does not say at what modulation level or audio frequency. Note the mono (L + R) THD result of -42 dB at 1kHz and 75% modulation level in Table 1.

Figures 6 and 7, giving distortion spectrum analysis at 1 kHz for modulations of 25 percent and 100 percent respectively, are included to show the marked increase in distortion products at higher modulations.

Figure 8 shows spectrum analysis of distortion products for 100 percent modulation for both stereo and monaural reception with a 500 Hz tone. Distortion products are equal. However, stereo reception results in greatly increased system noise, over 20 dB higher at frequencies just below the fundamental!

Figure 9 shows the results of impulse testing, which are slightly better than expected. Whilst the response is ragged, high frequency roll-off appeared to extend further under impulse testing (to over 7.5 kHz) than for swept sine wave testing.

Carrier frequency drift testing showed the TM-152 coped with a frequency variation of +/- 250 Hz.

Subjective testing

I would have to say that subjective testing confirmed the results of frequency response tests. The tuner does not produce high fidelity sound, although the quality is clearly improved by the stereo reception. By comparison with FM tuners, the AM tuner is clearly second choice for listening quality. A constant problem with AM broadcasts, particularly at night, is the limited bandwidth and station separation, giving rise to high frequency whistling at around 9 kHz due to interference from other stations about 9 kHz away in frequency. Expensive AM tuners incorporate filters at frequencies corresponding to licenced transmission frequency separations to eliminate the problem whilst lower cost units such as the TM-152 rely on rapid roll-off of high frequency response to reduce the problem. Unfortunately, an inevitable result of this is lost performance. My own experience has been that the tuner suffers AM interference and noise in the same manner as most budget AM tuners or receivers that I have used. The TM-152 has provision at the rear for attaching an external antenna. For best results, particularly in obtaining improved signal-to-noise ratio (especially for stereo reception), I would recommend the use of an external antenna.

For speech intelligibility, the bandwidth covered by the tuner is more than adequate while for music, quality of reception is adequate for non-critical listeners. One thing did make an impression on me — station programming is still way behind the FM rivals. Stereo AM receivers are not common beasts, and if you already own an FM tuner and are interested in adding dimension to your listening, then the TM-152 tuner is probably worth looking at.

We are indebted to John S. Innes for the loan of the exciter, synthesiser and willing assistance.

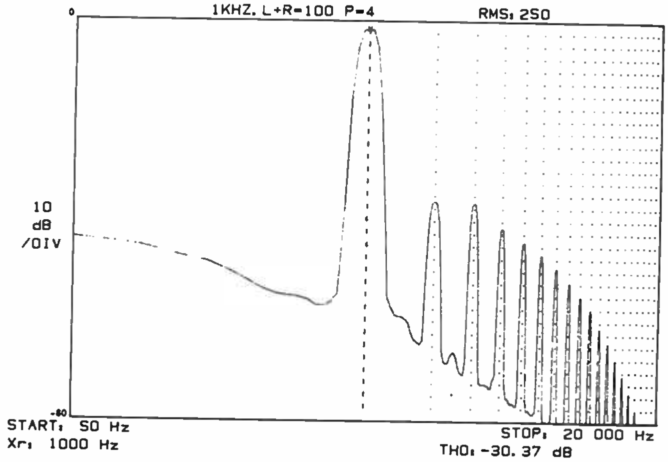


Figure 7. Spectral analysis of 1 kHz distortion at 100% modulation, L + R (AM reception).

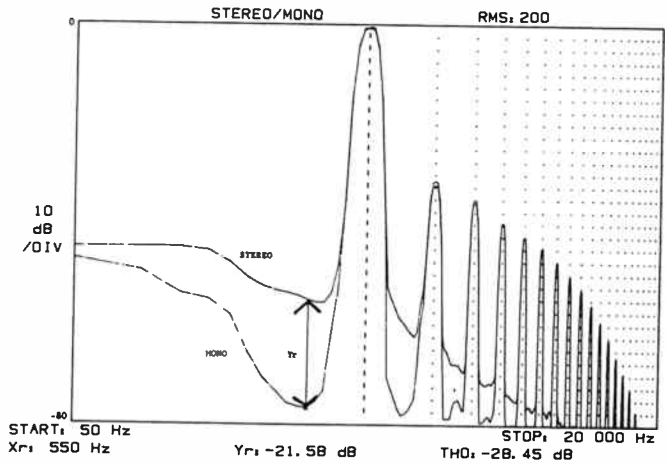


Figure 8. Distortion, stereo versus mono reception. Note the increased noise floor on stereo reception (Yr).

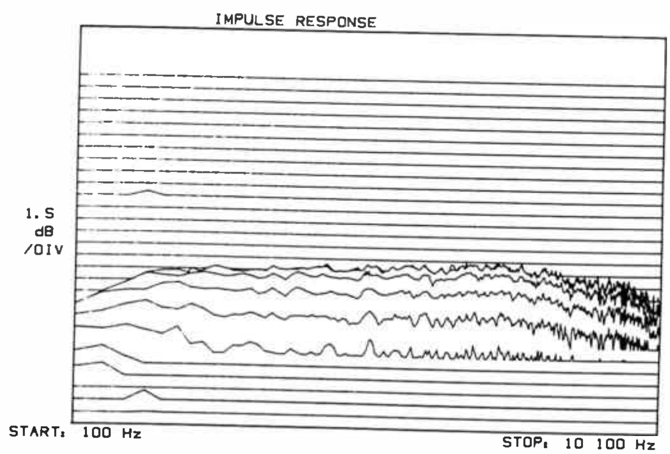


Figure 9. Impulse response testing reveals a frequency response out to 7.5 kHz.

Compact new soldering station features zero-crossing temp. control

A soldering station featuring zero-crossing temperature control of the iron has been released in two models by Hakko Metal Industries through the Heyden-Spike Co. in Australia.

The Hakkomach-II models 925 (240 V direct mains operated) and 926 (24 V transformer operated) each feature a zero-crossing on/off heater element control for electrically noiseless operation.

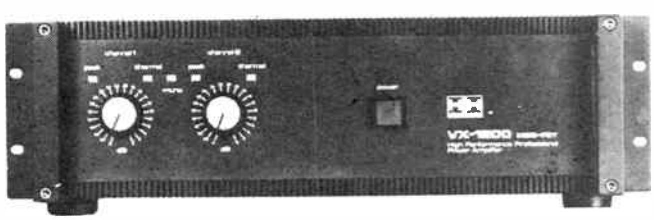
The temperature control is housed in the 'station', which results in a compact, lightweight, easily handled iron 170 mm long which should reduce the likelihood of operator fatigue. Fully variable potentiometer temperature control is provided, giving a tip temperature range from 160 degrees C to 420 degrees C at saturation. Hakko claim heat-up takes just two to 3.5 seconds.

Some nine tip styles are available with diameters ranging from 4 mm to 0.5 mm. Hakko claims their ceramic heater permits bigger thermal capacity and faster thermal recovery.

Heyden-Spike also has available the Hakko Ace Model 481 vacuum desoldering tool. This features a gun-type construction and dual steel wool/felt filter set. Four tip styles are offered with external/internal diameters ranging from 2.5/0.8 mm to 3.0/1.6 mm. This tool also has a ceramic heater element.

Further details available from **Heyden-Spike Co. Pty Ltd, Unit 1, 91-93 Old Pittwater Rd, Brookvale 2100 NSW. (02) 938-1566.**

Pro amplifiers from Klarion



Klarion Enterprises Pty Ltd has introduced a range of professional power amplifiers by the British company HH Electronics Ltd.

The range, called the "VX" Series, is claimed to be the latest in power amplifier technology, the result of years of development. HH is well known in the world of professional 'live' sound as one of the most reliable amplifier brands on the market, able to withstand the rough and tumble of road tours and one-night gigs. Most of the major sound hire companies carry HH equipment, which is a favourite among professional bands, Klarion say.

The HH VX Series offer a wide range of power ratings through seven definitive amplifiers. The amplifier range is evenly and practically spaced from 150 to 1200 watts.

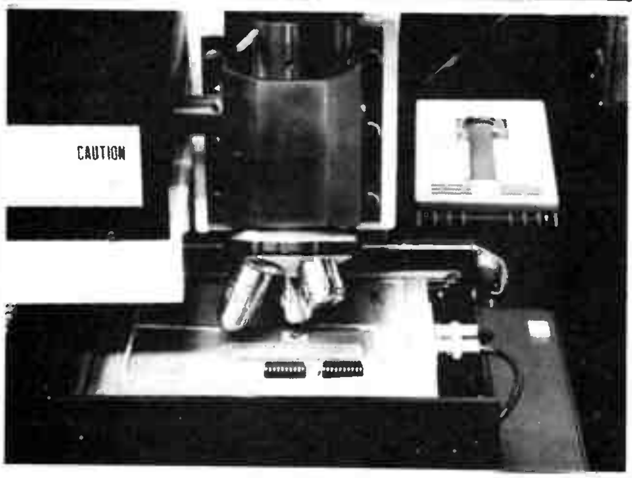
Klarion says that HH's superior engineering has resulted in the VX Series' smaller size and lower weight, generating valuable savings in the rack space required and transport costs without compromise to durability and performance.

VS Series amplifiers are said to provide ultra low distortion through the use of MOSFET technology, which gives an absolutely neutral sound quality and eliminates all forms of audible distortion.

The wide bandwidth, fast slew rate and relatively low amounts of negative feedback guarantee effortless transient performance and exceptional stability, say Klarion. Because of this inherent thermal stability, protection circuits are greatly simplified, allowing clean performance into highly reactive loads such as electrostatic loudspeakers or transformers.

HH VX amplifiers promise to deliver high frequency, high power signals without difficulty and stay cool even under the toughest conditions, it is claimed.

Further information from **Karl Seglins, Klarion Enterprises Pty Ltd, 16 Suakin St, Pymble NSW 2073 (02) 449 5666.**



LASER 'EYE' FOR VLSI

The Matsushita Electrical Industrial Co Ltd of Osaka, Japan, has developed a laser probing technique for fault diagnosis in very large scale integrated circuits. Conventional LSI probing methods are done mechanically, detecting faults with a needle. However, as the integration of LSIs increases, the need for non-contact probing methods using electron beam or laser beam are increasing.

In Matsushita's new system, a laser beam is used which eliminates the electrical damage, known as 'charge-up'', caused by electron beams in VLSI fault diagnosis. The system can be operated under ordinary atmospheric conditions, unlike electron beam methods that require a vacuum.

The entire system is computer-controlled. Its fault-diagnosis software, also developed by Matsushita, links the system to a data base of LSI circuit designs, enabling more efficient fault diagnosis, the company says. Because the system's laser beam is narrowed to 1 um, Matsushita's new laser probing can be applied to VLSIs fabricated in sub-micron rule (currently the densest integration made), they say.

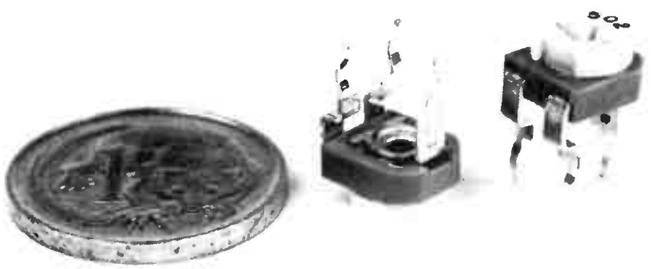
New 5½-digit DMM

Elmeasco Instruments has announced the introduction of the Fluke 8842A 5½-digit multimeter. The 8842A is the second meter in the highly successful 8840 family, and provides a natural complement to the widely accepted Fluke 8840A, Elmeasco say.

The 8842A offers enhanced measurement capabilities for such applications as production test or research and development, Fluke says. It features 0.003% basic dc accuracy and 0.08% basic ac accuracy (at one year).

It also features 100 nV resolution for dc voltage measurements, 1 μA resolution for dc current measurements, and 100 micro ohm resolution for resistance measurements. The unit is hermetically sealed and uses proprietary thin film resistor technology. Fluke give it a two year calibration cycle and warranty period.

An IEEE-488 interface and true RMS options can be added. User selectable reading rates are standard. Three rack-mount kits are available (for single or dual meter applications). The 8842A also comes equipped with an adjustable tilt bail/handle for bench use. Contact **Elmeasco** in your state for details.

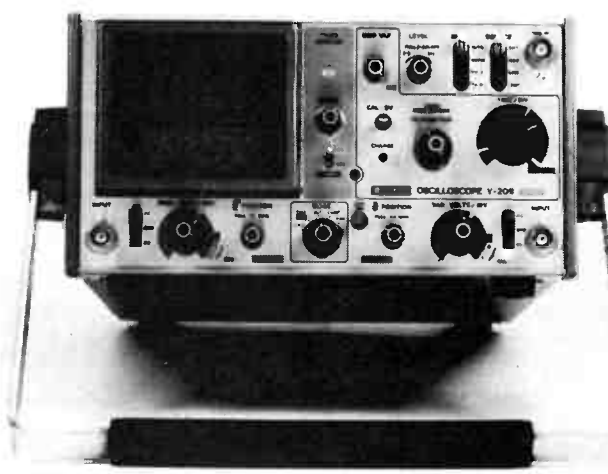


Resin-moulded trimpots

Soanar Electronics has announced the inclusion of resin-moulded trimpots in their extensive range of electronic components. Known as 'type VTL,' these miniature trimming potentiometers are manufactured in Japan by Koa Denko Co. Ltd, and offer a very low cost alternative to cermet film trimpots, Soanar say.

Owing to the moulded construction, the VTL offers greater resistance to solder heat and flux interaction than normal types of trimpot, the company claims. This makes them ideal for automatic insertion, wave soldering and automatic adjustment and cleaning processes in accordance with the latest assembly techniques. They are supplied in plastic tubes for this purpose.

Resistance values range from 200 ohms to 1M and pin spacing is based on the industry standard 5 mm grid. Further detail is available from the Soanar Branch in your state or by writing to the head office address, **Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill 3128 Vic. (02) 895 0222.**



Mini portable dual-trace CRO

Bell-IRH has released a 20 MHz mini portable oscilloscope by Hitachi, model V209, capable of operating from the mains supply, or 12 Vdc for two hours of continuous use.

It is lightweight at only 5 kg and measures 110 × 215 × 350 mm. This makes an ideal oscilloscope for field service but just as useful for research and development, Bell-IRH say. It has a 3.5"-high luminescent high-resolution CRT with internal graticule, 1 μV/div vertical sensitivity and 0.5 μ sec/div to 0.2 sec/div with × 10 magnifier to 50 nsec/div timebase.

Included is a TV sync separator with 'one-touch' synchronisation of horizontal and vertical signals. As with all Hitachi oscilloscopes, a two year warranty applies. For further information, contact **Bell-IRH Pty Ltd, 32 Parramatta Rd, Lidcombe 2141 NSW (02) 648 5455.**

New Documentation house set up in Sydney

Technical documentation means many things to many people, but to the engineers and programmers who have to write it, the managers who have to schedule and pay for that writing, and the users who have to read the resulting document — all it means is a headache.

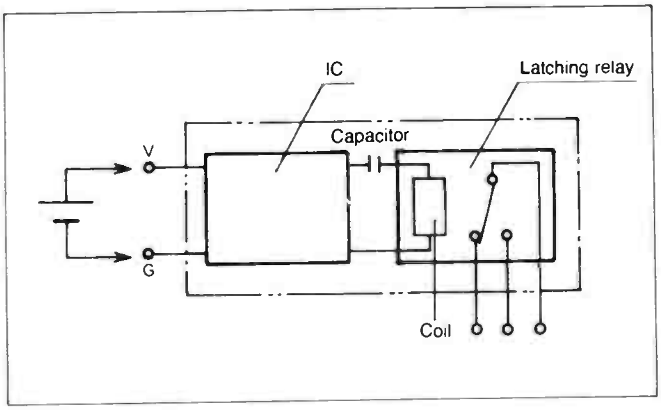
In the US and Britain, specialist documentation houses make life a lot easier by taking on the whole job of researching, writing and even printing and distributing technical manuals. They use full-time writers and editors to come up with the sort of quality documentation that many Australians only see when they buy an imported software package.

Now a Sydney firm called 'Hard Copy' is offering full-service writing and production to local companies. According to the company's Director, Phil Cohen, the use of a documentation house can save time and money. "When you find out how many pages per day the average programmer or engineer can write, then multiply that by his wage plus overheads, the cost of producing manuals in-house is astronomical", he said.

"Not only that, but with skilled manpower in short supply in Australia, taking documentation out of the critical path can mean a much better use of scarce resources. And production and updating is no longer a problem."

Hard Copy has already tackled some major technical writing tasks, including a two-volume manual for Computer Accounting Services in Sydney and documentation for what is being described as Europe's largest computerisation project — British Telecom's 'CSS' system.

For further information, call Phil Cohen in Sydney on **(02) 264 8166.**



RVB opens in Sydney

Sydney is now graced by the presence of R.V.B. Products P/L, in the shape of Jim Berry, who is occasionally found to inhabit the hallowed halls of Unit 14, 37-43 Alexander St, Crows Nest.

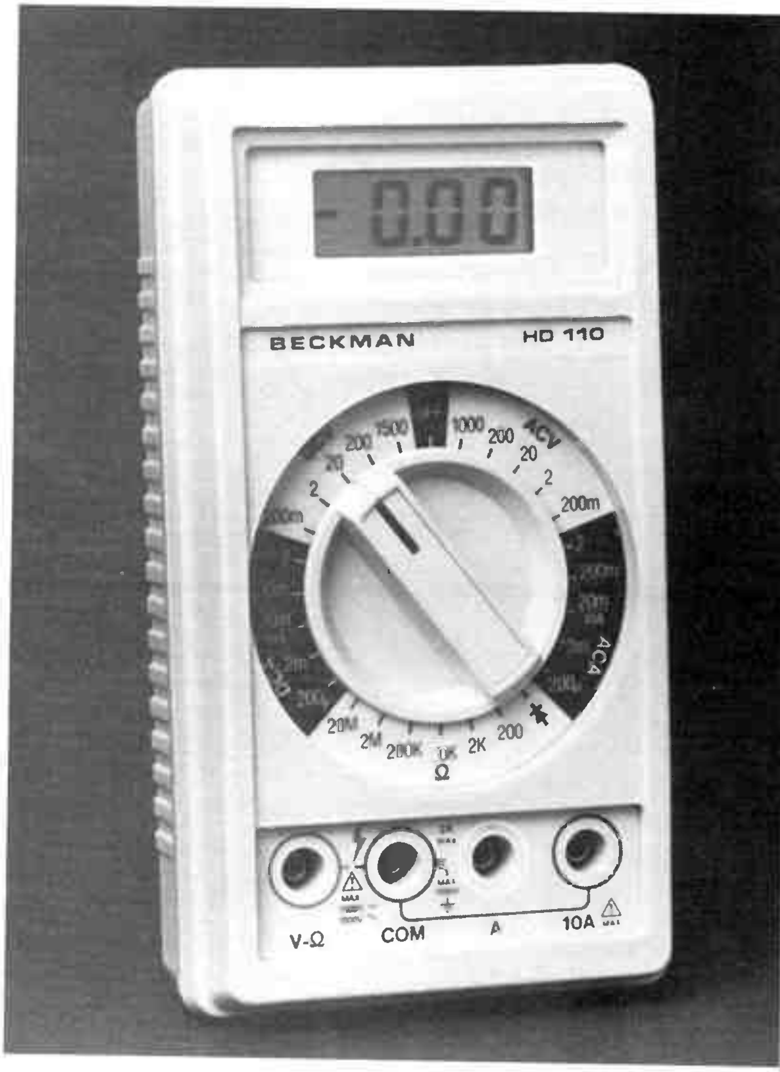
R.V.B. Products are the Australian distributor of National Relays and carry a comprehensive range of relays and other National electromechanical components.

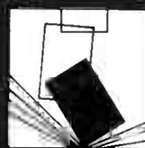
An example of the National relay range are the RF relays featuring 65 dB minimum isolation and maximum insertion loss of 1.5 dB a 900 MHz. The National IC relays consume only microamps of current, making them suitable for energy saving applications and are especially compatible with battery operated devices.

For further information, contact Jim Berry at **Unit 14, 37-43 Alexander St, Crows Nest 2065 NSW. (02) 439 1419.**

Now, more than ever, engineers are switching to Beckman digital multimeters.

Introducing the HD-110





DROP-PROOF

The HD-100 Hardhat series meters are built to take it. Even accidental falls are no match for the heavy-duty construction of these tough meters. They won't break even after repeated falls.

WATERPROOF

You can take the Hardhat meters wherever you go...without worrying about moisture, dirt or grime seeping in and causing damage.

SHOCKPROOF

The electrical ruggedness of the HD-100 series matches the external toughness head-on. All dc voltage ranges are protected for inputs up to 1500Vdc or 1000 Vrms. Current ranges are protected to 2A/600V. Resistance ranges are protected to 600Vdc. Voltage ranges are further protected against voltage transients up to 6kV for 10 microseconds.

The Beckman HD-100 series meters are indispensible tools that have rugged protection from mishaps and adverse environments. Wherever you find a dirty, dangerous job, you'll find the HD-100 series.

Now you can fight back against dirt, dust, water and hard knocks that would destroy lesser meters. In addition to all the heavy - duty features, the HD-100 series are high performance meters that meet your needs of accuracy, precision and reliability.

Other models available: 3010, RMS 3030, 3020B, 3020, RMS 3060, 3050.

anitech
A DIVISION OF THE ANI CORPORATION LTD (INC IN N S W)

ADELAIDE: (08) 356 7333 **BRISBANE:** (07) 275 1766 **HOBART:** (002) 34 4511
MELBOURNE: (03) 795 9011 & 795 5111 **PERTH:** (09) 277 7000 & 277 1944
SYDNEY: (02) 648 1711 & 648 4088 **AUCKLAND:** (09) 444 2645

Inside the modern digital multimeter

Roger Harrison

Digital multimeters these days offer accuracy, functions and features that only existed on very expensive 'top shelf' instruments or engineering 'wish lists' a few years ago. Indeed, the technology employed in many instruments is less than a decade old. Advances in solid-state circuit techniques, large scale integration and microprocessor technology has fuelled a rapid advancement in development and a rapid retreat in costs. This article examines the fundamental measurement technologies employed and illustrates the range and variety of instruments available.

The 'face of the future'? This instrument is a digital 'scope, multimeter and transient recorder, model M 2050, manufactured by Brown Boveri Goerz Metrawatt and distributed here by Kent Instruments (Australia). The 32-range DMM has a 3½-digit LCD readout and ac measurements may be made as either average or true RMS. The flat screen LCD oscilloscope provides a high contrast graphic image with 128 × 64 dot matrix resolution, completely free of distortion right to the edges. Trigger capabilities include ext/int and auto, with variable trigger level. It can display a true RMS curve. As a transient recorder it used two separate memories to store random events and sampling rate is 500 kHz max. The unit is completely battery powered. Kent Instruments are located in Melbourne, Adelaide, Brisbane, Perth and Sydney. (02) 525 2811.

ACCORDING TO G.W.A. Dummer, in his book *Electronic Inventions 1745-1976*, the digital instrument revolution was started in 1952 when Andy Kay in the US unveiled the first digital voltmeter. Reportedly, both the idea and the company formed around the idea, Non-Linear Systems, took off like a rocket.

Today, digital voltmeters and multimeters are found not only in areas ranging from electronic engineering labs to electronics hobbyists' workshops, but in such diverse fields as process engineering, chemical and medical applications, and the aerospace and mining industries.

The digital conversion

Primarily, electronic measurement is concerned with measuring voltage. This is because the dc volt has a primary standard accurate to better than one part in one million. Digital readout or display of quantities has decided advantages, particularly the quantities we wish to measure in electronics.

When reading a quantity from an analogue meter scale, you have to 'interpret' the reading. If it's not on a scale point, you have to interpolate — a euphemism for an educated guess. This is a source of error. Because of this, the accuracy of analogue meters varies across the scale, being least at full-scale and greatest around the zero end. You can readily read to within ± half a scale division which, on a 0-100 scale, is ±0.5% at full scale, but ±50% at the zero end! In addition, errors in the analogue movement mechanism plus parallax reading error contribute to the full-scale errors and error variation across the scale.

It's obvious that, when you make a measurement and get a numerical readout, the uncertainties are reduced and convenience enhanced. Errors can be reduced, too, and held constant across a reading range. To obtain a digital readout, the quantity — which is analogue in the 'real world', needs to be converted to a digital form. This is done by an *analogue to digital (A-D) converter*. Because the volt derives from quite an accurate fundamental standard, most other quantities are converted to a dc voltage and this, in turn, converted to digital form.

Accuracy is the primary consideration because one of the advantages of a digital instrument is the very high resolution possible giving very high accuracy providing any appreciable sources of error can be avoided. The overall accuracy is determined by the A-D converter which means any sources of error here must be minimised or eliminated to ensure the required accuracy and stability.

The voltage arriving at the input of an A-D converter is rarely pure dc. Almost always there will be both hum and noise present. This unwanted hum etc is called *series-mode noise*. But, we want the A-D converter to ignore it, otherwise measurement accuracy is affected. An obvious solution is to use a low-pass filter to reject the series-mode noise, but you would require it to cutoff at a few Herz or so, and this has the disadvantage that it slows down the measurement. Another solution is to integrate the signal to average-out the series-mode noise. If the integration period is long enough, the average unwanted ac signal imposed on the dc to be measured will be almost zero and good series-mode rejection is obtained.

Measurement *speed* is another important requirement. For run-of-the-mill bench applications, about two or three measurements per second is generally adequate. Where 'instantaneous' value readings are called for, and in automated or ▶

Philips' PM2519 4½-digit bench DMM features analogue bar readout atop the LCD display, autoranging and measurement against a preset quantity. Temperature measurement is available by means of a plug-in probe. Further details through Philips Scientific, call toll free (008) 22 6661.

We are indebted to Philips, Tech-Sales and Elmeasco for providing material from which this feature was compiled.

GOT A MICROBEE SERIES I/II/III?

GOT THE VITAL CONNECTION?

CONVERT IT FOR VIATEL OPERATION AND JOIN THE 'REVOLUTION' NOW!

If you're capable of wielding a soldering iron and prepared to spend an hour or so working on your 'Bee, then send for this

'Short Form' Conversion Kit

Comprising full instructions, a small printed circuit board, software on ROM or disk, manual and Viatel control key overlays.

FOR JUST $29.50!

Inc. post and handling

All you have to provide is a few common ICs, a resistor and some capacitors, plus a little time and effort – then your Microbee's ready to roll on Viatel!

We have only a limited quantity of these conversion kits left, so don't delay, fill out the coupon now and post it today!

This offer is exclusive to readers of Australian Electronics Monthly. Don't delay. Once we run out of stock, there are no further supplies available.

Take advantage of this offer today! Just fill out the coupon and send it, together with your cheque, money order or credit card details, to:

Australian Electronics Monthly
'Microbee Viatel Conversion Kit Offer'
PO Box 289, WAHROONGA NSW 2076

All mail orders will be despatched by certified post. Please allow for normal mail turnaround delays.

Name ....

Address................................

.........................**Postcode**......

Signature ....

(Unsigned orders cannot be accepted)

PLEASE RUSH ME . . . Short Form Microbee Viatel Conversion kit(s)

FULL COST: $29.50, inc. post and handling.

I require software on:

. . . ROM (2764 only)

. . . 3.5" disk

. . . 5.25" disk

I enclose payment by : ....

Credit Card No.: ....

Expiry Date: . . ./. . ./. . .

Cheque or Money Order No:.....................................

Please make cheques or Money Orders payable to 'Australian Electronics Monthly'.

MANY, MANY . . MULTI-METERS

Compact, highly accurate, technical, not so technical, inexpensive, large and small multimeters for the scientist, technician, tradesman and hobbyist.

ARLEC
QUALITY PRODUCTS

Victoria
30-32 Lexton Road, Box Hill, 3128
Victoria, Australia.
Tel: (03) 895 0222. Telex: 32286

43 Drummond Street, Belmore, N.S.W. 2192
Tel: (02) 789 6733 Telex: 176307.

Queensland
54A Vernon Terrace, Newstead, QLD, 4006
Tel: (07) 852 1131 Telex: 43263.

South Australia
24 Maple Avenue, Forestville, S.A., 5035
Tel: (08) 297 7066 Telex: 89234.

Western Australia
1-3 Carbon Court, Osborne Park, W.A., 6017
Tel: (09) 445 3611 Telex: 93973

semi-automated measuring systems, 10, or even up to 100, readings per second may be required. Thus the speed of the A-D conversion may be a limitation.

As with their analogue predecessors, the more accurate the measurement is required to be, the more important it is that a DVM or DMM itself does not influence the signal being measured. A high input impedance ensures the instrument does not 'load' the signal source. Also, care is taken to see that internal signals are not be fed back to the signal source being measured. Such signals, called 'kick-back' signals, appear as series-mode noise, and may be difficult to reject.

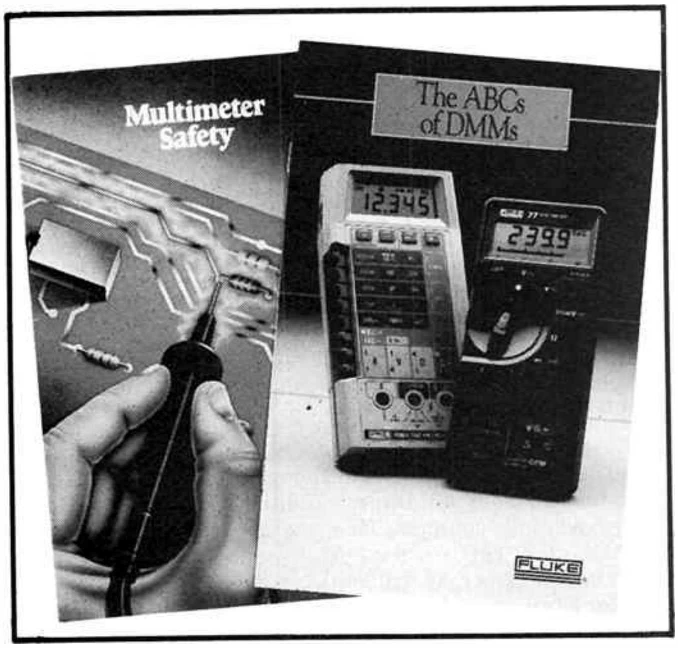
The common A-D conversion systems

Quite a number of A-D schemes have been developed over the years, but, as I said, three are generally used among the currently available DMM instruments.

The *successive approximation* technique offers rapid conversion for reading the instantaneous value of input but has no inherent series-mode noise rejection capability.

The *dual-slope* or *multi-ramp* is a simple integration technique requiring minimum circuitry and offering high noise rejection. Conversion time is relatively slow compared to the other methods, particularly if a readout of more than four digits is required.

The *delta-pulse* or *pulse-width modulation* technique combines the advantages of the above two methods while overcoming their limitations, providing a balance between high resolution precision measurements and high speed operation while providing good noise immunity. ▶



Elmeasco, the Fluke distributors, has available these two excellent booklets put out by the John Fluke Manufacturing Co. "Multimeter Safety" covers shock hazards possible when using multimeters and the safe practices and procedures to adopt. "The ABCs of DMMs" covers the terms applied to DMMs, typical measurement problems regarding voltage, current and resistance, plus accessories, etc. Both publications are quite informative generally and, naturally, about Fluke products too. Elmeasco generally distribute them free to education institutions, electronics labs, service workshops etc. Copies can be obtained, free of charge, by writing on your company's or institution's letterhead to: Paul Twigg, Elmeasco Instruments, PO Box 30, Concord NSW 2137.

The Modern DMM

With all of them, different instrument manufacturers have different versions, but the underlying principles are similar. Let's have a look at each of them in turn.

Successive approximation

Figure 1 shows the block diagram of a successive approximation A-D converter. An electronic switch, or chopper, alternately switches the input to the amplifier (Vin) chain (Amp1/Amp2/Amp3) beteen the input voltage and the output of a digital-to-analogue converter (DAC). The output of the DAC (Vdac) is varied in successive steps, depending on the digital input from the counters, until there is a vanishingly small difference between the DAC output and the input voltage.

Before a measurement is made, the counters are reset and the DAC output is zero. The output of the electronic switch (ESo) is a square wave, the amplitude of which is determined by the difference between Vin and Vdac. This can be seen in the upper section of Figure 2. The pulse shaper produces pulses from the positive-going edge of the ESo signal. The amplitude of these pulses is related to the amplitude of the ESo signal.

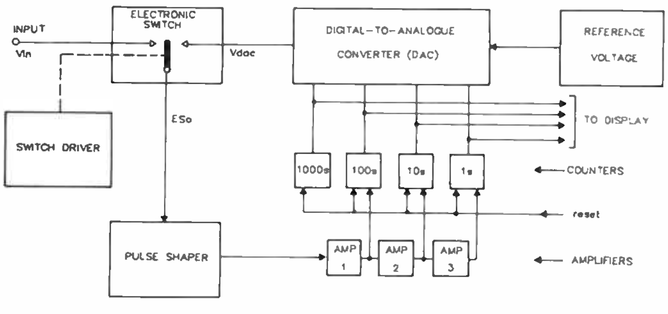


Figure 1. Successive approximation A-D converter.

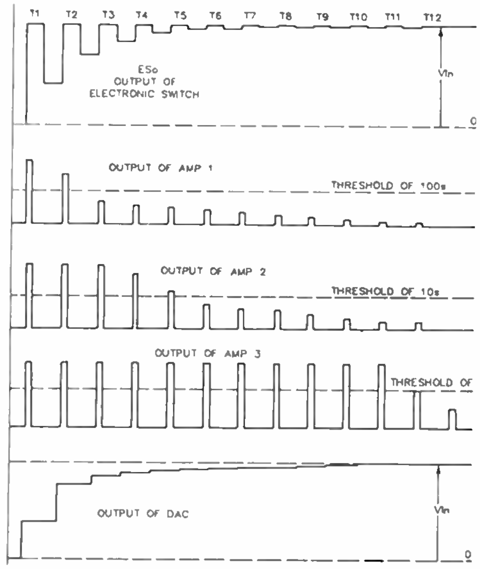


Figure 2. Timing diagram of events during the operation of a successive approximation A-D converter.

The outputs of Amp1, Amp2 and Amp3 set the threshold level of the 100s, 10s and 1s decades. Initially (at T1), the output pulses from all three amplifiers will be above the threshold of the counters. Thus, the counter registers 100 plus 10 plus 1 (i.e: 111) and the DAC produces an output voltage of 111 steps. The DAC will add 111 steps to the output at T2, but at T3, the amplitude of ESo is insufficient to produce

This Hioki 4½-digit bench DMM, model 3222, includes manual-auto facilities on the usual volts/ohms/current ranges but features programmable comparator, scaling, percent deviation, counter and dB measurement as well as pulse generator functions. A memory function allows storing up to 10 sets of measurement data, including function switch setting, to be stored and recalled at will. Nilsen Rowe of Melbourne distribute Hioki here. (03) 347 9166.

pulses that exceed the threshold of the 100s counter. Thus now, only the 10s and 1s decades will drive the DAC and only 11 steps are added to Vdac. This process continues until, as can be seen in Figure 2, at T6 only the 1s decade is active. Thereafter, Vdac is varied in single steps until, at T12, the difference between Vin and Vdac drops the output of Amp3 below the 1s counter threshold. The measurement is completed when the 1s decade output undergoes no further change after a predetermined number of cycles of the electronic switch. The next measurement is commenced by resetting all the counters.

With this method, a direct reading in millivolts can be obtained simply by the right choice of reference voltage. Measurement speed is quite fast, depending on the switch driver frequency.

The disadvantage of this method is that the instantaneous value of Vin will influence ESo. With hum and noise present, and because the electronic switch 'samples' the input voltage at narrow intervals, ESo will 'jitter' and the result will not be accurate. An analogue low-pass input filter or synchronous digital filter is thus essential to provide adequate series-mode rejection for precision of measurement. As mentioned earlier, this effectively slows down the measurement speed.

The accuracy of this technique is only as good as the smallest DAC steps and the stability and accuracy of the reference voltage. However, good 5-digit readout instruments using this technique are available, generally using additional error reduction circuitry to improve performance.

Dual-slope integration

Possibly the most widely-used technique, because some eight years ago an IC manufacturer worked out how to put the whole A-D converter and display driver on a single chip, making low-cost handheld DMMs possible. ▶

NEW

The Revolutionary HIOKI

ULTRA-SLIM Pocket Book Sized DMM (3½ DIGITS)

GREAT FEATURES

- *Attractive, calculator-style case; fits neatly into pocket*
- *Full auto-ranging*
- *Clear, 10mm LCD display*
- *Automatic polarity switching*
- *Beautifully compact 108 x 54 x 8mm*

Special introductory offer $35*

Offer expires 31st July '86.

Only available direct from

NILSEN ROWE AUSTRALIA Pty. Ltd. (Inc. in Victoria)

*Sales tax, if applicable, not included.

SPECIFICATIONS

(1) General

Measurement method:	Integration
Display:	3.5-digit, 10mm character height
Range selection:	Full auto-ranging
Polarity:	Automatic switching ("-" only displayed)
Sampling rate:	2 times/s
Operating temperature & humidity:	0 to 40°C, 80% RH maximum
Batteries:	LR44 x 2

(2) Measurement ranges

DC V:	2/20/200/450V
AC V:	2/20/200/450V
Resistance:	2k/20k/200k/2000k Ω
Continuity:	Threshold level approx. 1.5 to 15kΩ
Typical accuracy:	±0.7% or rdg at 2VDC

(3) Dimensions: 108 (L) x 54 (W) x 8 (D) mm

ORDER FORM

TO: NILSEN ROWE AUSTRALIA Pty. Ltd.
P.O. BOX 927, CARLTON, VIC. 3053

Please rush me my ULTRA-SLIM model 3217 pocket book sized DMM(s). OFFER EXPIRES 31st JULY '86

Name .... Date: ....

Company .... Sales Tax Exemption No .... (if applicable)

Address ....

....

.... Phone No.: (.....) .... Xtn .....

My cheque/postal note herewith, or debit my Bankcard.
Bankcard Account No. ....

Cardholder's Signature .... Card Expiry Date ....

Model	Qty.	Price Each*		Sales Tax	
3217		$35		20%	
			Allow 4 weeks for processing and delivery	Delivery	$3.50
				TOTAL	

PLEASE SEND ME HIOKI GENERAL CATALOGUE ☐

NILSEN ROWE AUSTRALIA Pty. Ltd. (inc. in Victoria)

Brisbane:
8 Allison Street,
Mayne, Qld. 4006
Phone: (07) 52 5231

Adelaide:
100 Regency Road,
Ferryden Park,
SA 5010
Phone: (08) 268 2300

Melbourne:
200 Berkeley Street,
Carlton, Vic. 3053
Phone: (03) 347 9166

Sydney:
Unit 4B,
128 Frances Street,
Lidcombe, NSW 2141
Phone: (02) 643 2088

Perth:
12 Roberts Street,
Osborne Park,
WA 6017
Phone: (09) 443 1522

The Modern DMM

The dual-slope technique is illustrated in Figures 3 and 4. The input voltage (Vin) is integrated for a fixed period, charging Cint. At the end of this time, Cint. is discharged with a constant current, the discharge period, being proportional to Vin, is counted and displayed.

At the start of a measuring period, the switch is set to position 1 and the counter-timer starts counting off a fixed number of pulses equal to time Tup. The input voltage during this time is connected to the integrator (op-amp, Rint., Cint.), the input voltage being integrated in Cint. causes Vc to rise ('ramp up') linearly. Thus, at the end of Tup, Vc is directly proportional to Vin. The switch is now set to position 2 and the reference voltage (-Vref.) is connected to the integrator's input. Notice that it is negative, or the opposite polarity to Vin. Thus, Cint. will discharge, Vc falling at a constant rate ('ramp down'), *no matter what value* Vc reached, as the reference voltage is constant. The time needed to discharge Cint. is thus directly related to the value reached by Vc at the end of Tup, and hence Vin. Thus:

$$\frac{\text{Vin}}{\text{Vref.}} = \frac{\text{Tdown}}{\text{Tup}}$$

When Vc reaches zero, the counter-timer is stopped and the number of pulses counted-in from the clock during Tdown are displayed, scaled as a voltage. The resolution achievable depends on the clock speed; the more pulses you can count during Tdown, the better the resolution.

The multi-ramp or multi-slope technique is a refinement of this that provides greater accuracy. The ramp-up process is identical, but the ramp-down process is different. Here, ▶

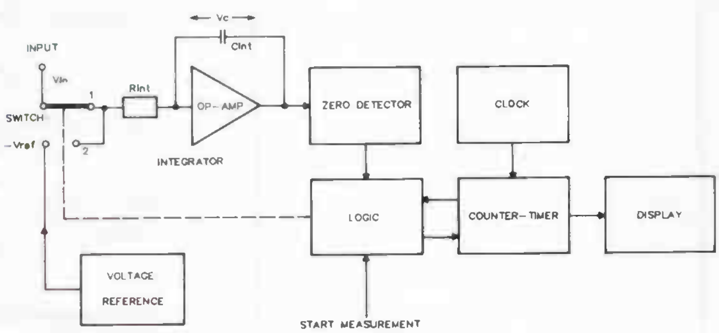


Figure 3. A dual-slope or dual-ramp A-D converter.

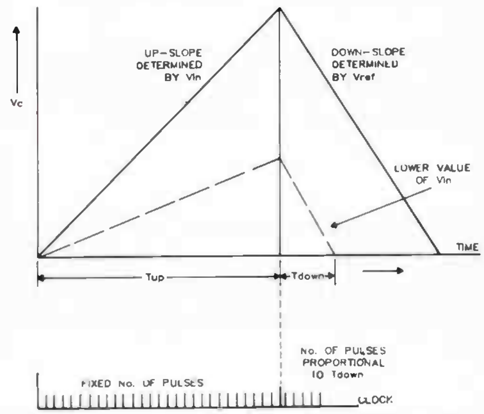


Figure 4. Timing diagram of the dual-slope converter.

there is an initial fast (high slope) ramp-down for partial conversion, followed by a reduction in the reference voltage which slows the ramp-down, providing a precise final result.

Dual-slope integration is a simple, effective measuring technique that can be implemented for minimal cost. Dual-slope DVM and DMM ICs are quite common and widely used in both handheld and benchtop instruments.

The technique can give very good series-mode noise rejection, particularly if the ramp-up period is one or more complete cycles of the mains frequency (20-100 ms for 50 Hz mains). The clock frequency can be quite low, and it's accuracy does not directly affect the measurement accuracy because only the one clock and counter are used to count Tup and Tdown. For mains-operated instruments, this fact permits the clock to be phase-locked to the mains to provide greatly improved series-mode rejection of hum. In addition, Rint. and Cint. do not directly influence accuracy. The only factor influencing the accuracy is, in fact, the reference voltage. This, along with its very good series-mode rejection, makes the dual-slope system suitable for precision measurements to six or seven digits.

The main disadvantage is its relatively slow speed. Also, the display is only updated after ramp-down and, if the wrong input range has been selected, no range changing can occur till after ramp-down which, in auto-ranging instruments, contributes to slowing down the measurement speed.

Readout accuracy can be affected by the fact that the input is only averaged during the up-slope period. During ramp-down, the input signal is disconnected and not measured at all. If any variation of the input signal occurs during this time, the instrument will not register it and hence, true averaging of the input signal does not occur. However, this is only of concern when precision beyond six digits is required. ▶

This Norma Messtechnik DM1218 handheld 3½-digit DMM has some unusual features. Apart from the usual V/I/R measurement, it can also be used to determine the direction of a rotary field, measure temperature up to 1200 degrees Celcius and store max. and min. values. The DM1218 is intended for application in labs, production testing and service departments. Paton Electrical of Sydney are the distributors. (02) 797 9222.

PROGRAMMABLE POCKET SCANNER

—MICROCOMM—

SX-155

PROFESSIONAL POCKET SCANNER WITH OVER 16,000 CHANNELS & 160 MEMORIES

26 to 32, 68 to 88, 138 to 176 and 380 to 514 MHz

The Microcomm SX 155 represents the latest developments in State-of-the-art LSI CMOS technology as applied to scanning monitor receivers. It incorporates many features, a lot of which are not even found in today's larger base scanners.
For example the SX 155 has 160 memory channels which can be programmed in either of two modes. The first allows you to manually program the entire 160 channels. The second mode provides for manual programming of the first 40 channels with the top 120 reserved for use by the SX 155 while in its SEARCH mode. It uses these channels to automatically store frequencies on which it has found signals during the search phase.
The SX 155 also features a Priority Channel (for that important frequency). An LCD display providing readout of all receiver functions including an accurate crystal controlled 24 hour clock.
Supplied complete with rechargeable Nicad batteries, charger, and rubber duck antenna, the SX 155 is a must for anybody with an interest in monitoring.

PRICE $449 + $14 P & P

AUSTRALIAN DISTRIBUTOR
GFS ELECTRONIC IMPORTS
Division of DERIBAR PTY LTD
17 McKeon Road, Mitcham, Vic. 3132
PO Box 97, Mitcham, Vic. 3132
Telex: AA 38053 GFS
Phone: (03) 873 3777 3 Lines

SUPER MODEM.

★ Fully Software Controlled
★ CCITT V.21 (300 Baud)
★ CCITT V.23 (1200/75 Baud)
★ Bell 103 and Bell 202
★ Auto dial and Auto answer
★ Internal Speed Convertor
★ Optional V.22 1200/1200
★ Fully assembled, tested and Telecom approved.
★ As featured AEM April and May
★ $395 incl tax and warranty. (s/ware $19 extra).

APPLE II/MPF-III Internal Modem
300 and 1200/75 Baud
$249 incl tax and Viatel s/ware

EMQUIP AUSTRALIA

(02) 799-9777
139A QUEEN ST ASHFIELD
BOX 35 CROYDON, NSW 2132.

BACK COPIES OF AEM

$4.00 including postage

- ☐ July 1985
- ☐ August 1985 (Limited copies)
- ☐ September 1985
- ☐ October 1985
- ☐ November 1985
- ☐ Dec. 1985 (Not available)
- ☐ January 1986
- ☐ February 1986
- ☐ March 1986
- ☐ April 1986 (Not available)
- ☐ May 1986

Please send me the copies of AEM I have ticked. My cheque for ______________ is enclosed.

Name ....

Address ....

....

.... Post Code ....

Please post to
BACK COPIES OF AEM
Australian Electronics Monthly
PO Box 289
WAHROONGA 2076 NSW

See why workshops specify ESCORT DMMS

Why not prove it for yourself . . .

EDM-70B NEW

New miniature pocket-sized multimeter. "Easy-to-find" safety bright yellow case. Basic accuracy 0.5%. Ranges include: VDC, VAC, ADC, Ω, diode test, audible continuity and battery test.

$59 incl tax

EDM-1111A

- 3½ digit LCD
- Transistor test
- Capacitance Measuring
- 0.5% Accuracy

Full AC & DC ranges: 200 mV to 1 kV, 200 μA to 10 A. Ohms range. Diode test. Audible continuity. Safety yellow case **$113** incl tax
Full range of ESCORTS available: from basic LCD DMMs to 41/2digit,0.05% TRMS Instruments.

EMONA INSTRUMENTS

1st Floor 720 George St
Sydney 2000.
Phone: (02) 212 4599

DISTRIBUTORS

NSW:	Davred Electronics, Sydney. Phone: 267 1385
	Geoff Wood Electronics Pty Ltd, Rozelle. Phone: 810 6845
	Martin De Launay (Newcastle) Pty Ltd. Phone: 52 8066
VIC:	Radio Parts Group, Melbourne. Phone: 329 7888.
QLD:	Baltec Systems Pty Ltd, Brisbane. Phone: 369 5900
	Nortek (Townsville). Phone: 79 8600
	Anitech (Brisbane) Pty Ltd. Phone: 277 0222
SA:	Int'l Communication Systems, Port Adelaide. Phone: 47 3688
	Anitech (Adelaide) Pty Ltd. Phone 356 7333
	Electronic Components Pty Ltd, Fyshwick. Phone: 80 4654
	Forster Warden Pty Ltd, Fyshwick. Phone: 80 5132
TAS:	George Harvey Electrical, Hobart. Phone: 34 2233
	Launceston. Phone: 31 6533
WA:	Hinco Engineering Pty Ltd, Perth. Phone: 381 4477

SOLARTRON
Schlumberger

Solartron Instruments
SETTING THE PACE IN PRECISION

Solartron 7061 & 7062 SYSTEMS VOLTMETERS

FAST CAPTURE

1500 readings/S

Capture 1500 readings a second straight into internal memory.

FAST THROUGHPUT

400 readings/S

400 readings per second of continuous throughput to the IEEE-bus.

FAST RESPONSE

3mS from a trigger

While other voltmeters are still thinking, 7061 and 7062 have stored the result and sent it on the bus.

FAST CONTROL

1ms for alarm output

Process control requires fast action. These dvms can output a signal within 1 ms of reaching a preset value.

FAST SCANNING

300 Chan/S, <1μV error

Built in 18 channel Scanner option. Channels can be scanned in any sequence.

FAST SOLUTIONS

For your applications

Contact Tech-Sales for a full brochure and specification.

Voltage dc	7ppm	Current dc	0.02%
True rms ac	0.05%	Current ac	0.05%
Resistance	7ppm	Temperature	0.1°C

Tech-Sales

TECH-SALES PTY. LTD.

Melbourne	(03) 879 2266
Sydney	(02) 808 3055
Perth	(09) 322 1085
Brisbane	(07) 369 8500
Adelaide	(08) 344 6999

FULLY OWNED SUBSIDIARY OF TECH-RENTALS PTY. LTD.

Tech-Sales

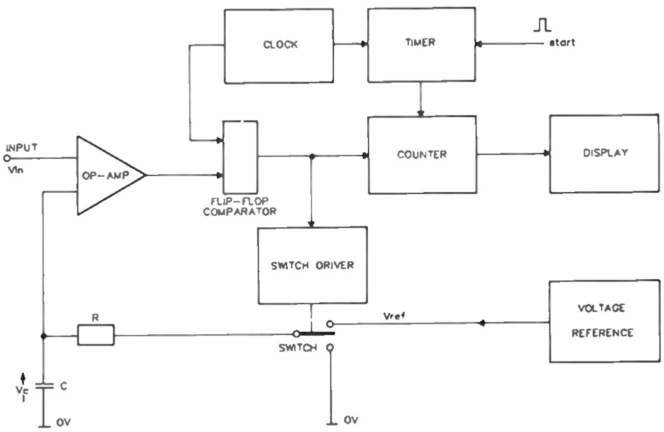


Figure 5. The delta-pulse or pulse-width A-D converter.

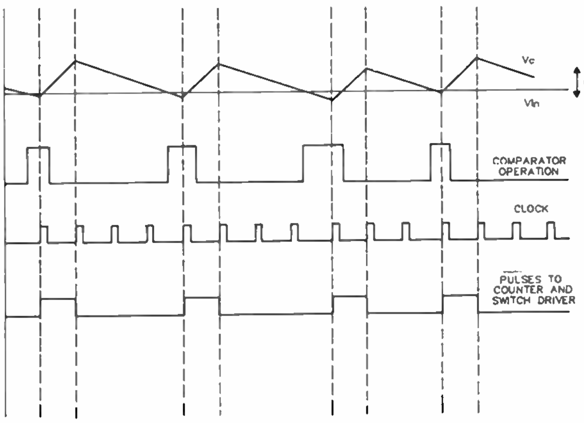


Figure 6. Typical timing diagram illustrating how a pulse A-D converter functions.

The delta-pulse or pulse-width method

This is an integrating technique that enjoys the advantages of the above two systems without their disadvantages. The system is illustrated in Figures 5 and 6.

A capacitor is alternately charged, via R, from a voltage reference (Vref.) and discharged by switching R to 0 V. The op-amp continually measures the difference between the input voltage (Vin) and the voltage on C (Vc). The op-amp output drives a flip-flop comparator. So long as Vin is above Vc, the comparator output causes the switch driver to connect R to Vref and C charges, causing Vc to rise towards Vin. When Vin is lower than Vc, the comparator causes R to be switched to 0 V, discharging C, causing Vc to fall towards Vin.

The gain of the op-amp is very high and, as the process is continuous, Vc will (after a very short initial period) be verly close to Vin — within a few microvolts once a steady state has been reached.

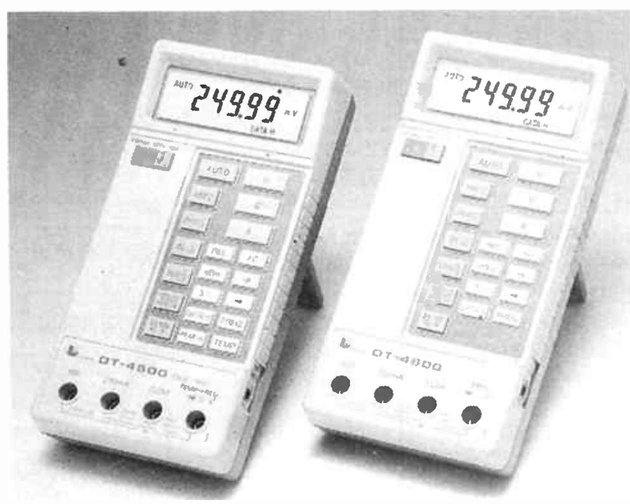
If Vin is constant, the charge held by C will also be constant. Thus the incoming charge when R is switched to Vref., will equal the outgoing charge when R is switched to 0 V when measured over a given period. The capacitor voltage (Vc), and thus the input voltage (Vin) will be directly related to the reference voltage (Vref.). The comparator flip-flop is set when Vin is greater than Vc and not when Vin is less than Vc. The flip-flop will produce pulses with a duration equal to two clock pulse intervals (i.e: it acts as binary scaler) so long as Vin is greater than Vc. It is these pulses which control the switch driver, causing C to be charged for their duration; C being disharged in between times.

The latest in Dick Smith's range of multimeters is this 3½-digit handheld unit, Q-1515, featuring autoranging and a memory function which allows measurement relative to a particular reading.

The timer is started and it counts a fixed number of clock pulses, say, 1000. Simultaneously, the counter counts the output pulses of the flip-flop. When the timer reaches the end of its count, the counter is stopped. If the counter reading is x, say, the capacitor has been charged for x out of 1000 clock periods. Thus, it can be shown that:

$$\text{Vin} = \frac{x}{1000}\,\text{Vref.}$$

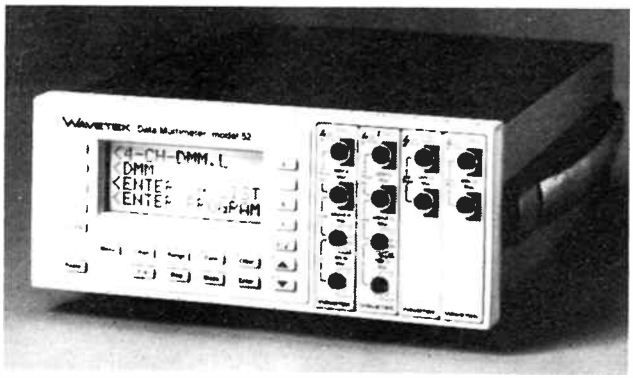
If all the comparator pulses passed onto the switch driver, ▶



These Univolt 4½-digit handheld DMMs probably represent the 'leading edge' so far as features and functions in handheld instruments are concerned. The 4500 at left and 4600 at right both feature autoranging and 'data hold' which holds the value displayed once the probes are removed. This includes true RMS ac measurement, temperature measurement and a 'peak hold' function. Benelec in Sydney are the Univolt distributors. (02) 665 8211.

the maximum value of x will be 500 in this case. This means that Vref. should be twice the highest value of Vin to be measured on the scale chosen. Figure 6 shows the case where Vin is about a quarter of Vref. As the op-amp has very high gain, when the system is near equilibrium, the voltage changes across C will be only microvolts in peak amplitude.

The method has the same advantages as dual-slope, with good series-mode noise rejection and accuracy which depends primarily on the reference voltage. The A-D conversion is very rapid and continuous ('dynamic integration') so that it can follow input variations to give true averaging of the signal resulting in a true dc measurement. In addition, the display can vary from three digits up to eight digits to suit a wide variety of applications. Despite being somewhat more complex than the dual-slope technique, it lends itself to large-scale integration.



This Wavetek instrument is a good example of just how sophisticated multimeters can get. Wavetek call their model 52 a 'Data Multimeter' as it combines the functions of a digital multimeter, a data logger/data acquisition system and a process controller. It has four interchangeable input channel modules, allowing you to select one with the appropriate specifications for the application required. Wavetek instruments are handled by Scientific Devices who have offices in South Australia and NSW, with a Melbourne head office. (03) 579 3622.

Comparisons

All three techniques exhibit low kick-back signals as the input circuitry in each case is isolated from the digital measurement and display circuitry. Both the dual-slope and delta-pulse methods have inherently high input impedance. Some dual-slope instruments boast a *one giga-ohm* (1000 megohms) input impedance! The input impedance of a successive approximation A-D converter is not constant because of the switched input sampling and needs buffering.

The series-mode rejection of the dual-slope and delta-pulse methods is high, while successive approximation suffers from low series-mode rejection, requiring added filtering. So far as speed is concerned, successive approximation is inherently the fastest, but the requirement for series-mode filtering slows it down. Dual-slope and delta-pulse are medium speed methods, with delta-pulse generally having the edge over dual-slope.

Automation

Automation of a variety of functions on a multimeter is desirable for the convenience offered and the elimination of ambiguity. Automatic zeroing and auto-polarity indication are included on virtually all DMMs available these days, while auto-ranging is becoming more and more common on handhelds and bench models alike. ▶

Check our test equipment range!

SPECIAL OFFER $69.95 DURING JUNE!

605 3½ DIGIT MULTIMETER

New replacement for YF1100. See specification tables below for details

Cat. Q11035 .... $79.95

SPECIAL OFFER $109 DURING JUNE!

705A 3½ DIGIT MULTI/CAPACITANCE METER

See specification table below for details

Cat. Q11040 .... $119

605 & 705A SPECIFICATIONS

Capacitance

Range	Resolution	Accuracy 605	Accuracy 705A	Test [illegible]	[illegible]
2nF	1pF	NC	3.5% + 4	400[illegible]	3V DC peak AC on all ranges
20nF	10pF			512 Hz 40mV [illegible]	
200nF	100pF				
2000nF	1nF				
20µF	10nF				

AC Current

Range	Resolution	Accuracy 605	Accuracy 705A	Burden Voltage	Overload Protection
200µA	100nA	NC	1.2% + 4	0.3V max	705A [illegible] fuse up to [illegible] 605 [illegible] fuse up to [illegible] 10A range not fused
2mA	1µA	1.2% + 4			
20mA	10µA				
200mA	100µA				
2000mA	1mA	2% + 4	NC		
10A	10mA	1.5% + 4	1.5% + 4	0.7V max	

Resistance

Range	Resolution	Accuracy 605	Accuracy 705A	Open Voltage	Overload Protection
200Ω	100mΩ	[illegible]	[illegible]	Hi [illegible] 3.5V Lo [illegible] 0.25V	450V DC rms on all ranges
2KΩ	1Ω	0.8% + 2	0.8% + 2		
20KΩ	10Ω				
200KΩ	100Ω				
2000KΩ	1KΩ				
20MΩ	10KΩ	2% + 4	2% + 4		

DC Voltage

Range	Resolution	Accuracy 605	Accuracy 705A	Input Impedance	Overload Protection
200mV	100µV	0.5% + 1	0.5% + 1	10MΩ on all ranges	1000V DC peak AC on all ranges
2V	1mV				
20V	10mV				
200V	100mV				
1000V	1V	0.8% + 1	0.8% + 1		

AC Voltage

Range	Resolution	Accuracy 605	Accuracy 705A	Input Impedance	Overload Protection
200mV	100µV	1% + 4	1% + 4	10MΩ on all ranges Capacitance < 1000pF	750V rms on all ranges except 200mV AC ranges 15 seconds max above 250V rms AC
2V	1mV				
20V	10mV				
200V	100mV				
750V	1V	2% + 4	2% + 4		

DC Current

Range	Resolution	Accuracy 605	Accuracy 705A	Burden Voltage	Overload Protection
200µA	100nA	NC	1% + 2	0.3V max	705A 0.2A fuse up to 250V 605 2A fuse up to 250V 10A range not fused
2mA	1µA	1% + 1			
20mA	10µA				
200mA	100µA				
2000mA	1mA	1.5% + 1	NC		
10A	10mA	1% + 1	1% + 1	0.7V max	

NC = Not Connected

12 months warranty!

Includes two free probes!

HUNG CHANG (RITRON) 20 MHz DUAL TRACE OSCILLOSCOPE

- Wide bandwidth and high sensitivity
- Internal graticule rectangular bright CRT
- Built in component tester
- Front panel trace rotater
- TV video sync filter
- Z axis (intensity modulation)
- High sensitivity X-Y mode
- Very low power consumption
- Regulated power supply circuit

COMPONENT TESTER is the special circuit with which a single component or components in circuit can be easily tested. The display shows faults of components, size of a component value, and characteristics of components. This feature is ideal to troubleshoot solid state circuits and components with no circuit power. Testing signal (AC Max 2 mA) is supplied from the COMPONENT TEST IN terminal and the result of the test is fed back to the scope through the same test lead wire at the same time.

CRT

CRT: 6" (150mm) Flat-faced high brightness CRT with Internal Graticule
Effective display area: 8 x 10 div (1 div = 10 mm)
Acceleration potential: 2KV

VERTICAL

Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter, 0.2ufs - 0.5ms/div Chop, 1ms - 0.5s/div
CHOP frequency 200KHz approximately
Deflection factor: 5mV/div 20V/div +/-3%, 12 ranges in 1-2-5 step with fine control
Bandwidth: DC, DC - 20MHz (−3dB) AC, 10Hz - 20MHz −3dB)
Rise Time: Less than 17ns
Overshoot: Less than 3%
Input Impedance: 1M ohm +/-5%, 20pF +/-3pF
Maximum Input Voltage: 600Vp-p or 300V (DC+AC Peak)
Channel Isolation: Better than 60 dB at 1KHz

HORIZONTAL

Sweep Modes: NORMAL, and AUTO
Time Base: 0.2ufs - 0.5s/div +/−3% 20 ranges in 1-2-5 step with fine control
Sweep Magnifier: 5 times (5X MAG)
Linearity: 3%

TRIGGERING

Sensitivity: INTERNAL 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz) EXTERNAL 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz)
Source: INT, CH-A, CH-B, LINE and EXT
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch
TV-V 0.5s/div to 0.1ms/div TV-H 50ufs/div to 0.2ufs/div

X-Y OPERATIONS

X-Y Operations: CH-A: Y axis CH-B X axis Highest Sensitivity 5mV/div

COMPONENT TESTER

Component Tester: Max AC 9V at the terminal with no load. Max current 2mA when the terminal is shorted. (Internal resistance is 4.7K ohm)

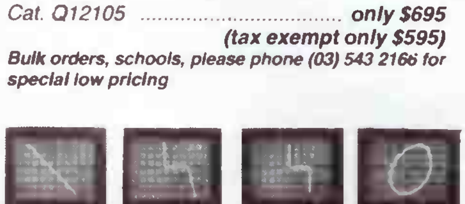
OTHER SPECIFICATIONS

Intensity Modulation: TTL LEVEL (3Vp-p), Positive brighter
BANDWIDTH; DC - 1MHz MAXIMUM INPUT VOLTAGE 50V (DC+AC Peak)
Calibration Voltage: 0.5Vp-p +/−5%, 1KHz +/-5% Square wave
Trace Rotation: Electrically adjustable on the front panel
Power Requirements: AC. 100, 120, 220, 240V 20W
Weight: 7kg approximately
Size: 162(H) x 294(W) x 352(D)mm

Cat. Q12105 .... **only $695**

(tax exempt only $595)

Bulk orders, schools, please phone (03) 543 2166 for special low pricing



FREE POSTAGE FOR ALL AEM READERS DURING JUNE!*
Just quote this advertisement!
(Applies to test equipment only)

METEX MULTIMETERS

These instruments are compact, rugged, battery operated, hand held 3½ digit multimeters. Dual-slope A-D converters use C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided.

METEX 3800 MULTIMETER

Features...
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS
Maximum Display: 1999 counts 3½ digit type with automatic polarity indication
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

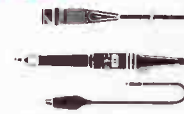
Cat. Q91530 Normally $99.95
SPECIAL $79.95

METEX 3530 MULTIMETER

Features...
- Push-button ON/OFF power switch
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS
Maximum Display: 1999 count 3½ digit type with automatic polarity indication.
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 Normally $129
SPECIAL $109



BESWICK 88100 PROBE SET

CONTAINS: Compensated probe lead with
- Detachable 6 inch earth lead
- Retractable hook
- IC test tip
- Tip insulator
- BNC adaptor
- Trimming tool

SPECIFICATIONS:
Bandwidth: 10:1 position 250MHz at −3dB into 20 pF
Rise Time: 10:1 position less than 1.4ns nominal
Switch Function:
(a) 10:1 attenuation +/− 1%, with oscilloscope of 1 Mohm input resistance
(b) 1:1 attenuation with bandwidth of 10 MHz approx
(c) Reference position, tip grounded via 9 Mohm, oscilloscope input grounded
Input Capacitance: 16pF typical depending upon oscilloscope input capacitance
Compensation Range: oscilloscopes of 15 to 60 pF input capacitance
Working Voltage: 600V DC or peak AC

$34.95

ROD IRVING ELECTRONICS
425 High Street, NORTHCOTE, 3070
VICTORIA, AUSTRALIA
Phone (03) 489 8866

48 A Beckett St. MELBOURNE, 3000
VICTORIA, AUSTRALIA
Ph. (03) 663 6151

Mail Order and correspondance
P.O. Box 620, CLAYTON 3168
TELEX AA 151938

MAIL ORDER HOTLINE (03) 543 7877 (2 lines)

POSTAGE RATES

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

This is for basic postage only. Comet Road freight, bulky and fragile items will be charged at different rates.

Certified Post for orders over $100 included "free"!
Registered Post for orders over $200 included "free"!

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

Errors and Omissions Excepted

When you short the input of a voltmeter, you expect the display to read zero. In a 3½-digit DVM or DMM, with a maximum readout of 1999, a 0.05% of full-scale zero error is enough to give a 0001 display. To avoid this and maintain accuracy with low-value readings, a zero adjustment is necessary. Automating it means you don't have to perform the

This Sansei model 2650 4½-digit bench DMM employs the dual-slope integration measuring technique and features full autoranging and a 'hold' function that holds measured values on the display. Sansei instruments are distributed in Australia by University Graham of Sydney. (02) 53 0644.

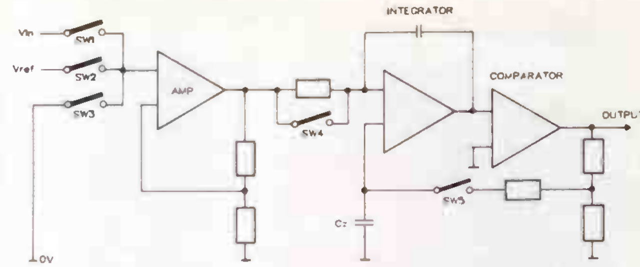


Figure 7. Typical (simplified) auto-zeroing circuit used with dual-slope A-D instruments.

operation manually every time you take a reading where zero error might matter.

Figure 7 shows a typical circuit seen in dual-slope A-D systems. Before a measurement is made, the switches SW3-4-5 are closed for a brief period, setting the input to 0 V, decreasing the integrator's RC period and connecting the comparator output to the capacitor Cz. When SW3-4-5 are opened at the end of this period to start the actual measurement, the total offset voltage of the circuit, which represents the zero error, is stored in Cz. This 'bucks' the zero error and the actual input voltage is measured.

Auto-ranging can greatly enhance the convenience of using a DMM. The object is to obtain a reading with the best resolution under all conditions. For example, on a 3½-digit display, 150 mV should be displayed as 150.0, not 0150.

An autoranging unit for a 3½-digit display (1999 full-scale) is shown in Figure 8. here, a group of range relays is controlled by an up/down counter which responds to the count

The Victorian-based Tech-Sales Pty Ltd represent the European electronics giant Solartron-Schlumberger in Australia. The Solartron 7151, featured on our cover, is a 6½-digit Computing Multimeter said to incorporate two features that have never appeared in any other DMM on the market — an analogue output complete with 'zoom', and comprehensive power fail recovery. The unit can measure from 100 nV to 1 kV dc, up to 2 A ac and dc, from one milliohm to 20M and temperature from -200 to +600 degrees C. It employs two microprocessors providing a comprehensive list of programs, clock control with real and elapsed times and storage of results in a 500-reading 'history file'. for full details on this and other Solartron instruments, call Nigel Gamblin at Tech-Sales, (03) 879 2266.

to be displayed. Now, the ranges need to overlap, otherwise ranging jitter occurs at the transition between ranges. For example, without overlap, an input of 200 (mV, say) with slight variations would be displayed as a reading varying be-

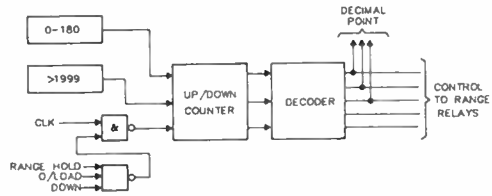


Figure 8. Block diagram of a typical auto-ranging unit.

tween 199.9, 0201, 0200 etc. In an autoranging unit, with the exception of the lowest range, each range has a lower limit set a little within the full scale end of the next lowest range. In Figure 8, it's 180. For the 2 V range (1.999 V), the lower limit would be 0.180 V. Thus, a stable display results around the transition because variations lie generally within the one range. The A-D converter will generate a control pulse for down-ranging when the count is less than 180 and another for up-ranging when the count is greater than 1999. The up/down counter reacts when it receives a clock pulse at the end of the measurement period, the new data being used to set the range relays via the decoder. Simultaneously, the decimal point display is updated. When the input changes across several ranges, it takes several measuring periods to reach the final display.

For auto-polarity indication, data from the A-D converter is used to set the display. For integrating-type A-D methods, the polarity of the integrating signal only is important. The polarity is measured at the end of the integration period and, as this is determined by counting the number of clock pulses during that time, the last count or last few counts are used to initiate the polarity measurement. The integrator output is then used to set a flip-flop whose output drives the display as well as being stored in memory until the next measurement.

ADMARKET

Readers' free adverts.
READERS-CLUBS-ASSOCIATIONS

WE'LL PUBLISH your advertisement of up to 32 words (maximum), totally free of charge. Either fill out the coupon here, or write or type it out on a clean sheet of paper. But **please** make it legible, other wise it may not turn out as you intended! Copy **must** be with us **six weeks** prior to the month of issue. Every effort will be made to publish you advertisement, but no responsibility for so doing is accepted or implied.

CONDITIONS You must include your name and 'phone number and/or address within the 32 words (for amateurs, 'QTHR' is acceptable). Accepted abbreviations such as DSDD, 100 W RMS, ONO etc, may be used. Please include you name and full address plus 'phone number with a covering letter. **Private advertisements only** will be accepted. We have 'small ads' for traders, who should contact our advertising representatives.

Send your adverts to: **AEM ADMARKET**
Australian Electronics Monthly
PO Box 289 WAHROONGA 2076 NSW

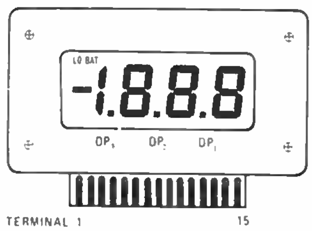
Siemens Varistors for the Hash Harrier

Siemens advise they're "... not the only kids on the block" when it comes to manufacturing and supplying Varistors, a fact they pointed out following publication of the AEM5505 Hash Harrier project featured in our April issue.

They can supply quite a range of Varistors with differing ratings, a number of types being suited for use in the 5505 project. Either 275 V or 300 V types may be used (the higher voltage ones would be preferred in areas of high mean mains voltage, like W.A.). They come in a variety of dissipation ratings, and we would suggest either the S14K or the S20K types.

The Siemens Varistors have both ratings marked on the body of the device thus — "S14K 275" or S14K 300" would be suitable types; higher dissipation types would be marked "S20K 275" or S20K 300".

If your favourite electronics retailer does not stock Varistors, they should be able to order your requirements through the Siemens distributors in your state. In NSW, **Promark Electronics** and **Nexus Electronics** are Siemens Distributors, in Victoria it's **Promark**, in South Australia it's **R.G. Pank** and **Protronics**, in Queensland **ECQ Electronics**, West Australia **Reserve Electronics** and in New Zealand, **Delphi Industries** in Auckland.



Digital panel meter module

A 3½-digit liquid crystal display digital panel meter module priced at only $39.95 was released by Dick Smith Electronics in April.

Going under the "Galaxy" name, the display has 12.7 mm high digits and includes minus sign and "LO BAT" annunciators. It can be operated from a single supply of between 7 and 9 V and draws but 1.3-2.0 mA. The module employs the Intersil ICL7106 dual-slope integration DVM chip and features 200 mV full-scale input sensitivity and basic accuracy of 0.1% +/- the last digit. Input impedance is quoted as >100M with input leakage of 10 picoamps maximum.

Both differential and single-ended input can be arranged and the sampling rate is given as 2.5 samples per second. Auto-zeroing is provided, eliminating any zero adjustment.

The module comes with a mounting bezel and is suited for use as a volt or current meter, thermometer, pH meter etc. See your local Dick Smith Store or dealer, ask for cat. no. Q-2200.

The gentle art of chassis bashing

What with the ready availability of a whole range of good quality instrument cases these days, in both plastic and metal, it seems the art of 'chassis bashing' — fabricating your own cases and enclosures, may become extinct.

However, the Melbourne Machinery Co. seems bent on dispelling such an eventuality. They are marketing quite an excellent little 'pan brake' sheet metal folder that's just right for electronic work, in the home, at school or even the lab. at work.

Their 24" wide pan brake is designed for benchtop mounting, will handle steel up to 18 gauge, they say, and it's very simple to use. So, if you'd like to take up the gentle art of chassis bashing, with 'professional' results, contact **The Melbourne Machinery Co. (Sales) Pty Ltd, 51 Queensbridge St, South Melbourne. (03) 61 2911.**

Turn on with double clap

A genius of an idea that never took on — that's how "The Great Australian Turn On" was described to us — a device that will turn on a mains-powered appliance when you clap your hands twice in succession.

It's a box that plugs into any 240 Vac wall outlet. Plug any appliance into the 3-pin mains socket on the front of the Turn On — clap your hands twice, and plink! your appliance is turned on. Just the thing for, oh, ... all sorts of applications.

When released, it sold at around $40 to a totally underwhelmed public who left it on the retailers' shelves in great droves. Ho hum. Then along came Jaycar, rescues the Cinderalla and puts a fair price on it — just $11.50! It's a great gimmick for parties — keep your guests in the dark, then give them the clap treatment and turn on the lights!

You'll find a true Turn On in every Jaycar store — four in Sydney and one in Brisbane. Or call toll-free **008-022 888** and pledge your plastic. They're electricity authority approved and warranted for three months.

PROJECT BUYERS GUIDE

The April issue feature project, the AEM5505 Hash Harrier mains filter sure stirred a lot of interest. If you're looking for kits, Eagle Electronics in Adelaide has a 'short form' kit with the board and components — with the 'right sort' of capacitors, and a 'case kit' for housing it. Call on Malcolm Ling at 54 Unley Rd, Unley 5061 S.A. (08) 271 2885. While we're on the Hash Harrier, Geoff Wood Electronics in Sydney is stocking boards, toroids and the special X/Y type mains rated capacitors for it. Geoff will gladly receive you at 229 Burns Bay Rd, Lane Cove 2066 NSW, or on (02) 427 1676 (this month, we get the number correct!).

We note that Jaycar stock a range of capacitors which are suited to this project, in the right range of values.

The AEM4610 Super Modem is available through our special offer on page 97. Note that any computer can be used with this project. All you need is 'terminal' or 'communications' software.

The AEM6000 MOSFET Power Amp will be stocked by Jaycar, at least, as a kit — due next month. Fortunately, the components are widely stocked, except perhaps for the 2SK176/2SJ56 Hitachi MOSFETs, which are distributed by Ellistronics — but it shouldn't take too long before retailers stock them the country round. Imark, in Melbourne, also have the MOSFETs.

The AEM4502 Code-to-Speech Synthesiser features a pair of special chips made by General Instruments, the SP0256A-AL2 and CTS256A-AL2, and distributed through Daneva in Sydney and Melbourne. Try Geoff Woods in Sydney for boards and bits.

This month's star project, the 2m GaAsFET Preamp, will be stocked in kit form by Dick Smith stores throughout Australia.

EVERYTHING YOU NEED TO MAKE PRINTED CIRCUITS

NOW STOCKING COMPLETE RANGE OF E-Z CIRCUIT DRAFTING AIDS

FULL RANGE OF RISTON MATERIALS, CHEMICALS CALL FOR PRICES

Dual in Line Packages All $4.37/pack

Cut Pad

No. of Leads	Qty/ Pkg.	Scale	Catalog Number
14	32 28	1X 2X	EZ6014 EZ6038
16	32 28	1X 2X	EZ6004 EZ6109
18	28 26	1X 2X	EZ6900 EZ6901
24	12 12	1X 2X	EZ6535 EZ6536
28	12 12	1X 2X	EZ6903 EZ6904
40	8 8	1X 2X	EZ6906 EZ6907

Cut Pad With Conductors

- Use where conductor traces must be routed between pads

No. of Leads	Qty/ Pkg.	Scale	Catalog Number
14	32 28	1X 2X	EZ6760 EZ6761
16	32 28	1X 2X	EZ6763 EZ6764
40	8 8	1X 2X	EZ6984 EZ6985

Narrow Cut Pad

- Use where a longer terminal area is desired. Can be used with conductors between terminals

No. of Leads	Qty/ Pkg.	Scale	Catalog Number
14	32 28	1X 2X	EZ6013 EZ6071
16	32 28	1X 2X	EZ6453 EZ6244
40	8 8	1X 2X	EZ6987 EZ6988

Pre-Spaced Pads $4.37/pack

Center to Center Spacing	Pad Type	Scale	Pads Per Strip	Strips Per Pack	Catalog Number
.100"		1X	40	6	EZ5000
		2X	20	7	EZ5001
		1X	40	6	EZ5003
		2X	20	7	EZ5004
		1X	40	6	EZ5017
		2X	20	7	EZ5018
		1X	40	6	EZ5020
		2X	20	7	EZ5021
.156"		1X	25	6	EZ5014
		2X	13	7	EZ5015

Edge Connectors $4.37/pack

Patterns shown 1X (1:1) scale. Dimensions shown 1X (1:1) scale. For 2X scale multiply values shown by 2.

Center to Center Spacing	Scale	Contacts/ Strip	Catalog Number	Strips/ Pack
.100"	1X	44	EZ6805	2
	2X	22	EZ6809	5
.125"	1X	35	EZ6704	2
	2X	17	EZ6716	4
.156"	1X	28	EZ6708	3
	2X	14	EZ6720	5

P.C. Drills

Take your pick of tungsten carbide or high speed steel. Available in 0.8 0.9 1.0 and 1.2mm. T.C. drills $5.85 each. H.S. Steel $1.75 each.

Donut Pads

The basic all-purpose PC terminal area for termination of wire or component leads extending through the PC board. ID aids in accurate pad location to grid centers.

E-Z CIRCUIT Tape Donut Pads are unsurpassed for uniformity and accuracy. These photographically opaque terminal areas are accurate to ± .002 (0.05mm). E-Z Circuit opaque black pads are only .005 (0.13mm) thick.

$3.35/pack

1. Select the largest possible pad. Allow enough room for conductor traces and the physical conditions of artwork preparation and manufacturing of the actual board (MIL-STD-275).
2. A small ID makes registration easy, but may make it difficult to locate pad center after photo reduction.
3. Choose an ID smaller than hole to be drilled. (Drill size for plated-through holes must be larger than final hole.)
4. Use Multi-Pad configurations for multi-pad terminal patterns.

It is much easier, much faster, and much more accurate to lay down a whole pattern printed to specific tolerances than to tediously position individual pads.

STANDARD INCH

OD in.	OD mm	ID in.	ID mm	Cat. No	Qty/ Pkg
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD239	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD102	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD144	96
[illegible]	[illegible]	[illegible]	[illegible]	EZD103	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD247	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD138	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD139	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD109	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	EZD111	[illegible]

Precision Slit Tapes

"Super" 201 is a flexible extra-strong photographically opaque, pressure-sensitive precision slit tape with exceptional adhesive characteristics. It will not creep or lift if stretching is avoided during application. "Super" 201 is extremely flexible and has a non-reflective matte finish. Only .005" (0.13 mm) thick.

- Precision slit to exacting tolerances to assure highest quality PC artwork and photography
- Manufactured from the same high quality materials as E-Z CIRCUIT PREKUT TAPE SHAPES to insure compatible PC artwork and photography

STANDARD INCH
20 Yds./Roll

Tape Size in.	Tape Size mm	Cat. No.
.020	0.51	EZC3000 $3.05
.026	0.66	EZC3002 $3.05
.031	0.79	EZC3004 $3.25
.040	1.02	EZC3006 $3.25
.050	1.27	EZC3008 $3.25
.062	1.57	EZC3010 $3.35
.080	2.03	EZC3012 $3.35
.093	2.36	EZC3014 $3.35
.100	2.54	EZC3016 $3.35
.125	3.18	EZC3018 $3.35
.200	5.08	EZC3020 $3.46
.250	6.35	EZC3022 $4.57
.500	12.70	EZC3024 $5.70

Accurate Grids

Grids are produced on accurate stable film with 0.1" pattern for maximum accuracy. Matte one sided .003" thick.

10 x 10

Sheet Size	Catalog Number
[illegible]	EZ1463 $2.63
[illegible]	EZ1466 $4.87

CONNECTOR SPECIALS

25 WAY 'D' CONNECTORS
Great special on panel mounted D connectors.
Male $2.50 Female $3.50

CENTRONIC 36 WAY PLUGS
Solder type with metal backshell.
No special tools needed to fit these!! ONLY $4.50

DIN41612 Connectors All $4.37/pack

DIN41612 connectors patterns have three row designations A, B and C. Three pattern combinations are available AB, AC and ABC. They are also available with round or square pads.

ROUND PAD

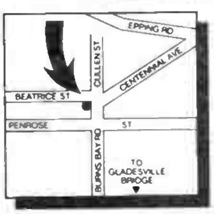
64-Pin Pattern (A-B) Scale	Symbols Per Pkg	Catalog Number	64 Pin Pattern (A C) Scale	Symbols Per Pkg	Catalog Number	96 Pin Pattern (A B C) Scale	Symbols Per Pkg	Catalog Number
1X	[illegible]	EZ6869	[illegible]	[illegible]	EZ6875	[illegible]	[illegible]	EZ6871
2X	[illegible]	EZ6870	[illegible]	[illegible]	EZ6876	[illegible]	[illegible]	EZ6872

SQUARE PAD

64 Pin Pattern (A B) Scale	Symbols Per Pkg	Catalog Number	64 Pin Pattern (A C) Scale	Symbols Per Pkg	Catalog Number	96 Pin Pattern (A B C) Scale	Symbols Per Pkg	Catalog Number
1X	[illegible]	EZ6878	[illegible]	2	EZ5881	[illegible]	[illegible]	EZ6884
2X	[illegible]	EZ6879	[illegible]	[illegible]	EZ6882	[illegible]	2	EZ6885

8.30 to 5 Monday to Friday. 8.30 to 12 Sat.
Mail Orders add $3.00 to cover postal charges.
Next day delivery in Sydney add $5.00.
All prices INCLUDE sales tax.
Tax exemption certificates accepted if line value exceeds $10.00.

BANKCARD, MASTERCARD, VISA, CHEQUES



GEOFF WOOD ELECTRONICS P/L
INC IN NSW
(02) 427 1676
229 BURNS BAY RD.
(CORNER BEATRICE ST.)
LANE COVE WEST N.S.W.

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

OR CASH CHEERFULLY ACCEPTED

specialising in electronic components for the professional and hobbyist.

TOLLFREE TELEMAIL 008 022 888 FOR COST OF A LOCAL CALL

No.1 for KITS

STORES LOCATED AT GORE HILL, SYDNEY, CARLINGFORD, HURSTVILLE, CONCORD, BRISBANE

AM/FM STEREO SYNTHESISED TUNER

Ref EA December '85 - Feb '86

This tuner will outperform any commercially available tuner REGARDLESS OF PRICE. We could not say that unless it was true. As well as getting an FM stereo section which is at least as good as any synthesised tuner ever built, it is the only unit featuring a genuine wideband, low distortion AM stereo (CQUAM) tuner! Not only do you get that you get a digital frequency readout, 12 station memory, automatic station seek and an optional infra red remote control.

Cat KA-1635

ONLY $399.00

REMOTE CONTROL FOR AM/FM STEREO TUNER

Ref EA April 1986

Go all the way and build the remote control - you deserve it. Complete kit

Cat KA 1636

ONLY $89.50

"ULTRA FIDELITY" PREAMPLIFIER

Ref AEM October - December 1985

The definitive Preamplifier by **David Tillbrook**

Cat KM 3030

ONLY $289

COMPACT DISC PLAYER ATTENUATOR

If you have just purchased a compact disc player your amplifier could be in trouble! CD players seem to have standardised on a 2V output level whereas most Hi Fi amps have a 500mV sensitivity for full rated output. In order to overcome this you may need a CD attenuator. It does not distort the signal in any way. It makes an ideal project for beginners but can be useful to the most advanced constructor. The Jaycar kit includes box, switch, front panel, etc.

Cat KA 1624

ONLY $7.95

IONISER KITS - Complete

High efficiency emitter head - fits completely inside a high quality ABS box (NOT a metal lid) - only 2 core mains flex protrudes from the box - you can pay over $80 for a built up inferior unit!

Cat KI 6611

NORMALLY $49.50
SAVE $15 ONLY $34.50

SHORTFORM KIT

Runs directly from 240V mains and has a low power consumption. Produces high intensity electric field with an output of around 7.5kV. Does not necessarily produce ozone in standard form. Ideal for those who wish to try an ioniser at an economical price.

Cat KI 6610

NORMALLY $27.50
SAVE $8 ONLY $19.50

5000 POWER AMP "BLACK MONOLITH"

The Jaycar "Black Monolith" is WITHOUT DOUBT the best 5000 amplifier kit on the market today AT ANY PRICE. There have been imitations but none have the features of our kit.

- *Completely redesigned flag heatsinks for the driver transistors. Thoroughly endorsed by D.T. himself.*
- *Strategically located ventilation slots in the covers.*
- *Blind tapped holes in the original "Superfinish" front panel.*
- *Heavy gauge EXTRUDED heatsink bracket.*
- *Our one-and-only "Superfinish" front panel - the best!*
- *Dual 3 pin DIN 30V power outlets*

Naturally all of our much copied features as well as standard viz: 1% metal film resistors, prewound chokes, pretinned fibreglass PCB's, heavy earth braid quality capacitors, flux shorting straps and of course the original chassis bar design (developed by Jaycar)

The "Black Monolith" is a special kit for a very special person - the perfectionist.

Cat KE 4200

ONLY $359

MUSICOLOR IV

The ultimate lighting controller • Front panel LED display • 4 different chaser patterns • Auto and manual reverse chase • Sound triggered chase • Inbuilt electret mic • Safe, opto isolated circuitry AND JUST LOOK AT THE PRICE!!

Cat KA 1010

ONLY $99.90
DON'T PAY $119

"BLUEPRINT" PREAMPLIFIER

Featuring a Moving Coil Cartridge Preamp with unbelievably low noise.

Cat KE-4202

COMPLETE KIT NORMALLY $339.00

SAVE $50 ONLY $289.00

NEW NEW NEW NEW NEW

ETI 1402 DIGITAL SAMPLER

Ref ETI May - June 1986

This kit enables you to record short bursts of sound i.e. "sample" or behave as a digital delay. It is a very low cost way of getting "into" digital sound techniques. You never know you may end up becoming the next "Frankie Goes to Hollywood"! The Jaycar kit includes case, knobs, plug pack, all board components etc.

Cat KE 4720

ONLY $119.00

CD COMPRESSOR

Ref EA June 1986

This little black box allows you to record from compact disc to cassette without losing the highs and lows, thereby retaining the quality.

Cat KA 1665

ONLY $69.50

⅓ OCTAVE (28 BAND) GRAPHIC EQUALISER

This kit enables you to control 28 narrow bands of frequencies between 31.5Hz and 16kHz. By being able to do this you will be able to very efficiently compensate for acoustic deficiencies in any indoor environment.

SPECIFICATIONS:

S/N Ratio	*−102dB with respect to 1V*
Freq Response	*12Hz-105kHz to −1dB*
Boost/Cut	*14dB (28dB total)*
Distortion	*100Hz (0.007%) 1kHz (0.007%) 10kHz (0.008%) essentially irrespective of cut or boost*
Current Consumption	*Approx 100mA @ ±15V (requires 30V AC CT)*

Cat KE 4204

USUALLY $209 each
SAVE $35 ONLY $174.00 each

8 CHANNEL AUDIO MIXER JAYCAR 8002

A balanced input/output 8 channel mixer with features found in units costing well over $2,000!!

MAIN FEATURES: • Balanced (600 ohm) mic inputs/line inputs • Input attenuators • Cannon connectors included in the price • Bass, mid and treble equalisation on each input • "Effects" (i.e. echo, etc) capability • Foldback on all 8 inputs • Stereo pan on all 8 inputs • 60mm slide faders used throughout • 19" rack mount capability (or console mount) • Professional black front panel with format borders and multicoloured knobs to assist function indentification • Designed for quick and easy service • VU metering • Only high quality components used • 5534A OP amps used for low noise and very low distortion

Cat KJ 6504

ONLY $560.00

SAVE $30
JAYCAR 2010 MkIIA STEREO EQUALISER

If you can't afford to pay for 2 x ⅓ octave 5000 graphic equalisers then the 2010 might be for you. The 2010 is an octave (i.e. one control per octave) equaliser. Octave centre frequencies: 31, 62, 125, 250, 500, 1k, 2k, 4k, 8k & 16kHz. This still gives you tremendous room equalisation. The 2010 also features separate level controls for right and left channels and a multi function pushbutton mode switch. Supplied in a pre punched 88mm (2 rack unit) cabinet which matches the 5000 system or looks on its own.

Cat KJ 6535

NORMALLY $159.00
ONLY $129.00

NEW CATALOGUE!

Haven't got your new copy of the 1986 Jaycar Catalogue yet? Send a large stamped address envelope and we'll send you one. It has 100 pages crammed with exciting electronic goodies.

"PEST OFF" ULTRASONIC PEST REPELLER

Ultrasonic type pest repellers have become very popular. Far too many commercial food processors now use ultrasonic pest control for it to be considered ineffective. You can build this kit and save a fortune over commercial units. The kit is in fact far superior to some commercial units tested.

Cat KA 1620

ONLY $44.50

WATCH OUT FOR THE NEW AEM POWER AMP

AEM 6000 - 200 WATT MOSFET MODULE

Ref AEM April 1986

These are the power amp modules that will be used in David Tillbrook's new stereo power amp.

Cat KM-3044

ONLY $109 (mono)

CD ADAPTOR

Ref EA April 1986

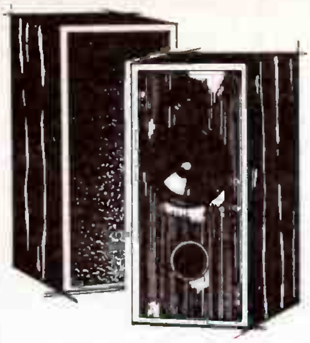
Have you ever wanted to fit a CD player to your car but were scared off by the high cost? This simple circuit will allow you to use one of the new portable CD players. It plays through your existing car stereo and even gets its power from the car.

Cat KA 1645

ONLY $32.00

GORE HILL OPEN TILL 4pm SATURDAY

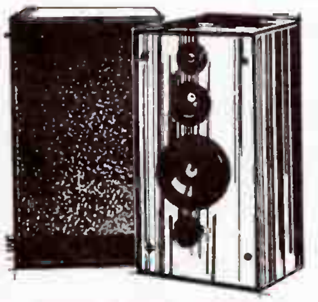
BRAND NEW 100 page 1986/7 ENGINEERING



AEM 6102 - 2 WAY VIFA KIT

This system consists of 2 x P21 Polycone 8" woofers and 2 x D25T Ferrofluid cooled dome tweeters with Polymer diaphragms and 2 pre built quality cross overs. The cabinet kit consists of 2 knockdown boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

SPEAKER KIT Cat CS 2460
ONLY $499.00
CABINET KIT Cat CB 2650
ONLY $179.00
OR TOGETHER FOR $599.00
SAVE $79.00
COMMERCIAL UNITS COST ABOUT $1,400



AEM 6103 - 3 WAY VIFA KIT

The system consists of 2 x D19 dome tweeters, 2 x D75 dome midrange, 2 x P25 woofers and two pre built crossovers. The cabinet kit consists of 2 knock down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.
Call into any of our stores for an audition.

SPEAKER KIT Cat CS 2465
ONLY $790 pair
CABINET KIT Cat CS 2652
$319.00 pair
SAVE A MASSIVE $110.00
BUY BOTH TOGETHER FOR $999.00

WATCH OUT FOR THE NEW PLAYMASTER 60 + 60 AMP KIT OUT SOON!
Cat KA 1650
ONLY $229.00

LOW COST SPEECH SYNTHESISER

AEM 4504 see AEM Feb 1986
This is the real thing. It can be interfaced to any computer having an 8 bit I/O port. It uses the SP0256A AL2 General Instruments chip. DIP header and computer connector are not supplied. IC sockets ARE supplied.
Cat KM 3042 **ONLY $39.95**

INTELLIGENT MODEM POWER SUPPLY

ETI 684 see ETI March 1986
The high quality power supply to match the new Modem due out in May.
Cat KE 4715

ONLY $49.95

UHF/VHF CONVERTOR

Ref EA April 1986
This kit is about ½ the cost of a built up unit. It converts UHF signals to VHF so you can pick them up on your older type colour TV. It is tuneable so it covers more than just channel 28.
Cat KA 1650
ONLY $59.50 NEW

ETI 4600 DUAL SPEED MODEM

Ref AEM December 1985
This project enables you to construct a modem that operates at either 300 Baud full duplex or 1200/75 Baud half duplex (i.e. CCITT V21 Orig, CCITT V21 Ans, CCITT V23 (mode 2) Orig & CCITT V23 back) for a fraction of the cost of equivalent built units. The Jaycar kit uses all original components and after much field testing has been de bugged. It works well!!
Cat KM-3040
NORMALLY $169.00
SAVE $20 ONLY $149

ETI 668 MICROBEE EPROM PROGRAMMER

Ref ETI February 1983
This simple, low cost unit plugs into the Microbee's I/O port and enables you to save programs in any of 5 different EPROMs (2716, 2732, 2532, 2732A & 2764), which can be used in your Microbee or any other microprocessor based system. As your Microbee I/O port is effected with a Z80 PIO chip, this programmer can be used with any other system employing the same I/O.
Cat KE 4651
NORMALLY $67.50
SAVE $12.50 ONLY $55.00

ETI 1527 ECONOMY HOME BURGLAR ALARM

This clever design by Robert Irwin features 4 sectors (2 with entry delay, two without) ability to use N.O. AND N.C. reed switches on the one circuit, a comprehensive LED status display. All electronics fit on the one board. The Jaycar kit includes all PCB components and an attractive Scotchcal front decal.
Cat KE 4698
NORMALLY $26.95
SAVE $7 ONLY $19.95

These are not kits, but built and tested modules

SUPER HI FI BI-FET PREAMP - 0.005% distortion

This magnificent preamp measuring 200(W) x 110(D) mm has many features. Phono in (RIAA equalisation within 0.2dB), phono out (to tape) and auxiliary input (as many as you like). Provision for switching "loudness" control in or out as well as the provision of a tone defeat switch. Bass, treble AND midrange controls are provided as well. A 40 detent clicker volume potentiometer is also provided. Naturally frequency response is flat over the audio spectrum and beyond and the S/N figures are outstanding. (Requires ±15V 200mA power supply, a circuit for this is included)
Cat AA 0315
ONLY $69.95

INFRA RED REMOTE CONTROL SYSTEM

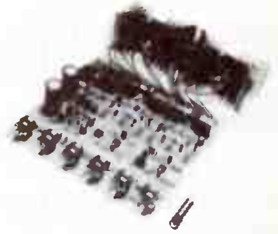
The system comprises two basic components, the handheld transmitter and the receiver. The handheld transmitter is supplied in an attractive plastic case and is powered by a 9V battery. It has an approximate range of 10 metres. Both transmitter and receiver use a proprietary Hitachi encoder/decoder IC set to preclude false triggering by daylight, sparks, flashes etc. The receiver output is by relay with N.O. or N.C. output. The relay is NOT 240V AC mains rated but will switch considerable DC loads, i.e. 5 amp (resistive) at 12-24V or up to 100V AC. An on board switch configures the unit to either operate while the transmitter switch is held "on" or alternatively in latch mode, i.e. press transmitter button and switch "on", press again to switch "off".
P.S. It also works as an event counter.
Cat AA 0346
ONLY $42.95

DUAL LED AUDIO LEVEL METER ASSEMBLY

This meter enables you to display power levels from −30dB to +5dB. The meter operates directly from the output of your amplifier, i.e. from the speaker leads. It does not consume any amplifier power. The level meter is powered by any voltage source between the range 3-20volts so it is ideal for 12V auto use. The meter can be calibrated to operate on amplifiers from 1 - 200 watts! A circuit for mains power supply is included.
Cat AA 0326
ONLY $32.50

80 + 80WRMS PRE-MAIN AMPLIFIER

A complete preamp and high power amp - with power supply electronics and loudspeaker protector in the one package! All that you need to connect is a power transformer and a signal source! The AA 0310 features TWO huge heatsinks for the power transistors, bass, treble and midrange controls, a microphone preamp and mixer pot, balance and volume control. There is a facility for preamp out (to dub from source to tape) as well as phono out. All in all it's a very well thought out unit. The main board measures 245(W) x 240(D), the heatsinks 130(W) x 75(D) x 70(H)mm are connected to the main amp board by about 150mm of wiring.
Cat AA 0310
ONLY $149.95
Suitable power transformer 4361 type - Cat. MM-2015 **$55.00**



STEREO LOUDSPEAKER PROTECTOR

An absolute must for all high power amplifiers. If anything goes wrong with a high power amplifier that is OCL* (i.e. does not have a large coupling capacitor between the final output stage and the speakers) a very high power source of DC can present itself directly across the voice coils of your expensive speakers destroying them probably before a fuse blows. The AA 0320 measuring 85(W) x 55(D) x 35(H)mm draws very little current at 12V DC. (A circuit showing how to connect it inside an existing amp is shown as well as a separate power supply.) The protector has a 3 second de-thump turn on delay and a DC fault sense circuit. The protection relay is massive and will not offer any significant voltage drop in even the highest power amps. Cheap insurance.
*Output capacitor-less. The enormous bulk of Hi Fi and PA amps are now built this way.
Cat AA 0320
ONLY $22.95

MINIATURE FM TRANSMITTER

THE LATEST & GREATEST IN A LONG LINE OF FUN BUGS
KE-4711 is a two transistor two stage transmitter that has the other benefit of being VERY compact.
Cat. KE-4711
ONLY $8.95

THE 'LISTENING POST'

This device attaches between the audio output of a shortwave receiver and the input port of a computer. It allows decoding and printing out of morse code, radioteletype (RTTY) and radio facsimile (FAX) pictures.
Cat KM-3015
ONLY $37.50

LARGEST RANGE OF KITS EX STOCK IN AUSTRALIA No.1 FOR KITS

SHOWROOMS

SYDNEY 117 York St (02) 267 1614
Mon - Fri 8.30 am - 5.30 pm
Thurs until 8.30 pm Sat 9 am - 12 noon

CARLINGFORD Cnr Carlingford & Pennant Hills Rd
(02) 872 4444 Mon - Fri 9 am - 5.30 pm
Thurs until 8.30 pm Sat 9 am - 12 noon

CONCORD 115 Parramatta Rd (02) 745 3077
Mon - Fri 8.30 am - 5.30 pm only

HURSTVILLE 121 Forest Rd (02) 570 7000
Mon - Fri 9 am - 5.30 pm
Thurs until 8.30 pm Sat 9 am - 12 noon

GORE HILL 188 Pacific Hwy (Cnr Bellevue Ave)
(02) 439 4799 Mon - Fri 9 am - 5.30 pm
Sat 9 am - 4 pm

Jaycar ELECTRONICS
INCORPORATING ELECTRONIC AGENCIES

QLD. BURANDA 144 Logan Rd (07) 393 0777
Mon - Fri 9 am - 5.30 pm
Thurs until 8.30 pm Sat 9 am - 12 noon

HEAD OFFICE 115 Parramatta Rd
Concord 2137
(02) 747 2022 Telex 72293

ROAD FREIGHT ANYWHERE IN AUSTRALIA **$13.50**

VISA · bankcard · MasterCard · AMERICAN EXPRESS · Cards Welcome

MAIL ORDER VIA YOUR PHONE

MAIL ORDERS
P.O. Box 185 Concord 2137
(02) 747 1888 **HOTLINE**
(008) 022 888 **TOLLFREE**

POST & PACKING

$5 - $9.99	$ 2.00
$10 - $24.99	$ 3.75
$25 - $49.99	$ 4.50
$50 - $99.99	$ 6.50
OVER $100	$10.00

CATALOGUE OUT NOW SEND LARGE S.A.E.

An 'ultra-fidelity' MOSFET power amplifier module

David Tilbrook

The demands of the 'digital era' require power amplifiers of unparallelled performance in every critical aspect – power output, total harmonic distortion, dynamic distortion, stability, and subjective 'sound' (or lack of it, in reality). It is no easy matter to meet, let alone exceed, the criteria required, but we believe this amplifier does just that. Two of these modules will be employed in our upcoming ultra-fidelity stereo power amplifier, the companion to our popular preamp published earlier.

Part 1

THIS PROJECT represents the second in our series of ultra-fidelity audio components. The first was the AEM6010 Ultra-fidelity Preamplifier which was designed as a no-compromise unit with subjective performance being the most important design criterion. This is the approach taken in the AEM6000 power amplifier. Its objective performance, such as the total harmonic distortion (THD), frequency response, slew rate and stability is excellent, but the vast majority of development time has been spent on achieving the best possible subjective performance. The design uses MOSFET output transistors with what has become known as a fully symmetric voltage amplifier stage driven by an asymmetric cascade differential pair which employs both bipolar transistors and a dual-JFET. This overall circuit topology was selected only after a great deal of experimentation and was found to give the best subjective performance of the various topologies tried during development. The design does not use an excessive amount of overall feedback and this, combined with intrinsic high speed, yields an amplifier with superb stability characteristics.

Output stage considerations

In order to understand the reasons for the choice of this particular topology it is useful to start at the output stage and work backwards. The output stage employs two pairs of Hitachi complementary power MOSFETs, the n-channel 2SK176 and p-channel 2SJ56. These are higher power dissipation and higher voltage versions of the 2SK134/2SJ49s used in the AEM6500 general purpose power amp modules (July '86 issue). The main limitation of these earlier MOSFETs that prevents their use in this application is their relatively low maximum drain-to-source voltage rating of 140 volts. In other words, the maximum voltage at any instant that can be applied from the drain to the source of these MOSFETs must never exceed 140 volts, otherwise permanent damage to them may occur.

The power MOSFET is a particularly robust device but it can be damaged by excessive voltage and so it is very important that this criteria be well controlled. Since this power amplifier, like most modern power amplifier designs, is intended to be powered from a rectified and filtered but unregulated power supply, the supply voltage varies proportionally with the mains voltage. Although the mains voltage is rated nominally at 240 volts it varies about this figure, sometimes very considerably. The mains voltage at our laboratory in Wahroonga in Sydney, for example, lies somewhere between 245 and 255 volts depending on the time of day. We have been advised by various electricity councils in several states that a maximum mains supply voltage of around 265 volts should be allowed for.

If, for example, a 300 VA 47-0-47 V power transformer was to be used for the power supply of a power amplifier then the supply voltage after full-wave rectification and with a load of 300 watts, would be around ± 66.5 volts. Under "no-load" conditions, supply voltages would be approximately 5% higher than this at around ± 70 volts. This is the case for a mains supply voltage of 240 volts and you need to allow for a peak mains supply of around 265 volts. Under these circumstances, the power supply rails could be as high as ± 77 volts. If this power supply were now used in conjunction with an output stage employing 2SK139/2SJ49 power MOSFETs then it is possible for the maximum drain-to-source voltage of 140 volts to be exceeded.

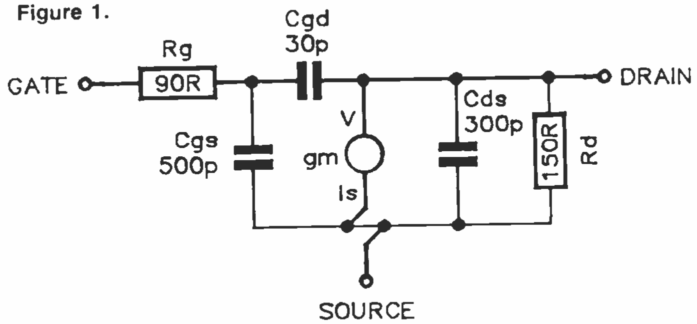
The vast majority of modern solid state power amplifier output stages operate in what is referred to as "class B" at high output powers. This means that only one side of the output stage is operational during any half cycle of the output signal waveform, the complementary side being 'off'. The complementary output devices alternate passing control of the load to and from each other each time the output signal voltage crosses zero. At full power then, even during a short, very large transient signal voltage, one set of output devices will be hard on, showing minimum drain-to-source resistance (as I'm talking about MOSFETs here) and allowing the output to approach as closely as possible to one or other of the two supply rails. Under this condition almost the full supply voltage is applied to the devices which are off during that half cycle. There is some voltage drop across the 'on' MOSFETs due to their source-to-drain resistance and their source resistors. Even this, however, cannot be relied upon because the module might be operated with no load and hence these drops will not be present. Under these conditions it is quite possible to apply in excess of 150 volts across those MOSFETs in the 'off' state. Under such circumstances, power MOSFETs with a maximum drain-to-source voltage of 140 volts can be relied upon to have a very short life indeed!

For these reasons I have chosen the 2SK176/2SJ56 complementary pair for use in this design. These devices are even more robust than their counterparts. They have a maximum drain-to-source supply voltage rating of 200 volts, maximum power dissipation rating of 125 watts and a maximum drain current rating of 8 amps. The use of two pairs of these devices in the output stage of this power amplifier makes it appropriate for use with supply voltages ranging from ± 50 to ± 70 volts, allowing maximum output powers from around 100 to over 200 watts RMS. If you were building a power amplifier to accompany a compact disk player and perhaps a modern pair of direct radiating loudspeakers, then you should opt for the higher power.

The power MOSFET is a voltage driven device. By this I mean that the applied voltage expressed between its gate and its source determines the resistance of the device from its drain to its source. If the gate-to-source voltage is increased the drain-to-source resistance is decreased (n.b: This is only the case with enhancement mode devices, most JFET devices, for example, are depletion mode types and operate more like a vacuum tube. Increasing gate voltage causes an increasing drain-to-source resistance). The maximum gate-to-source voltage that can be applied is a characteristic of the particular choice of MOSFETs employed. If the maximum gate-to-source voltage of the power MOSFETs is exceeded by the driving amplifier stages, the MOSFETs will be damaged irreparably. This is the most common reason for MOSFETs to be destroyed once they are properly in circuit (that is, not from electrostatic discharge) and to prevent this possibility a series diode/zener diode string is incorporated in parallel with the MOSFET from gate to source. The zener diodes specified are 12 V/1 W types and, being in series with the diodes, prevent the gate-to-source voltage from exceeding 12.6 volts.

The circuit diagram in Figure (1) shows the equivalent circuit of a power MOSFET similar to the types employed in this design.

Figure 1.



WHERE Rg = SERIES GATE RESISTANCE
Cgs = GATE/SOURCE CAPACITANCE
Cgd = GATE/DRAIN CAPACITANCE
Rd = DRAIN RESISTANCE
Cds = DRAIN/SOURCE CAPACITANCE

Equivalent circuit of a typical power MOSFET

The gate appears as a 90 ohm resistance in series with a 30 pF capacitance to the drain and a 500 pF capacitance to the source. At dc, the input resistance is many thousands of megohms, being determined by the effective dielectric constants of these two input capacitances. The amount of gate-to-source capacitance for the n-channel and p-channel power MOSFETs is substantially different, with the capacitance usually being substantially less for the n-channel types.

The equivalent circuit gives us several insights into the characteristics of these power MOSFETs. At low frequencies the gate impedance is extremely high. As the frequency increases, however, the gate-to-source and gate-to-drain capacitances become increasingly important, decreasing the input impedance substantially. When used in a class B amplifier the different load capacitance that is presented by the n-channel and p-channel MOSFETs produces an asymmetric load to the drive stage at high frequencies and, if uncorrected (a common omission in published designs), this tends to increase high frequency second harmonic distortion. Fortunately, the problem is realatively simply solved by increasing the gate-to-source capacitance of the n-channel power MOSFETs by the addition of parallel 330 pF capacitors connected between the gate and source.

The equivalent circuit also gives us an insight into the high frequency performance of the power MOSFET. The effective gate resistance and the gate-to-source capacitance couple to form a low-pass first-order filter that determines the high-frequency response of the device. The cutoff frequency of a power MOSFET is well in excess of 3 MHz when correctly driven and the absence of an effect called "minority carrier storage" ensures that the power MOSFET is unrivalled in switching speed. The extremely fast response, coupled with the high input impedance and the gate-to-source and gate-to-drain capacitances, however, make the devices prone to oscillation if they are incorrectly used. The cure is to decrease the cutoff frequency of the output stage by the addition of series gate resistors for each device. These add to the internal gate resistance and decrease the frequency response of the output stage. These resistors, shown in the AEM6000 main circuit diagram as 270 ohms, must be mounted physically as closely as possible to the gates of the power MOSFETs. Remember that these components are incorporated to cure a problem that will only exist at high frequencies, so any inductance in series with the gate circuitry will decrease their effectiveness. Although these series resistors do decrease the slew rate of the output stage slightly, the effect is not dramatic and the overall slew rate figures of the power amplifier remain very good. The extremely high slew rate of the output stage facilitates a very broad open-loop bandwidth which in turn contributes greatly to the reduction in slew-induced and other dymanic distortion mechanisms.

Power amplifiers employing the more conventional bipolar output transistors often suffer from inferior open-loop bandwidth and tend to rely on the application of negative feedback to linearise high frequency performance. In this case, the amount of overall negative feedback decreases with increasing frequency, leading to increased distortion figures at higher frequencies.

There are other advantages of the power MOSFET that are not revealed by examination of the equivalent circuit. Probably the most important of these is its thermal characteristics. The power MOSFET, unlike the bipolar transistor, has a negative temperature coefficient when operating above a certain drain current. In the case of the 2SK176 and 2SJ56 ▶

devices, this is around 100 mA. Above this operating current the power MOSFET has the characteristic such that an *increase* in its operating temperature will cause a *decrease* in the drain-to-source current for a given gate-to-source voltage. The positive temperature coefficient exhibited by the bipolar transistor, on the other hand, causes an increase collector-to-emitter current as temperature rises when the base current is held constant. The increased collector-to-emitter current increases power dissipation within the device and the consequent increase in the operating temperature leads to a further increase in the collector-emitter current. The result is an effect called "thermal runaway" which leads inevitably to the to the destruction of the device. The negative temperature coefficient of the power MOSFET is the characteristic that makes it so robust in comparison to bipolar power transistors.

Inspection of the main circuit diagram of the AEM6000 power amplifier reveals that, associated with each output MOSFET there is a 0.22 ohm (0R22) resistor in series with the source. These resistors have a three-fold purpose. Firstly, they encourage current sharing between the two pairs of MOSFETs. This is particularly important if the devices are operated with a quiescent current of less than 100 mA. Secondly, they greatly improve the stability characteristics of the output stage, and finally, they help to linearise the transfer characteristics of the devices. The final components used to ensure stability of the output stage are associated with the RC network connected from the output of the power amplifier to ground, which serves to provide the power MOSFETs with a load at high frequencies. At a sufficiently high frequency, the two 22 ohm/1 watt resistors in parallel represent an 11 ohm load from output to ground.

The initial specification for the AEM6000 power amp was that it should be capable of delivering in excess of 200 watts RMS into an 8 ohm load. This means that, when driven by a sinewave it will develop 40 volt RMS across the load (i.e: one having a peak amplitude of 56.6 volts). Since the minimum drain-to-source on-resistance for the Hitachi devices is around 1.8 ohms, I would expect a voltage drop of around 6 volts as a result of the current necessary to develop 200 watts in an 8 ohm load. Allowing for a further voltage drop of around 1 volt across the source resistors, the required supply voltage to ensure 200 watts into an 8 ohm load would be around 64 volts. The recommended maximum suply voltage of around 70 volts should therefore suffice.

The voltage amplifier

The main voltage amplifier is a two-stage fully symmetric differential amplifier. The differential voltage amplifier circuit was chosen since it was determined that the open-loop distortion should be kept to a minimum. By this I mean that the distortion of each individual amplifier stage within the power amplier should be a minimum. In this way, good overall distortion performance can be achieved without the introduction of large amounts of overall negative feedback. The differential amplifier has a much lower intrinsic distortion than a single-ended voltage amplifier. This is shown clearly by the diagram in Figure 2. This graph shows the difference in distortion performance between a differential. pair and a single transistor for various open-loop gains. The distortion figures for the differential pair are around 30 dB below those of a single transistor.

The voltage gain stage is fully symmetric since it became clear during the development of this power amplifier that the subjective performance of this type of voltage amplifier is clearly superior to the earlier asymmetric designs.

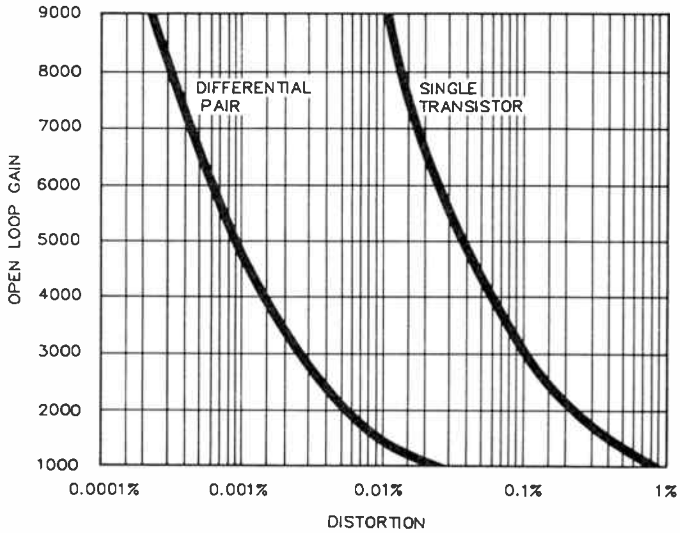


Figure 2.

However, this was found only to be the case in those parts of the power amplifier design that necessitated large signal level, and hence large signal slopes or slew rate (the ability to change voltage output very rapidly). In fact, both the subjective and objective performance of fully symmetric differential pairs employing bipolar transistors proved to be inferior to that of an asymmetric differential pair when used at low signal levels.

The voltage amplifier stage consists of the fully symmetric differential pairs formed by Q11-Q14, followed by a differential voltage amplifier stage formed by Q15-Q18 and fed from a pair of constant-current sources formed by Q9, Q10 and their associated resistors and diodes.

The input differential pair

The input stage is an asymmetric cascade differential pair formed by the combination of a dual-JFET, Q1 and Q2, and a pair of bipolar transistors, Q3 and Q4. The correct operating conditions are established by two constant-current sources in conjunction with a zener diode. The first of these current sources is formed from Q7 and Q8 in association with resistors R13 and R14, while the second is formed from Q5 and Q6 and resistors R8 and R10.

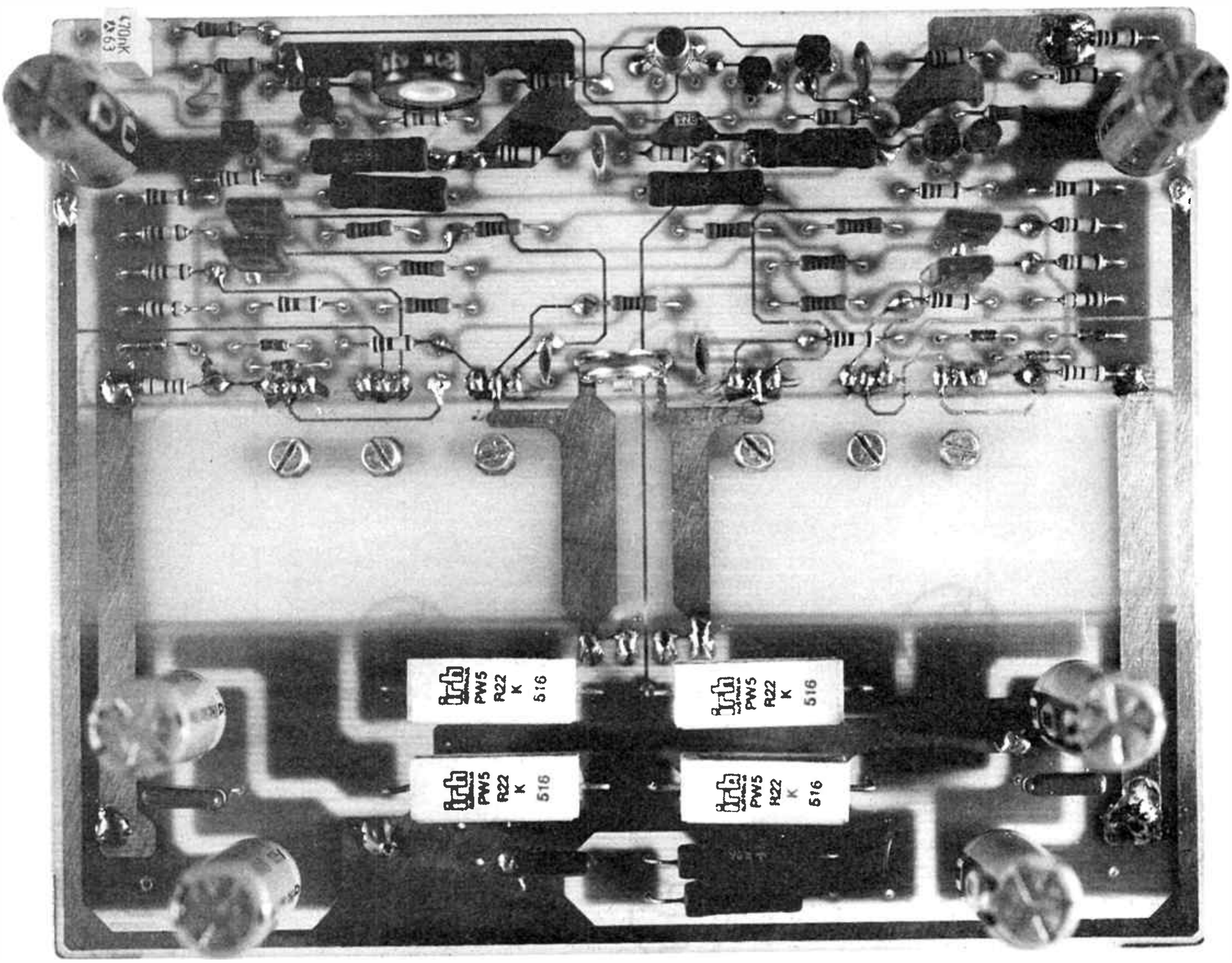
I have chosen an asymmetric input differential pair in preference to a fully symmetric stage since, as mentioned above, both the subjective and objective performance of the asymmetric circuit proved to be superior. The reasons for this are associated with a fundamental problem of symmetric stages, that of asymmetry of the characteristics of npn and pnp transistors. The reality is that, although the principle of a symmetric amplifier circuit is to oppose every npn device with a pnp device so that the non-linearities generated by these two devices cancel; in practise this does not occur. Because npn and pnp bipolar transistors have different characteristics, some asymmetry in the operation of the circuit is inevitable. This problem is most significant for small signal levels and so the choice of a fully symmetric stage using bipolar transistors for the input differential pair is, in my opinion, inappropriate. No doubt these remarks will cause some controversy, but my opinion is supported by both objective and subjective analysis of a variety of test amplifiers. Some of these were fitted with asymmetric stages. The test amps were otherwise identical. The CMRR (common mode rejection ratio) of the asymmetric stages was consistently superior to those of the fully symmetric stages as was the THD and the overall output offset voltage. The symmetric stages do exhibit decided advantages, however, for application in the voltage amplifier stages where the relatively poor CMRR performance is unimportant.

Another aspect of the input stage design that was found to be of particular importance to the subjective performance of the power amp, was the elimination of capacitors from the signal path. In particular, the dc blocking capacitor usually employed in the feedback loop to reduce the overall dc gain of the amp, and hence the dc offset, was found to cause significant degradation of subjective performance. In order to facilitate removal of this capacitor altogether, the dual-JFET input pair was required. If a bipolar transistor pair was to be used instead, the base-emitter bias current necessary would produce an input offset voltage of around 20 mV. After amplification by the dc gain of the power amp, an output offset voltage of around 1 V could easily result. The JFETS, of course, do not suffer from this problem. Furthermore, since the two JFETS are mounted on the same chip, this ensures excellent thermal tracking and consequent stability of the output offset voltage with temperature changes.

The power amplifier can be operated entirely direct-coupled if required, although some caution should be executed if attempting to do so. Remember that the power amp will be driven to full power from a 1 V input signal. Application of just 1 Vdc to the input of the power amp will result in full power dc signal (around 70 Vdc) being applied to the base driver of your loudspeakers with obvious catastrophic results! In next month's issue we will be describing a dc protection circuit that detects the presence of dc on the output stage of any power amp and automatically disconnects the loudspeakers if necessary. This unit will also be incorporated into the AEM6000 power amplifier and is recommended for use with this power amp module. In general, I would recommend the use of the input coupling capacitor C1. It has little, if any, effect on the subjective performance and could help to prevent a costly accident in the event of a dc offset problem associated with the preamplifier used to drive the power amp.

Next month I will be describing the construction of the power amp modules in detail and, as mentioned above, the design and construction of the dc protection circuitry. Until then, take the time to examine how the circuit functions, as described in the Circuit Operation section of this article. Direct- (or dc-) coupled power amps, particularly high power ones, can be difficult to service at times and familiarity with the circuit under these circumstances is imperitive. ▶

Below: A prototype board.



STORES LOCATED AT GORE HILL, SYDNEY, CARLINGFORD, HURSTVILLE, CONCORD, BRISBANE

SPECIAL NEW ANTENNA

PICK UP TV THEY DON'T WANT YOU TO WATCH!

LETS YOU PICK UP PROGRAMS BLACKED OUT IN YOUR CITY!

You know the story - it's the big footy game, cricket match, boxing fixture, etc. and it's happening in YOUR CITY. Everyone else in the country - including people in nearby towns - can watch it live except you. Well now you can do something about it! Jaycar has produced a TV antenna ESPECIALLY MADE to have VERY HIGH GAIN on channels 4 and 5A. If you live in Sydney, for example, you must mount the antenna as high as possible and point it due south towards Wollongong where there is generally no TV sports blackout. Maybe not applicable in your city - please check. Hotel publicans have spent fortunes having expensive antennas installed so their patrons can watch sport live - now you can have this benefit in your own home for a fraction of the cost! Start watching live sport NOW.

Cat. LT 3190

ONLY $59.95

EXCLUSIVE!!

ALARM STICKERS

LARGE 125mm x 75mm

Suitable for houses, factories, caravans etc. Will stick on the outside i.e. sticky on the back.

Cat. LA 5102

ONLY $1.95 each

SPECIAL 5 for $7.50

SAVE $2.25

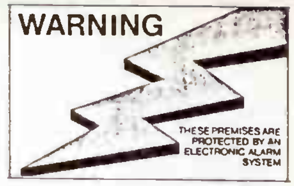
SMALL 73mm x 33mm

Specifically designed for cars. Sticky on the front so you can stick them on the inside glass. Thieves will not know whether you have an alarm or not.

Cat. LA 5100

ONLY 95¢ each

SPECIAL 5 for $3.50



IT TURNED ON BUT PEOPLE DIDN'T. . .

The Great Australian Turn On was supposed to take the market by storm. But it didn't.

WHAT IS IT? Well, it's basically a device that plugs into a normal 240V power point. You then plug another appliance into it. You clap your hands twice and - PRESTO - the appliance turns on! GREAT! A remote controlled switch for TV, lights, radios, stereos etc. BUT - at $39.95 it was too dear although it worked well. Jaycar has purchased the entire distress stock at a never-to-be-repeated price.

Cat. YS-5600

- **IMPRESS YOUR FRIENDS**
- **ELECTRICITY AUTHORITY APP.**
- **3 MONTH WARRANTY**

NORMALLY $14.95

SAVE $3 ONLY

$11.50

☆ COMING SOON ☆

ULTRASONIC AIR HUMIDIFIER

CREATE YOUR OWN CLIMATE

Airconditioners are great. They keep us cool on hot days. But in a big office building sometimes you have no control over them in your immediate work area. They de-humidify the air and dry your skin out. You get a dry raspy throat and sore eyes. In a natural environment the air is much more moist!

The Jaycar ultrasonic humidifier corrects the balance in your work or home environment! This unit re-humidifies air automatically by an ultrasonic mist evaporator. You can adjust the humidity in your environment in the range 30-90% R.H.! It simply plugs into the power point and draws little power. It has a large water container (4.15 litre) and switches off automatically when dry. The mist output is free of dust as the air drawn into the unit is filtered.

FEATURES: ★ Cutout switch when water runs out ★ Generous 4.15 litre water tank ★ Ultra quite operation ★ Adjustable humidity control ★ Air filter included ★ Safety cut out switch if tipped over ★ Humidifies up to 3,000 cubic feet ★ Great for gardeners who need to keep the humidity up for their indoor plants. **SPECIFICATIONS** Power consumption 45 watts ★ Maximum output 380ml/hour ★ Power source 240V AC ★ Humidity control range 30-90% ★ Dimensions 356(L) x 266(H) x 146(D)mm

Cat. YH 5510

ONLY $149.00

SPEAKER ACCESSORIES

GRILLE CLOTH

High quality acoustically transparent grille cloth is ideal for protecting those expensive drivers - but making sure all the sound gets through. Comes in a 1.5 x 1 metre roll. Black in colour.

Cat. CF 2752

$11.50 per metre

SPEAKER GRILLE CLIPS

Have you ever wondered how expensive speaker grilles are held in place? They use a plastic clip in plug and socket. Now you can have them on your speakers instead of Velcro tape.

Cat. CF 2761 **SET OF 4**

ONLY $3.25 set

SPEAKER SEALANT

This is a special non hardening sealing compound. Ideal for getting a really airtight seal between drivers and cabinets. This is vital with the acoustic suspension designs popular today. 2 metre roll.

Cat. CF 2762

ONLY $2.95

VELCRO TAPE

This tape is ideal for holding grilles on speaker cabinets. One side is glued or stapled to the box and the other to the grille. The grille then sticks to the box. Comes as a packet of two rolls 300mm long.

Cat. CF 2763

ONLY $2.95

INNERBOND

Innerbond is the ideal substance for lining the insides of speaker cabinets. It has excellent damping properties and is clean and non irritating unlike many substitutes. Use the best! Comes on a roll approximately 900mm wide. Thickness is 25mm.

Cat. AX 3690

ONLY $4.95 per metre

BLANK FIBREGLASS PCB

Single sided copper clad for making your own PCB's. **300mm x 300mm.**

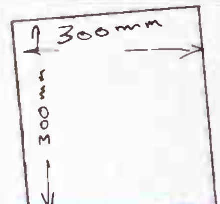
Cat. HP-9510

NORMALLY $8.95

SAVE $3.95

THIS MONTH ONLY

ONLY $5.00 ea



QUARTZ CRYSTAL CLOCK MOVEMENT

NOW WITH 3 SETS OF HANDS AT NO EXTRA CHARGE. . .

★ Very compact ★ Self starting one second stepping motor has strong torque ★ Powered by 1.5V AA battery that lasts for 1 year ★ ±15 second/month accuracy ★ 56mm square, 15mm deep.

Fit your own custom clock face. Great for novel applications such as fitting to a picture, etc.

INCLUDES SWEEP SECOND HAND

Cat. XC 0100

ONLY $12.95

240 VOLT CANNON MADNESS

Genuine Cannon XLR LNE-11C 240 volt mains line female connector.

Cat. PS 1002

USUALLY $9.95 each SAVE 75%

ONLY $2.50 each 50+ $2 each

Genuine Cannon AXR LNE 32 240 volt mains chassis male connector (the mate to the PS 1002 above)

NORMALLY $7.95 each

SAVE NEARLY 70%

$2.50 each 10+ $2 each

(BELOW NORMAL WHOLESALE COST)

SAVE UP TO 67%

GENUINE CANNON 15D RIGHT ANGLE SOCKET

NORMALLY $5.75

NOW ONLY $2.50 ea

10 up $2.20 each

100 up $1.90 each

Prices include tax

Cat. PS 0826

CAR ALARM REPLACEMENT GLOBES

Replacement globes for flashing switches/bezels for car alarms.

1) Possibly the most common 12 volt push-in. Metal flange up two sides. Used in Red Light, Yellow Light, Pirahana and Cobra.

Cat. SL-2638 ____ **$4.50 each**

2) Used in Yellow Light and possibly others.

Cat. SL-2637 ____ **$4.50 each**

3) Used in Yellow Light and possibly others.

Cat. SL-2636 **$4.50 each**

5mm LED CLIPS

HEWLETT PACKARD BRAND

FROM 4¢ each!!

Pkt of 20 $1.20 SAVE 30¢

Cat. HP 1102

Pkt of 100 $4.00 SAVE $1.00

That's only 4¢ per clip!

Cat. HP 1103

UNBELIEVABLE!!!

MIXED PACK IC SOCKETS

NORMALLY $24.95

THIS MONTH ONLY

$16.50

Consists of: ★ 15 x 8 pin ★ 20 x 14 pin ★ 20 x 16 pin ★ 10 x 18 pin ★ 5 x 20 pin ★ 10 x 22 pin ★ 5 x 24 pin ★ 5 x 28 pin ★ 10 x 40 pin

Cat. PI 6490

DIGITAL ALARM CLOCK/ THERMOMETER

This great new product has a built in temperature sensor so displays the temperature in both C and F. It also tells the time. An alarm will sound when the temperature falls below or goes above a preset temperature. Handy pocket size measures 53 x 82 x 22mm. Temperature measuring range −20°C to 70°C, 0°F to 160°F. Uses one AAA battery.

Cat. XW 0390

ONLY $19.95

DIE CAST BOXES AT ½ PRICE

BOX 1 - A large box measuring 170(D) x 116(H) x 170(W)mm

NORMALLY $15.95 JUNE $7.98

BOX 2 - This one is similar in size to a can of sardines. Measures 120(D) x 28(H) x 95(W)mm

NORMALLY $8.50 JUNE $4.25

SPEAKERS AT SILLY PRICES

BARGAIN No 1 - 5¼" 8 ohm 5 watt car radio replacement type speaker complete with dust cover. These are normally $6.95 each. Cat. AS 3004

WE HAVE 140 ONLY AT **$2.50 each**

BARGAIN No 2 - 6" 4 ohm 5 watt radio replacement. Normally $6.95. We have 110 to clear at

ONLY $2.50 each - Cat. AS 3005

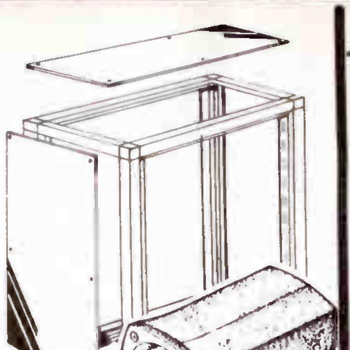
MAILORDER HOTLINE 02 747 1888

RACK FRAMES

The Jaycar racking system is available in two formats. Firstly as a racking frame only and then with the addition of the optional panels it becomes a complete equipment panel. Supplied in flat pack form they can be assembled in a very short time.

SEE THE 1986 CATALOGUE FOR FURTHER DETAILS

Cat HR 5210 6 unit Frame set (370mm)	$89.50
Cat HR 5215 6 unit Panel set	$49.00
Cat HR 5220 18 unit Frame set (907mm)	$119.50
Cat HR 5225 18 unit Panel set	$89.00
Cat HR 5230 30 unit Frame set (1450mm)	$149.50
Cat HR 5235 30 unit Panel set	$129.00
Cat HP 0645 16mm bolts pack of 12	$2.95
Cat HP 0640 Captive nuts pack of 12	$4.95



116dB of TWEETIE PIE

Incredible piezo screamer measures 57(L) x 33(H) less bracket. Emits a 116dB wail sounding very much like a canary. Ideal for any compact high noise alarm application.
Cat LA 5255

SAVE $10 on 1985 PRICE
ONLY $14.95

POTENTIOMETER LUBRICANT

Specially formulated for slider pots. Can be used with metal to metal, metal to plastic & plastic to plastic.
Cat NA 1012

ONLY $11.95

MINI BURGLAR ALARM

★ GARAGES ★ TOOL SHEDS ★ HOLIDAY HOUSES ★ LAWN LOCKERS ★ BOAT SHEDS ★ BUILDING SITES ★ PORTABLE BUILDINGS ★ VIDEO RECORDERS ★ BOATS ★ CARAVANS etc.

SEE 1986 CATALOGUE FOR FURTHER DETAILS
Cat LA 5010

ONLY $39.50
Optional Video Cable Cat LA 5012 $6.50

10 AMP DIGITAL MULTIMETER

WITH TRANSISTOR TEST FACILITY

Superb features and specifications. Includes 0.5" high digits, single function range switch, long battery life etc. Size 170(H) x 90(W) x 35(D)mm.
SEE THE 1986 CATALOGUE FOR FULL DETAILS
Cat QM 1530

ONLY $89.95

10 AMP DIGITAL MULTIMETER + TRANSISTOR TESTER + CAPACITANCE METER

The big daddy, this superb unit features 0.5" high digits, CMOS logic, auto polarity etc.
SEE THE 1986 CATALOGUE FOR FURTHER DETAILS
Cat QM 1540

$129.00 A BARGAIN

MAIL ORDER VIA YOUR PHONE

SIDE ELEVATION: D = 254mm; C (internal chassis height); B (mounting bolt centres)

	Finish	A	B	C	Each	5 +
Cat HB-5411	Natural	44	34	38	$55.00	$52.00
Cat HB-5413	Natural	88	57	82	$65.00	$61.00
Cat HB-5415	Natural	132	89	126	$75.00	$70.00
Cat HB-5410	Black	44	34	38	$55.00	$52.00
Cat HB-5412	Black	88	57	82	$65.00	$61.00
Cat HB-5414	Black	132	89	126	$75.00	$70.00

Beware of other rack cabinets that do not conform to International Rack sizing.

DELUXE RACK CABINETS

NOW YOUR PREAMPS, AMPS, CONTROL MODULES, MONITOR PANELS ETC., CAN LOOK EVERY BIT AS GOOD AS TECHNICS, NAKAMICHI AND OTHER TOP MANUFACTURERS

MICROPHONE MADNESS

JAYCARS UNBELIEVABLE MICROPHONE DISTRESS STOCK PURCHASE

WIRELESS/WIRE MIC UNIDIRECTIONAL
DISTRESS STOCK PURCHASE

No more cords! It has a built in FM transmitter that can be picked up by any FM receiver. The signal can be amplified for PA etc. Service area is up to 50 metres. Also usable as a conventional microphone with the supplied cable. Frequency 88 - 108MHz.

THESE WOULD NORMALLY SELL FOR $32.50

Due to distress stock purchase we have a quantity available for only

$19.95

SAVE $12.55 - 61%!!!
Cat AM 4071

SAVE OVER 50% ON SOME

Jaycar has purchased an entire "Job Lot" of quality "Unisound" microphones. Most are below half what you'd expect to pay. Quantities are strictly limited, and once sold can never be repeated.

FM WIRELESS MIC
ELECTRET CONDENSER

If you want an FM mic to experiment with or use in a small public address system, this is the one. Only 100 available. Transmitting frequency range 88.1MHz to 106MHz. Omnidirectional. Field strength is less than 50uV/m at 50 feet. Supplied with windscreen, frequency adjuster, Lavalier and battery.
Cat AM 4072

NORMALLY SELLS FOR $27.95
½ PRICE SAVE $14
ONLY $13.95

SAVE HEAPS

FM WIRELESS MIC
ELECTRET CONDENSER CARDIOID

This is a top quality FM mic. Frequency transmitting range 88MHz - 106MHz. Unidirectional.
Cat AM-4073

NORMALLY SELLS FOR $38.50
LESS THAN ½ PRICE
SAVE $20.00
ONLY $18.50

50% OFF

PROFESSIONAL ELECTRET CONDENSER UNIDIRECTIONAL DUAL IMP - DUAL TONE

This mic has a unique dual tone switch. At the "flat" position it is suited to music, recording and other Fi purposes due to its perfectly flat character at frequencies. At the "Vocal" position it is suited to work which prevents too much low tone or indistinct sound when mic is held close to the mouth. Freq Response 30-20,000Hz. Impedance Lo 1k, Hi 10k. Sensitivity Lo −68dB ±3dB; Hi −57dB ±3dB. Complete with cable and 6.5mm plug. A TRULY PROFESSIONAL MICROPHONE.
Cat AM-4080

NORMALLY $47.50
SAVE $18.00
ONLY $29.50

PA MICROPHONES
2 TO CHOOSE FROM

UNIDIRECTIONAL DYNAMIC

Incorporates 155mm gooseneck on a heavy base with on/off switch. Frequency 50-13,000Hz. Impedance 500 ohms. Sensitivity −78dB. 4 metres cables with plug.
Cat AM 4076

USUALLY SELLS FOR $42
SAVE $20.00
NOW ONLY $22.00

LIMITED STOCKS

OMNIDIRECTIONAL DYNAMIC

With 155mm gooseneck on heavy base with on/off switch. Frequency response 50-13,000Hz. Impedance 400 ohms. Sensitivity −78dB. 4 metres of cable with plug.

USUALLY SELLS FOR $34.50
SAVE $19.50
NOW ONLY $15.00
Cat AM 4077

LARGEST RANGE OF KITS EX STOCK IN AUSTRALIA No.1 FOR KITS

SHOWROOMS

SYDNEY	117 York St (02) 267 1614 Mon - Fri 8.30 am - 5.30 pm Thurs until 8.30 pm Sat 9 am - 12 noon
CARLINGFORD	Cnr Carlingford & Pennant Hills Rd (02) 872 4444 Mon - Fri 9 am - 5.30 pm Thurs until 8.30 pm Sat 9 am - 12 noon
CONCORD	115 Parramatta Rd (02) 745 3077 Mon - Fri 8.30 am - 5.30 pm only
HURSTVILLE	121 Forest Rd (02) 570 7000 Mon - Fri 9 am - 5.30 pm Thurs until 8.30 pm Sat 9 am - 12 noon
GORE HILL	188 Pacific Hwy (Cnr Bellevue Ave) (02) 439 4799 Mon - Fri 9 am - 5.30 pm Sat 9 am - 4 pm

Jaycar ELECTRONICS

INCORPORATING ELECTRONIC AGENCIES

QLD. BURANDA 144 Logan Rd (07) 393 0777 Mon - Fri 9 am - 5.30 pm Thurs until 8.30 pm Sat 9 am - 12 noon

HEAD OFFICE 115 Parramatta Rd Concord 2137 (02) 747 2022 Telex 72293

ROAD FREIGHT ANYWHERE IN AUSTRALIA $13.50

VISA · bankcard · MasterCard · AMERICAN EXPRESS Cards Welcome

MAIL ORDER VIA YOUR PHONE

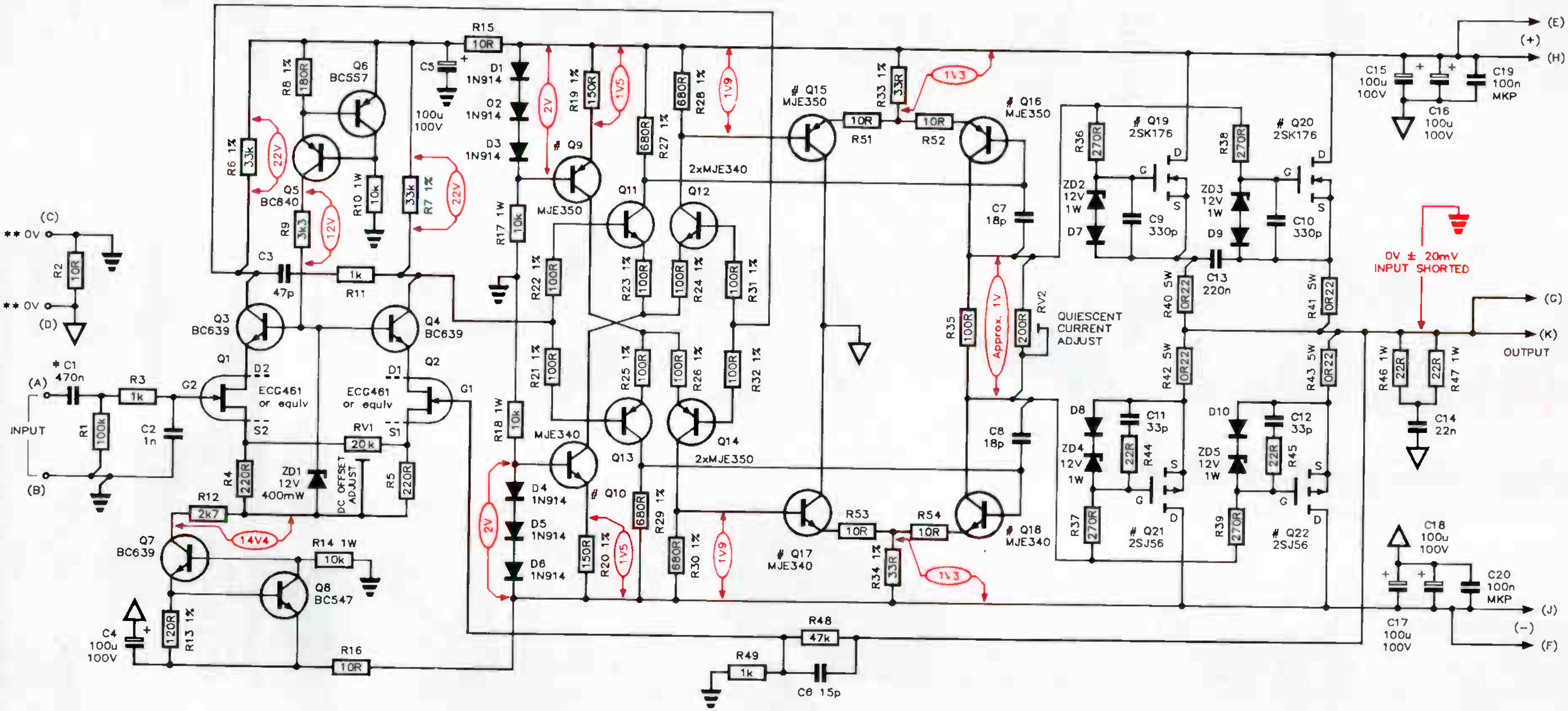
MAIL ORDERS
P.O. Box 185 Concord 2137
(02) 747 1888 HOTLINE
(008) 022 888 TOLLFREE

POST & PACKING

$5 - $9.99	$2.00
$10 - $24.99	$3.75
$25 - $49.99	$4.50
$50 - $99.99	$6.50
OVER $100	$10.00

CATALOGUE OUT NOW SEND LARGE S.A.E.

aem project 6000



N.B. These two earths must remain separated on the p.c.board. Run separate wires to them from the power supply filter capacitors. This will be explained in greater detail in part 2.

* C1 IS OPTIONAL (see text)

** JOIN TOGETHER ONLY AT POWER SUPPLY

Q1,Q2 .....ECG461 IS A DUAL JFET BY NEW-TONE ELECTRONICS (NTE) OR A SUITABLE EQUIVALENT (see text)

\# MOUNTED ON HEATSINK

D7–D10 ARE 100V 1A.FAST RECOVERY DIODES

VOLTAGES

Expected approximate voltages with the input shorted [connect (A) to (B)] –refer to circuit operation

CIRCUIT OPERATION

The input signal is coupled via capacitor C1 to resistors R1 and R3. This capacitor provides dc decoupling, preventing any dc component of the input signal from being connected to the input of the power amp. With the exception of this capacitor, the entire power amplifier is dc coupled, so the gain of the circuit at dc is the same as that for signals within the audio passband. i.e: around 48 with the feedback components specified. This will be covered in greater detail later, but it implies that the application of 1 Vdc to the input without the dc blocking capacitor installed, would result in roughly 48 Vdc appearing at the output of the power amp and hence to the bass driver of any loudspeaker system connected. This, of course, would result in very rapid destruction of the bass driver. The use of C1 therefore, although still optional, is highly recommended.

Resistor R3 and capacitor C2 form a low-pass first-order RC filter, the purpose of which is to limit the maximum signal slope of the input signal. If it is assumed that the output impedance of the preamp used in conjunction with the power amp is significantly less than the value of R3 (1k), then the –3 dB point for this filter is given by the simple equation:

$$f = 1/(2\pi RC)$$

where f is the –3 dB point
R is the resistance of R3
C is the capacitance of C2.

i.e: $f = 1/2(\times 10^3 \times 10^{-9})$
$= 159$ kHz.

This frequency clearly lies well above the audio passband and therefore has no effect on the frequency response performance of the power amp. Its purpose, as mentioned above, is to limit the maximum signal slope of the input signal. This is necessary to help to ensure complete freedom from slew induced distortion, sometimes referred to as TIM, or transient intermodulation distortion. This type of distortion is analogous to a more commonly understood distortion mechanism, that of clipping. In the case of clipping, distortion is generated when the input signal drives the power amp output beyond the limits of its available supply voltage. In a similar manner, if you attempt to drive the power amp beyond its maximum slew rate, the signal 'clips' or 'hard limits' and gross distortion results with products spreading across the audio spectrum. The solution is to design an amplifier with excellent slew rate figures and then to limit the maximum signal slope by the use of simple high frequency low-pass filter so that the slew rate limit of the design cannot be approached.

The effectiveness of this approach is, to a certain extent, dependent on the quality of the input filter. It is important to ensure that the filter employed introduces minimum signal degradation of its own. It is for this reason that the simple first-order RC is used which seems to introduce negligable, if any, degradation of the subjective or objective performance, provided the right type of capacitor is employed. A ceramic capacitor, for example, should not be used in this application. Ideally, use a polypropylene capacitor if one is available or, alternatively, use a good quality MKT type metallised polyester capacitor. Polypropylene capacitors are, unfortunately, very difficult to obtain in Australia in small quantities and also tend to be expensive, but they exhibit clearly superior characteristics in audio signal applications in comparison to many other types. This is also true for the other capacitors in the power amp, not just the input capacitor, C1, but the two high-frequency power supply decoupling capacitors C19 and C20 as well.

Resistor R1 provides a dc reference for the gate of the first of the JFETs (Q1) which, in conjunction with Q2 (also a JFET), forms the input differential pair. Note that Q1 and Q2 are a dual-JFET contained within a single encapsulation, fabricated on the same substrate to ensure close thermal coupling. Its use is necessary since this power amplifier is entirely dc-coupled and as mentioned above, the gain of the amp at dc is the same as that for signals within the audio passband. If separate transistors are used, each device is free to 'float' at a different temperature (no matter how slight that may be) and a drifting dc offset will result. JFETs are used in preference to bipolar transistors since the JFET requires negligable bias current. If bipolar transistors were used the base-emitter current required produces a dc voltage drop across the bias resistor R1 which, after amplification by the dc voltage gain of the power amplifier, will produce significant levels of dc offset at the output.

The entire input stage actually consists of the dual-JFET described above, in combination with a cascade paid of bipolar transistors, Q3 and Q4. The operating conditions for the input stage are determined by a pair of constant-current sources and the zener diode ZD1. The first current source is formed from transistors Q7, Q8 and their associated resistors R13 and R14. At the moment power is applied to the circuit current flows from the clean earth via R14 through the base of Q7 to the base of Q8 and resistor R13. When the voltage developed across R13 reaches 0.64 V, transistor Q8 is biased on and current flowing through R14 is robbed from the base of Q7. The circuit stabilises so that the current flowing through R13 is such that the voltage across it will be around 0.64 V. This is true regardless of the actual value of resistor R13, so varying the value of this resistor enables the current through it to be varied. Furthermore, once the value of R13 has been chosen, the circuit maintains the current through it at a constant level and the circuit acts as a constant-current source, or actually a constant-current sink in this case. With the value of resistor R13 set at 120 ohms, the current sink will set the current flowing through resistor R12 to 0.64/120 = 5.3 mA.

Resistor R12 is included for two reasons. Firstly, it drops a constant voltage as a result of the constant current flowing through it to decrease the power dissipation in the current sink. Since the current is set by the constant-current sink at around 5.3 mA, a voltage drop of around

$$5.3 \times 10^{-3} \times 2.7 \times 10^3 = 14.4 \text{ volts}$$

will be produced. Secondly, it acts to protect the input stage in the event of a failure of the constant-current sink.

The current set by the constant-current sink flows through the two cascade differential pairs Q1, Q3 and Q2, Q4 as well as through the zenor diode ZD1, which provides a dc reference for the bases of the cascade pair. In order to ensure that the differential pair is fed from a constant current to ensure maximization of the common mode rejection ratio (CMRR), it is necessary to use a second current source specifically for the zener diode. This current source is formed from transistors Q5, Q6 and their associated resistors R8 and R10. This constant-current source works in an analogous manner to that formed from Q7 and Q8 and establishes a current of 0.64/180, or around 3.6 mA. This current flows through the 33k resistor R9, which serves the same purpose as that of R12, and produces a voltage drop of around 11.9 volts. The current available to flow through the differential pair is the difference between the currents set by these two differential pairs, i.e.: around 1.18 mA. This current is shared equally between the two cascade differential stages so that a current of around 900 uA flows through the 33k resistors R6 and R7 producing a voltage drop across these of around 22 V.

The second stage is a fully symmetric differential amplifier employing the bipolar transistors Q11, Q12, Q13, Q14 and their associated resistors R21 to R32. The operating point for this stage is established by a pair of constant-current sources formed from Q9, Q10, R17-R20 and diodes D1-D6. The operation of this type of constant-current source can be understood by considering the negative current source first. The three diodes in series are biased on by current flowing through R18 from the clean earth to the negative rail. The current produces a voltage drop across each of approximately 0.7 V, giving a total voltage drop of 2 V. Since this is applied to the base of Q10, the voltage drop across resistor R20 is also constant giving rise to a constant current through it and hence through the emitter-collector junction of Q10. Since the voltage applied to the base of Q10 is 2 V, around 1.5 volts will be applied across resistor R20, giving rise to a current of 1.5/270 = 5.6 mA.

The current delivered by the constant current sources to the differential voltage amplifier is shared equally between the load resistors R27 and R28, producing a voltage drop across these resistors of around 1.9 V. This voltage biases the final and main voltage amplifier stage comprising Q15-Q18 and their associated resistors R33, R34, R51-R54 and capacitors C7 and C8. The application of 1.9 V to the bases of this stage causes a voltage of around 1.3 V to be expressed across resistors R33 and R34 and establishes the bias conditions for this stage. Since R33 and R34 are 33 ohms the current is set at 1.3/33 = 40 mA. This is a relatively large amount of operating current and is necessary to ensure that this stage has a sufficiently low output impedance to drive the input gate capacitance of the MOSFET final output stage. This helps to ensure very good open loop bandwidth which is essential for amplifier stability and freedom from slew induced distortion.

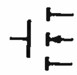
The final stage of the amplifier is the MOSFET current amplifier formed from the four power MOSFETs Q19-Q22 plus associated resistors and capacitors. The bias current for the output stage is set by adjustment of the preset potentiometer RV2. Since the current flowing through this preset is constant, the voltage dropped across it will be directly proportional to its resistance. As the voltage is increased by increasing the resistance of the preset, the output MOSFET's are biased on and a quiescent current will flow from the positive rail to the negative rail through the MOSFETs. This is necessary to provide an area of class A operation to decrease crossover distortion and other nonlinearities that occur at low signal levels. Resistors R36-R39, in conjunction with the gate-to-source capacitance of the power MOSFETs, produce a low-pass first-order filter with a –3 dB point around 1 MHz which is necessary to ensure stability of the output stage. In addition, capacitor C13 acts to prevent oscillation that can occur because the two 2SK176s and the inductance of the source resistors R40 and R41 form a push-pull Colpitts oscillator circuit.

The source resistors have been included to linearise the transfer characteristics of the MOSFETs and also to assist current sharing between the two sets of MOSFETs. Some recently published designs employing power MOSFET output stages have omitted the source resistors, adopting the approach that the negative temperature coefficient of the MOSFETs makes these resistors unnecessary. The problem with this is that the MOSFETs' temperature coefficient is not constant and is a function of the source-drain current. Also, here the use of the source resistors in combination with the source-gate capacitors C9, C10, C13 and the RC networks R44, C11 and R45, C12 yields an output stage with maximum stability and long term reliability.

The RC network consisting of R46, R47 and C14 serves to ensure that the output stage has a load of high frequencies, again to ensure stability of the power amp output stage. Resistor R48 and R49, and capacitor C6, determine the gain of the power amp. The values shown set the overall voltage gain to 48 for frequencies within the audio passband. At higher frequencies the decreasing impedance of capacitor C6 applies an increasing amount of overall negative feedback, reducing the overall voltage gain.

2SK176

n-channel Power MOSFET (p-channel complement: 2SJ56)



N–CHANNEL MOSFET

ELECTRICAL CHARACTERISTICS (at Ta = 25°C)

Maximum Ratings

Drain-Source voltage
V_{DSS} . . . . 200 V

Gate-Source voltage
V_{GSS} . . . . ±20 V

Drain Current
I_D . . . . 8 A

Channel Power Dissipation
P_{ch} . . . . 125 W

Channel Temperature
T_{ch} . . . . 150° C

Device Characteristics

Transconductance
μ . . . . 1 Siemens (typ.)
[0.7 min. to 1.4 max.]

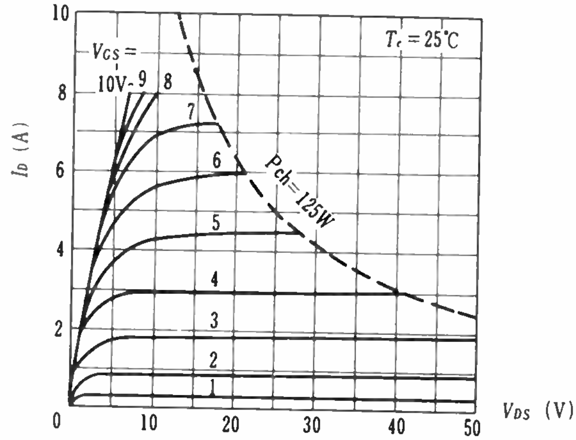
Input Capacitance
C_{is} . . . . 700 pF (typ.)
at I_D of –5 mA, V_{DS} of 10 V

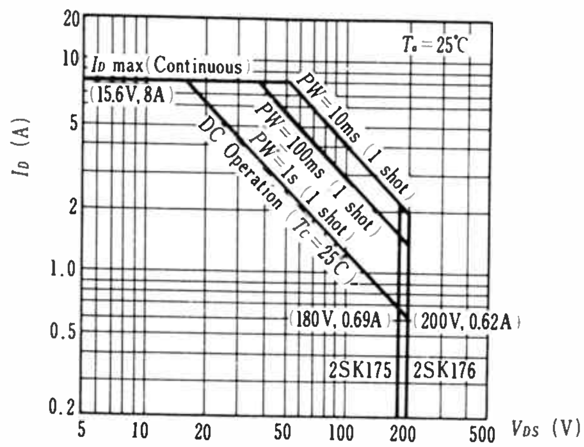
Feedback Capacitance
C_{rs} . . . . 8 pF (typ.)
at V_{GS} of –5 V, V_{DS} of 10 V

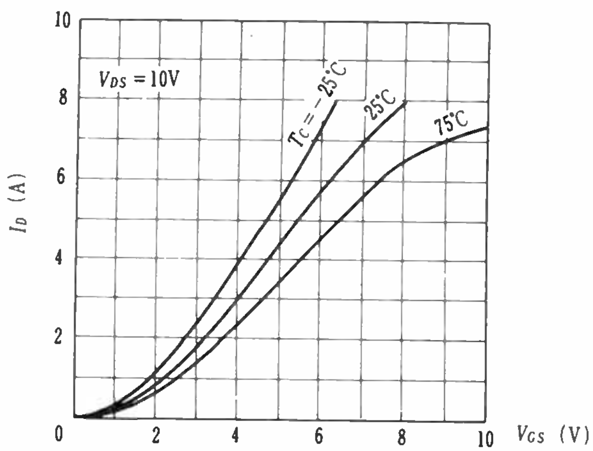
Drain-Source Saturation voltage
$V_{DS\ (sat)}$ . . . . 12 V (max.)
at I_D of 8 A, V_{GD} of 0 V.

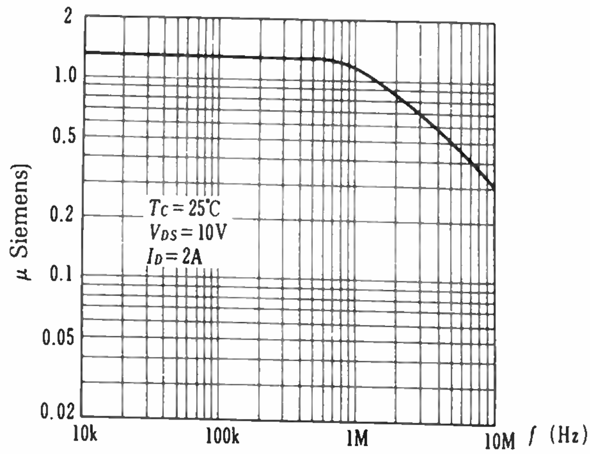
Package TO3

The data presented here has been extracted, with permission, from the FET Manual, published by CQ in Japan and available in Australia through Imark Pty. Ltd., 167 Roden Street, West Melbourne 3003, (03) 329 5433. The FET Manual is one of a series of 13 covering Japanese semiconductors. Each costs $12.50 plus $5.00 post and packing charge for one to all 13 manuals, from IMARK.









2SJ56

p-channel Power MOSFET (n-channel complement: 2SK176)

ELECTRICAL CHARACTERISTICS (at Ta = 25°C)

Maximum Ratings

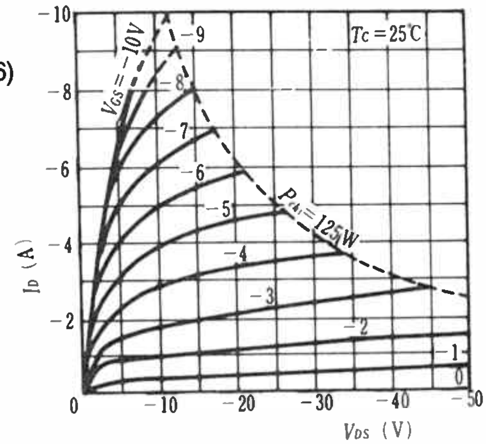
Drain-Source voltage
V_{DSS} .... –200 V

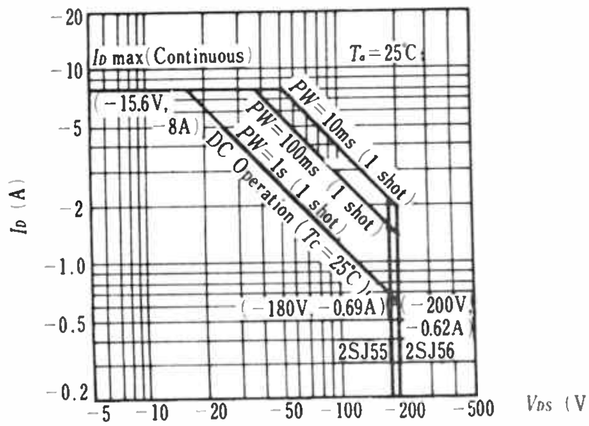
Gate-Source voltage
V_{GSS} .... ±20 V

Drain Current
I_D .... –8 A

Channel Power Dissipation
P_{ch} .... 125 W

Channel Temperature
T_{ch} .... 150° C





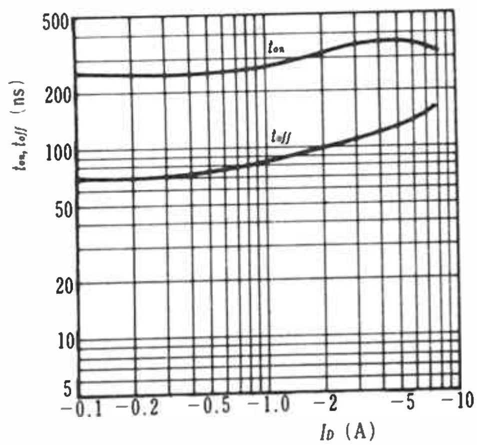
Device characteristics

Transconductance
μ .... 1 Siemens (typ.)
[0.7 min. to 1.4 max.]

Input Capacitance
C_{is} .... 1000 pF (typ.)
at V_{DS} of –10 V, I_D of 5 mA

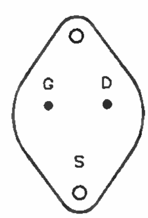
Feedback Capacitance
C_{rs} .... 50 pF (typ.)
at V_{GS} of 5 V, V_{DS} of –10 V.

Drain-Source Saturation voltage
$V_{DS\ (sat)}$ .... –12 V (max.)
at I_D of –8 A, V_{GD} of 0 V.

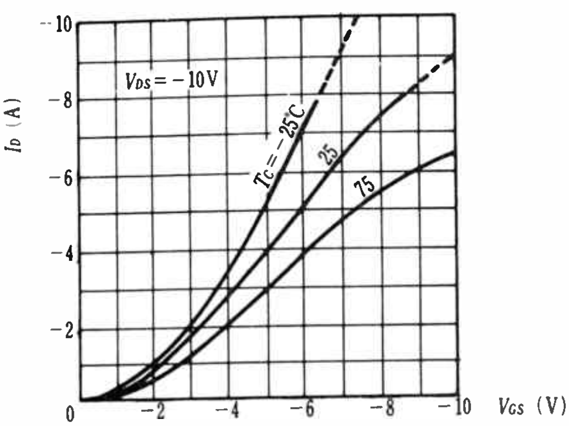


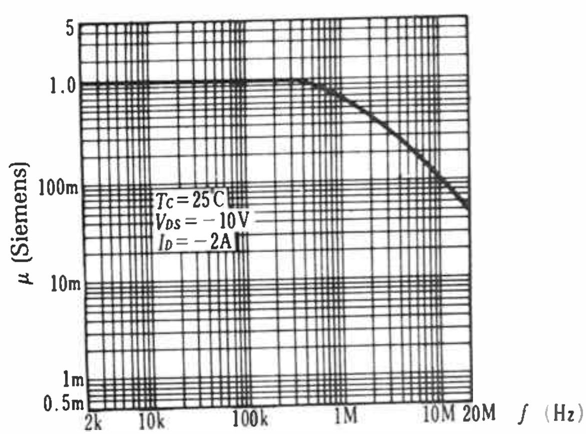
Package TO3

P-CHANNEL MOSFET



MOSFET PINOUT BOTTOM VIEW





AUSTRALIAN ELECTRONICS Monthly

PC BOARD SERVICE

As a service to our readers, we offer quality pc boards for our projects featuring fibreglass substrate with roll-tin over copper tracks and a silk-screened overlay printed on the component side.

Project	Retail Price
1500 Metronome	$ 4.67
3500 Listening Post	$ 8.06
6500 Universal Mosfet Amp Module	$ 9.69
9500 Beat-triggered Strobe	$ 11.32
6102 2-Way Speaker	$ 21.75
5501 Negative Ion Generator	$ 12.35
4500 Microtrainer	$ 28.47
6510 4-Input Mixer	$ 20.40
6010LL	$ 19.06
6010MA	$ 23.10
6010F	$ 16.37
6010R	$ 16.37
Set of 4	$ 74.90
4501 8 Channel Computer Relay Interface	$ 13.00
6502 Order 6500 and 6501	
8500 Courtesy Light Extender	$ 9.92
4502 Real Time Clock	$ 10.46
4600 Dual-speed modem (no overlay, mods required)	$ 15.00
5502 Microwave Oven Leak Detector	$ 9.12
2500 Sine/Square Audio Generator (add $12 for RA53 thermistor)	$ 9.65
6503 Active Crossover	$ 23.06
4504 Speech Synthesiser	$ 11.53
5503 Bedwetector	$ 9.16
5504 Electromyogram	$ 15.88
3502 Signal-operated Cassette Controller	$ 9.16
2600 Peak RF Power Meter	$ 10.46
5505 Hash Harrier Mains Filter	$ 17.72
4610 Super Modem (includes EPROM)	$139.00

Note: The boards found in this issue are also available, price on application.

Please rush me the following boards

Project No. . . . . **Price** $ . . . . . .

Allow a minimum of 4 weeks delivery
Price includes postage & packing
New Zealand, add $1 00 to these charges

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

Name . . . .

Address . . . .

Postcode . . . .

I enclose my cheque/money order for . . . .

Please tick payment method

Cheque/money order ☐ Bankcard ☐ Visa ☐

Mastercard ☐ American Express ☐

Card No . . . . Expiration . . . .

Signature . . . .

((Note Unsigned credit card orders cannot be accepted)

You can buy the boards at our offices if you wish, at any time during business hours We're located at WB Building, Cnr Fox Valley Rd and Kiogle St, Wahroonga NSW, the entrance is in Kiogle St

aem data sheet

PLASTIC MEDIUM POWER SILICON TRANSISTORS

300 VOLTS 20 WATTS

NPN MJE340

PNP MJE350

- High Collector-Emitter Sustaining Voltage — $V_{CEO(sus)}$ = 300 Vdc @ I_C = 1.0 mAdc
- Excellent DC Current Gain — h_{FE} = 30-240 @ I_C = 50 mAdc
- Plastic Thermopad Package

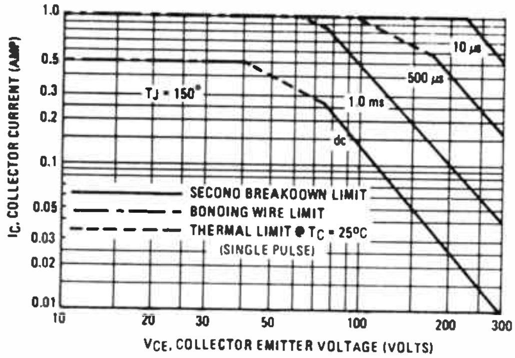
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	20 0.16	Watts W/°C

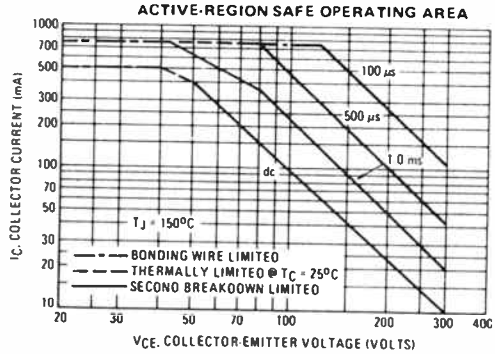
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	300	—	Vdc
Collector Cutoff Current (V_{CB} = 300 Vdc, I_E = 0)	I_{CBO}	—	100	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	240	

ACTIVE-REGION SAFE OPERATING AREA MJE340

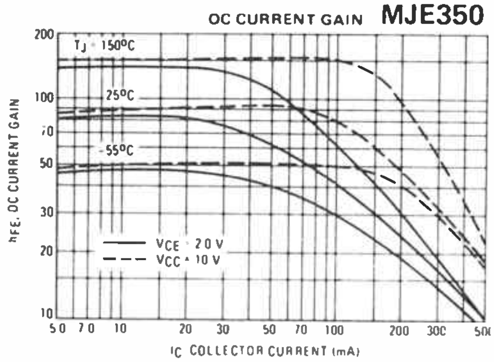


ACTIVE-REGION SAFE OPERATING AREA

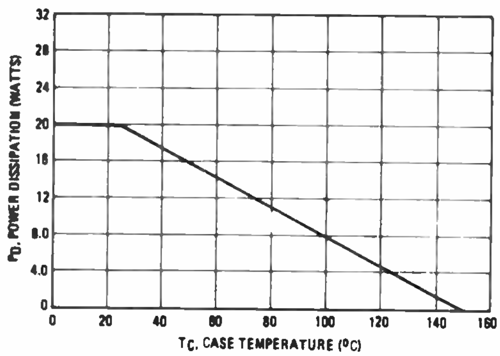


There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

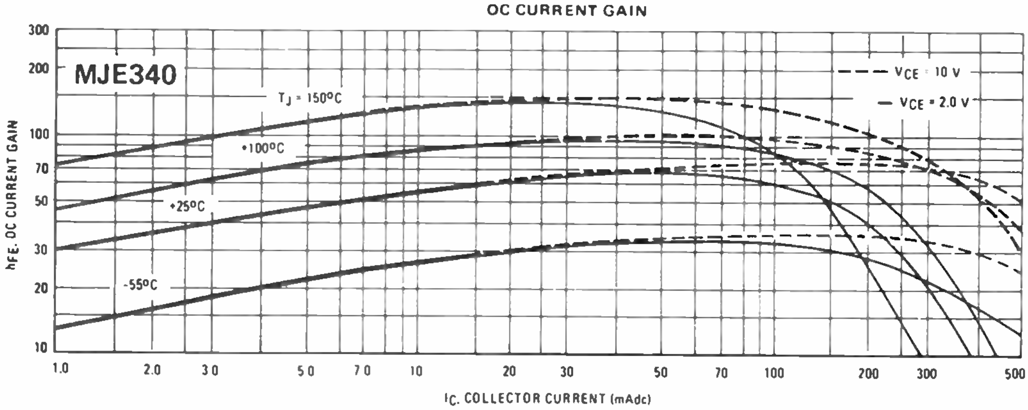
DC CURRENT GAIN MJE350

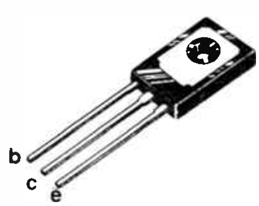


POWER TEMPERATURE DERATING



DC CURRENT GAIN





THE RIGHT ATMOSPHERE

NEW FOR '86

Breathe a sigh of relief! The Aironic 2000 combats stale and stuffy rooms contaminated by cigarette smoke, airborne bacteria and other pollutants. Leaves rooms, large and small, dazzlingly fresh and exhilarating.

- **Inbuilt ionizer produces negative ions to combat excessive positive ions in the air.**

Cat Y-9004 **$399**

MORE NEGATIVE IONS

Combats positive ions and freshens the air in rooms and offices. Simply plugs into any power point — but uses so little power that meter will hardly tick over.

$69 Cat Y-9000

Keeps you alert while driving! This model is specifically designed for car use where cigarette smoke and other pollutants are trapped in the cabin.

Cat Y-9002 **$69**

FOR THE PHOTOGRAPHIC ENTHUSIAST!

Digital Lux Meter

NEW FOR '86

Ideal for photographers, video users, laboratories — anywhere there's a need to measure light quickly and accurately. This DSE meter is fantastic value — you'll pay twice as much at a photo store. Accurately measures up to 50,000 LUX over three range selectors and comes complete with carry case.

Cat Q-1400 **$149**

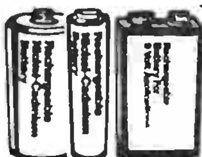
Type-right

NEW FOR '86

Wow! Now there's an easier way to learn how to type without the need to enrol in expensive classes. TYPE-RIGHT teaches you to speed type to an impressive 45 w.p.m. An instruction manual takes you step-by-step through the lessons. You'll start slow making mistakes, but TYPE-RIGHT points them out; and in no time your speed and accuracy will increase to expert level. Fantastic!

Cat Y-7100 **$69.95**

NICADS NICADS NICADS NICADS



The economical way to keep those battery powered toys and appliances ready for action: long life re-chargeable NiCads. And at DSE's bargain prices they're better value than ever. We have all the popular sizes.

"AAA" size	Cat S-3305	$3.95
"AA" penlight	Cat S-3300	$3.50
"C" size	Cat S-3301	$7.95
"D" size	Cat S-3303	$8.95
"216" size	Cat S-3308	$19.95

Everything you want in electronics... at your nearest DSE store!

DICK SMITH ELECTRONICS PTY LTD

ON SALE DATES: ALL OF JUNE TILL IT'S FINISHED OR STOCK LASTS OR RUNS OUT!

The LATEST in RADIO CONTROL!

Mugen's Bulldog isn't a Bitza!

If you've been losing R/C competitions, it could be that your present car is a dog. Mugen's renowned Bulldog has a pedigree of success that can make you a winner! Rugged. Reliable. Boasting all the competitive features that makes it streak ahead of the competition. Or if you're just interested in off-road R/C action, the Bulldog is for you. Three forward and three reverse speeds. Four-wheel drive. Four-wheel steering. Independent four-wheel suspension and adjustable air shocks for demanding tracks. And three limited slip differentials (front, centre and rear) for optimum traction on any terrain. Its sturdy roll cage withstands all the spills and thrills to race you past the checkered flag. Cat Y-2540

ONLY $269

Mugen — sturdy as a bulldog, fast as a whippet!

How are they performing?

Official results:

Ryde, NSW Club meeting:
Bulldogs 1st & 2nd in open class
Bulldogs 1st & 2nd in stock class

Toronto Trade Fair, NSW:
Of eight finalists, Bulldogs were seven!
Bulldogs 1st to 7th

ACT Championships:
Bulldogs 1st & 2nd in open class
Bulldogs 1st & 2nd in stock class
Improved lap record — from 17.5 to 15.9

Pitt Stop Team:
Bulldog 28 starts for 25 wins!

2-Ch Digital Proportional R/C

Super responsive . . . feel like your behind the wheel! Boasts extended range on 29MHz. Forward, reverse and left/right joysticks feature selectable control. Spring or ratchet throttle control. Plus many more advanced operational features. Cat Y-2544

$149

Charging Leads

Real trouble saver! Allows you to recharge NiCads 'directly' from a car battery. Cat Y-2521

$13.95

NiCad Fast Charger

Keeps your machine charged up. Quickly recharges in 15 minutes. A built-in timer automatically cuts off trickle charge. 12V DC input. Cat Y-2546

$44.95

7.2V NiCads

Suits most popular R/Cs... Bulldog, Tamiya, etc. Cat S-3326

$54.95

Bumper Offer! Our full Bulldog Pack at a saving...

DSE can put you on the right track with a winning formula at a considerable saving! Our superb Bulldog Pack is an immediate start to competitive-class racing.

- Mugen Bulldog Mk. I
- 7.2V NiCad Battery
- Charging Leads

Cat Y-2539

SAVE OVER $50!

$430

DICK SMITH ELECTRONICS

"LOONEY JUNE"

Stingray HF Marine Transceiver

THESE PRODUCTS AVAILABLE ON ORDER IF NOT IN STOCK IN ANY STORE.

$2495

Quality performance and ease, it's all here with the Stingray! This powerful 100W SSB marine transceiver will handle any of the marine channels with ease. Suitable for all HF marine frequencies including emergency,club, chatter frequencies, etc. Why settle for second best? Very heavy construction makes it a rugged workhorse — so you can count on it in a crunch! Plug-in frequency cards give you single knob selection over the 2-30MHz range so selection is childs play. Comes complete with mounting hardware and mic — just take away and fit in a day!

Just look at these value for money features:

- 100W SSB
- Suitable for any marine channel *
- 2-30MHz range
- Plug-in frequency cards for single knob selection and much more! Cat D-1410

** FITTED WITH 2182K DISTRESS CHANNEL*

Antenna Tuning Unit

$699

Suitable for use with longwire or backstay antennae etc. for maximum range

Say goodbye to all those antenna matching hassles, once and for all! The Stingray Antenna Matching Unit can match your transceiver to any antenna without fuss or bother. Why waste time adjusting equipment when you can be out there having a good time?

You'll get maximum performance from your transceiver. Operates over the 2-30MHz range. Get the most from your transceiver — your safety depends on it! Cat D-1412

Stingray Noise Blanker/Mute Card

Accessory for Stingray HF Marine radio. Effectively reduces annoying background noise. Easily plugs into transceiver. Cat D-1414

$199

Stingray Loaded Whip Antenna

2182KHz loaded whip that puts a 'sting' into marine communications. Operates on the international marine distress frequency. Cat D-1418

IDEAL BACKUP ANTENNA

$199

See DSE for all your Amateur Radio, Marine and Communication needs.

Yaesu FRG9600 VHF/UHF Receiver

The FRG-9600 is a scanning receiver capable of covering the **complete** 60 to 905MHz VHF/UHF spectrum. But even more than that, the FRG-9600 is **all mode** — FM, AM, CW, SSB... the lot. At the touch of a button, it opens up an exciting world of communication. Tune into FM-Wide for standard FM and TV station sound transmissions. FM-Narrow is your passport to the arena of two way communication — emergency services, business, military and amateur radio. Other amateur bands plus aircraft bands are accessible through the AM & SSB modes. (SSB covers up to 460MHz). And if that's not enough, the FRG-9600 even covers the new ASCB mode which is becoming increasingly used by the military and looks like becoming firmly established in VHF/UHF as well.

$849

Cat D-2825

AM/FM/CB/SW/VHF

Top value for the avid radio listener — or the boat owner who wants to know just where he is! This quality radio receiver has a built-in radio direction finder to pinpoint your position against AM radio stations. Plus you get 6 bands including all 40 CB channels plus shortwave AND VHF! Can even double as a PA amplifier with optional microphone! Cat D-2832

$129

'Sangean' Multiband Radio

Sangean is a respected name amongst enthusiasts. And when you see its ATS-803, you'll understand why! It's a great combination of listening excitement : local AM/FM plus LW/MW/SW. And it boasts state of the art features.

150kHz to 30MHz in 12 bands.

Cat D-2831

$349

Sangean 10 Band Radio

Here's a great little 10 band portable at a fantastic value for money price! At 160 × 76 × 28mm it's small enough to carry with you to the beach, football, work — anywhere! With AM/FM, 8 shortwave bands, built-in antenna, carry cord, slide band selectors and much more!

$79

Cat D-2834

Air Band VHF Radio & AM/FM!

You've probably wondered what goes on, what pilots and air traffic controllers talk to each other about... Wonder no more! This budget aircraft band radio tunes the entire band, so you don't miss a thing.

Cat D-2836

$29.50

DICK SMITH ELECTRONICS HAS THE MOST COMPREHENSIVE RANGE OF TEST EQUIPMENT TO SUIT EVERYONE'S NEEDS

LOONEY

Digital Blood Pressure Meter

(Sphygmomanometer)

Medical authorities will tell you that blood pressure is one of the first indications of a problem (notice how the doc always takes your blood pressure?) Now keeping a check of your own blood pressure is as easy as checking your weight — and you don't have to be a medico whiz to work it all out! Measures both blood pressure and pulse (ie checks to see if you're still alive!) with ranges of 20-280mm Hg (pressure) and 40-200 per minute (pulse). Cat Y-5010

$99

LAST YEAR'S PRICES ON TEST EQUIPMENT!!

6.5MHz HOBBYIST'S CRO

Every hobbyist knows how valuable a good oscilloscope is: probably the most useful piece of test gear you can own. At last, we've been able to obtain a new 6.5MHz CRO, at a bargain price.
Here's what it offers:

- **Retrace blanking for a much clearer display**
- **10mV per division verticle sensitivity**
- **500mV per division horizontal sensitivity**
- **10Hz to 100kHz timebase (in 4 ranges)**
- **Internal or external sync**
- **And a usable response to beyond 6.5MHz**

Cat Q-1280

$299

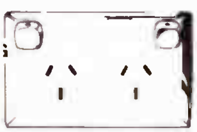
Power SWR/Meter	Q-1340	$139.00
Battery lamp and fuse tester	Q-1525	$13.75
PWR/SWR Meter 27MHz	Q-1350	$24.75
IC test clip leads	W-4509	$3.95
4mm plug test lead sets	W-4508	$2.95
1.5mm plug test lead set	W-4504	$2.50
Mini alligator clips (red/black)	W-4550/2	.30

NEW PRODUCTS FOR '86

Personal LCD with auto ranging DMM	Q-1555	$49.95
3.5 digit with memory DMM	Q-1515	$89.50
Bench Meter VDC	Q-2140	$29.95
Bench Meter ADC	Q-2130	$29.95
Digital LUX Meter	Q-1400	$149.00
Universal test lead set	W-4523	$4.95

Double Power Point

Replace old single outlets with a double: much more convenient! Cat P-5560



$8.95

Double Adaptor

Standard 3 pin AC plug into 2AC sockets enabling you to use 2 appliances on one outlet. Cat P-5440

$2.75

DICK SMITH ELECTRONICS PTY LTD

Walk-A-Jog Meter

How far do you go? Now you'll know! The Walk-A-Jog tells you how far you've walked or jogged. This compact device clips to your belt and measures your footsteps. Now you can plan your health program accurately! Set yourself a limit and you'll know when you can sit down to rest. Cat Y-5020

$29.95

Digital SHARP Thermometer

Take temperatures the modern way with a quality Sharp thermometer. The kids won't mind having their temperatures taken and the 3.5 digit display provides a more accurate reading at a glance. Features automatic battery cut-off when inadvertently left on. Comes with its own clear protective case and full instructions. Cat Y-5000

BARGAIN! $16.95

NiCad Battery Charger

You'll never go flat again! Or your batteries either. Universal design for all popular battery sizes. PLUS it checks battery strength so you know when to recharge before you run down. Cat M-9518

ONLY $29.50

Charger Plug Pack

What a great idea! Two part charger consists of plug pack and separate snap-on battery holder. Charges four penlight 'AA' NiCads easily and simply. Cat M-9520

VALUE $10.95

New Tools for 1986. Dick Smith

Mini 15W Soldering Iron

$14.95

The perfect iron for hobbyists and enthusiasts... at an ideal price! Miniature size and ligtweight. Suits soldering jobs involving semis and delicate work. Cat T-1333

Desoldering Iron

$69

A 'must' for any serviceman's or hobbyist's took kit! A self-contained, fully portable 240V, 30W desoldering tool that operates quickly and efficiently. Cat T-1340

WE'VE GONE CRAZY! CHECK OUR KIT PRICES.

UHF/VHF DOWN CONVERTER

NEW FOR '86

Brilliant kit which enables your VHF-only TV to receive UHF. Pre-aligned for ease. Covers UHF bands 4 and 5 (Ch. 28-63). Features 'bypass' switch for viewing VHF without the need to disconnect, then re-connect antenna lead. Also tuner module (K-6051) available separately............$29.95

Cat K-3236

$69.50

RADIO DIRECTION FINDER

NEW FOR '86

An easy to build, valuable amateur accessory! Quickly locates RF signal direction using an electronic rotating antenna which produces frequency modulation by Doppler shift. Features 32 LED 'positional' indicator.

Cat K-6345

$139

2m LINEAR AMPLIFIER

Powerful, all mode amp that provides access to distant repeaters. 13.8V — suits mobile and base station use. Requires as little as 3W input. Includes huge heatsink. Freq. range:144-148MHz. Insertion loss: 0.6dB. Input VSWR: < 1.2:1.

NEW FOR '86

Cat K-6313

$249

VHF WATT METER

Measures power output of VHF transceiver and antenna efficency. Useable freq. range: 144-148MHz. Max. power: 150W. Ranges: 0-150W., 0-30W. Accuracy: +/-10%.

Cat K-6316

$49.95

BREATHE EASY...

NEW FOR '86

Negative ion generators counter the effects of excessive positive ions, reduce the effects of hayfever, etc. Build one yourself and save! Kit includes 24 stage voltage multiplier (app. 8.1kV output.)

Cat K-3333

$34.50

LOONEY

DSE MULTITECH

POWERFUL COMPUTING PRICED FOR HOBBYISTS!

Monitors available from $299

At last a powerful 128K RAM home computer with a built-in 360K floppy disk drive that serious programmers can afford! And because it operates MS-DOS there's an extensive range of software to run.

EXPANDS FOR FUTURE NEEDS!

Full colour & sound plus graphic capability!

ONLY **$1395**

Multitech System One matches IBM's JX feature for feature — but costs over $400 less even with their discounts! Its 84 key, ergonomically designed keyboard boasts 10 function keys and numeric pad. Connect a wide variety of monitors. Expand with peripherals: includes game port, parallel printer connection and serial port. Plus many more fine features.

- 256 expanded ASCII character set
- Fully integrated crystal real time clock/calendar with battery back-up
- IBM compatible colour graphics interface with 640x200, 300x200 graphics resolutions and 16 colour text mode.

Cat X-8000

SEE DICK SMITH ELECTRONICS — FOR THE FINEST SOFTWARE RANGE

INFRARED CONTROLLER

Talk about luxury! A remote control just the size of a 'match box' but has the power to turn on/off electrical appliances — TV, lamp, stereo, etc. — up to 12m away! Low power drain for high battery life.

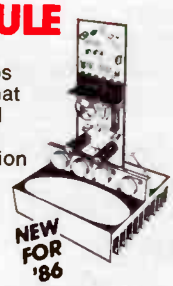
Cat K-3428

NEW FOR '86

GREAT BUY!

$69.95

120W MOSFET AMP MODULE



Gives moderately powered PA and amps more oomph! And what performance! Second and third THD below 0.001%, intermodulation distortion below 0.003% at 10kHz. Full power noise is limited to -100dB. And freq. response (flat) is within +/- 0.4dB from 8Hz-29kHz. Includes heatsink. Cat K-3443

NEW FOR '86

$99.50

DICK SMITH ELECTRONICS PTY LTD

DSE Kits — Easy to build and affordable.

JUNE'S CRAZY MID YEAR BARGAINS!

NOW CAT COMPUTERS ARE EVEN BETTER VALUE!

HUGE SAVINGS!

If price has held you back from entering the world of powerful computing, then our popular CAT is the 'purr-fect' choice. Its impressive 64K RAM provides huge memory capacity for serious programming. And the 81 key keyboard features a numeric pad and 8 function keys for 24 software/program functions. Even enjoy sound and full colour... great for graphics. Includes inbuilt cassette, joystick, RS-232C serial and printer connections.
Cat X-7500

Was $499
NOW $399

TAKE OUT THOSE SPIKES AND SPRUGLES FROM YOUR COMPUTER!

Deluxe mains filter eliminates all the garbage from your computer for a clean line of supply. So if you're having 'crashing' problems this could be the answer! Rated at 240V, 2 amps. Cat M-9850

ENERGY APPROVED AUTHORITY

$125

DATAPHONE 1200 MODEM

Easy data transference without the high cost! Features its own RS-232 serial interface, push button phone with 12 number memory and last number re-dial. 300/600/1200 full or half duplex modes. And it's Telecom authorised. Cat X-3300

Telecom Authorisation No: C85/37/1353

$349

DATAPHONE 300 MODEM

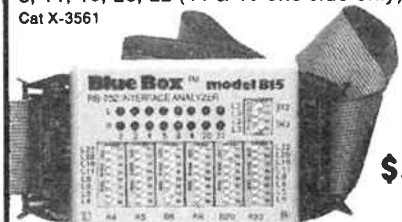
Super economy 300 baud, full duplex modem that comes with its own push button phone. Features an answer/ originate switch. And considering it measures a mere 135 x 95 x 47mm, it does a big job of transfering data.
Cat X-3301

Telecom Authorisation No. C85/37/1373

ALL NEW!
ONLY $199

'BLUE BOX' INTERFACE ADAPTOR

Acts as a quick connect RS-232 interface test set, status activity monitor and configuration device on mini, micro and main frame computers. Ideal for trouble shooting RS-232 installations too! Transmission speed: 50-19200Baud. Monitors lines: Pins 2-6, 20, 22. Cross connectable lines: Pins 2-6, 8, 11, 19, 20, 22 (11 & 19 one side only).
Cat X-3561



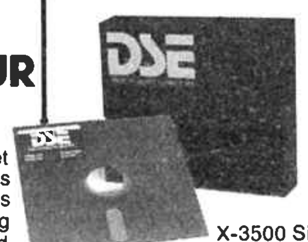
ONLY $199

Telecom VIATEL
AUSTRALIAS NATIONAL VIDEOTEX SERVICE

FREE INFORMATION & ORDER SERVICE ON DSE VIATEL NO. 34 5720

DISKS FROM ONLY $2.75 EACH!

Huge savings on DSE Floppy Disks! The highest quality single/ double sided, double density disks at a DSE value price. You know how much you pay for the others so look at DSE disks for the quality, reliability and incredible savings.

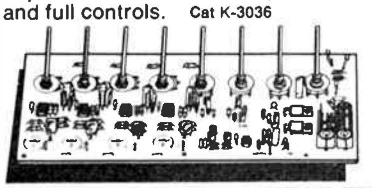


X-3500 Single sided, double density.
In box of 10 .... $27.50

X-3501 Double sided, double density.
In box of 10 .... $29.50

FOUR INPUT MIXER PRE-AMP KIT $59.95

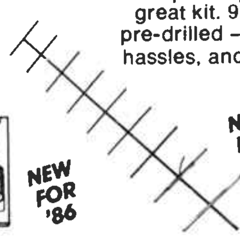
Garage bands love it! Use all 4 inputs to connect guitars or a mix: guitar mic, line inputs. Features selectable gain and impedance on individual inputs and full controls. Cat K-3036



NEW FOR '86

VHF 2m AMATEUR YAGI ANTENNA

With an amazing 10dBd gain! Get superior performance with this great kit. 9 Elements and comes pre-drilled — so there's no tuning hassles, and it can be assembled in no time! Cat K-6297



NEW FOR '86

ONLY $89.95

Enjoy the latest in Electronics.

DICK SMITH ELECTRONICS PTY LTD

Sale Ends June 30.

"LOONEY JUNE"

Mosfet Amp Kit

Build-it-yourself and save $$$! Respectable 45W per channel output delivers mind blowing sound. All components are on a single PC board. Features sturdy chassis, heatsinking PLUS integral speaker protection. Frequency response: 30-20KHz/1dB RIAA. Sensitivity: 2mV phono, 190mV high level. THD: 0.2% full power, 0.05% normal.

Features:
- LED input indicator
- loudness control
- muting control
- speaker switching
- stereo/mono switch
- tape monitor switch

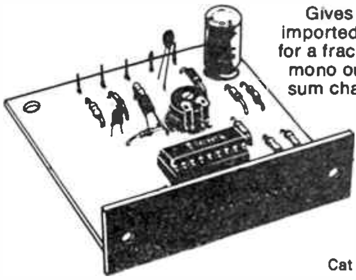
As described in EA
Cat K-3515

LAST YEAR'S PRICE

WHILE STOCKS LAST

$199

LED Level Meter



Gives your amp the expensive look of imported units... but you build it yourself for a fraction of the price! Displays either mono output, one stereo channel or the sum channel outputs. Or build two for a true stereo level meter.
- 10 green LED displays
- 2 red LEDS for max. power and overload indication.

Cat K-3370

$16.50

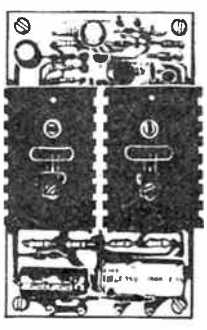
20 Watt Amp

Handy general purpose amp. Use it for virtually any project or for learning how audio amps work.

- Input impedance: 100K ohm
- Output impedance: max 4 ohms
- Signal to noise: +58dB/1W
- Frequency response: -3dB at 45Hz and 68KHz
- Supply voltage (power): 20V (6.6W), 30V (12W), 35V (19W)

Cat K-3445

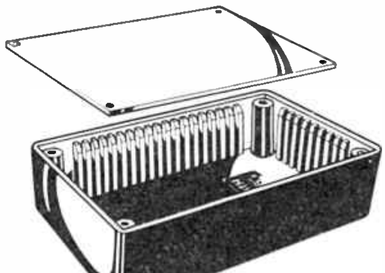
$14.50



DSE Zippy Boxes

There is only one genuine 'Zippy' box — the one with the all round deep ribbing. Don't be fooled by inferior copies — this is the one used by the major electronics magazines because of its versatility. Insist on the one and only — genuine — Zippy Box which comes complete with both aluminium and plastic lids.

More projects are built in genuine DSE 'Zippy Boxes' than any other case. And the reason is simple: they're so versatile! From the tough moulded case with its deep ribbed sides, to the close fitting aluminium lid with screws supplied — for ease of use and versatility you cannot beat a genuine Zippy box. The ribbed sides are ideal for mounting PCB's without worrying about screws — and the PCB can be mounted either lengthwise or across the box. These are the boxes used by beginners in the Funway into Electronics projects — and thousands of other projects.



Small - UB5 (28 x 54 x 83mm) Cat H-2855
$1.95 (10 up $1.75)

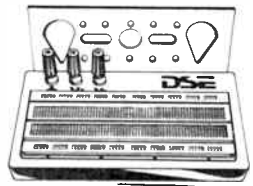
Medium - UB3 (41 x 68 x 130mm) Cat H-2853
$2.75 (10 up $2.45)

Large - UB1 (50 x 90 x 150mm) Cat H-2851
$3.25 (10 up $2.90)

Giant - UB2 (60 x 113 x 196mm) Cat H-2852
$4.50 (10 up $4.10)

Bread Board

Ideal work bench companion for prototyping, experiments and temporary circuits. Features 128 groups of 5 TIE points 8 BUS of 25 TIE points and 3-pc.. binding posts. Nickel reduces oxidization. Measures 122x195x22mm, weighs 275g.
Cat P-4617



$18.95

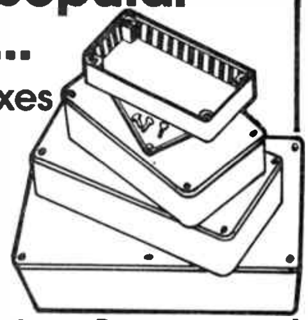
Plus we're holding the price on these popular hobbyists lines...

Diecast Aluminium Boxes

Affordable precision-made boxes with channeled walls for easy PCB mounting. Ideal for RF circuits too! And nothing better withstands heat: up to 600 degrees C. Two sizes:

150x50x80mm. $10.50 Cat H-2206

100x25x50mm. $5.50 Cat H-2221



Aluminium Boxes

Ideal for those weekend projects. Two piece sliding box comes with holding screws.

127x102x76mm. $4.25 Cat H-2320

133x76x54mm. $3.75 Cat H-2325

DICK SMITH ELECTRONICS
PTY LTD

B.178/BB

"LOONEY JUNE"

FT757GX "The Radio"

Cat D-2940

$1495

...'without modesty, the best transceiver'
That's what Amateur Radio Action magazine said about the FT757GX when it was released. When you look at the outstanding specifications of the FT757GX, then look at its size, you'll wonder how Yaesu managed to pack it all into the case. Here's what it offers you:

• All mode AND all WARC HF bands built-in (nothing extra to buy) • 100 watts continuous output power (SSB/CW/FM) • Two VFO's, 8 memories, with complete control • Triple conversion receiver covering full 0.5 to 30MHz • 0.25uV sensitivity (SSB) • Yaesu's famous IF shift/width passband control system • Duct flow forced air cooling • 4-bit microprocessor built-in • IAMBIC electronic keyer circuit built-in.

YAESU

Yaesu's 2m/70cm FT-2700RH

Cat D-3515

The FT-2700RH is a suberbly designed unit with a host of impressive features. Enjoy Yaesu's renowned programmable memory scan. 10 memory channels. Priority scan. Dual independant front ends, local synthesizers, IFs and transmitter RF stages. Full duplex crossbanding — it's child's play. More and more amateurs are adopting the adage: that 'two bands are better than one'! And with the superb FT-2700RH the enthusiast can enjoy the old favourite 2m and the large, uncrowded 70cm bands.

• 25 watts continuous on both bands
• Two 4-bit CPUs for complete control
• Wide anlge LCD display
• Includes scanning microphone and mobile mounting bracket

$1095

2m Mobile FT-270RH

Not just one, but two microprocessors to do everything for you except make coffee (they're working on that one!) That's the new FT-270RH mobile 2m. Absolutely the latest word in flexibility and performance — including 45 watts output! With 10 memories, dual VFO's and incredible scanning facilities, you're ready to take on the two metre pile-up: and win! And this is packed into just 140 x 162 x 40mm: small enough to go anywhere! Features high/low power output (45/5W) so it's just right for the city or the bush!

Cat D-3517

$879

Push button 70cm FT-709R

Absolutely everything that the serious UHF'er could ever want — all in a hand-held! For a start, 10 memories to remember all your favourite repeaters and sked frequencies (covers the full 10MHz 430-440MHz band) with selective scan, priority scan, skip scan, busy or clear scan... band scanning — either full or within (your set) limits... Yaesu's unique Power Saver System: programmable receiver activation to check a selected channel.

Cat D-3509

$399

Tri Band Beam

While stocks last

$399

Cat D-4303

Mini-Multi's MSC33 offers top performance on 10, 15 & 20 metres and its compact design make it ideal where space is a limiting factor. Durable and lightweight for tower installations.

Hi Mound Morse Key

$44.50

Double ball pivot rollers and full adjustment for superb quality code. Contacts for break-in keying included.

Cat D-7104

Universal Mic

Designed especially for AM & SSB transceivers. This economical mic is supplied with a 5-wire (4 lead plus shield) 2 metre lead that can be adapted to any transceiver.

Cat C-1102

$15.95

Deluxe Gutter Mount

At last! A gutter grip that will grip anywhere! If you have a difficult mounting problem, try this one.

Cat D-5100

$13.50

HF Linear Amplifier

Now you can have power and performance without breaking the bank! Our superb broad-band, bi-linear amplifier delivers over 100W with only 4W input. Ideal for mobile or fixed use with three level RF power selection. Includes over-voltage and over-drive protection. Advanced semiconductors and specially wound ferrite transformers permit operation over the full HF band (2-30MHz) without re-tuning.

$499

Cat D-2547

VHF/UHF Antenna Kit

No more wondering 'which one to buy?': this one does the lot! And everything you need is suppplied. All this makes the perfect solution to your mobile antenna problems, whether they're amateur, UHF CB or commercial radio. A complete kit.

$29.95

Cat D-4025

HF Mobile Whips

All are approx. 6 feet (2m) loaded whips with adjustable tuning (no cutting!) and features a heavy duty stainless steel stud mount, RG58C/U coax and PL259 connector.

80 metre. Cat D-4307
40 metre. Cat D-4308
20 metre. Cat D-4309

All $59.95

DICK SMITH ELECTRONICS PTY LTD

Automated receiver for the UoSAT 'educational' satellites

A fully assembled and ready-to-use receiver unit from Britain gives personal computer users an easy access to information broadcast by the two UoSAT satellites, built in England's University of Surrey. Transmissions from these satellites include data on shuttle flights, experiments in space, developments in space technology, news bulletins, pictures of the Earth's surface and a variety of scientific information.

The receiver tunes automatically to the UoSAT transmissions just below 146 MHz in the two-metre amateur band, and it can be used at present with Acorn or Sinclair Spectrum microcomputers, but software will soon be available to permit its use with other home computers having a suitable serial interface (including the Apple IIe, Commodore 64 and Amstrad 464).

Designed for easy use by people having no detailed knowledge of satellites or radio systems, the receiver is supplied complete with leads, decoding unit, handbook, sample test tape, display program, and an antenna with 8 m of feeder.

The antenna is nondirectional, making it easy to pick up signals, the makers claim. A tape recorder switches on automatically when the signals are in range, and switches off again when the signals stop.

The manufacturer of the receiver is seeking agents. Delivery on large orders is currently eight weeks, but should soon be ex-stock. Enquiries to the nearest office of the **British Consulate-General,** quote AL47/TELEC/EDUCE/COMPP.

CB from GFS

Melbourne-based GFS Electronic Imports of Mitcham, recently announced their decision to further enhance their extensive range of amateur radio and commercial communications products by adding citizens band lines to their inventory.

Greg Whiter from GFS says "the highly regarded 'Electrophone' brand would feature prominently amongst the 27 MHz and UHF transceivers". He added, "our eight years of experience in the amateur and commercial communications field provide us with an expertise that most others selling CB don't have. For example, we are able to advise our customers on such subjects as the correct antenna and coax cable to use for a particular application".

GFS say they also have a fully-equipped workshop so they can meet the servicing requirements of the CB market including back-up service on the products they sell.

In the area of accessories GFS stock beams, a range of different low loss coaxial cables, antenna rotators and non conductive high strength 'Deglass' guy wire.

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

More packet radio gear

A new packet radio adaptor, designed to suit IBM PCs and compatibles, has been brought to our attention by the Sydney Amateur Digital Communications Group. Released by the Canadian Hamilton Area Packet Network and dubbed the "HAPN Packet Adapter', it comprises a card that plugs straight into one of the slots of your PC or compatible. It contains a built-in modem which interfaces to your transceiver via a DB9 connector.

Software-wise, it runs the AX.25 protocol as well as the Canadian 'Vancouver' V1 and V2 protocols, although the latter is optional. Other options include bulletin board software and file transfer programs.

Interfacing to your transceiver is simple. All it requires is the Rx audio and push-to-talk lines. The carrier detect (radio channel busy) is generated internally from the received data or, optionally, brought out from your squelch circuit.

The built-in modem is Bell 202 compatible employing the XR2206/XR2211 chipset with 1200 Hz and 2200 Hz tones. The data rate is 1200 bits/sec. A hardware 'watchdog' timer prevents possible Tx runaway as a result of power glitches, etc.

The board is 220 mm (8.5") long and features a pre-drilled prototype area. The circuitry is based on the Intel 8273 HDLC/SDLC protocol controller chip with straightforward interface to the PC.

You can buy the adaptor from the HAPN in assembled and tested form, complete with AX.25 host software and self-test program plus documentation, for US$199. The bare board with AX.25 software and construction detail costs US$75.00. The optional bulletin board and file transfer programs cost US$25 the pair as does the Advanced VADCG experimental software, while the AX.25 software by itself costs US$40. Payments should be made to 'HAPN'. Orders to **HAPN, Box 4466, Station D, Hamilton, Ontario Canada, L8V4S7.**

Scrambler for Sawtron 990

Imark Pty Ltd has released the Digiscram voice security System for use with the Sawtron 990 UHF two-way radio.

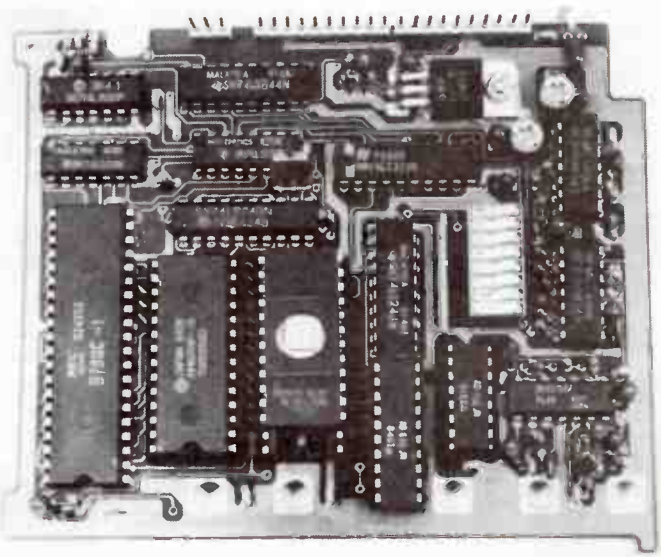
The Digiscram operates by "scrambling" your voice into an unintelligible signal before transmitting it with your carrier frequency. When this signal is received by the complimentary Sawtron 990, the signal is decoded and fed to the speaker as a normal intelligible voice signal. Obviously, other radios will be able to hear the signal but would not be able to understand the conversation. The Digiscram is not a voice inversion type scrambler (as they can be decoded quite easily).

The unit employs a high security digital time domain reversal technique. There are a total of 65 535 code combinations of which each transceiver can be programmed to one of 256 codes by the appropriate switch settings. Naturally, all transceivers within a system must have the same code setting to operate. Transceivers not fitted with a Digiscram will not be able to decode the scrambled signal.

The unit plugs straight into the options interface on the Sawtron 990 transceiver and only one slight modification has to be made to the transceiver to complete the installation.

A version for fitment to any type of transceiver will be available shortly.

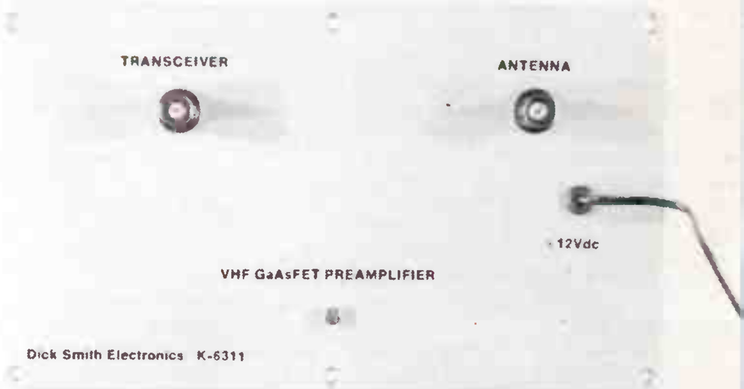
Further details can be obtained from the designers and manufacturers, **Imark Pty Ltd, 167 Roden Street, West Melbourne 3003 Vic. (03) 329 5433.**



A low-noise two-metre amateur band masthead mounted GaAsFET preamp

Dick Smith Electronics
Research & Development Division

Here's a 'sister' unit to the UHF GaAsFET preamp, designed to lift receiver front-end performance, particularly if you find it necessary to run a long length of feedline between your antenna and your rig.



The preamp is housed in a diecast aluminium box which is mounted as close as possible to your antenna. Note the dc supply lead entering the box at right.

RECEIVER FRONT END noise figure is a major factor in any VHF station 'system performance'. Two things, primarily, determine front end noise figure: feedline loss between the antenna feedpoint and the receiver input, and the noise factor (or noise figure) of the device employed in the first RF stage. Feedline loss between the antenna and the receiver input can be minimised by mounting the first RF stage as close as possible to the antenna feedpoint. Employing a low noise device for the RF stage is the next step. Unless your transceiver or receiver has a demountable front end, you've got a problem. The solution is to employ an 'outboard' RF stage, or preamp.

Two decades ago, the 'vogue' low noise RF amp devices employed for low noise applications on two metres were either a 416B 'lighthouse' tube (valve or 'bottle'), so-called because of its shape, or a 6CW4 'nuvistor' — also a vacuum tube of special construction. They could achieve noise figures of around 2-3 dB when run-of-the-mill front end noise figures were twice that.

These days, noise figures around 1 dB, or less, are regarded as pretty well state-of-the-art on the 144-148 MHz band. But station system performance below 200 MHz, for terrestrial working, is ultimately limited predominantly by atmospheric and man-made noise and this sort of noise figure will pretty well ensure your performance exceeds that. However, for satellite and other space applications, a 1 dB or better noise figure is a distinct advantage and the 3SK121 GaAsFET, with a typical noise figure of 1.5 dB at 800 MHz, falling to under 1 dB at lower frequencies, readily achieves the required performance — and at modest cost.

Design consideration

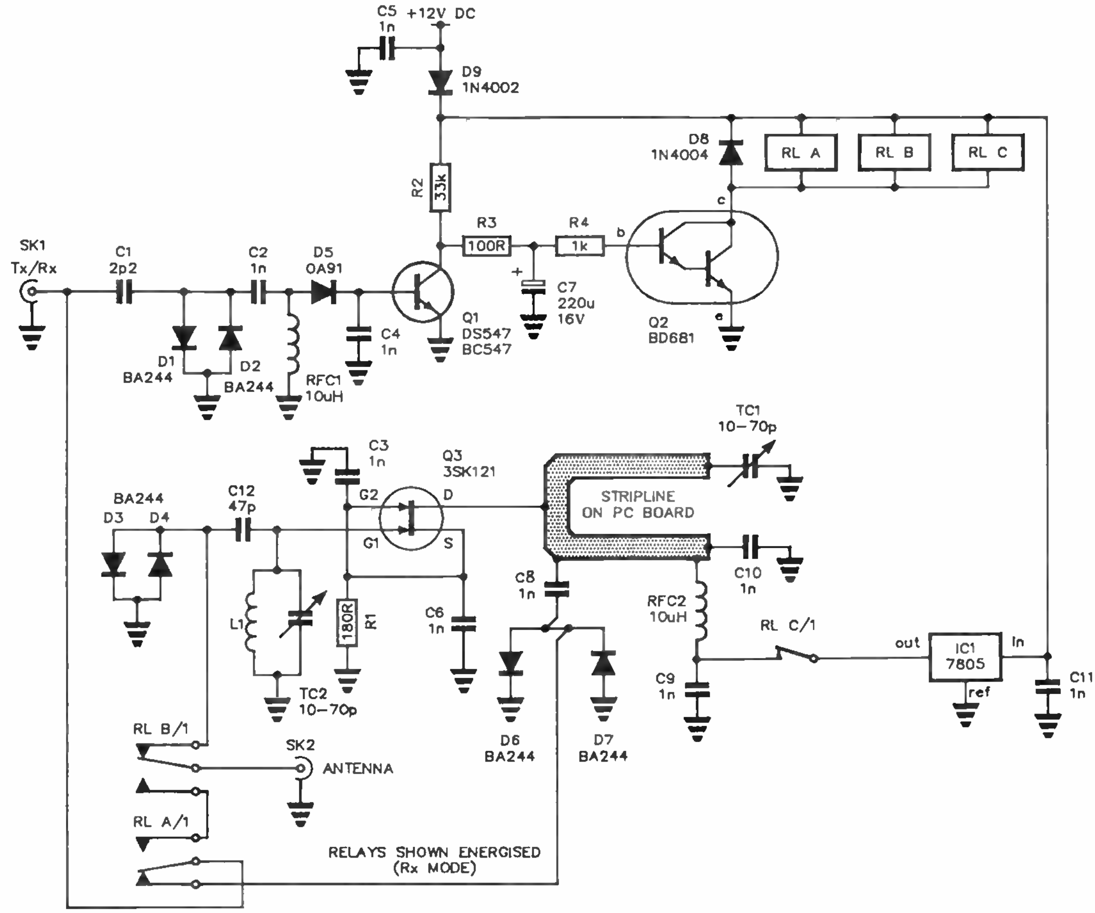
As pointed out at the head of the article, there are good reasons to mount a low noise preamp as close as possible to the antenna. Firstly, why have a preamp at all? Many operators would be surprised at the noise figure offered by some commercial transceivers — especially the older models. It is the first stage of a receiver which largely determines the overall noise figure. If you added a preamp having a 1 dB noise figure ahead of a receiver with a 4 or 5 dB noise figure (not uncommon!), the resulting noise figure is only slightly higher than the noise figure of the preamp itself. Thus, you can gain quite a worthwhile increase in the signal-to-noise ratio (S/N) of received signals, particularly with FM reception where a 2 dB increase in S/N can mean the difference between a 'scratchy' signal and full quieting!

It is a popular misconception that a preamplifier fitted inside a transceiver will achieve a similar performance. This is borne out by the number of operators who use the recent breed of RF power amplifiers with in-built GaAsFET receive preamps. These can be considered a singularly useless device when trying to achieve low noise figures, unless mounted at your antenna, the reason being that feeder loss is ignored.

If you had a 15 metre (about 50 feet) run of RG58 coax between your preamp/power amp and your antenna, this would introduce a loss ahead of the preamp of around 2.9 dB as RG58 has a loss of about 5.8 dB/30 metres. This loss just *adds* to the noise figure of the in-built preamp which have typically quoted noise figures of under 1 dB. You would thus end up with a noise figure in excess of 3 dB. Solution — put the preamp up the pole! Better yet, use better quality coax!

Another misconception with preamplifiers is "the more gain they have the better". This is not necessarily true. As can be seen from the above, decreasing the noise figure will give an increase in the signal-to-noise ratio. There is not much point in simply amplifying a signal if you are also amplifying the noise as well, you just get a louder signal and louder noise — no change in the ration of signal-to-noise. Too much ▶

This month's ★ Star Project ★ is from Dick Smith Electronics who will be marketing kits through their stores and dealers; cat no. K 6311, $129. Mail order enquiries to PO Box 321, North Ryde 2113 NSW. (02) 888 3200.



CIRCUIT OPERATION

A Toshiba 3SK121 dual-gate GaAsFET is the 'heart' of the preamp. Input matching and tuning is achieved with a parallel-tuned circuit comprising L1/TC2. Output matching and tuning is accomplished with a stripline in the pc board, resonated by TC1.

In the 'through' mode, the antenna input is connected via the two coaxial relays and 50 ohm stripline to the output socket.

In 'receive' mode the three relays, RLA-RLB-RLC, are energised. This is done to provide 'fail-safe' operation so that if the 12 V supply to the amplifier should fail or be inadvertently turned off, the amplifier will assume the 'through' mode.

Coaxial relays RLA and RLB connect the antenna to the input of the amplifier and the output to the receiver or transceiver. The miniature relay, RLC, connects the supply from the five volt regulator IC1 to the GaASFET.

The 3SK121 (Q3) is self-biased via R1 in the source circuit. The antenna is coupled to gate 1 via C12, the input tuned circuit being in parallel with gate 1.

The unit employs RF sensing to automatically switch between receive (preamp) and transmit (through mode). Fast-switching diodes D3-D4/D6-D7 are used at the input and output of the amplifier itself to shunt excessive RF whenever the transmitter is activated.

When power is first applied, C7 charges via R2-R3, turning Q2 on after a short delay. Whenever the transmitter is activated, the RF signal is coupled to the sensing circuit via C1 (2p2). Again, fast-switching diodes, D1-D2, prevent excessive RF voltage appearing here. The RF is rectified by a germanium diode, D5, and the resultant dc turns transistor Q1 on. Capacitor C7 (220μ) discharges quickly through R3 and Q1, thus turning the Darlington transistor Q2 off and relays RLA, RLB and RLC de-energise.

When de-energised, the coaxial relays switch the transmitter straight through to the antenna, while relay RLC removes the 5 V supply to the GaAsFET.

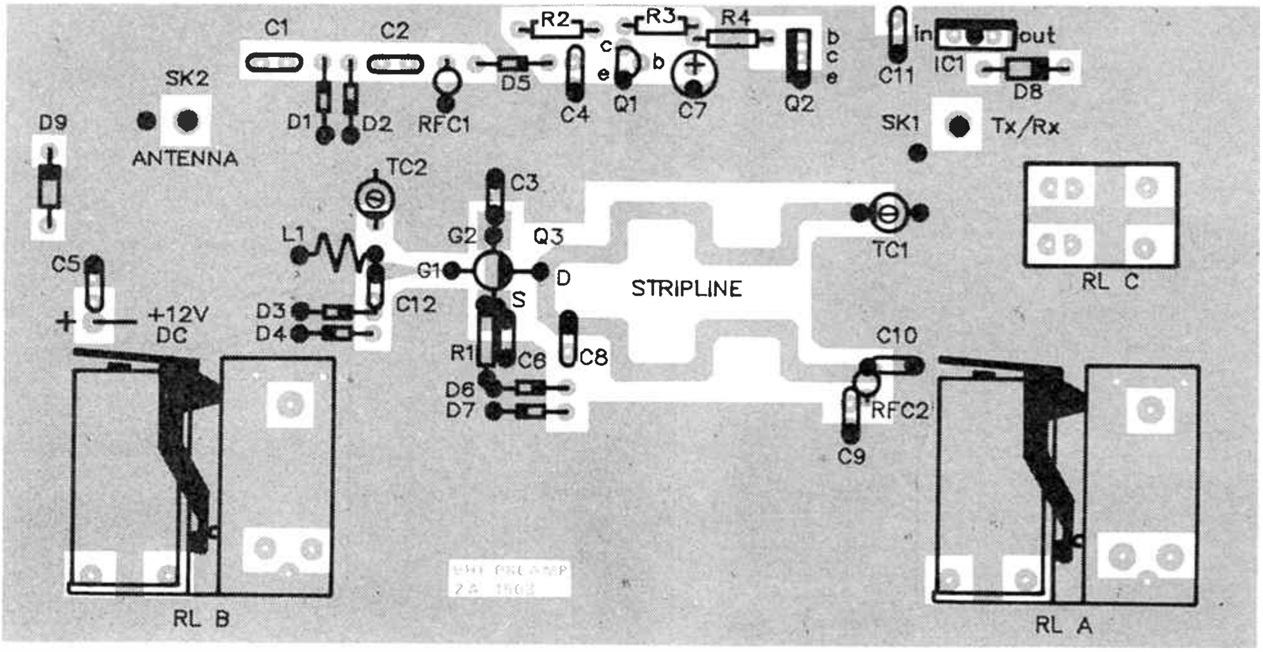
Whenever the transmitter is turned off, transistor Q1 will turn off also, allowing C7 to charge slowly via R2 (33 k) and R3 (100 R). When C7 has charged sufficiently (to about 1.3-1.6 V), the Darlington Q2 will turn on again, receiving bias via R2-R3-R4, thus energising the three relays. The signal is then coupled to the receiver via the preamp (C12-Q3-C3). The delay in turning on is provided to prevent relay chatter when using SSB or CW modes. The delay may be shortened if desired by reducing the value of R3.

Diodes D3-D4 serve another purpose, apart from preventing excessive RF from the transmitter reaching Q3. They secondarily prevent any static charge which may build up on the antenna from destroying Q3.

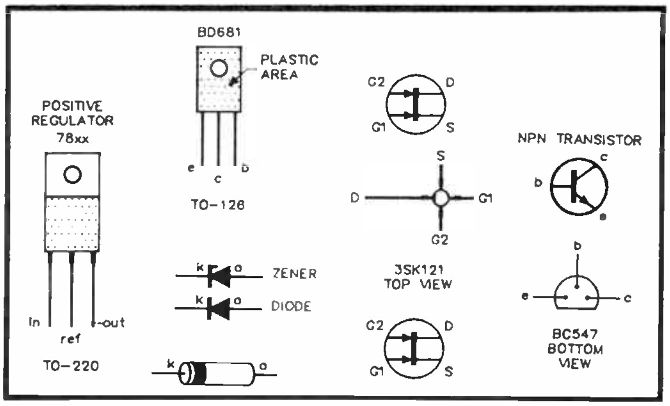
Some operators may prefer to use hard switching in lieu of RF switching. This can be accomplished by omitting C1, D1, D2, C2 etc, and connecting the switching voltage (usually 12 V) via a suitable resistor to the base of Q1. It would be wise to retain C4 (1n), and also feed the switching voltage into the enclosure via a suitable feedthrough capacitor.

The unit is powered from an external 12 V dc (nominal) supply and consumes about 200 mA in receive mode. If extremely long runs of cable are used, it would be advisable to check that the supply is not below 12 V at the amplifier or the 12 V coaxial relays may not switch reliably. Diode D9 provides reverse supply polarity protection.

It is important to remember that the dc return (-ve side of supply) is via the outer braid of the coaxial feedline, from the transceiver to the amplifier, and if a separate supply is used to power the amplifier, a connection should be made between the negative side of the supply and the braid of the feedline. If the same supply is used to power both the amplifier and the transceiver this will probably be unnecessary as the coax outer braid connection of the transceiver will usually be common to the negative supply.



Component overlay. A double-sided pc board is employed, but only the topside copper area is shown here for clarity. Component leads marked with '●' are soldered to the top side of the board. (Note: some leads are soldered both sides — check the text).



PARTS LIST
VHF GaAsFET PREAMP

Semiconductors
D1-D4, D6, D7 . . . . BA244
D5 . . . . OA91
D8, D9 . . . . 1N4002
IC1 7805
Q1 . . . . DS547, BC547
Q2 . . . . BD681
Q3 . . . . 3SK121

Resistors all ¼ W
R1 . . . . 180R
R2 . . . . 33k
R3 . . . . 100R
R4 . . . . 1k

Capacitors
C1 . . . . 2p2 ceramic
C2-C6 . . . . 1n ceramic
C7 . . . . 220u/16 V electro.
C8-C11 . . . . 1n electro.
C12 . . . . 47p electro.
TC1, TC2 . . . . . 10-70p trimmer

Miscellaneous
L1 . . . . see diagram
RFC1, RFC2 . 10 uH RF choke, L-1773
RLA, RLB . . . pc-mount coaxial relays, 12 V coil, Z-7402
RLC . . . . SPST ultra-mini relay pc-mount 12 V coil, S-7112
SK1, SK2 . . BNC coax sockets

PC board ZA 1503; H2201 die-cast box; small grommet; wire, nuts, bolts, etc.

Kit price: $129

gain can also introduce instability in an otherwise stable receiver.

The amplifier described here has a gain of around 15 dB at 146 MHz, which should be more than adequate for most applications.

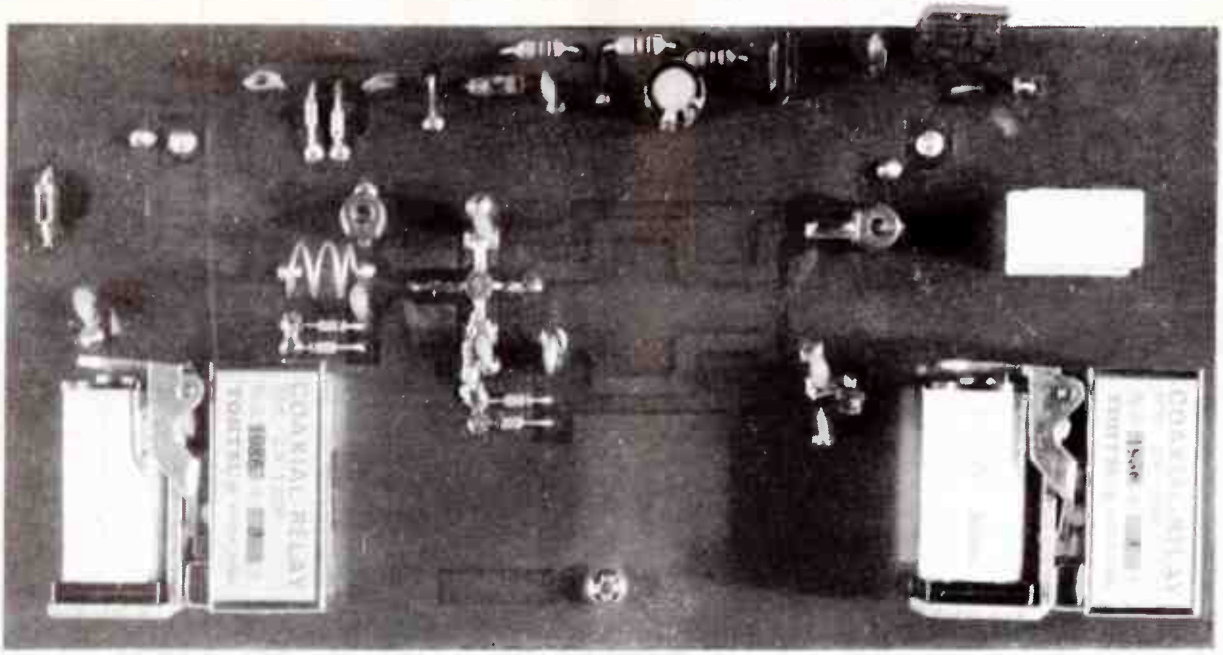
Construction

As with the UHF unit, this preamp employs a double-sided printed circuit board with fibreglass substrateand a solder mask for ease of construction. The GaAsFET output matching circuit is a stripline etched on the pc board, as can be seen in the accompanying overlay and photograph. In addition, the input and output coupling lines running to the relays RLA and RLB are 50 ohm striplines. Thus, the pc board is an integral part of the design. The artwork is reproduced elsewhere in the article for reference. Note that it is copyright to Dick Smith Electronics.

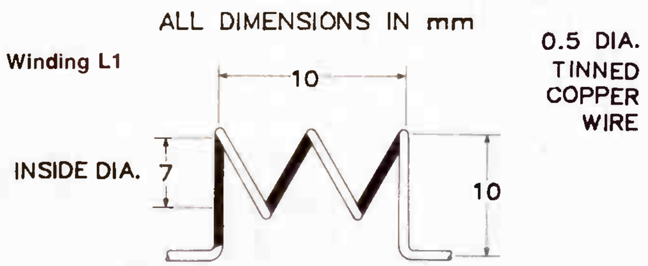
The construction of the board is quite straightforward. First, make a visual check that all the required holes are drilled and of the right size. Components may be mounted in any order but it is preferable to leave Q3, the 3SK121 GaAsFET, till last. Note that some components are mounted on the surface of the pc board with no holes to guide you, so make careful reference to the overlay diagram when mounting these.

The pc board supplied is double-sided but the holes are not plated through. Where possible, solder components to both sides of the board. This is particularly important with those components which pass through the earth planes such as inductor L1, diodes D1-D4, D6 and D7, C12, C3, C6, etc. Refer to the overlay diagram. It is *absolutely essential* that components are mounted with the *minimum possible* lead length, especially around the active circuit. This applies particularly to C12, C3, C6, R1, C8, C9 and C10. Don't forget to observe the correct orientation with polarised components. Failure to observe all these precautions may cause instability or even prevent the unit working!

The usual electrostatic discharge (ESD) safety precautions should be observed when soldering the GaAsFET, i.e: use an iron with an earthed tip, don't use too much or too little heat and don't run around on nylon shag pile carpets beforehand. It will probably be necessary to trim the drain lead of the GaAsFET before soldering. Gently tin the device's leads



View of the completed preamp.



and the tracks on the pc board to which they mount before soldering it in place. To solder it in position, hold it in place with needle-nosed pliers or a pair of tweezers, making sure it's correctly oriented (see the pinout diagram). Then apply the flat of the iron tip to each lead in turn, applying a little pressure, so that the device's leads are sweat-soldered to the tracks.

As you can see from the lead photograph, the unit is housed in a diecast box, which comes pre-drilled. The board mounts to the lid in the same fashion as the UHF preamp. This is the only 'difficult' part of the construction. Before mounting the board, solder a length of medium duty hookup wire, about 150 mm long, to the +12 V pad on the board, adjacent to C5. Tie a knot in it about 20-30 mm from the board to prevent any strain being put on the pc board joint whenever the wire is tensioned. The accompanying diagram shows the overall board mounting arrangement.

The two BNC sockets are mounted to the lid of the box, in the holes provided. Solder lugs are mounted under the securing nut and washer on each. About 20 mm of heavy gauge tinned copper wire should be soldered to each lug which needs to be oriented such that the wire can be soldered to the rear (non-component) side groundplane of the pc board adjacent to the pads for the coax sockets' centre conductor pins. The +12 V supply input wire passes through a small grommeted hole in the diecast box lid adjacent to the ANTENNA socket.

There is very little room to solder the centre pins of the coaxial connectors to the underside of the board, and care should be taken to obtain a good electrical and mechanical joints here as the board is, in part, supported by these connectors. The method used in constructing the prototype was to liberally tin the tracks on the underside of the board as well as the centre pin of each connector. The pc board is then placed over the pins and heat from the iron applied from the upper (component) side of the board to the pins whilst solder is fed to the joint on the underside. It is a bit awkward but can be accomplished, with care. Don't forget to solder the wires from the BNC socket lugs to the board on both sides. It would be advisable to check the joints with a multimeter (on resistance) after soldering.

Finished? Give everything a thorough visual check. ▶

LEVEL

We expect that constructors of an

INTERMEDIATE

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

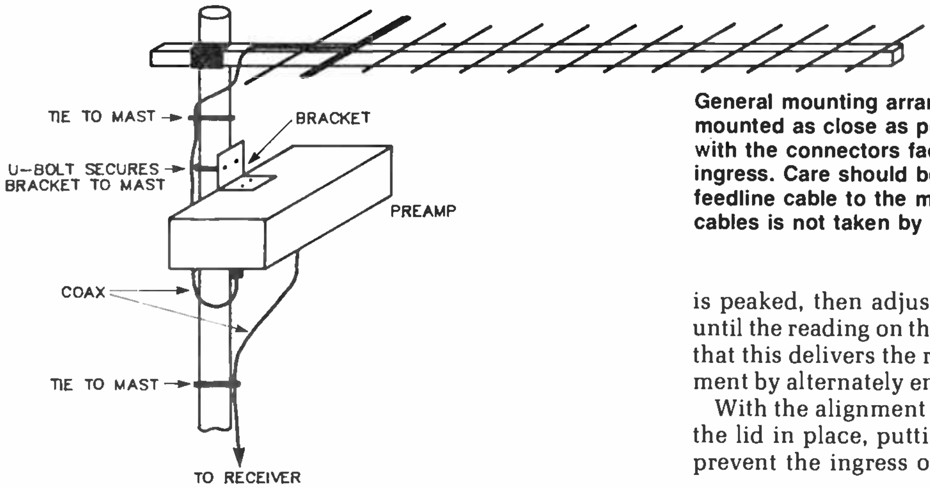
A WORD ON GaAsFETS

FET devices employing gallium arsenide (GaAs) first appeared around a decade ago. They are depletion mode field-effect devices, similar to depletion metal oxide silicon (MOS) FETs.

A moderately doped n-channel runs between heavily doped drain and source regions. Without gate-to-source bias, a current will flow from drain to source. If the gate is now made negative, the resultant electric field will force electrons out of the channel, 'depleting' the channel of charge carriers, reducing the drain-source current flow. When a positive voltage is applied to the gate, the channel will be 'enhanced', increasing drain-source current flow.

Single gate types are not as linear as enhancement types, but having two gates on the channel overcomes this. Hence, dual-gate types are widespread. Gallium arsenide is an inherently lower noise, higher speed semiconductor, though devices employing it are generally costlier to manufacture than silicon-based semiconductor devices. However, their cost has dropped considerably in recent times.

Typically, they are employed as low noise amplifiers and mixers in UHF circuit applications. For this reason, they are generally housed in a "macro-X" stripline package as illustrated in the 3SK121 pinout.



General mounting arrangement. The unit should be mounted as close as possible to the antenna feedpoint with the connectors facing downwards to prevent moisture ingress. Care should be taken to securely strap the coaxial feedline cable to the mast so that the full weight of the cables is not taken by the preamp's coax connectors.

Initial tests

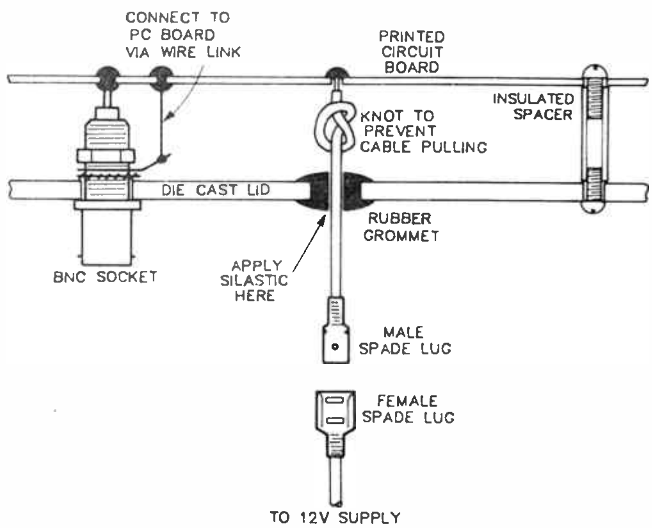
Test the unit 'on the bench' before attempting to mount it up your antenna mast. Apply +12 V to the supply lead, the supply negative going to the case. Ensure that the relays energise when the supply is connected, and de-energise when it's disconnected.

Attach either a dummy load or an antenna to the ANTENNA socket and your transceiver to the other coax connector. Apply the 12 V supply, energising the three relays. See that the relays de-energise when you key the transmitter.

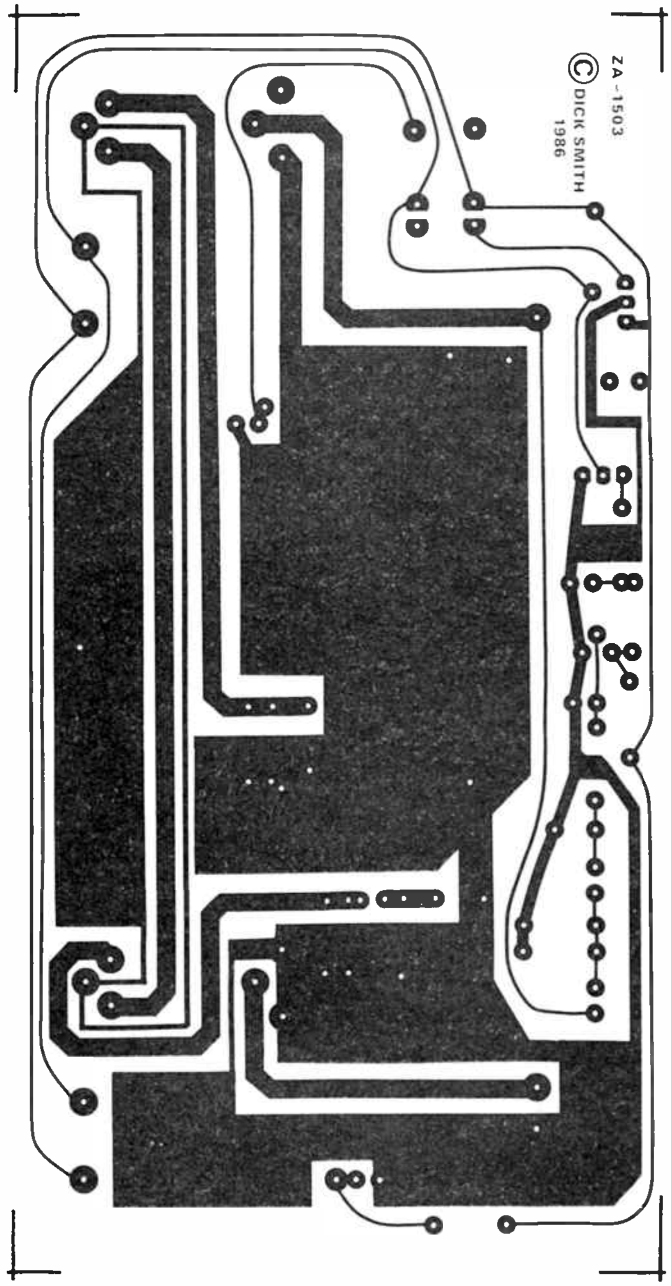
Alignment

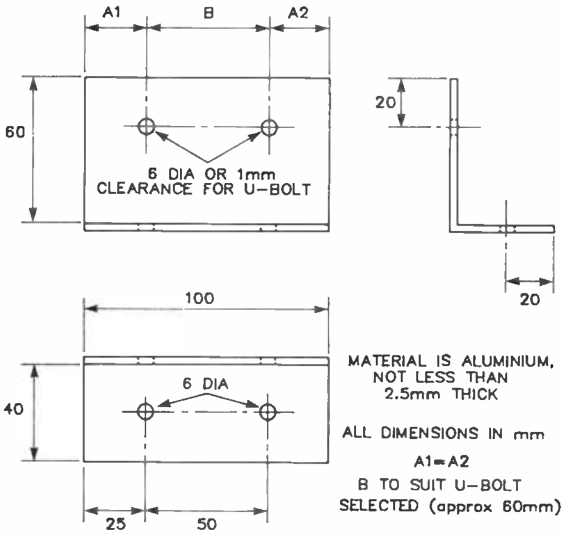
There are two adjustments to make — tuning TC1 and TC2. How you go about alignment will depend on what test equipment you have available but excellent results were obtained on the prototype by aligning for maximum S-meter reading on a weak signal. Start with TC2 and adjust till the reading is peaked, then adjust TC1 for a peak. Repeat a few times until the reading on the S-meter is maximised. You can check that this delivers the required signal-to-noise ratio improvement by alternately energising and de-energising the relays.

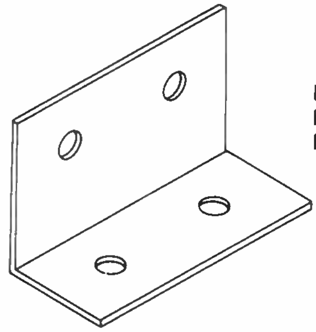
With the alignment completed to your satisfaction, screw the lid in place, putting silicone sealant around the rim to prevent the ingress of moisture.



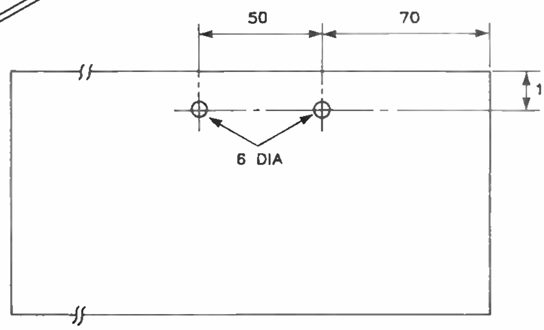
Showing arrangements for the +12 Vdc supply lead. Care should be taken that, when mounting the preamp on your mast, the spade terminals should be prevented from shorting against the case or the metal mast. Slip plastic 'spaghetti' insulation or heatshrink tubing on one lead, then smear petroluem jelly ('Vaseline') on the assembled spade connector before covering it with the spaghetti or heatshrink.

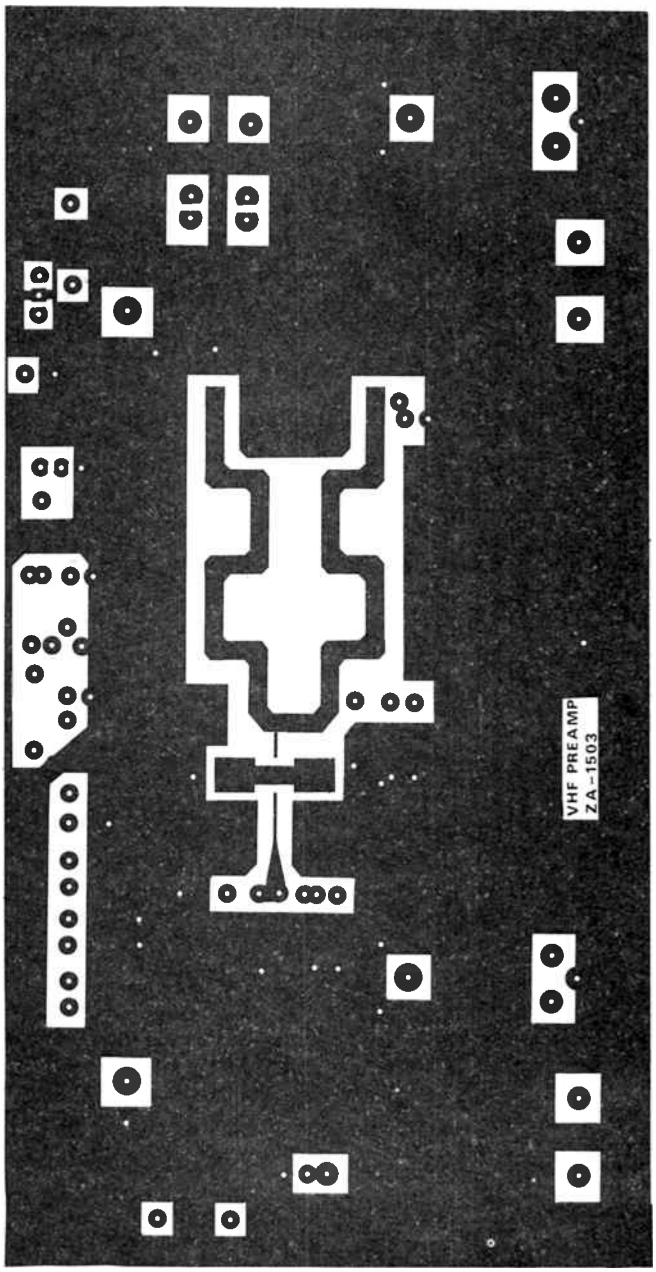






Mounting bracket details, left. Drill the bottom of the diecast box, as shown below, and bolt the bracket to it.





Installation and use

The completed and aligned unit should be mounted on the antenna mast and the ANTENNA socket linked to the antenna feedpoint with a short piece of good quality coax. The feedline to the transceiver is then connected to the TRANSCEIVER socket of the unit and a line run from the unit's +12 V lead to the power supply in your shack.

A mounting bracket, as shown in the accompanying drawings, may be needed to secure the completed unit to your antenna mast, unless you have some other arrangement in mind. This can be bent up from a scrap piece of metal, as shown here, and attached to the box with a pair of large, galvanised bolts and nuts. The bracket should be attached before final assembly.

Care should be taken to secure the coaxial feedlines to the mast to prevent undue strain on the connectors. This applies for the 12 volt supply also. Mount the unit with the connectors facing downwards to prevent the ingress of water. If desired, the whole unit, including the coax connectors, can now be painted with a sealant, such as Selley's "Redskin" or similar, to gain an absolutely watertight installation. Smear all the exposed bolts with petroleum jelly ('Vaseline'), or spray them with WD40, to prevent corrosion.

If you are using very low power, like 2.5-5 watts, it may be necessary to replace the input coupling capacitor, C1, in the sensing circuit with a slightly higher value, e.g: 4p7, to ensure reliable switching. On the other hand, if you are using very high power, e.g: 80-120 watts, C1 should be reduced to 1 pF.

Printed circuit artwork. This is given for reference purposes as it is impractical to make a double-sided pc board such as this and obtain the required critical registration and etched line widths using the methods and techniques generally available to the home hobbyist.

WELLER CROSSWORD COMPETITION NO. 10

SEND IN YOUR ENTRY BY LAST MAIL JUNE 25

Our tenth crossword is made easy because every word begins with B. The prize for the lucky winner is the superb Weller WTCPN Controlled Output Soldering Station which would find pride of place on any workbench. Post us your answers, even if you've missed a couple (so might everyone else) by no later than June 25.

Our crosswords are prepared using 'Crossword Magic' supplied by and available from Edsoft Pty Ltd, 20 Blackburn Rd, Blackburn, Victoria.

The winner of Weller Crossword No. 8 (April) was Craig Chitty of Chatswood, NSW.

Answers to Crossword No. 9 (May) are on p.10.

CooperTools

THE PRIZE

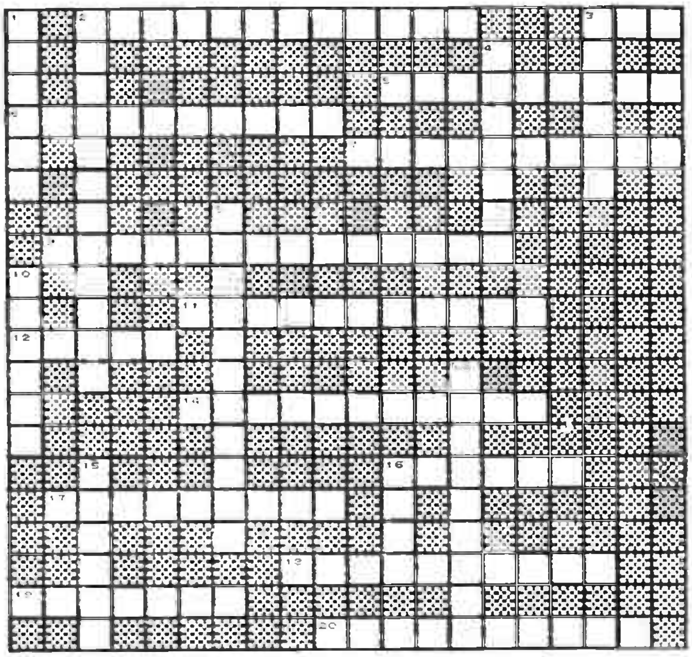
A transformer powered soldering station complete with a low voltage, temperature controlled soldering pencil. The special Weller closed loop method of controlling maximum tip temperature is employed thereby protecting temperature sensitive components while the grounded tip and non inductive heater protects voltage and current sensitive components. The soldering pencil features stainless steel heater construction, a non burning silicon rubber cord and a large selection of iron plated tips in sizes from .8 mm diameter to 6 mm diameter with a choice of tip temperature of 315°C/600°F, 370°C/700°F and 430°C/800°F. The transformer case features impact resistant noryl for durability and protection against accidental damage, a quick connect/disconnect plug for the soldering iron, extra large wiping sponge, tip tray to store extra tips, plus an improved off/on switch with a long-life neon indicator light, a non heat sink soldering pencil holder and a 2 m flexible 3 wire cord.

ACROSS

2. Storage medium in which information is moved from cell to cell by an external magnetic field (2)
3. Circuit fault
5. Having essentially uniform response over a wide range of frequencies
6. Noise heard during a radio program
7. Method of representing numbers in a scale of two
9. A wave filter with a single transmission band (2)
11. The loss of power through friction in bearings of an electric motor. (2)
12. A code character to denote no information is present.
14. Reverse current (2)
16. A replacement for an item which has failed to perfom.
17. A position which lies between the trailing edge of a horizontal sync pulse and the trailing edge of a corresponding blanking pulse (in a composite picture signal). (2)
18. Will accept a banana plug.
19. The maintenance of equal coverage volume of both speakers of a stereo system
20. A place in a routine where that routine may be interrupted.

DOWN

1. Cross talk
2. A drawing in which essential units are indicated by blocks. (2)
3. a guidance or warning aid.
4. A partition for the insulation of electric circuits.
8. A central command post communicating with mobile stations. (2)



10. A small insulated spool.
13. A frequently used routine for selecting different makes of an item. (2)
15. A shielding structure.
16. ß

We will accept entries postmarked no later than June 26.

The competition is open to all persons normally resident in Australia or New Zealand, with the exception of members of the staff of Australian Electronics Monthly, the printers, Offset Alpine, and/or associated companies.
The winning entry will be drawn by the Editor, whose decision is final; no correspondence will be entered into regarding the decision.
Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next possible issue of the magazine.

Cut out or photocopy the entry form, complete it and send to:

"Weller Crossword"
Australian Electronics Monthly
PO Box 289,
Wahroonga NSW 2076

In case two or more entrants correctly complete the crossword, we'll have to judge who's best at waxing lyrically, in 30 words or less, over: ***"Why I think the Weller WTCPN is the soldering station for me".***

. . . .

. . . .

. . . .

. . . .

. . . .

Name . . . .

Address . . . .

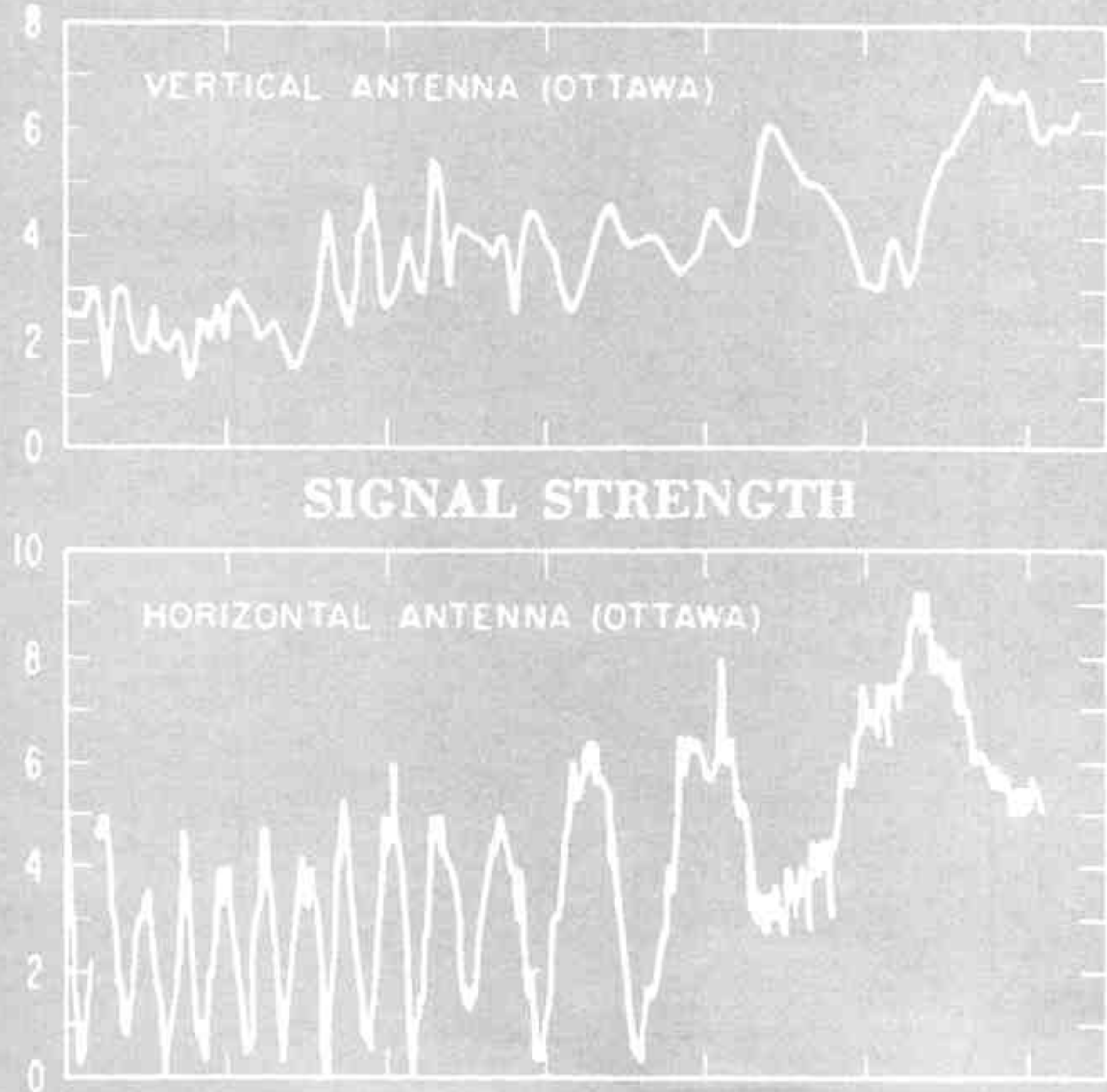
. . . . **Postcode** . . . .

Radio communicators guide to the ionosphere

Part 7

Leo McNamara and Roger Harrison

Problems under normal conditions



EVEN WHEN THINGS ARE GOING WELL, and we have done everything correctly, we can still encounter problems in the use of HF. Some of these arise from basic properties of the normal undisturbed ionosphere which act as fundamental limitations to HF propagation and it is these problems which we shall consider here. Other problems arise from disturbances to the ionosphere caused by events on the sun, but we shall defer discussion of these to the next part.

Fading

Fading is a repetitive rise and fall in signal level, the signal getting stronger and weaker in turn. It is described by its depth — whether it is shallow or deep — and by its rate — whether it is fast or slow. The rate usually increases with frequency. In general, deep and fast fading is a disaster, but slow and shallow fading can be tolerated. Under conditions of deep fading, the signal level can drop below the noise level and thus be lost. To avoid loss of signal, we need to ensure that the signal level is sufficiently above the noise on the average that even a deep fade will not cause loss of signal. In other words, we have to ensure an adequate *fading margin*. When an adequate fading margin is available, the amplitude changes may be eliminated by using an automatic gain control (AGC) circuit. Examples of fading signals are given in Figure 7.1.

Fading may usually be attributed to one of four effects:

(1) Movement of the ionosphere and changes of the propagation path length
(2) Rotation of the plane of polarization of the wave
(3) Variations of ionospheric absorption with time
(4) Focusing and temporary disappearance of the signal due to MUF failure

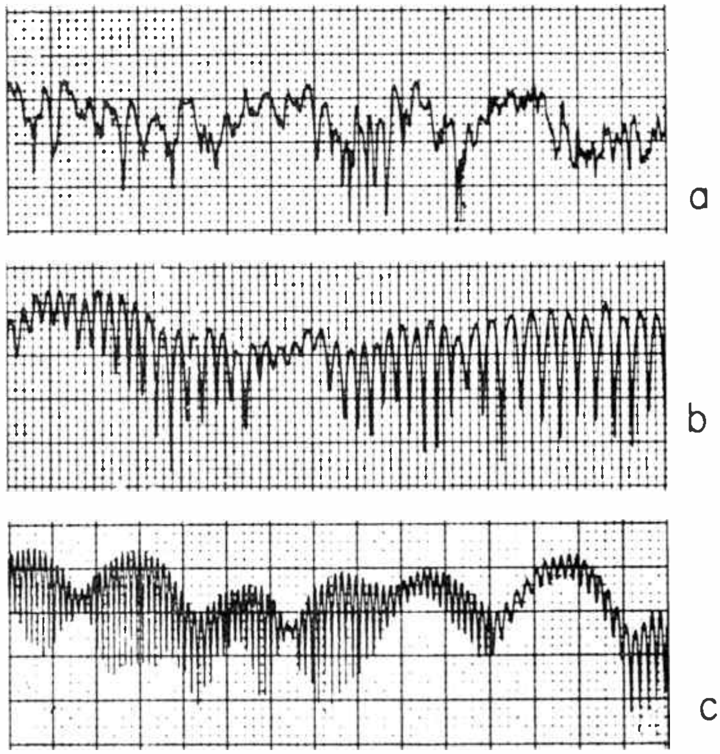


Figure 7.1. Some examples of fading signals. The fading in panel (a) is random. The periodic fading in panel (b) is the resultant of two waves of almost equal amplitude whose phase difference is changing at a constant rate. Panel (b) illustrates combined slow and fast fades. The fast (short period) fading could be due to interference between the high and low rays, while the slow (long period) fading superimposed on the fast fading could be due to beating between the ordinary and extraordinary waves.

Multipath fading

On any particular HF circuit, and for a given elevation angle, the transmitting antenna will effectively illuminate an area of the F region (called the Fresnel zone) about 1 km wide, and rays (or waves, if you prefer to think in terms of waves rather than rays) reflected from all parts of that region will arrive at the receiving antenna. These rays will have random phases with respect to each other because the path lengths will all be slightly different, and the phase differences will change in response to the ever-present fluctuations of the ionosphere. Thus, when the rays combine at the receiver, the resulting signal will fluctuate in intensity as the individual rays go in and out of phase. In other words, the signal will *fade*. This fading will not be too severe because the phase differences are small and there is little chance that the multitude of signals will cancel each other out at any time. There will therefore be a bundle of rays, with changing overall amplitude, which can be considered as *the* ray for the given elevation angle.

The situation is, however, quite different when we have only two rays, travelling by two different propagation modes. It is then possible for the rays to interfere with each other to such an extent that they will occasionally cancel each other out completely, leaving no signal to be detected by the receiver.

If the ionosphere were a rock-steady reflector, the phase difference between any two propagation modes would remain fixed and the net result of combining two signals at the receiving antenna would remain constant. However, the ionosphere is a moving and irregular medium, so the path lengths on any propagation mode are continually changing by small amounts. Thus when two signals from different propagation modes combine, the resulting signal will fade as the two signals interfere with each other, alternately cancelling and reinforcing each other. This is called *interference fading*. The period of this type of fading is usually relatively short, about a second or two. That is, the signal will wax and wane, with about a second or two between successive maximum amplitudes.

Fast interference fading is called *flutter fading*. If the fading rate changes rapidly with frequency, it is known as *selective fading*, and can produce distortion if the carrier fades to a level below that of the sidebands.

Multipath fading can be expected to be severe whenever 1F and 2F modes, or 2E and 1F modes, exist on the same circuit, because the ray paths will be very nearly, but not quite, equal in length. Every time the difference in path length becomes equal to half a wavelength, the two signals would be exactly out of phase, and would cancel each other out to a large extent. The cancellation would be complete if the amplitudes of the two rays were equal.

Different signal modulation techniques are affected in different ways by multipath fading. Analogue voice transmissions are relatively insensitive to selective fading, whereas digital data transmission is strongly affected. Selective fading is very severe on circuits for which the ground and sky waves are of comparable intensity.

The slow and deep fading observed at night on signals from distant MF broadcast stations, which we referred to in Part 3 (Nov. '85 issue) is due to interference between the ordinary and extraordinary rays. The amplitudes of the two signals are almost equal, because there is no absorption at night, so it is possible for the two signals to cancel each other out almost completely.

Polarization fading

We saw in Part 5 (April '86) that every plane polarized wave which enters the ionosphere can be considered as splitting into two components, called the ordinary and extraordinary waves, which are circularly polarized in opposite directions and propagate independently. These waves keep the same polarization as they propagate through the ionosphere, but the phase difference between them gradually increases as the wave propagates. Thus, when the two waves recombine on leaving the ionosphere, the plane of polarization of the plane polarized wave will have rotated with respect to the original plane of polarization of the transmitted wave. The amount by which the plane of polarization has rotated depends on the total number of electrons along the path between the transmitter and receiver and will thus change during the day. This phenomenon is known as *Faraday rotation*, after Michael Faraday, who discovered the effect in optical experiments.

Polarization fading is the result of changes in the state of polarization of the composite (ordinary and extraordinary) wave relative to the orientation of the receiving antenna. When the electric field of the composite wave points in the same direction as the antenna, which we can consider for simplicity to be a straight length of wire, the induced voltage will be a maximum. On the other hand, when the electric field is at right angles to the antenna, the induced voltage will drop to zero. If the incoming wave at the receiver kept its same polarization, the induced voltage would remain fixed. However as the number of electrons along the path between the transmitter and receiver increases or decreases, the plane of polarization will rotate and the induced voltage will alternatively increase and decrease, passing through zero whenever the planes of polarization of the wave and antenna are at right angles.

Polarization fading can occur whenever there are changes in the total number of electrons along the path. This includes irregular changes, as well as the expected diurnal changes. An example of polarization fading is given in Figure 7.2. Deep fading can be avoided by the use of two antennas polarized at right angles. In this way, if a wave is inducing zero voltage in one antenna, it is inducing maximum voltage in the other.

Skip fading

Skip fading, or MUF fading, occurs when the receiver is on the edge of the skip zone for propagation from a given transmitter. This means that the operating frequency is exactly equal to the MUF for the circuit. However as the ionosphere fluctuates, so does the MUF, and at times the actual MUF will drop just below the operating frequency and the signal will disappear. Another way of looking at this is that the skip distance will lengthen and shorten as the ionosphere changes, alternatively covering and not covering the receiver.

The signal strength does not in fact drop immediately to zero as the skip zone covers the receiver. Just outside the skip zone, the amplitude oscillates because of interference between the four rays which arrive at the receiver — the high and low angle rays of the ordinary and extraordinary rays (Part 5). Right on the edge of the skip zone, *skip focussing* occurs, increasing the signal amplitude by a factor of about two (3 dB). If we were to increase our operating frequency from well below the MUF up to the MUF itself, we could expect to see the following sequence of events:

(1) Long-period fading as the ordinary and extraordinary rays interfere, the rate of fading increasing (the period decreasing) with frequency

(2) A rapid fading, due to interference between the low and high angle rays, superimposed on the slow fading

(3) As the frequency increases, the slow fading gets faster, and the fast fading gets slower

(4) The fading rate decreases as the operating frequency passes through the MUF.

Absorption fading

Absorption fading is due to inhomogeneities in the lower ionosphere, from where the HF absorption arises, because of changes in the background atmosphere in which the ionosphere is embedded. The period is very irregular, and can be an hour or more. ▶

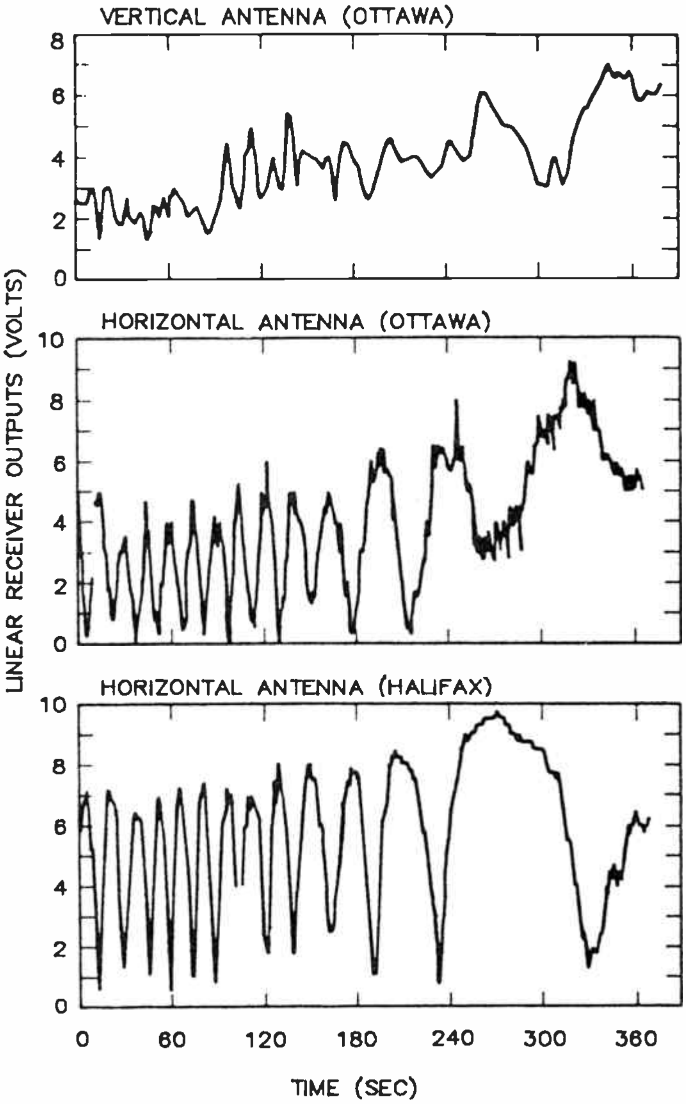


Figure 7.2. The polarization fading observed at the vertical and horizontal antennas on a 1000 km path, Ottawa to Halifax. Panels (a) and (b) illustrate a much more severe fading problem on the horizontal antenna than on the vertical one. Panels (b) and (c) illustrate the fact that polarization fading is not usually the same at both ends of a circuit. In other words, polarization fading is usually non-reciprocal. In this case, the fades at Ottawa and Halifax are almost antiphase.

Scintillations

Scintillations are rapid fluctuations in amplitude, phase and angle of arrival imposed by irregularities in the ionosphere on signals passing through it. They are most intense in the equatorial and polar regions, occurring only at night in the former. The fading has adverse, and often severe, effects on satellite communication systems. It is usually fairly slow, with a few fades per minute, and deep, often up to 6 dB at 200 MHz.

It can also cause increases in the signal strength, but these are not important on an operational circuit. The amplitude of the scintillations decreases with frequency, but is still significant in the GHz band currently used for satellite communications systems.

Some solutions

Even when a signal fades severely, no great problems will be encountered provided the fading does not drop the received signal level below that of the local noise. One way to ensure that this does not happen is to ensure that the transmitter power is large enough to keep the received signal above the noise level even during a deep fade. This procedure is called having an adequate *fading margin*. The fading margin required will vary with the nature of the fading, of the modulation system in use, and of the desired quality of reception.

However, increasing the transmitter power is not always the best solution. An alternative is to use techniques which are less vulnerable to fading. These techniques rely on the fact that the fading is not quite the same on two closely spaced frequencies or on two very similar, but not quite identical, propagation paths.

In *diversity techniques*, the signal is received in two or more ways, and added together in such a fashion as to enhance the signal and cancel out the fading.

There are at least five types of diversity reception which may be employed. The choice of type depends on the particular application.

(1) Space diversity
(2) Frequency diversity
(3) Angle-of-arrival diversity
(4) Polarization diversity
(5) Time (signal repetition) diversity

Space diversity is achieved through the use of two receiving antennas several wavelengths apart, which receive signals travelling by slightly different propagation paths.

Frequency diversity involves the sending of the same signal on two slightly different frequencies, but is not recommended because it is wasteful of the usable frequency spectrum and twice as expensive as the use of a single frequency.

Angle-of-arrival diversity requires the use of large, expensive, directional antennas which can select out each of the several propagation modes.

Polarization diversity is useful when the ordinary and extraordinary modes of polarization have about equal amplitudes and involves the use of two antennas arranged at right angles to each other.

Time diversity, in which the signal is sent more than once, has been found useful for the transmission of digital data.

Sporadic E

We have already encountered sporadic E (or Es) in Part 4b (Mar. '86), where we described its properties and occurrence.

The Es layer is a problem in HF communications because of its irregular and unpredictable behaviour. If we were able to predict its presence and its critical frequency, we could take it into account. Es is in fact often a very good reflector at HF and when it is there, it is well worth using. However, we still know too little about what causes Es to be able to predict it.

One of the most important effects of Es on HF is the *screening effect*, in which an Es layer reflects a signal which would otherwise have gone up to the F layer. As illustrated in Figure 7.3, the Es layer will limit the range of transmission and the signals will not usually reach the intended receiver. Even if they do, they will probably arrive at a very low angle not allowed for in the design of the circuit.

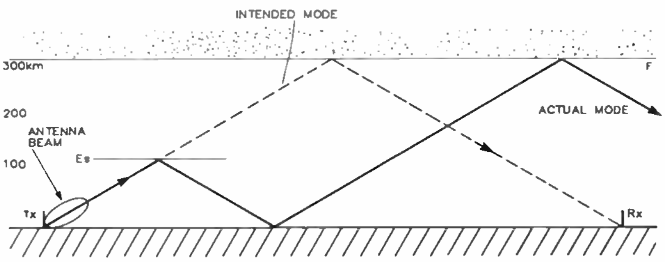


Figure 7.3. The screening effect of a dense sporadic E layer. The Es layer will reflect waves at all frequencies up to the MUF for the Es layer. For example, if foEs is 5 MHz and the Es layer is 500 km down range, the obliquity factor will be about 4.4 (See Part 5, April '86, p.87 — the path length would be 1000 km) and the Es layer will reflect all frequencies up to a value of 5 × 4.4 = 22 MHz. After reflection by the Es layer, the signals will hit the ground, then the F layer, and finally the ground again, but not at the desired location. The only way to avoid screening by an Es layer is to use a propagation mode which will either miss the Es layer, or hit it at such a steep angle that the lower obliquity factor will ensure that the signal is not reflected by the Es layer. The normal E layer also screens the F layer, but not to as high a frequency as an Es layer, since foE is normally only 2 to 3 MHz.

Problems at low latitudes

In many ways the low latitude ionosphere could be expected to be an exceptionally good medium for HF communication — the critical frequencies are normally quite high, it is rarely affected by ionospheric storms and does not suffer the irregular perturbations found at high latitudes, (see "Problems at high latitudes" later). However, the high critical frequencies lead to large horizontal gradients (variations) of critical frequency, in which the critical frequency can change rapidly over a few hundred kilometers. Rapid increases in critical frequencies during sunrise also cause difficulties.

Temporal gradients in foF2

Here we shall be concerned with rapid changes of foF2 with time, the sunrise period being the most important. We saw in Part 4a (Jan. '86) that foF2 at Manila in January, at high solar activity, increases from around 6 MHz at 06LT, to 14 MHz at 07LT, only one hour later. (See Figure 4.5). Most operators receive only two allocated frequencies from their national Frequency Allocation Board, a day frequency and a night frequency.

For short distance communications around Manila in January at high solar activity, suitable values for these frequencies would be 5 MHz (night, with possible failure of communication around dawn) and 12 MHz (day). What fre- ▶

EMTRONICS

RECEIVERS & MONITORING DEVICES

AR2002

25-550MHz/800-1300MHz VHF & UHF monitoring & surveillance

PROFESSIONAL RECEIVER

The AR2002 receiver provides high performance monitor and surveillance reception over a wide frequency range; 25-550MHz and 800-1300 MHz

The wide frequency coverage, combined with reception modes of AM, FM (wide), and FM (narrow), make the AR2002 a versatile unit for a range of applications:

- General off air monitoring
- Spot frequency monitoring/ measurement
- Selective multi frequency analysis
- Spectrum surveillance
- Detection of unwanted transmission ...... and much more

BLACK JAGUAR

NEW

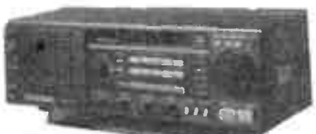
Unique new POCKET SCANNER — with superior performance and largest freq. spectrum of any other pocket scanner. AM-FM modes, 16 ch. memory, Freq. coverage 26-30 MHz, 55-90 MHz, 115-178 MHz, 220-290 MHz, 340-470 MHz, 470-510 MHz.
Write for full specs.

ICOMR71A

IC-R71

Best communication receiver — ICOM R71A

The new standard of comparison — straightforward to operate and feels the way a receiver should.
Continuous tuning (100kHz-30MHz), 32 ch. memory effective noise blanker and many unique features.

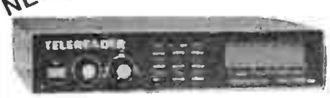


KENWOOD R-2000

CAPTURE THE WORLD WITH FAMOUS KENWOOD R2000 COMM RECEIVER

Top reception with PUSH BUTTON EASE. Outstanding freq. stability, 10 memories, 100 kHz-30MHz freq. coverage, clock, timer etc. makes R2000 an outstanding SHORT WAVE RECEIVER

NEW



CWR-880

CWR 860

SHORT WAVE LISTENERS — NOW YOU CAN MONITOR — MORSE, RTTY, ASCII, TOR, SITOR, AMTOR Signals with the new TELEREADER CWR-880 & CWR-860 computerised decoders. All you need in your receiver and TV set or VDU.

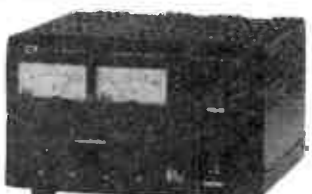
SEE WHAT YOU HAVE BEEN MISSING! MONITOR: PRESS-EMBASSY-WEATHER-MARINE-INTERPOL-MILITARY AND AMATEUR TRAFFIC. IF YOU HAVE EVER WONDERED WHAT ALL THOSE UNUSUAL SIGNALS ON YOUR SHORT WAVE RECEIVER REPRESENT THEN GET A TELEREADER

REGULATED DC POWER SUPPLIES

We stock a full range of top brands regulated DC power supplies

DAIWA: PS 120M -3 to 15V DC variable at 12A max
PS 310M -13.8V DC at 31A max & 3-15V DC at 10A

ALINCO: EP-570 - 10 to 15V DC, 6.5A MAX
EP-1510 - 10 to 15V DC, 20A MAX
EP-2510 - 10 to 15V DC, 30A MAX



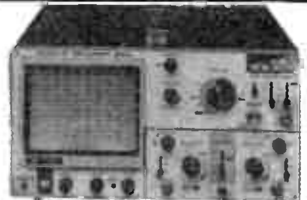
ANTENNAS FOR SHORT WAVE LISTENERS

TEST INSTRUMENTS

OSCILLOSCOPES

FAMOUS BRAND IN STOCK

- KIKUSUI-COS-5020:20MHZ, 2CH, DUAL TRACE, COMPLETE WITH PROBES, 2 YEARS WARRANTY ....
- KIKUSUI-COS-5041, 40MHZ, 2CH WITH DELAY, DUAL TRACE, COMPLETE WITH PROBES, 2 YEARS WARRANTY
- GW-GOS 955: 5MHZ, ICH, 130mm CRT
- GW-GOS-3310: 10MHZ, 1CH, 75mm CRT, COMPACT TRIGGERING CRO



CRO

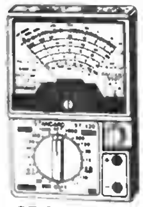
FREQ-COUNTERS

FULL RANGE OF CONVENTIONAL COUNTERS — RELIABLE & COMPETITIVELY PRICED

- GFC-8010F, 120MHZ, 8 digit LED
- GFC-8055F, 550MHZ, 8 digit LED
- GFC-8100F, 1GHZ, 8 digit LED

MULTIMETERS-LC METERS

POPULAR RANGE OF ECONOMICAL MULTIMETERS

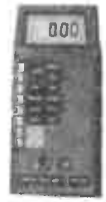


ST-325

ST-325 TAUTBAND MOVEMENT
- ALL PURPOSE MULTIMETER
- FUSE & DIODE PROTECTION
- DROP PROOF MOVEMENT

L/C METER DLC-400

INDUCTANCE AND CAPACITANCE MEASUREMENT
- 3½ DIGIT LCD DISPLAY
- INPUT PROTECTED AGAINST CHARGED CAPACITORS



PRINTERS

5500 1200
YOUR PERSONAL COMPUTER DESERVES THE UNEQUALLEDPRINTER QUALITY OF SAKATA
THE SAKATA RANGE OF DOT MATRIX PRINTERS ARE THE RESULT OF THE LATEST TECHNOLOGY, MAKING THEM FAST, QUIET AND ABOVE ALL — RELIABLE

AMATEUR RADIO

EMTRON ACE

APPLICATIONS

• Commercial & Professional Work • Motor Sports • Factory Management • Hunting and Fishing • Building & Road Construction • Boating • Flying & Gliding • Farming & Pastoral • Crowd Control • Bushwalking • Marshalling • Construction Work • General Sport • Surveying • Personal • Communication Security Business Mobile and Portable Communication

UNIDEN AX144 AM/SSB

40 Channel mobile

Electrophone

Electrophone TX560 AM/SSB 27 MHz DELUXE 40 CHANNEL

- Large 40 channel readout
- Dedicated Phase Locked Loop Circuitry
- L.E.D. Power Meter
- L.E.D. Signal R.F. Local/Distance Meter
- Uncluttered controls
- Front Microphone connection

EMTRON RECEIVER ANTENNA TUNER

NSW STORE & HEAD OFFICE:
92-94 Wentworth Ave, Sydney, NSW. 2000
Ph: (02) 211 0988. Telex: AA73990 (EMOLEC)

VIC STORE:
288-294 Queen St, Melbourne, Vic. 3000
Entrance from Little Lonsdale St.
Ph: (03) 67 8551 or 67 8131

EMTRONICS

Retail Division of EMONA ELECTRONICS P L

All Mail to: PO Box K21, Haymarket, NSW 2000

quency do we use between 06 and 07LT? We cannot use 12 MHz, because it is too high until almost 07LT, so we are stuck with 5 MHz. However, we then have the problem that 5 MHz signals are heavily absorbed during this transition period, so we are in a no-win situation.

Even if we had a large number of allocated frequencies, we would still have problems because we would have to change the antennas whenever we changed frequency. The factor of two in operating frequencies (5 to 12 MHz) would prohibit the use of the one antenna, especially if it is tuned to the operating frequency (as is usually the case). The situation is especially difficult for HF broadcasters, and a disaster for all if the predictions of the MUF do not give an accurate picture of when this sudden rise of foF2 will occur.

For long-distance circuits in the east-west direction, which would involve multi-hop F-region propagation, the problem of the sunrise period will extend to several hours, as the sunrise period affects each hop of the circuit in turn.

Horizontal gradients in foF2 and hmF2

The steep gradients in foF2 and hmF2 associated with the equatorial anomaly cause problems with north-south circuits, especially from the point of view of predicting the correct MUFs.

The maps of foF2 and hmF2 in the equatorial region are not as reliable as the maps for mid-latitude regions; the simple methods normally used for calculating MUFs do not allow for hops of unequal lengths (equal length hops happen only when hmF2 is constant along the circuit); and foF2 and hmF2 change rapidly with latitude. All three of these facts lead to discrepancies between predicted and observed MUFs, which can make it difficult to use HF efficiently.

Scattering by irregularities in the F region

We encountered F-region irregularities in Part 4b (Mar. '86). Field-aligned irregularities in the equatorial F region have both advantages and disadvantages for HF communications. Satisfactory communications via modes which rely on scattering by irregularities is sometimes possible at frequencies well above the predicted MUF. On the other hand, irregularities can result in interference signals.

The main disadvantage in using scatter signals at HF is that movements of the irregularities cause deep and rapid fading (flutter fading). Fading rates of up to 10 Hz occur, depending on the frequency used. Changes in the azimuth of arrival also occur, deviations of up to 50 degrees having been observed on trans-equatorial paths (across the equator) associated with spread F.

The systematic movement of a group of regularities results in a Doppler shift of the transmitted frequency (up to about 30 Hz at 20 MHz), while random motions of individual irregularities leads to Doppler spreading (up to about 20 Hz). The observed fading rates are different for different wave frequencies.

Figure 7.4. The probability of auroras occurring overhead of the north polar regions. The shaded "maximum zone" corresponds to the auroral oval. The oval expands in step with geomagnetic activity, the probability of its being overhead at latitudes equatorwards of the "quiet" auroral oval being indicated by the contour lines. It is very rare for the oval to expand as far south as Moscow or New York. Note that this diagram ignores changes to the oval throughout the day.

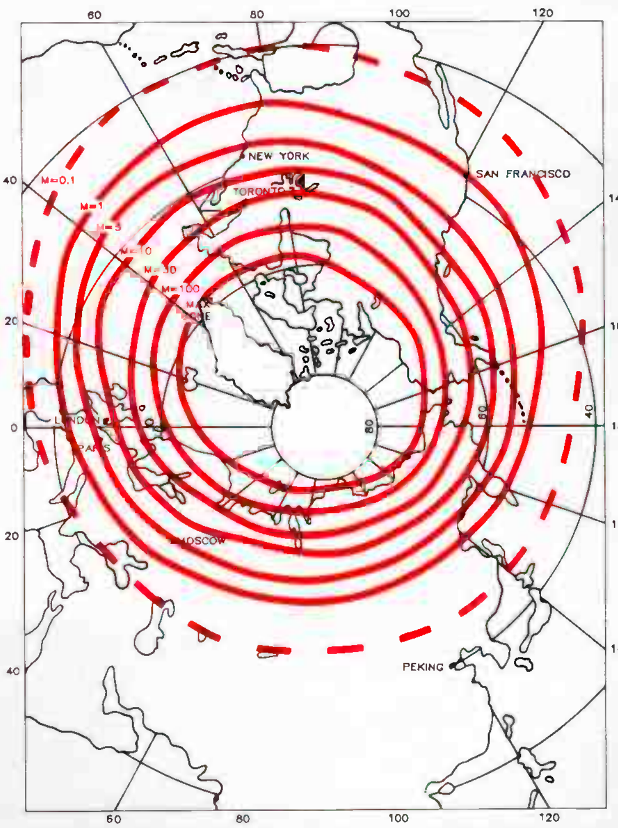
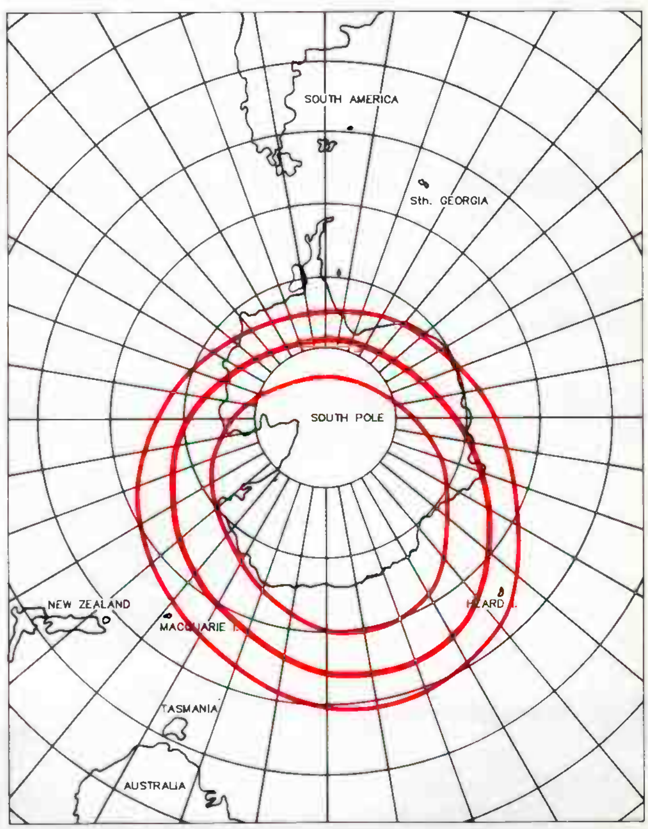


Figure 7.5. An approximate sketch of the southern auroral oval. The southern oval is not as well known as the northern oval because of the large expanses of ocean surrounding Antarctica. This sketch corresponds to a reasonably disturbed geomagnetic field (the oval has expanded equatorwards) and to a universal time of around 18UT. We can deduce the time because we know that the oval lies closest to the equator (further from the pole) at midnight.



Problems at high latitudes

The high latitudes, that is the regions near the north and south poles, are by far the worst regions to be in from the point of view of HF communications. This is because the high latitude ionosphere is exceedingly variable both in space and time. Most of us live in the mid-latitude regions, where the ionosphere is relatively benign and cooperative, but at high latitudes we really have our work cut out for us when we try to use HF communictions. Worse still, we often have no other choice but to use HF. The same problems occur for circuits between mid-latitude stations which go over the polar regions i.e: on trans-polar circuits.

Many of the HF problems at high latitudes arise because the earth's magnetic field is almost vertical there. This means that any particles from the sun, arriving in either the quiet solar wind or in gusts associated with events on the sun (see Part 2, Oct. '85) can penetrate right down into the low levels of the ionosphere.

The charged particles spiral around the lines of force of the earth's magnetic field, but cannot normally cross them. They can cause increased ionization in a process called *collisional ionization*, so that the electron density in the high latitude ionosphere depends not only on where the sun is in the sky, but also on what particles are arriving into the region directly from the sun. As we shall see further in a later article, any event on the sun can therefore affect the high latitude ionosphere and hence HF communications.

The most important feature of the high latitude ionosphere is the *auroral oval*, which is an oval-shaped annulus centred on the earth's magnetic pole. It is the region in which the *aurora* can be seen most often — the aurora borealis (northern lights) or aurora australis (southern lights). The auroras are produced at E-region heights (about 100 km) during the process of collisional ionization. Some of the energy supplied by the high speed charged particles reappears as visible light during collisions with the atoms of the neutral atmosphere.

The auroral oval can be considered as being fixed with respect to the sun, with the earth rotating about the geographic pole beneath it. The minimum distance of the oval from the magnetic pole occurs during the daytime, while its maximum distance occurs at night. Typical positions of the oval are shown in Figure 7.4 (northern) and Figure 7.5 (southern).

The auroral oval expands and contracts in step with the changes in the solar wind. When all is quiet, the auroral oval will contract to a narrow band about 20 degrees from the magnetic pole, and only a few degrees wide. Under disturbed conditions, however, the oval gets wider and expands towards the equator. In the southern hemisphere, the oval will occasionally pass overhead of Hobart, while in the northern hemisphere it will occasionally pass overhead of New York City.

Small scale field-aligned irregularities in the E and F regions associated with the auroral oval and high latitude spread F may seriously degrade the performance of a high latitude HF circuit. Severe "garbling" of AM transmissions is very common in aurorally affected signals because of destructive interference between the two sidebands. A considerable improvement can be achieved using the SSB and CW modes of operation, but even then the signals are sometimes unintelligible during severe auroral disturbances.

Many of the difficulties associated with HF communications at high latitudes can be put into some sort of order by considering the location of the circuit relative to the auroral oval. The ionosphere at the latitudes covered by the auroral oval itself is disturbed at all heights, so any HF signal reflected from it will be very difficult to use. The increased ionization in the D region causes increased absorption, while the irregular (that is changing a lot with time or distance) ionization of the E and F regions leads to heavy scattering of HF signals. Increased ionization in the E region, which is called *auroral sporadic E*, can also lead to E-layer screening which we met earlier in this article.

On the equatorwards edge of the auroral oval lies the *mid-latitude trough*, which is a region of the ionosphere only a few degrees wide in which the critical frequencies suddenly drop by a factor of two or more and the altitude of the peak suddenly rises by 100 km or more as we go across it in latitude. For short circuits with a reflection point near the trough, the MUFs can suddenly drop by a factor of two or more when reflection occurs within the trough rather than outside it. Long circuits can also be affected if reflection takes place within the trough because the large horizontal gradients (that is, things are changing rapidly with latitude) can cause off-great-circle propagation as the signals bounce off the walls of the trough. The mid-latitude trough is mainly a nighttime phenomenon.

The second region of importance which can be related to the auroral oval is the *auroral absorption zone*, which is a zone of particularly severe absorption which can completely absorb all HF Signals. The increased absorption is important from about midnight until late morning and is restricted to a band of latitudes a few degrees wide, approximately at the latitude of the auroral oval.

Polarization mismatch

We saw earlier in this chapter that we need to exercise some caution to ensure that the wave incident on our receiving antenna is not plane polarized in a direction at right angles to the polarization of the antenna itself. If it is, the voltage induced in the antenna will be zero, even though a strong incident wave actually reaches the antenna. In some cases, however, we have very little control over what the ionosphere does to our signal as far as its polarization is concerned.

Under some conditions of propagation, depending particularly on the wave frequency and the orientation of the raypath relative to the earth's magnetic field, only one of the characteristic waves (the ordinary and extraordinary waves) will propagate through the ionosphere. For example, it is possible for a plane polarized incident wave to be converted completely into the ordinary wave, no energy going into the extraordinary wave. The wave which reaches the receiver will be circularly polarized and a plane polarized antenna will pick up only half the incident energy. If the polarization conditions are such that all of the energy is converted into the extraordinary wave, we would encounter problems if we are using low frequencies (say 0.3 to 3.0 MHz) because at these frequencies the extraordinary wave is heavily absorbed and we will end up with no signal arriving at the receiver.

As a general rule of thumb, if polarization mismatch is found to be, or expected to be a problem, appropriate antennas should be used:—

(1) For east-west propagation along the magnetic equator, *horizontally* polarized antennas should be used.

(2) At high latitudes, *vertically* polarized antennas should be used.

(3) In mid latitudes, there are several sets of conditions under which polarization mismatch can be a problem. In these cases, which are too difficult to describe here, *vertical* polarization is preferable to horizontal.

Polarization effects become less important as the frequency increases. ▶

Noise and interference

No matter how great a signal level that a transmitter provides at a receiver, it will be to no avail if the signal level is not greater than the level of signals already existing at the receiving site, signals which we do not want but are forced to contend with. A loud shout will doubtless be effective in a church, but at a football match even a loud shout may not be heard above the background noise. Radio noise is similar in many respects to ordinary noise and arises from four main sources — atmospheric, galactic, local and interference.

Atmospheric noise is caused by distant thunderstorms, lightning strokes being very profuse emitters of radio waves. Spark transmitters, which are very similar in operation to lightning discharges, were in fact the fore-runners of modern HF communication techniques. The radio waves from thunderstorms propagate over the earth just like any other radio waves and arrive unwanted at all receivers. Atmospheric noise cannot be eliminated and must always be allowed for in the design of an HF link. Some respite is gained during the day when the D region absorbs a large part of the noise, especially at the lower frequencies.

The noise level at any point on the earth's surface will depend on the geographic location, time of day, season, operating frequency and bandwidth of the receiver. Atmospheric noise is well understood and has been mapped the same way as the ionosphere has been mapped. Reliable estimates of it can also be calculated using the known distribution of thunderstorms, a model of the ionosphere such as described in Part 6 (May '86), and simple HF propagation theory. Atmospheric noise levels decrease with frequency and are greatest at low latitudes, where thunderstorm activity is greatest.

Galactic noise is radio emission from our own Galaxy. It is usually not as important as atmospheric noise and is important only at frequencies above foF2 since lower frequency signals cannot penetrate the ionosphere. In sparsely populated countries such as Australia, galactic noise can be the major daytime noise source outside of urban regions, at frequencies greater than 10 MHz.

Local noise includes noise due to local thunderstorms and man-made noise. We have all experienced the effects of local thunderstorms, which also affect the MF broadcast band. The effect is the same as that of distant thunderstorms but is much greater and more obviously related to a thunderstorm. Man-made noise is another source of noise which is all too familiar, being caused by electrical equipment such as motor vehicle ignition systems, diathermy machines, welding machines and so on.

Interference is a particular kind of man-made noise, being caused by another transmitter working on, or very close by, our frequency. Although this is not supposed to happen in the well-regulated world of HF it does, sometimes because the regulations have been ignored, and sometimes because propagation conditions exist which were not allowed for by the regulatory body when it allocated the frequency to more than one communicator.

The best solution to the problem of noise normally involves locating the receiver well away from centres of population, thus decreasing the local radio noise level. Narrower receiver bandwidths are also invoked, since the wider the bandwidth, the greater the amount of noise being added to the signal. Signal coding, which allows the signal to be pulled out of the noise, is also a good but somewhat expensive option. One simple solution is to use a horizontally polarized antenna, since a lot of man-made noise is vertically polarized. In some cases, it is possible to use a directional antenna which can be pointed at the transmitter while having a null in the direction of the source of noise.

It is essential when designing an HF circuit to know the likely noise level and what phenomenon will set that level. In lightly populated areas, the noise level is often set by atmospheric noise, whereas in more densely populated regions such as Europe, the noise level is set by man-made noise and interference.

ADMARKET

Readers' free adverts.
READERS-CLUBS-ASSOCIATIONS

WE'LL PUBLISH your advertisement of up to 32 words (maximum). totally free of charge. Either fill out the coupon here. or write or type it out on a clean sheet of paper. But **please** make it legible. other wise it may not turn out as you intended! Copy **must** be with us **six weeks** prior to the month of issue Every effort will be made to publish you advertisement. but no responsibility for so doing is accepted or implied.

CONDITIONS You must include your name and 'phone number and/or address within the 32 words (for amateurs. 'QTHR' is acceptable) Accepted abbreviations such as DSDD. 100 W RMS. ONO etc. may be used Please include you name and full address plus 'phone number with a covering letter. **Private advertisements only** will be accepted. We have 'small ads' for traders. who should contact our advertising representatives.

Send your adverts to: **AEM ADMARKET**
Australian Electronics Monthly
PO Box 289 WAHROONGA 2076 NSW

WANTED: CIRCUIT LAYOUT for Fox Apple computer Ver. 4.6, also Motorola D2 kits or expansion modules and other computer scrap material. F. Horvat (08) 388 5430. PO Box 359, Glenside S.A. 5065.

WANTED BY INVALID PENSIONER: ZX81 low-priced computer add-ons, complete, working or not. Memories, interfaces, expansion ports, anything accepted. Please write: D. Sheppard, 11 North St, Nerange 4211 Qld. (075) 58 2543.

NEED URGENTLY: Cheap double-density board and any publications for TRS80 Model 1 computer, by prisoner using same to complete programming diploma. Contact: Gary Greaves, H.M. Prison, Beechworth, Vic. 3747.

SOUTHERN CROSS DX CLUB: DXers and swls with an interest in shortwave, mediumwave, utility and amateur news and broadcasts. All enquiries welcome to GPO Box 1487 Adelaide, 5001.

US success of Zenith PC hoped to flow-on in Australian market, says Anitech

Zenith Data System's success in scooping a US$242 million contract for around 90 000 of its new Z-200 PC compatible machines to the US military spells high hopes for its success in Australia, according to Peter Dawson, national marketing manager for Zenith's Australian distributor, Anitech.

Anitech is hoping for some spin-off from Zenith's US success, and Dawson adds that Anitech will be looking towards local assembly of the Zenith range of products once Australian sales reach a viable level.

Zenith can supply Anitech with product in kit form, ready for local assembly. Anitech says local assembly gives them a buffer against exchange fluctuations and a lead-in to increasing local content, according to Dawson.

The Z-200 is claimed to be fully compatible with the IBM PC AT, but running faster. It is offered in two versions — one with a single floppy drive and one with a 20 Mbyte hard disk, both featuring 512 Kbytes of RAM and six AT-compatible expansion slots.

There are four other Zenith computers in the range, including a PC-compatible transportable featuring an 80 × 25 back-lit LCD screen.

Further details are available from **Anitech, 1-5 Carter St, Lidcombe 2141 NSW. (02) 648 1711.**

New screen for GRid portable

Vicom Australia Pty Limited, Australasian distributors of the GRid portable computer, has announced a new screen to offer the greatest readability of any LCD in the laptop computer market. The new screen features the highest contrast ratio of any LCD available today at no extra price.

The new LCD is part of the GRiDcase 2 range of up-market portables marked by Vicom since mid 1985. The GRiDcase range features a battery-powered gas plasma display which Vicom claim is aimed at the "serious" laptop user.

Russell Kelly, Managing Director of Vicom said, "The new LCD is a real breakthrough in LCD technology. This screen is as easy to read as a printed page. The new LCD screen will strengthen the market for lower-priced laptops. In this market, the plasma screen's clarity and wide-angle viewing characteristics are essential for effective presentations."

In April 1985, GRiD originally selected the best yellow LCD then available for its GRiDcase 2 computer. Today's new yellow LCD has been selected over competing technologies, including back-lit LCDs, after extensive technical review, the company says.

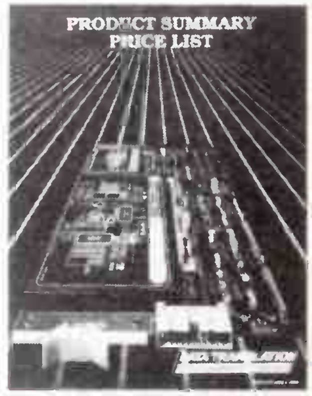
Kelly said: "GRiD's new LCD has a contrast ratio of seven-to-one, almost twice the previous four-to-one contrast ratio of GRiD's earlier enhanced LCD Display."

The GRiDcase line of laptop computers offers up to 512K RAM, a built-in 3½" floppy disk drive (720K), and as much as 512K of user-installable software in read-only-memory (ROM). Each unit can support PC-to-mainframe or PC-to-PC communications from remote locations. GRiDcase 3 with the gas plasma screen, continues as the most popular model in the line. Vicom's Head office is situated at **Melbourne,** with branch offices in **Sydney, Brisbane and Wellington.**

Support for Atari 520ST

Paris Radio Electronics has announced their support for the Atari 520ST with the availability of high quality software, hardware and books for it. Products will be available from major US Companies such as Michtron Inc USA, Hippopotamus Software Inc, Migraph Inc. USA, VIP Technologies USA, Batteries Included USA, and the Dragon Group USA.

Some of the software to be available will include utilities, RAMdisk drivers, hi-res games, C compilers, Forth programming language, communication software, word processors and spreadsheets. Books will also be available. For more information, call **Paris Radio Electronics on (02) 344 9111** or call the **Infocentre BBS, on (02) 344 9511 (300 baud) or (02) 344 9600 (1200/75 baud)** after hours.



New agent for Data Translation products

Laboratory Software Associates Pty Ltd (L.S.A.) has been appointed Victorian distributor for the Data Translation range of data acquisition products. Data Translation is recognised as one of the world's leading developers and suppliers of microcomputer analogue I/O boards and supporting software for Q-bus, Unibus, Multibus and STD bus systems. More recent product offerings provide analogue, digital and video I/O capabilities for the IBM PC/XT/AT and compatibles, Apple IIe and DEC Rainbow.

L.S.A. is a supplier of complete data acquisition systems, components and software and the Data Translation agency complements the company's in-house capabilities. Data Translation's current range of board products includes 10, 12 and 16 bit resolution multiple channel and simultaneous acquisition boards, real time clocks, intelligent colour graphics interfaces and image processing systems.

For further information contact **Laboratory Software Associates Pty Ltd, 12/35 Gertrude Street, Fitzroy 3065 Vic.**

The video "composer"

The Australian-developed Fairlight Instruments computer video device which stole all the accolades at last year's international video shows has been further refined with the help of a digitising tablet marketed by computer graphics specialist, The TCG Group.

At its launch, Fairlight's Computer Video Instrument (CVI) was reported by the US magazine Billboard as being "a breakthrough device which opens the realm of real-time digital effects to video production and post-production houses which could not previously afford such technology."

However, applications have become widespread among a number of corporate and educational bodies and today, Australian users include Westpac, which has a video network producing video productions for point of sale in which the CVI is used; MLC and BHP Laboratories, both of which produce in-house films; the ABC uses a CVI to produce the title sequence of its 7.30 Report program; and educational institutions Swinburne Institute of Technology, the Melbourne Film and Television school and NSW's Macquarie University.

Using the newly incorporated digitiser in Fairlight Instruments' Computer Video Instrument (CVI) greater drawing and menu selection control is afforded the user in creating this original on-screen concept of visual imagery.

Its development followed the introduction in 1978 of Fairlight Instruments' now famous Computer Musical Instrument (CMI) and is the brainchild of Kia Silverbrook. Silverbrook created the CVI initially as a simple computer graphics paintbox which developed rapidly once he entered the world of video effects.

Said to represent a new generation of video effects technology, the CVI is both a paintbox and video effects processor offering a palette of thousands of colours and a wide range of functions allowing the user to explore original concepts in visual imagery.

The CVI is suited to the economics and capabilities of ¾" production facilities. It also provides a tool for music video, story-boarding, video artistry, live performance and educational and commercial applications and even some forms of video animation.

No programming is required to operate the CVI — it is a simple matter of a few push buttons, slide faders and what was a small graphics tablet in the same control panel. This last unit has been replaced by the GTCO digitiser which, according to Amanda Reid-Young, marketing co-ordinator for Fairlight Instruments, provides a larger working area for graphic input which is more comfortable for artists working the 'painting' functions of the CVI.

"The digitiser is being used as an accessory to the CVI, as an alternative to the small graphics tablet in the control panel," she explained. "It offers better control for detailed drawing and menu selections."

For further information, please contact Mike Barraclough at TCG, (02) 699 8300.

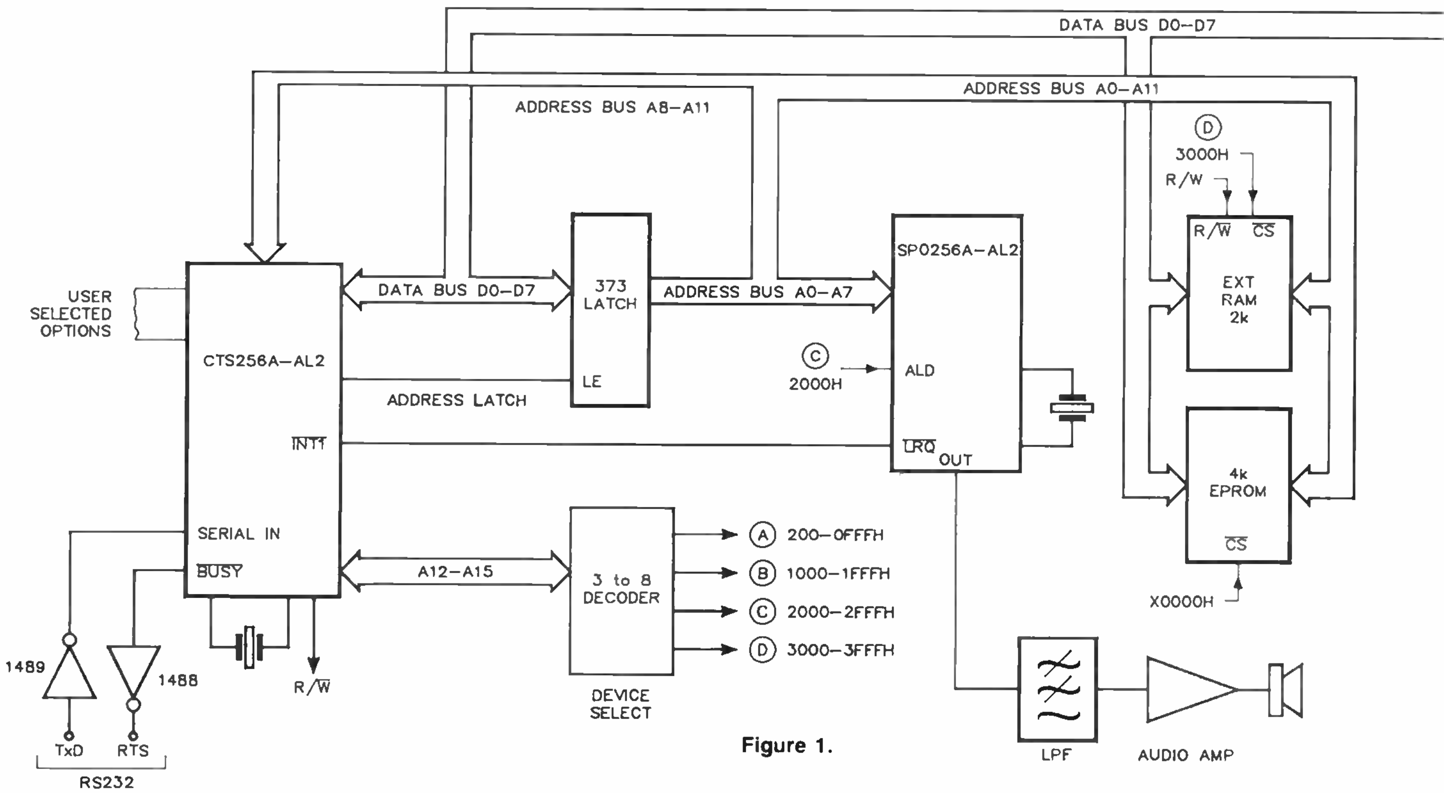


Figure 1.

An experimental 'code-to-speech' synthesiser for your computer

Rowan Deppeler – design
Roger Harrison – article

This project will convert ASCII text files to spoken English, providing simple speech synthesis output from a word processor, screen editor or the like, sent to it via either a serial or parallel printer port. Included on the pc board is an edge connector also enabling the unit to be plugged into a slot on an IBM pc or compatible.

UNDOUBTEDLY, the most satisfactory way to produce synthesised speech is by means of direct text-to-speech conversion from a text file stored in a computer's memory. It gets around having to do all the laborious sound-by-sound, word-by-word coding yourself in order to directly drive a speech processor or synthesiser chip. I made mention of the development of text-to-speech conversion at the end of my article *The Mindless Mouth — speech synthesis technology* featured in the February '86 issue.

The General Instruments company is one of the few specialised chip manufacturers at the forefront of speech synthesis technology. Their SP0256A-AL2 *Narrator Speech Processor*, featured in our February '86 issue cover project, is one of the more sophisticated speech processor chips currently available and is widely employed in electronic speech applications. The device electronically assembles words from stored *allophones* — speech sounds comprising *phonemes* which are the fundamental vocal sounds of speech. There are about 45 phonemes in English speech. However allophones, being essentially fundamental 'word parts', are easier to handle knowing the rules required to assemble them into words. Thus, speech 'synthesis by rule' is much more readily used to assemble words electronically and you may have a virtually unlimited vocabulary.

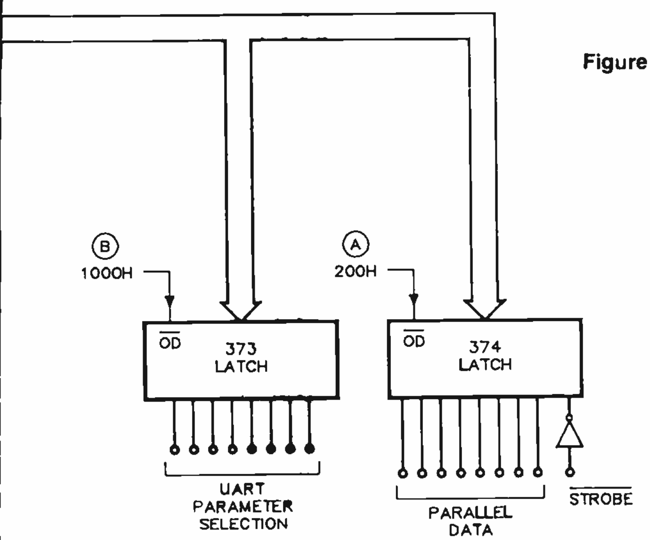


Figure 1.

The code-to-speech chip set

In February 1985, G.I. released a chip which, used in conjunction with their SPO256A-AL2 processor, provides the 'rules' required to convert text into speech, known as the CTS256A-AL2. It is an 8-bit microcomputer with internal ROM in which is stored the code-to-speech algorithm which permits the conversion of ASCII characters into allophone addresses for the SPO256A-AL2 using letter-to-sound conversion rules. The SPO256/CTS256 chip set is the 'heart' of this project.

Briefly, the SPO256A-AL2 speech processor is General Instruments' standard allophone chip and is based on the company's earlier SPO256A speech synthesiser. This synthesiser consists of a digital 10- or 12-pole second-order cascaded linear predictive coding (LPC) filter, a controller and a 16K ROM in which 59 allophones and five pauses of differing lengths are stored. It achieves an output frequency response flat to 5 kHz, a dynamic range of 42 dB and a signal-to-noise ratio of approximately 35 dB. A complete data sheet on this device was published in the February '86 issue, pages 92-95.

General Instruments' CTS256A-AL2 is a PIC7041 microcomputer-on-a-chip which has an on-board mask-programmed ROM preprogrammed with G.I.'s code-to-speech algorithm. This converts English text in the form of standard ASCII characters into allophone addresses for the SPO256A-AL2 using letter-to-sound rules. The PIC7041 is a licensed second-source for Texas Instruments' TMS7041 processor. No data sheet for the CTS256A-AL2 has been issued and the information presented here is taken from General Instrument's Application Note AN-0505, Revision C, issued July 1985.

The CTS256A-AL2 can take in the ASCII text from either a parallel port or serial input via an internal UART (universal asynchronous receiver-transmitter). This serial input can operate at seven selectable signalling rates from 50 to 9600 baud and requires TTL-level signal input. The UART parameters are either hardware selectable or software selectable (via the data bus). The chip has internal input and output buffers with limited capacity. The input buffer can accommodate words or phrases that are no greater than 19 characters in length followed by a 'delimiter' — any punctuation following a word or numerical sequence, such as , . ; : ! ? carriage-returns and spaces. The output buffer accommodates an allophone translation of the input word or phrase that is no greater than 26 allophone addresses. Since the translation more often than not results in the output buffer contents being twice that of the input buffer, the input is generally limited to words no longer than 13 characters and numerical sequences no longer than four numbers. External RAM may be used to extend the capacity of these two internal buffers.

External ROM or EPROM may be used to improve the pronunciation of certain proper names, acronyms and technical words ("exception-word" EPROM). For example, 'Au' — the chemical designation for the precious metal gold — may be encoded as an exception-word so that the synthesiser pronounces the word 'gold' each time 'Au' is encountered in text. External EPROM can also be used to store a user program for dedicated speech applications. Both exception-word and user programs can reside in the one EPROM if so desired, provided there's enough memory space.

Six pins on the CTS256A-AL2 provide for the selection of a number of operating options:

Input interface — serial port and baud rate vs parallel port.
Input buffer — on-chip (internal) RAM vs external RAM
Delimiter — any delimiter vs carriage return only
UART parameters — program defaults vs data bus selectable or EPROM definable.

There is an 8-bit serial port mode register on-board which permits UART parameter selection via the data bus.

In the code-to-speech algorithm aboard the CTS256A-AL2, the ESCAPE and BACKSPACE key codes have special functions. The 'ESC' key code (1B hex), when sent, will cause the contents of the input and output buffers to be dumped and will also silence speech output which is in progress — effectively, a *shutup!* code. The BACKSPACE key code (08 hex), when sent, erases the input buffer one character at a time, beginning with the latest entry.

Figure 1 shows the block diagram of a suggested code-to-speech synthesiser from the G.I. App. Note AN-0505. (Copies of this App. Note may be obtained from Daneva's offices in Melbourne and Sydney.) This shows what might be regarded as a 'maximum implementation' of the options available with the CTS/SPO chip set. Parallel or serial input may be used, a 2K RAM provides extra buffering for the CTS chip, a 4K EPROM provides for user programs and UART parameters may be selected externally or from the on-board EPROM. Output from the SPO256A-AL2 passes to the audio power amp via a low-pass filter.

Overview of the project

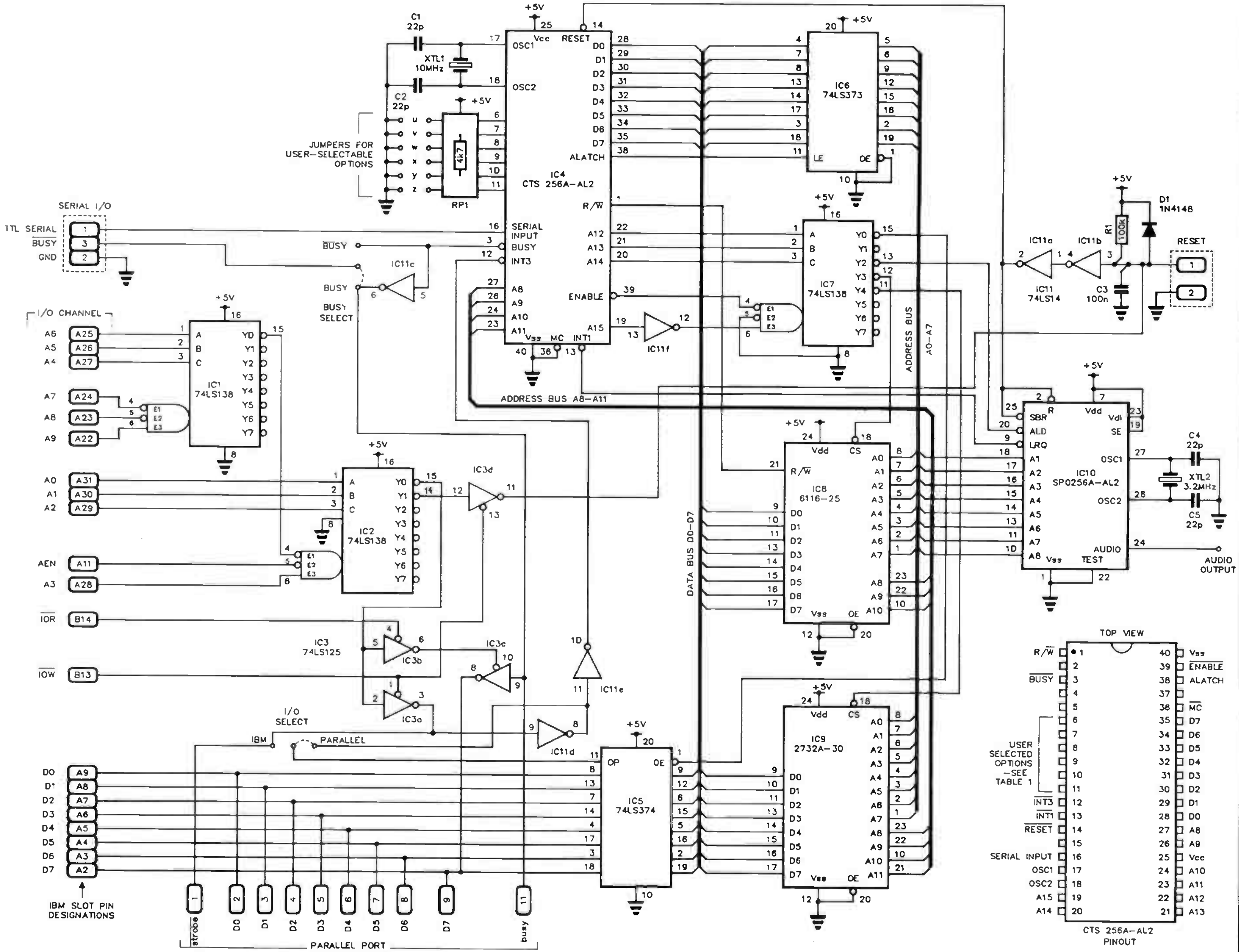
To gain maximum flexibility, most hardware aspects of the Figure 1 diagram were incorporated in the project design. A few were left out in order to keep the project relatively simple and the cost down and because it was felt they were not prime requirements.

Adequate buffering for the CTS chip was considered essential, so a 6116 2K x 8 RAM was included. Provision for a 2732A exception-word/user EPROM has been made on the board, but this is optional. We hope to explore its use later.

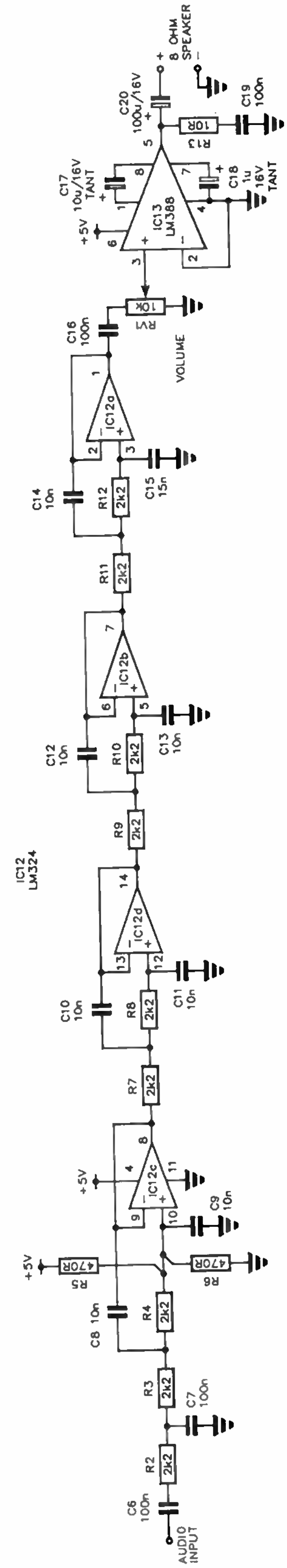
There are three options for driving the project: via a parallel port (i.e.: Centronics), via a serial port or via an IBM bus in- ▶

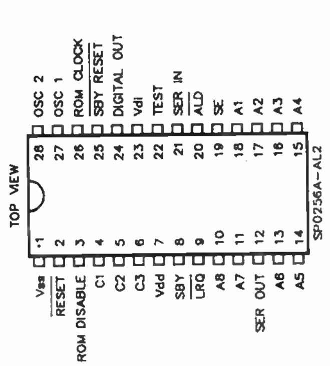
Rowan Deppeler is an applications engineer with Daneva Australia Pty Ltd, distributors for General Instruments, manufacturers of the speech processor chip set employed in this project.

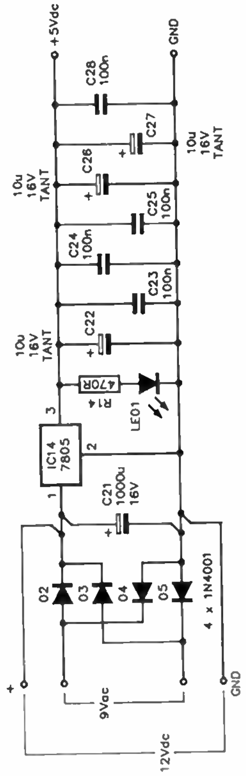
aem project 4505



terface. The serial port employs TTL-level signals. This enables the project to be interfaced to a variety of computer peripheral interface devices — such as a PIO (parallel input/output device), a VIA (versatile interface adaptor), or ACIA (asynchronous communications adaptor) etc, and is







particularly suited to dedicated speech output applications. Note that the BUSY handshake line may be linked for active-low (direct) or active-high assertion. If interfacing to a standard RS232 serial port is required, it needs to be done off-board. This is simply done with standard MC1488/1489 line driver devices as illustrated below.

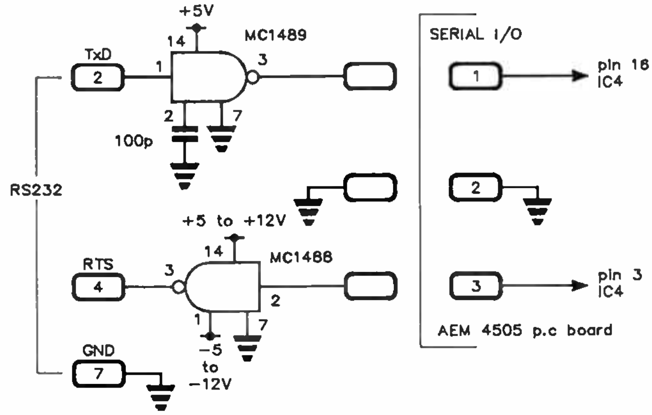


Figure 2. Interfacing to a standard RS232 serial port is simply arranged using the 1488 and 1489 line driver ICs. The BUSY line is linked for active-low operation (i.e: direct from pin 3, IC4).

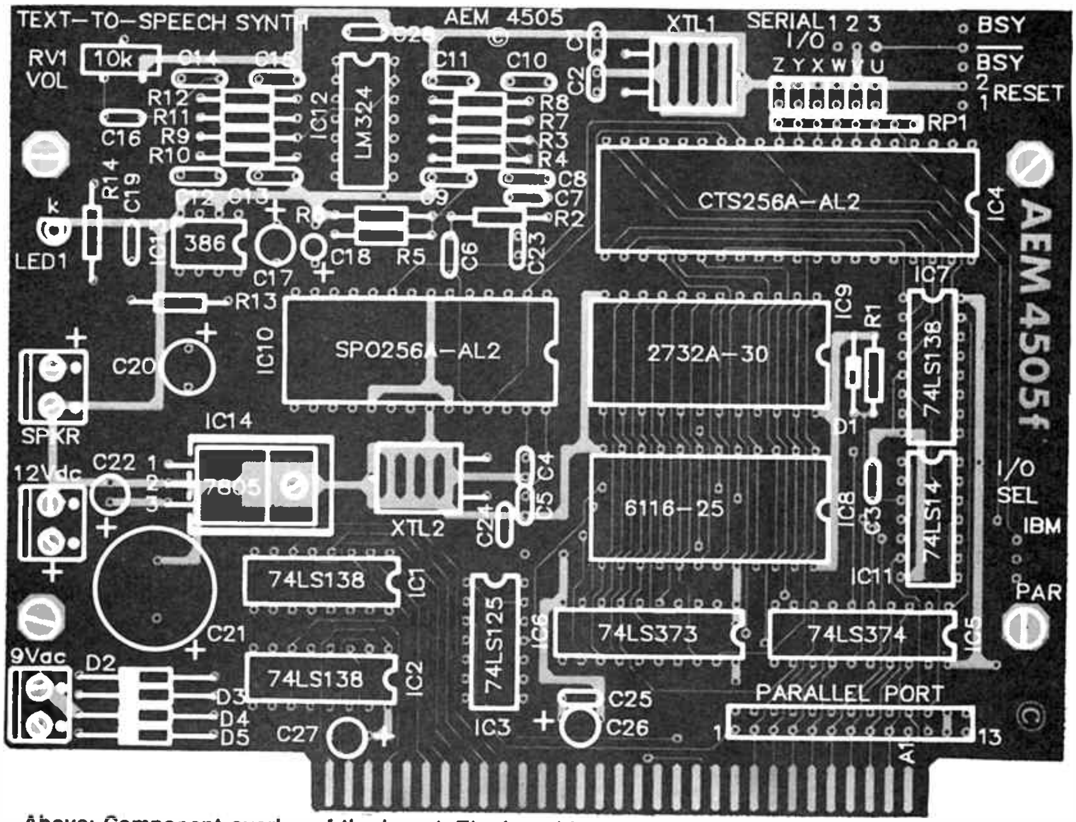
The pc board has an edge connector and optional circuitry enabling the project's use in an IBM PC or close compatible. On-board links provide for selection of the interface option between the IBM bus and the parallel port. The various operating options for the CTS256A-AL2 are hardware selectable via a set of on-board jumpers and firmware-selectable from the user EPROM.

The address locations of the on-board devices are similar to the arrangement in Figure 1. The parallel port is at 200H (hex), selected via the YO output of IC7. The SPO256 is at 2000H, selected by IC7's Y2 output, the 6116 RAM buffer at 3000H (selected by Y3 of IC7), while the 2732A EPROM is located at 4000H, selected by Y4 of IC7. The 4K block 1000-1FFFH is unoccupied. Address lines A12-A14 of the CTS chip (IC4) are decoded to provide on-board device selection via IC7, a 3-to-8 line decoder. The low eight bits of IC4's output addressing are latched by IC6.

Parallel port interfacing is provided by IC5, a 74LS374. The STROBE line (active-low) is buffered by IC11d,e, while the BUSY line is inverted by IC11c. The IBM bus interfacing comprises IC1, IC2 and IC3. The first two are 74LS138 3-to-8 line decoders for address selection and software reset control, respectively. IC3 is a quad package tri-state buffer/inverter, three gates being used for the bus I/O read and write lines, and one for reset signal inversion from an output of IC2. The board's I/O address is 208H, RESET being located at 209H.

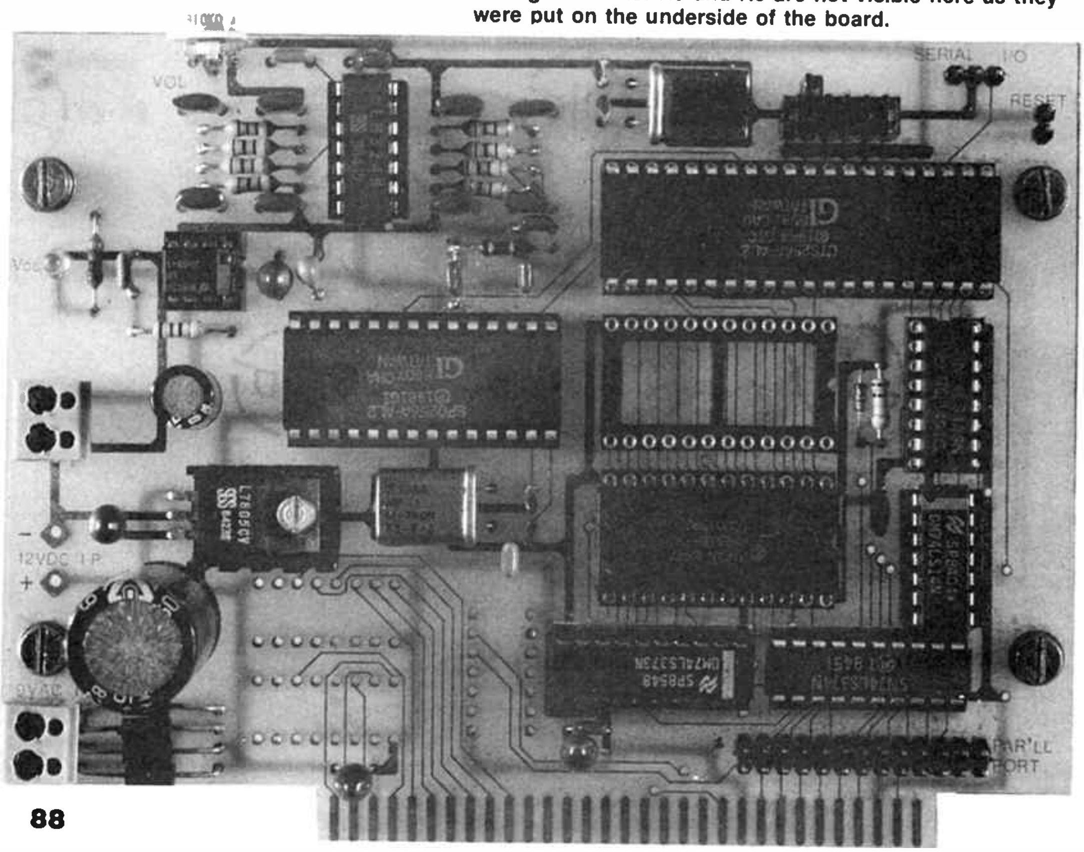
Audio output from the SPO256A-AL2 is filtered by an 8th-order four-stage, low-pass filter that provides a very steep roll-off from around 4.5 kHz providing good attenuation of the output quantization noise and improving both intelligibility and signal-to-noise ratio. Speaker level output is provided by an LM386 1 W audio power amp IC. A trimpot preset provides setting of the volume. The speaker connects to the board via a pc-mount two-way screw terminal.

The board may be powered from either of two sources: 9 Vac or 12 Vdc. Another pc-mount two-way screw terminal provides for power supply connection, mounted according to which option you choose. An on-board three-terminal regulator provides a regulated 5 V rail. A LED on-board, powered from the 5 V rail, indicates when the project is powered-up. A momentary action pushbutton, mounted off- ▶



Above: Component overlay of the board. The board is double-sided with through-plated holes. Only the topside tracks are shown here, for clarity. As it is well-nigh impossible to make a double-sided, plated-through hole board at home, we have not reproduced the artwork.

Below: A prototype board. Note that there are some minor differences to the overlay, which incorporates the option linking additions. R5 and R6 are not visible here as they were put on the underside of the board.



AEM4505 PARTS LIST

Semiconductors

D1	IN914, IN4148
D2-5	IN4001
IC1, IC2	74LS138*
IC3	74LS125*
IC4	CTS256-AL2
IC5	74LS374
IC6	74LS373
IC7	74LS138
IC8	6116-25
IC9	2732A-30#
IC10	SPO256-AL2
IC11	74LS14
IC12	LM324
IC13	LM386
IC14	7805

*only required for IBM PC interface.

#optional — see text.

Resistors

R1	100k
R2	2k7
R3, R4	2k2
R5, R6	270k
R7-R12	2k2
R13	10R
R14	470R
RP1	4k7 SIP resistors
RV1	1k min. vert. mount trimpot.

Capacitors

C1, C2	22p ceramic
C3	100n ceramic
C4, C5	22p ceramic
C6, C7	100n greencap
C8-C14	10n greencap
C15	15n greencap
C16	100n greencap
C17	10u/16 V tant.
C18	1u/16 V tant.
C19	100n ceramic
C20	100u/16 V RB electro.
C21	1000u/16 V RB electro.
C22	10u/16 V RB electro.
C23-C25	100n ceramic
C26-C27	10u/16V tant.
C28	100n ceramic

Miscellaneous

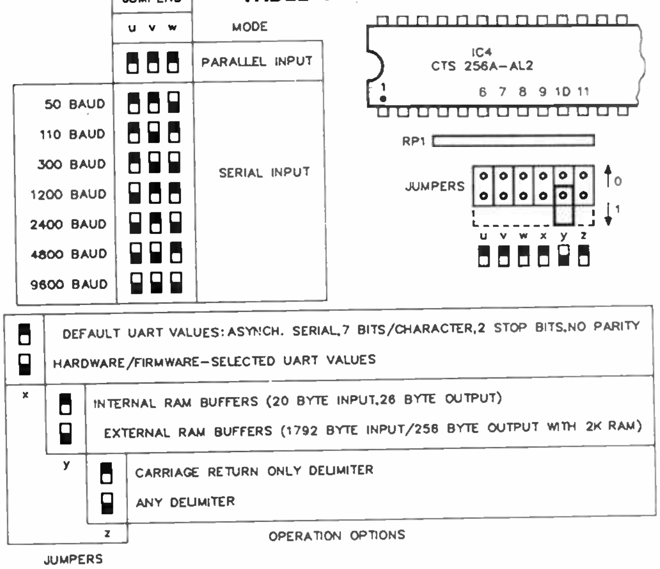
XTAL1	10.000 MHz crystal, HC18/U can.
XTAL2	3.2768 MHz crystal, HC18/U can.

AEM4505 pc board (double-sided, plated-through holes); 1 x 26-way pin header; 1 x 12-way pin header; 1 x 3-way pin header; 1 x 2-way pin header; 6 x 2-way jumpers; 2 x 2-way pc-mount screw terminal blocks; 8 ohm speaker to suit; 1 x TO-220 heatsink; mounting hardware to suit (if required); 9 Vac/200 mA supply or 12 Vdc/200 mA supply (if required).

Expected Cost: $85-$125 (depending on configuration)

NOTE: the two crystals are series resonant types.

TABLE 1



board, can be used to provide hardware reset.

The accompanying photograph shows the 'minimum' configuration. The 2732A exception-word/user EPROM and the IBM slot interface components have been omitted.

Of necessity, the board is double-sided with plated-through holes. Four standoff pillars are used to mount the board in a suitable case. Connections to the parallel and serial input ports and the off-board reset switch are made via pin headers, or suitable leads may be directly wired to the board. A pin header was used with shorting jumpers for selection of the CTS chip operating options. In a dedicated application, where these options are fixed, links may be used in lieu of the pin header and jumpers arrangement.

Construction

Assembly is quite straightforward. Sockets are used for all the ICs (except the three-terminal regulator, of course). First, make a close visual inspection of the board. All the tracks are roll-tinned with solder. See that there are no solder 'bridges' between closely-spaced pads and where tracks run between pads. See that none of the through-plated holes are filled. There is one thing to note before you start — all soldered joints are made on the non-component side of the board.

Start with the resistors and the diodes — make sure you get these correctly oriented. The SIP resistor pack is mounted with its pin 1 closest to pin 1 of IC4. Pin 1 of the SIP resistor pack is marked with a spot adjacent to it. Then solder the capacitors in place, except for the two electrolytics. They will be left till later. Make sure you get the tantalums the right way round or you'll find they'll 'flame out' when the board's first powered up. Now solder the LED in place, also ensuring it's the right way round.

Next come the two crystals. You will notice a small area of copper grid on the board adjacent to the position of the crystal lead holes. You will find a small hole at the opposite end of the grid pattern. Solder a short length of 22 gauge tinned copper wire in here in each crystal position. Place each crystals' two leads in the appropriate holes so that, when you lay them on the board, the writing on the can faces uppermost. In each case, push the can down until the bottom is about 4 mm from the board, then lay the crystal over, bending the leads, placing the can such that the top abuts the wire you previously soldered in place. Then solder the can to the wire, trimming the excess when the solder cools. Do this quickly and do not apply excessive heat. The 10 MHz crystal goes adjacent to IC4, the 3.2768 MHz one adjacent to IC10.

Now you can mount and solder all the IC sockets in place, taking care to orient them all correctly. With the edge connector facing you, pin 1 on each horizontal IC faces to the right, while pin 1 on the vertical ICs faces away from you. Follow by soldering all the pin headers in place, if you are using them.

Tackle the three-terminal regulator (IC14) next. Bend down the leads at a right angle, 4 mm from the case. Lay the small heatsink on the board, then insert the 7805's leads in the holes provided and carefully bolt the regulator and heatsink to the board using a 6BA bolt and nut. The volume trimpot and the two-way screw terminals for the speaker and power supply can be mounted next, followed by the two electrolytic capacitors.

Now you're set for initial testing. First, carry out a thorough visual check of the board. See that polarised components are correctly oriented. Look for joints which have not been soldered as well as small solder bridges between closely-spaced pads on the non-component side of the board.

Firing up

Don't put any of the ICs in the sockets at first. Check the +5 V supply rail with your ohmmeter first. You should see 2k ohms or more resistance. If it's shorted, find and clear the fault. It's most likely a small 'bridge' of solder between closely-spaced pads somewhere. Now you can insert all the ICs, taking care to get them the right way round, and hookup a speaker and power supply. The latter should be able to supply at least 300 mA or so as the 'bare bones' project (i.e: without the optional devices on-board) draws around 250-260 mA.

A preliminary test is simple. Power-up. Nothing should happen. Short the RESET pins. Upon releasing the short, the project should utter "OK". If so, it works! Now see if you can 'drive' it. Probably the simplest way is to hook up the parallel interface to your computer's Centronics (parallel data) printer port. As individual connector details vary from computer to computer, you should consult your machine's handbook for the required information. Microbee owners should use a parallel printer interface, which employs a 74LS123 to stretch the STROBE and BUSY pulses, plugged into the I/O port, redirecting the output with either an OUT#1 ON or OUTL#1 ON command. The u-v-w jumpers need to be set for parallel input, and the x-y-z jumpers for default UART values, external RAM buffers and carriage return only delimiter. Consult Table 1. For this arrangement, the jumpers should be set as illustrated there. Hooked-up to a parallel printer port, all you have to do is power-up and PRINT a short phrase, which ends with a carriage return, as if you were sending it to a printer.

Similarly, if you're using the serial interface, you'll need to set the u-v-w jumpers to your computer's serial printer output speed (commonly 1200 baud). The x-y-z jumpers are best set for default UART values, external RAM buffers and carriage return only delimiter. Note that, in the carriage return only delimiter mode, the unit only 'speaks' after a carriage return has been received, articulating all the text up to the carriage return.

We'll tackle the project's use in an IBM PC or compatible in Part 2, to follow.

A software-driven *super* modem project

Chris and Dan darling — design
Roy Hill — articles

Part 3

Now you can complete the final assembly and testing and get your modem 'on the air'. Usage of the commands and their functions is covered, with a handy reference table being included.

HAVING COMPLETED THE BOARD assembly, resist the temptation to 'lash-up' a power supply and interface cable to attempt a rushed tryout — you might be disappointed, for a variety of reasons.

The final steps

Put aside the board and attack the case to create some holes for the cables and LED in the rear and front panels. Use a sharp drill bit at lowest speed to drill any circular holes. Use either a low speed jig-saw or a hand fret saw to cut out the rectangular holes for the cables and connectors. Use a small flat file to finish off any rough spots. All these holes should be located as close as possible to the ultimate points of attachment. A suggested drilling diagram is given here. If you haven't already done so, connect the six RS-232 connection points (on the middle right-hand side of the board — see the overlay diagram) to the DB25 connector. The overlay and circuit in Part 2 may be used to assist. The connection points are numbered 1 to 7, from the front to the back of the board. CP1 (connect point 1) is connected to pin 20, CP2 goes to pin 3, CP3 to pin 2, CP4 to pin 8, CP5 to pin 22, CP6 to pin 5 and CP7 to pin 7.

Mount the DB25 connector to the hole you cut in the rear panel. Do NOT connect the RS-232 cable to your computer/terminal at this stage.

Before you connect the power

Place one of the probes of your multimeter (using the lowest resistance range) on the +5 volt track and the other on the ground or 0 volt track. The reading should be greater than 2k ohms. Leave the probe on the ground track and move the other probe to the -5 volt track (Vdd). Once again, the reading should be greater than 2k ohms. Now check the resistance between the +5 volt and the -5 volt tracks. Again, the reading should be greater than 2k ohms.

Attach one of the probes (use a clip) to the 'ref.' pin (pin 1 of the 7905 or pin 2 — centre pin of 7805/12) of any one of the regulator 1Cs and check the following pins:

Pin 1 of 1Cs 9, 10, 11, 12, 13 and 16
Pin 7 of ICs 5, 6, 7, 8, 15, 17, 22, 23 and 24
Pin 8 of ICs 1 - 4 and 14
Pin 14 of ICs 18 and 19
Pin 22 of IC21

The reading should be zero ohms (or very close to zero). Now attach the probe to pin 3 of the 7805 and check the following pins:

Pin 7 of ICs 10 and 20
Pin 8 of IC16
Pin 12 of ICs 11 and 12
Pin 14 of ICs 5, 6, 7, 8, 15, 17, 22, 23 and 24
Pin 16 of ICs 1 - 4 and 14
Pin 20 of ICs 9 and 13
Pin 2 of IC 21

Once again, the reading should be very close to zero ohms.

Finally, attach the clip to pin 3 of the 7905 and check the following pins:

Pin 1 of IC 24
Pin 4 of IC 20
Pin 4 of IC 21

The readings should be same as above.

You have just checked that none of the power supply tracks have been either short circuited (by solder bridges) or lifted off (by too much heat from the soldering iron). You may now solder the power supply connections to the points on the extreme left-hand rear of the board. Don't insert the ICs yet.

Hook up the supply, switch the power on at the power point, and carefully observe the modem board. You should hear a 'click' as the relay clicks on. (How does that song go — "Cheers for the click boys . . .")? If any of the components start to communicate with you by the old Red Indian smoke signal method, remove the power *immediately* and check the appropriate connections. The only parts on the board liable to send up smoke signals are the electrolytic capacitors, and only then if they have been inserted back to front.

If everything appears OK, switch you multimeter to the 10 to 12 volt dc range and measure all the power supply pins of the voltage regulators. Remember that the 7905 regulator will be delivering -5 volts. The 5 V rails should be within 4.8 and 5.2 volts. Keep the ground probe connected and check the collector of D4. It should read 12 volts, +/- 0.5 volts. If any of the above measurements do not agree, check the power supply connections (and check that you did switch it on!), then check the input to the board (use the 50 to 60 volt ac range). It should read around 18 volts. If it doesn't, then the plugpack is malfunctioning.

If you did hear the 'click' on the relay and if all voltages are correct, check the voltage on all three connections to the 'line'. These should all read 0 volts. If they don't, you have bridged some tracks on the board and must find the fault before using the modem. If any of the voltage readings were missing or incorrect, check that the voltage regulators were installed with the correct orientation and check that they are in the correct positions. Particularly check that the 7805 and 7812 positions have not been reversed. If the regulators all appear to have been correctly inserted and the +5 volt rail is not present, then you may suspect that D1 is either incorrectly oriented, omitted or open circuit.

Alternatively, R7 (the 12 ohm, 10 watt power resistor) may be open circuit. De-solder one leg, pry it up and check its resistance.

Warning — do no touch this resistor during operation or for at least 10 minutes after switch off. This resistor becomes exceedingly hot in operation (it has even been rudely suggested to the designers that if it had an aluminium plate attached to, it could be used as a coffee warmer during extended modem sessions!).

If the -5 volt rail is absent, suspect incorrect orientation, omission or short circuiting of D2. If there is no voltage at *either* D1 or D2 (use the 50 to 60 volt ac range of the multimeter), then one can assume a dead fuse. This is a likely indicator of a shorted power supply track and it must be located and corrected before replacing the fuse and re-applying the power. If the fuse is OK and there is still no voltage present — I hate to ask you — *you did switch it on, didn't you?*

If all the above tests were successful, remove the power and attach the line cable to the connection point at the rear of the board, near the relay.

Now you carefully insert all the ICs into their sockets (use an insertion tool). Insert them in numerical order and pay particular attention to IC15. This is a 7404, not an LS device.

The next sections involve operational checks to ensure that the modem is functioning correctly. For these tests, it is either necessary to use a multimeter or a logic probe. A logic probe is the far more useful of the two (bought ones only cost around $30), as it will respond to very quick transitions of state.

Ensure that the black ('negative' or 'common') lead of the multimeter (or probe) is attached to a suitable earth point (e.g: a ground pin of one of the regulators). Now re-apply the power. The first thing that should occur is the relay should now click twice. It clicks on automatically when the power is applied and then clicks again a little later as the microprocessor switches it off.

Step 1 — checking the reset lines
Ensure that the multimeter is switched to the 10 to 12 volt range and check the RESET line on each of the pins mentioned below. (It is really necessary to have a reset switch connected for this test. As an alternative, a wire may be soldered to one of the pads and used to make a connection at the appropriate time).

Pin 3 of IC16 (the 555 timer chip) — it should be at zero volts whilst the switch is being pressed, remain at zero volts after release, for about one second, and then go to +5 volts.

Pin 37 of IC10 (the microprocessor), **Pin 2** of IC7 (a 74LS04 inverter) and **Pin 34** of ICs 9 and 13 (the PIAs) should all be at +5 volts whilst the switch is being pressed, remain at +5 volts after release for about one second and then go the zero volts. If you have a logic probe, watch the transitions in the pulse mode of operation.

Step 2 — checking the 6809 control lines
The following pins of IC10 should all be at +5 volts:

Pin 2 (NMI), **Pin 3** (IRQ), **Pin 4** (FIRQ), **Pin 36** (MRDY), and **Pin 40** (HALT). The only pin that could possibly go to zero volts would be Pin 3, and only then if R5 was either the wrong value (i.e: too high), omitted, or open circuit. If any of these pins are at zero volts, a track has been bridged with solder and you will have to find it.

Step 3 — checking that the 6809 is operating correctly
Check that the following pattern is present on IC21 (the 7910 modem chip):

Pin 17 — 0 volts
Pin 18 — +5 volts
Pin 19 — +5 volts
Pin 20 — 0 volts
Pin 21 — 0 volts

These lines are the Mode Control lines of the modem and their correct initial setting is the one chosen for videotex operation (Viatel). Now check each of the PIAs (ICs 9 and 13) for the same pattern:

Pin 2 — 0 volts
Pin 3 — +5 volts
Pin 4 — +5 volts
Pin 5 — 0 volts
Pin 6 — 0 volts

▶

Note that there is a momentary pulse on each of these lines as the modem fires up, but this will only be detected by a CRO or an ultra-fast logic probe.

If all of the above checks proved positive, then it can be safely assumed that the modem is operating correctly. You may now proceed to step 6 and fire-up the modem. If, on the other hand, things are not well with your modem, then more diagnostics are necessary. In all cases, faulty chips should be the *last* suspects, for it's a true rarity.

Step 4 — checking chip selects

Chip select logic is controlled by IC14 (a 74LS138 3-to-8 line decoder). The following pins should all be at +5 volts:

Pin 9 — 16K EPROM select
Pin 12 — PIA (IC9) select
Pin 13 — PIA (IC13) select
Pin 14 — I/O select (to expansion bus)

Step 5 — checking the system clock

Either a CRO or logic probe is really necessary for this check. However, a check on the data bus with a multimeter (3-5 volt range) should indicate if the clock is operating properly:

Pins 24 through 31 of IC10 (the 6809) should all be pulsing between 0 and 4-5 volts. If the clock is not operating correctly, these pins will all be stuck in the high impedance state at 1-2 volts. If you have a logic probe or CRO, the following additional check can be made:

Pin 4 of ICs 1 to 4 should be pulsing, as should **Pins 1, 2, 3, 14** and **15.** These are the divided clocks that provide the required baud rates for the modem. Additionally, the Clock Out (E) line of the microprocessor may also be checked:

Pin 34 of IC10 (the 6809)
Pins 4 and **6** of IC7 (the inverter)
Pin 3 of IC8 (the flip-flop)

should all be pulsing — the latter three at the crystal frequency.

Step 6 — firing up the modem

One final check must be made prior to connecting the RS-232 line to your computer. Connection Point 4 (CP4) of the RS-232 should read zero volts, Connection Point 5 (CP5) should read +5 volts and Connection Point 6 (CP6) should read +5 volts. If any of these readings is not correct, check that you have not swapped the 1488 and 1489 chips.

Connect the RS-232 connector to the computer and fire-up the communications package in either 300, 600 or 1200 baud and type the letter 'A' (it MUST be a capital). If your communications package supports full duplex, the letter 'A' will appear on your screen. If your package is only half duplex (only about 1% of computers/packages and 10% of terminals operate at half duplex), you will see the letters that you type appear twice. The next section (Software Details) will show you how to make allowance for this.

Now type the letter **'T'**, followed by the number **'1'** and a carriage return. The message **'AT ERROR'** should appear on your screen. This message is a cause for celebration, rather than dismay, because it means *EVERYTHING* is operating correctly. Give yourself a pat on the back! Go directly to the section on Software Details (collect $200 monopoly money on the way) and continue learning about the features of your modem.

If the message did not appear and all the previous tests proved positive, the likely cause of the problem is the manner in which your particular computer implements its RS-232 port. Check the connections to Pins 2 and 3 of the RS-232 connector. If they are connected properly, try reversing these lines at one of the plugs and fire-up again.

Incidentally, NEVER MAKE ANY OF THESE CHANGES WHILST THE POWER IS APPLIED TO EITHER YOUR MODEM OR YOUR COMPUTER.

Measure the resistance between Pin 7 of your connector and the ground connection of the computer. The case of the power supply (if it's made of metal) is a good point to connect to. If the resistance is not zero ohms (or very close to it), then your computer probably has an isolated RS-232 connector. Check the operating manual of your computer (yes, I know — it's probably as bad as most manuals), or ring the distributor of your computer to find a solution. NO modem will work properly on a computer with an isolated RS-232 connector.

If the reading is zero ohms (or close to it) and the message still does not appear, then check Pin 1 of IC24 (the 1488) for the presence of -5 volts. It the voltage is correct, try your modem on a different brand of computer (you can't hurt it) and see if it works. If it does, your computer is at fault; if it doesn't, then it's probably the modem and at this stage, it looks like the best thing to do is to take advantage of the $100 'Sorry Dan, it doesn't work' offer.

Expansion connector pin assignments

The following diagram illustrates the pin assignments of the expansion connector. Note that the pins of the connector are numbered in exactly the same manner as the ICs on the board. That is, pin 1 of the connector is on the rear left-hand side of the board, pin 20 at the front left, pin 21 at the front right and pin 40 at the rear right-hand side of the board:

Pin 1	+5 volts	Pin 40	+5 volts
	+18 volts unregulated		-18 volts
	+12 volts		ground
	A14		ground
	A15		NC
	A13		Sel. I/O
	A12		+5 volts
	A7		A8
	A6		A9
	A5		A11
	A4		IRQ
	A3		A10
	A2		RAM ENABLE
	A1		D7
	A0		D6
	D0		D5
	D1		D4
	D2		D3
	2.4576 MHz		NC
Pin 20	NC	Pin 21	NC

SOFTWARE DETAILS

The details provided here are not necessary if you're using a commercial software package with your computer to communicate with other modems. It is, however, important that the package in use is compatible with the widely known and used *Hayes command* set. Please check the software details of your package before attempting to use the Super Modem with it. Examples of typical packages are "PCTalk", a public domain program for the IBM/PC, "ASCII Express" for the Apple 2II+/2IIe CrossTalk for both IBM and Apple computers. These packages (or any similar ones) may not require any more power than is inherent within them. The following details are provided as a means of allowing you to write your own software communications package, if you have the know-how, to take full advantage of the Super Modem's capabilities.

Firing Up

When your modem is fired-up using a suitable communications package (Apple users with a Super Serial Card for example, can take advantage of the communications firmware on the card), an operating menu can be made to appear on your screen, by typing ATL <RETURN>. This command is part of the Maestro command set and will be discussed in far more detail later. Details of the menu appeared in Parts 1 and 2 of this project, but are reproduced below (to save searching for the issues — Fido has probably lined his nest with them by now, anyway).

BRC refers to Bit Rate Conversion — a means of converting low bit rates to high bit rates and vice versa. This allows for conversion of 1200 to 75/75 to 1200 in either direction and also supports Bell 5-150 bit rate conversions from 1200 bps. Users of computers/terminals/communications packages should be aware that some of the above features *may not be supported* by the package and that if you select unsupported menu options (in particular B & D), the Super Modem may hang (i.e: appear to refuse to co-operate and not respond to any further commands).

You may select whichever communications protocol (i.e: baud rate) you want, simply by pressing the appropriate letter. Be careful, however, not to change the baud rate of the Host computer/terminal/communications package in the middle of a command line. If you do this, the remainder of the command line will become unintelligible to the Super Modem. Your current selection (or the default selection — the one the modem itself selects on power up) will be shown in the *current status* window. The menu does not automatically appear on the screen — it must be called up using the appropriate command (ATL in this case).

The default selection is the one normally used to communicate with Viatel.

When you have made your selection and pressed the appropriate letter, the current status window will be updated and the modem will respond with the reply 'OK'. This is the modem's standard (Hayes Standard) method of telling you that the modem is ready to accept the command. Note that the menu is NOT part of the Hayes command set.

If you wish to change baud rates from the menu, you MUST ensure that the host computer/terminal/communications package has also been set to the appropriate baud rate. If this has not been done, the Super Modem's auto baud rate sensing mechanism will simply ignore the new setting and revert to the previous setting. For example, assume that the current setting is 'A' (the default on power-up) and we wish to change to 'E'. If we do not set the host terminal/communications package to 300 baud, then the new setting (E) will be ignored and setting 'A' will continue to be used. For most applications, operation of the menu selection options will be unnecessary, as the auto baud sensing will be carried out by the Super Modem. The major reason for having the menu available is to allow for Bit Rate Conversion options to be selected.

Hayes and the Super Modem

The software for this modem has maintained a large degree of compatibility with the Hayes Smart Modem command set, in that most of the commands operate exactly as required. This means that existing communications packages using the Hayes command set will work quite satisfactorily with the Super Modem. The Super Modem, however, is much smarter than an ordinary, *mortal*, smart modem and some of the Hayes commands are redundant because of the super-intelligent manner in which this modem communicates with the host and remote computers (Super Modem contains one of the most advanced 8-bit microprocessors available, the 6809).

At this stage, a little modem terminology is necessary. Whenever a modem is used by one computer to 'talk' to another, the computer (or modem) that does the calling is known as the *HOST* and the computer (or modem) that is called is known as the *REMOTE*. This terminology can become a little messy, especially when the remote terminal is another user and files are being transferred backwards and forwards between the two. However, we'll keep it simple and only use the word *HOST* to refer to our computer/modem and the word *REMOTE* will be used to refer to the computer/modem/bulletin board that we are calling.

The 'OK' response is also the modem's way of telling you that it is in the COMMAND MODE. In this mode, the Super Modem is able to accept commands and activate a communications session. The other mode (ON-LINE mode), will be discussed later. All commands to the modem (for a summary of these see Table 1) commence with the letters **AT** (Hayes standard — meaning ATtention). There is only one exception to this rule which will be discussed later. The modem uses these two letters from the host computer to determine the communications protocol in use by the host computer/terminal/communications package. Note the capital letters — these first two letters must be capitals — see later under *Rule 2*. The information obtained included baud rate, parity, number of data bits and number of stop bits. The Super Modem does not cater for every possible combination of data bits (it doesn't handle 6, 5 or 4 data bits), so check your communications software before firing it up. ▶

DIRECT-CONNECT MODEMS AND YOUR RESPONSIBILITIES

Any device which you intend to connect to the Telecom line must be 'type-approved' as an attachment. It is an offence under the Telecommunications Act (1975), to attach any apparatus to a telephone line which is part of the public switched telephone network (this includes extensions on PABX switchboards), other than an approved device or an appliance leased from Telecom.

You are at perfect liberty to construct and use the modem described in this project, if you only intend to connect it to an internal building intercom line, or some other private 'twisted pair' line or a packet radio terminal node controller (TNC).

The electrical, electronic and physical design of this project complies with the relevant 'type-approval' specifications and those concerned with electrical safety. The optional plug-pack power supply conforms to AS3126 and is Telecom approved. The 600:600 ohm isolation transformer, the SPDT relay, the 2u/440 volt isolation capacitor, the 1.5_ isolation capacitor and the 100 ohm/1 W resistor are Telecom approved and the circuit layout of these devices conforms to the relevant Telecom specifications.

The Telecom specifications relating to this sort of equipment include documents 1050, 1053, 1222, 1240, 1302 and 1364. Authorisation for 'type-approval' must be made on Telecom's Form TS139 "Data and Non-Voice Equipment Directly Connected to the Telecom Network."

For those persons purchasing the completed and tested version of this kit, Telecom approval has been sought and is pending. Advice of approval will be given as soon as available.

TABLE 1
COMMAND SET SUMMARY

COMMAND	PARA-METERS	FUNCTION	EXPLANATION
ATA	0**	Answer mode	Switch from **Voice Mode to Data Mode** by immediately placing phone off-hook and wait for carrier
	1	Special Mode	Set the modem to Maestro **Special Answer Mode** (See Note 1)
ATC	0	Transmitter Off	**Turn off Transmit Enable** on the modem
	1**	Transmitter On	**Turn on Transmit Enable** on the modem
ATD	P**	Use Pulse Dialling	(See Note 2)
	T	Use Tone Dialling	
ATE	0	No Echo	**Don't display commands** typed to the screen
	1**	Echo	**Display commands** on the screen — See text after Notes
ATF	0	Half Duplex	**Modem echoes characters** as they are **sent** to the **remote** computer
	1**	Full Duplex	**Modem echoes characters** as they are **sent back from remote** computer
ATH	0**	On Hook	**Telephone hung-up** — can't conduct voice conversation, can dial
	1	Off Hook	Can conduct voice conversation — **can't dial**
ATI	—	—	Product Code and Checksum
ATM	0	Speaker Off	**Can't monitor line**
	1**	Speaker On Temp	**Speaker on until carrier detected** — then off (See Note 3)
	2	Speaker On	**Speaker on all the time**
ATO	—	On-Line	**Change** from COMMAND MODE to ON-LINE MODE (See Note 4)
ATP	—	Pulse Dial	Change from **Tone Dial to Pulse Dial** (See also Note 2)
ATQ	0**	Modem Response	**Echo Modem responses to Host** Computer (See Note 5 and text after Notes)
	1	No Modem Response	**Don't send Modem responses to Host** Computer
ATR	—	Dial	Only acts in Answer Mode (See Note 6)
ATSr=n	—	Registers	16 Status Registers used by Modem — not for general use. (See Note 7)
ATT	—	Touch-tone Dial	Change from **Pulse Dial to Touch-tone Dial** (See also Note 2)
ATV	0	Digit Response	**Send code numbers** instead of messages **to Host** Computer — See text after Notes
	1**	Message Response	**Send messages to Host** Computer — See text after Notes
ATZ	—	System Reset	**Reset** all options **to default** values and initialise Modem
,	—	Pause	**Insert a pause** (See Note 8)
:	—	—	**Return to Command Mode** after dialling number (See RULE 5 below)
:	—	—	Automatically switches to **Voice call mode** — used as an auto-dialler
+++	—	Command Mode	**Return to command mode** (or return control to the communications package from the On-line mode (See Note 4)

**NOTE: *All of the default settings are indicated using an asterisk (*). Any command that is incorrectly typed, or any command that is not recognised by the Super Modem, will result in the error message 'AT ERROR' appearing on the screen.*

NOTE 1: The modem monitors the DTR line of the computer to detect when power is removed, switched off, or drops below normal operating voltages. Should any of these occur, the modem automatically checks the DTR line and if DTR is not asserted (low), the modem waits for incoming calls in order to receive and store (in the RAM buffer) the text of any incoming calls whilst the computer is off-line. This will enable the modem (with the addition of extra RAM — an anticipated add-on for the modem) to act as an off-line one-way bulletin board or answering service. More details of this will be included in a future issue.

NOTE 2: The current version of the EPROM does not support Tone Dialling. This is planned for a later version release. When released, it will be possible to inject a P or T within the set of digits that comprise the phone number. This may be required in areas where a pulse dial is necessary to obtain an exchange and a tone dial is then necessary for the remainder of the number.

NOTE 3: The default setting for this command is automatically selected on power-up. If the user wishes to have the speaker remain on-line after a carrier is detected, the command ATM2 should be entered prior to the dial (ATD) command. (See also the text section on Use of Command Lines).

NOTE 4: The On-Line mode is used to permit the Host and Remote users to type information on their keyboards and have that information appear on the respective screens. This means that the users are conducting a two-way typographical conversation. It is not possible to issue commands in the On-Line mode. To return to the Command Line it is necessary to wait half a second after the last character has been typed, type three '+' signs, wait another half a second and the 'OK' response (to indicate that you are in command mode) will appear on the screen. If your timing isn't so good, and the 'OK' doesn't appear, then you will still be in the 'ON-LINE' mode. The only way to leave this mode is to get the timing right. If, when you return to the COMMAND MODE you press <RETURN>, the message 'AT ERROR' will appear.

NOTE 5: The default setting for this mode allows for any messages from the modem to be displayed on the Host computer. If this feature is turned off, no messages will be sent. This setting also depends on several other settings — see the text after the notes.

NOTE 6: This command allows the Host computer to dial in the Answer mode. This feature may only be necessary when using extremely low baud rates on the back channel e.g: Bell 202 with 5 baud back channel. The person attempting to reply at 5 baud is under a severe limitation (I can type at least five times faster than that) and it may become necessary to switch the channels.

NOTE 7: This command may be used for altering the contents of the modem registers, where 'r' is the register number (0 to 16) and 'n' is the value (0 to 255 decimal) to be stored in the register. This command may be used to compensate for a non-incrementing carriage return communications package. If the menu display shows additional blank lines between the selections, then the setting ATS4=0 should be used to remove the additional line-feed from any carriage returns emitted by the Super Modem's software.

NOTE 8: A pause may be necessary in a dialling sequence to allow time for exchanges using cross-bar switching mechanisms to activate, or to allow an outside line to be locked in from an internal PABX switchboard. As many commas as are necessary to obtain the desired length of pause may be inserted into the dialling sequence. Each comma generates a pause of between one quarter and one half second. See also the examples in the section headed 'Use of Command Lines'.

● Several of the above commands have an interactive effect. Namely, the ATQ and ATV commands. In order to receive message responses to commands on the screen, the settings described in **Example** 1 should be followed.

Commands to the modem are entered on what is called the COMMAND LINE. A Command Line can be made up of one or more commands — up to 80 commands may be entered on one command line, which is terminated by a carriage return. The only exception to this rule is the **A/** command, which repeats the previous command (See *Rule 6* below). Some commands also have parameters attached to them and these may also be included as part of the command.

If a command requires a parameter and the parameter is either missing or incorrectly keyed, then the default setting for the parameter will be used. The commands and their associated parameters are summarised in Table 1. Note that the Super Modem always powers up in the Command Mode.

Use of command lines

Any command to the modem must be entered on the command line. The command sequence may scroll to another line (up to a maximum of 80 commands), before a carriage return is required. All command lines are terminated by a carriage return. There are several other rules which need to be covered prior to giving actual examples of command lines. These are as follows:

RULE 1 Every command *LINE* must commence with the letters **AT**.

RULE 2 Capital letters are mandatory for the AT command which is usually the first command on the line (capitals and lower case have different bit patterns and the modem needs the capital letter bit patterns as described earlier). All subsequent commands on the command line are not affected by the case of the letters.

RULE 3 Spaces may not be embedded within commands and parameters, as these will cause the parameters not to be recognised. Spaces may, however, be included between commands to improve readability of a command line.

RULE 4 All command lines must be terminated with a carriage return.

RULE 5 A colon sign (':') may be appended to the END of any phone number and this will automatically return the modem to the command mode at the end of dialling.

RULE 6 The *only* command that does *not* commence with the AT command is the **A/** command. This command means "REPEAT THE LAST COMMAND". The A/ command is not terminated with a carriage return, as the previous command being repeated must have had a carriage return as the terminating character. This command may *NOT* be the first command issued to the modem (there isn't any command to repeat at this stage — is there?). This command may be used to redial a number (after the modem has tried five times and given up), or to repeat a lengthy command. Note that the Modem's five attempts to dial a number is not a Hayes Standard, but is included to allow terminal users to have a slightly easier life.

RULE 7 Any command that requires the inclusion of a parameter, must have the parameter correctly attached. If the parameter is not ▶

present, or if it is mis-typed, then the default setting will be used.

Examples of command line use

These examples that follow are intended to represent some of the common possible uses of Command Lines. Some examples of mistakes are also included.

EXAMPLE 1
Set the modem for word responses and dial Viatel:

ATQ0 V1 D01955<CR>

EXAMPLE 2
Set the modem to full duplex, leave the speaker on and dial the Apple User Group from a PABX line:

ATf1 m2 d0,,,,024516575<CR>

Note that, in the above example, the commas have been used to allow the switchboard time to connect to an outside line. (See also Example 4 for a similar situation with a country telephone exchange).

EXAMPLE 3
Set modem off-hook and dial Viatel:

ath1 d01955<CR>

There are two mistakes in the above line:

1) The leading attention command (AT) MUST be in capital letters.
2) You can't dial a number with the modem (or phone) set 'Off-hook'. However, ANY dialling command will override the 'Off-hook' command.

EXAMPLE 4
Set the modem for initial pulse dial, dial exchange, switch to tone dial (See Note 1 above), dial the Apple bulletin board and return to command mode:

ATp 0,,,,,t024516575:<CR>

Let us assume that the line was engaged and that the modem has tried five times (See *Rule 2* above) to re-dial and has finally given up — no problem ....

A/

The modem now goes through the above procedure again.

EXAMPLE 5
We only have a terminal that operates in half duplex and we wish to echo commands and responses, dial a number and then enter the On-Line mode:

ATe 1 f 0q0 v1 d0123450<CR>

There is a mistake in the above line — there should be no spaces between the parameters of the first two commands. The line should actually read:

AT e1 f0 q0 v1d0123450<CR>

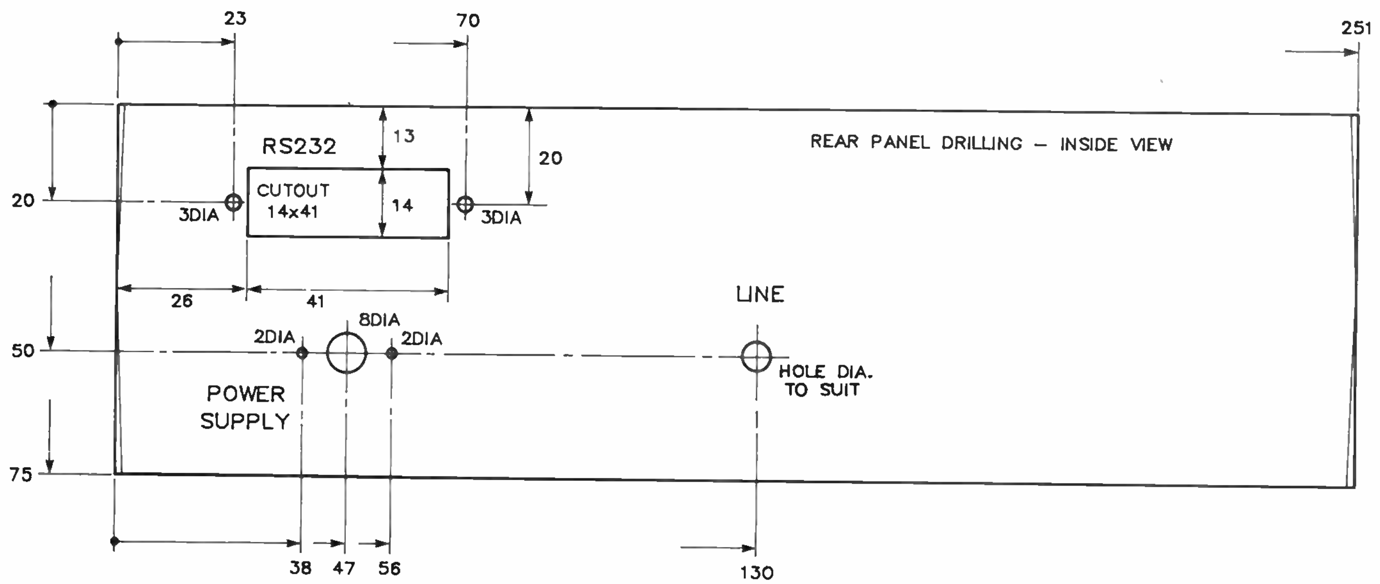
Note that spaces aren't really required — they only serve to improve readability. Note also the terminating '0' at the end of the number. This switches the modem to the On-Line mode at the completion of dialling.

EXAMPLE 6
Switch off responses, switch off the speaker, dial Viatel and return to the command mode:

ATq1 e0 m0 dO1955:<CR>

There is a rather subtle mistake on the above line — there is an alphabetical letter O, rather than a numerical zero as part of the Viatel number. This will set the modem to the On-Line mode prior to dialling the number. This also switches off all the responses as well, so you'll end up looking at a rather unco-operative screen.

Well, we've run out of room this month. Next issue, we'll wrap up with circuit operation details and flow charts of its operation.



FANTASTIC READER OFFER!

AEM4610 SUPERMODEM KIT

designed by Chris & Dan Darling, as described in Australian Electronics Monthly

By special arrangment with the designers, Australian Electronics Monthly is able to make this offer available, exclusive to our readers.

Don't miss this fantastic opportunity to own a truly smart modem and to enjoy the pride and satisfaction that comes from building it yourself!

Here it is at last! The modem kit that Australia has been waiting for. No need to buy expensive overseas modems when a kit is available to cover your current and future communications requirements. This kit has been fully designed, built and tested in Australia, so that local support is readily available. Furthermore, the kit is easily constructed by anyone with average soldering ability. To ensure a minimum of construction problems, all ICs are socketed and there are very few external passive components. All materials used in the kit are prime quality and there is even a "Sorry Dan, it doesn't work" offer available to all constructors. Even if you receive the kit and then decide that you aren't able to proceed, or if you can't get the completed kit to work, you can send $100 together with the kit to Maestro Distributors and it will be built (or fixed) and returned to you in fully working order.

The kit is supplied by Maestro and includes all components, pc board, EPROM (containing the required on-board software) and instructions.

Special Offer Price:

$295

(inc. tax)

Door-to-door delivery, anywhere in Australia: $6.60.

The expected retail price of the kit would normally be around $400.

If you plan on using the modem with your IBM PC or APPLE II, Maestro are able to supply Viatel software on 5.25" disk for a cost of $39.50.

★ An optional 16 Vac/1.5A plug pack power supply is available for an additional cost of $17.00.

This offer is made by Maestro and the magazine is acting as a clearing house for orders.

THIS AEM4610 MODEM KIT OFFER CLOSES LAST MAIL 30 JULY 1986

DON'T DELAY, COMPLETE THE COUPON NOW AND SEND IT, TOGETHER WITH YOUR CHEQUE, MONEY ORDER OR CREDIT CARD DETAILS, TO:

AEM4610 SUPERMODEM OFFER
Australian Electronics Monthly
PO Box 289, WAHROONGA 2076 NSW

If you do not require a full kit, you can obtain the pc board and EPROM (containing the necessary operating software) through the AEM PC Board Service for $139.00, inc. postage.

(Please allow up to four weeks for deliver to cover normal mail and cheque clearance and any unforseen delays)

RUSH ME my AEM4610 Supermodem kit for $295 (inc. tax) plus $6.60 delivery.
Please include (tick box if required):
☐ IBM Viatel software @ $39.50
☐ Apple II Viatel software @ $39.50
☐ Plugpack power supply @ $17.00.

I enclose $..... total, payment by
(please tick payment method):

Cheque/money order* ☐ Bankcard ☐ Visa ☐
Mastercard ☐ American Express ☐

Card No ....
Expiration date:..../..../....

Signature ....
(note: unsigned credit card orders cannot be accepted)

Name ....

Address ....

.... Postcode ......

(*Make cheques or money orders payable to Australian Electronics Monthly)

"Modem games"

— a new concept in computer communications

BORED with your old computer games? Frustrated at having the computer beat you all the time? Or are you looking for a real challenge? Wouldn't you like to play against a *real* person? Or are you looking for just a game with a difference?

After so many years of computer games which only allow you to play against the computer, comes the release of a new generation of games, produced by P&A software for the Microbee. These allow two people to play against each other on two Microbees which may be located across the room or across the world.

At present three different "modem games" are available these are:

- Concentration
- Warships
- Four-in-a-Row

Concentration and Four-in-a-Row already exist for the Microbee but have been revamped so that communication between two computers is possible. This being the case, the software package, although transparent to the user, consists of both the games program and the communications module.

Warships is the newest game. It follows the lines of the old favourite pen and paper game *battleships*, where each person places five battleships on a matrix. Each player takes turns at guessing the co-ordinates of their opponent's ships, thus trying to hit, or sink it. Two grids are drawn up on the screen, one shows the positioning of your ships and where your opponent has hit, the other shows only the co-ordinates you have hit or missed in.

Most of you will be familiar with the strategy game Four-in-a-Row, being a follow-on from noughts and crosses, only you need to get four, rather than three, markers in a row to win. Concentration, a memory and pattern recognition game, consists of 50 numbered cards being presented to both players. Each player then takes turns in selecting two cards to view their flip-side (a small picture). These are displayed for a few seconds then the other player chooses two. The object is to remember, and select, as many pairs of cards as possible.

Inter-computer communications

The basic concept behind the games is to have two human-operated, computers interfacing with each other whilst also running the game. As it turned out, the two people who produced the programs, Laurence Adney and Bruce Pratt, ended up with one writing the games, and the other the communications, both as separate modules. It was the communications which posed the problem. For one, nothing like this had ever been written before. Secondly, a high degree of data integrity was needed. After a lot of effort (and declarations of impossibility), this was eventually achieved.

As for the operation of communications, the two computers may be connected via a modem (giving yet another use for a modem) or direct connection of the RS-232 ports. In the first instance, only 300/300 baud operation is available, unless you have a 1200 baud full duplex modem. Full duplex 1200 baud communication is always available through connecting the serial ports directly, of course, but the computers must be in the same location.

When you purchase the program, you get a *master* (your copy) and a *slave*, (your friend's or opponent's). The slave is totally unprotected and may be sent (via Microbee's Telecom communications package) to as many people as you like, but a slave needs to communicate with a master to be able to be played.

While playing the game, a conversation line is available by just pressing ESC and typing your message to the other player; ESC again resumes play. This lets the two players converse without the hassle of interrupting the game and switching their modems to phone.

If, for some reason, communications are temporarily interrupted, the computer will display an appropriate message and wait for communications to resume. All *very* neat.

Graphics and sound are used to the best of Microbee's facilities in all three games. One observation, while playing the games, is that keyboard input is decidedly slow. This was explained to me by one of the authors. It is hardware limitation which causes this and not a software one. The absence of a UART (Universal Asynchronous Receiver Transmitter) within the Microbee itself does not allow for full keyboard buffering. Thus, all input is taken by the 6545. When the processor is tied up communicating, it cannot accept input, thus slowing down keyboard entry. An audible key click improves this situation somewhat, as well as the program polling the keyboard before each RS-232 operation.

Conclusion

Although there is a limitation with keyboard input, *this is a minor consideration*. The games, being oldies, are also goodies, and are enhanced two-fold by using a computer to control them but allowing you to play against a *real, live person*. This is the latest generation of computer games, following years of adventure games, flight simulators, and rehashes of arcade games. They're fine, but *people* get bored of playing with inhumane computers, (after all you can't effectively psychologically manipulate — or bully — a computer). For $34.50 on 5.25" disk, or $39.50 on 3.5" disk, it opens up a whole new dimension of amusement.

— Jamye Harrison

Review software supplied by P&A software, PO Box 5A, Seaforth NSW.

Cheap extra RAM for Series III 'Bees

This month, reader Roger Kermode shows how to add extra RAM to your Series III 'Bee at COOO-DFFFH for modest cost, using the ROM PAK location without the need for an external 'hard' switch to disable the ROMs. Only one other IC is used apart from the actual RAM chips.

FOR A MODEST COST of about $1 per K, one can add extra RAM at COOO-DFFFH by using a minimum of parts all of which can be mounted internally without the use of an additional circuit board. Having RAM at COOO-DFFFH is particularly useful as programs that are destined to be blown into EPROMs can be checked before blowing them. This RAM may also be used for frequently used utilities without the loss of normal memory.

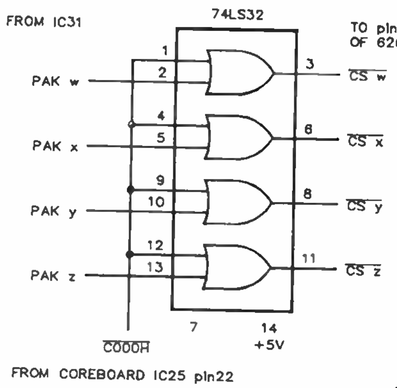
Series III ROM Microbees have a "ROM PAK" circuit included on the core board which will operate with 2764 EPROMs. The 2764 is very similar to the 6264 CMOS static RAM, a fact which makes the addition of the 6264 into the sockets for the 2764s very easy. One other IC however, is required to drive the RAMs properly as they can be written to as well as read. This IC, a 74LS32, can be mounted with a minimum of fuss in the "spare socket" of the mother board.

Two main signals control the EPROMs, PAK n from the 74LS138 (IC31), which selects which EPROM may be read, and COOO which determines when the selected EPROM may output its contents. For a particular EPROM to be in use, both signals must be low. Unlike the 2764 EPROM, the 6264 RAM also needs a WRITE signal as well as an Output Enable signal. To solve this problem the COOO and PAK n signals are ORed to give a Chip Select signal which is fed to Pin 20 of the RAM, while the XWR and RD lines are connected to pins 27 and 22 respectively. These pins — 20, 22, and 27 — are the only ones that need to be changed from the existing 2764 EPROM socket in order to accommodate a 6264 RAM.

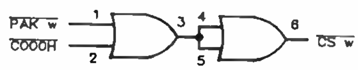
PAK SELECT TABLE

Pak n	IC31 pin	Firmware	
0	15	Wordbee	sockets on core board
1	14	Help	
2	13	unused	
3	12	unused	
4	11	unused	
5	10	Menu	
6	9	unassigned	no sockets on core board
7	7	unassigned	

CIRCUIT DIAGRAM

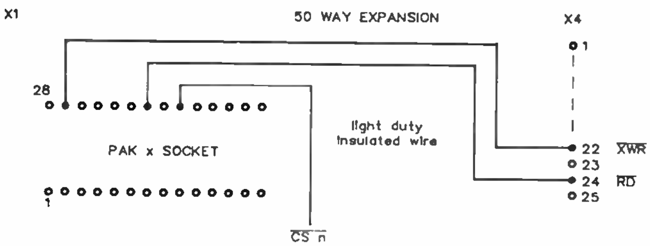


If a gate is unused it should be doubled up on one that is used,as shown



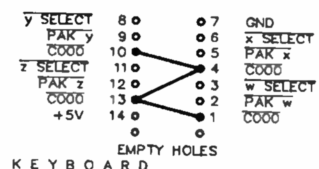
N.B. There is no need for links to power supply on spare as it is already wired in,looking from keyboard leave 2 closest holes empty.

LINK DIAGRAM FOR 6264 RAMs ON CORE BOARD



Pins 20,22 and 27 are bent out away from socket and connected as below
Pin 22 of all 6264 RAMs connected to X4 Pin 24
Pin 27 of all 6264 RAMs connected to X4 Pin 22
Pin 20 of each 6264 RAM connected to its respective Chip Select Pin (CS n) on the 74LS32 mounted in the Spare Socket on the Mother Board

LINK DIAGRAM FOR SPARE SOCKET ON MOTHER BOARD (VIEW FROM ABOVE)



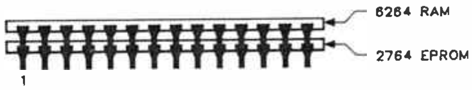
All signals except power fed to chip by light duty insulated wire

6264 CMOS RAM PINOUT

+5V	1	28	+5V
A12	2	27	WRITE
A7	3	26	NOT CONNECTED
A6	4	25	A8
A5	5	24	A9
A4	6	23	A11
A3	7	22	READ
A2	8	21	A10
A1	9	20	CHIP SELECT
A0	10	19	D7
D0	11	18	D6
D1	12	17	D5
D2	13	16	D4
GND	14	15	D3

PIGGY BACK CHIPS

Mount two chips on one another with the 6264 RAM on TOP of the 2764 EPROM by soldering all legs together except Pins 20,22 and 27 which are bent out side ways



The next problem is to decide where to mount the 6264 RAMs, the 74LS32 quad OR IC being mounted in the motherboard's spare socket. If your 'Bee has empty PAK sockets then you can insert the RAMs into them leaving pins 20, 22 and 27 bent outside the socket, otherwise you will have to "piggyback" the RAMs onto the EPROMs (see diagram).

Deciding which PAK locations to use also presents a dilemma. PAKs 6 and 7 are not assigned and so should be used first, but if you wish to add more than 16K you will have to use an unused assigned PAK location, usually PAKs 2, 3 or 4 (see table).

Once installed, the extra RAM may be accessed from BASIC by using the 'OUT 10, n' command where 'n' is the PAK number. PAK n cannot be used as BASIC checks to see if an EPROM is present after selecting a PAK location. This is done by seeing if the first byte at COOOH is equal to C3H or 195 and if this is not so an "option not fitted error" results. If all goes well, once installed the extra RAM will convert your ROM PAK into a RAM/ROM/MEMORY PAK.

STRINGS WITHOUT QUOTES

The programming example reproduced here shows a method of putting strings into DATA lines without the tedium of having to type quotation marks — " ".

Precede each string in the DATA line with any unshifted keyboard character, except comma and ESC. **Caution:** Don't mix strings and variables in the line, or else add a dummy to the variables.

Note that this can be extended for more arrays.

Ron Emerton, Port Macquarie NSW.

```
>list

00100 DIM A1 (5)
00110 FOR N=1 TO 5:READ A1$(N)
00120 L=LEN(A1$(N)):A3$=A1$(N):A1$(N)=A3$(;2,L)
00140 NEXT N
00150 DATA 3ABC,3DEF,3GHI,3JKL,3MNO
00160 FOR T=1 TO 5:PRINT A1$(T):NEXT T

>run

ABC
DEF
GHI
JKL
MNO
```

BenchBook

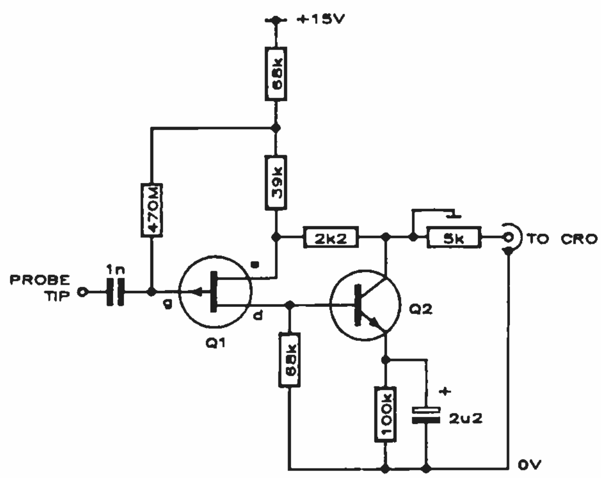
Fault-finding diagnosis training technique

Diagnosis is a thing learned from experience with fault-tracing. Teaching the techniques of fault tracing in electronics can become an expensive and time consuming business if faults are applied individually to pc boards. Damage can also result to the boards through repeated soldering and de-soldering to establish realistic faults.

One way of achieving a saving of time and expense in training aids is to use a dual in-line package (DIP) switch wired into different circuit nodes. The dip switch is glued to the reverse side of the pc boad with legs flattened and wires connected to the circuit nodes. Nodes are chosen from the Schematic to provide realistic situations of open circuit, short, no power, etc. With digital signals, failures may be connected directly to power or ground but analogue signals may need to be attenuated via a SIP (single in-line package) resistor network neatly attached to the DIP switch. "Noise" may be introduced from clocks and oscillators to summing nodes.

An instructor would need to keep his own list of what failures are controlled.

Jamie Hanson
M.I. Diag. Eng.



CRO probe provides over 1000M impedance

When looking at very high impedance circuits with an oscilloscope, most probes will load the circuit far too much, even x10 probes having a nominal 10M impedance. This circuit provides an input impedance of over 1000M and has a rise time typically faster than half a microsecond.

A JFET is used on the input, taking advantage of its already high input impedance. The 470M bootstrap feedback resistor boosts the input impedance to something like 1200M. The bipolar transistor in the output adds a little gain to compensate for the less than unity gain in the input stage. Overall gain is returned to unity. The maximum signal input level the circuit can handle is around 2 V peak-to-peak. The 5k trimpot in series with the output provides for equalisation adjustment. The 1n input capacitor should be a styroseal or mica type and the gate of Q1 mounted on a ceramic or teflon insulator, along with the 1n capacitor and the 470M resistor.

The emitter bypass of Q2 should be a tantalum type. Note that the supply rail should be well bypassed. Use a tantalum capacitor of between 1u and 10u. For the input device, Q1, use a 2N4381, 2N5460 or PN4360. The output device, Q2, can be a BC548 or 549, or a 2N3394, etc.

literature review

IPS RADIO AND SPACE SERVICES, USER TRAINING MANUAL by the Dept. of Science, IPS Radio and Space Services, 1985. Soft covers, 74 pages, 205 × 295 mm. Review copy from IPS.
Cost: $12.00, inc. postage, from IPS Radio & Space Services, PO Box 702, Darlinghurst 2010 NSW.

THE Ionospheric Prediction Service (IPS) provides a well used and widely patronised public service for communicators, HF broadcasters, geophysical companies and institutions, etc. IPS maintains a network of stations covering Australia and the Antarctic territories, continuously gathering data on the ionosphere from which a host of parameters are measured and used to produce a wide variaty of predictions of ionospheric behaviour. In addition, they gather solar and geophysical data from their own facilities as well as other agencies around the world. IPS not only issues a wide variety of predictions configured to suit the needs of different users, but also issues geophysical and ionospheric 'warnings' of impending or existing solar-terrerstrial events on a continuing 'real-time' basis.

The IPS User Training Manual, as stated in the Foreword, "... is designed to accompany the basic three-lecture User Training Course presented by IPS personnel." These courses are organised by IPS for their 'professional' users. If you or your organisation are such a user of IPS services, it would be a wise move to avail yourself of the opportunity to attend one of these courses. However, failing that, the Training Manual would be a useful addition to your reference works and makes an ideal accompaniment to the *Radio Communicators Guide to the Ionosphere* series currently running in the magazine. Principal author of this series, Leo NcNamara, is an ex-IPS scientist.

The book follows the organisation of the course, being divided into three parts. Part 1 covers the ionosphere and its formation, reflection and absorption of HF radio waves by the ionosphere, ionospheric variations plus mapping and predicting the ionosphere. Part 2 covers oblique propagation, and IPS predictions. Part 3 covers the IPS Warning Branch, some facts about the sun, the sun/earth ('solar-terrestrial') environment, solar activity, terrestrial effects of solar activity and IPS services. A very useful glossary is appended at the end of the book.

The text is brief, to the point of being 'truncated', but it's not meant to 'stand alone', as is explained in the Foreword. There are copious, clear illustrations which show the concepts quite graphically. Recommended if you're 'in the business', or for radio amateurs or shortwave listeners keen on getting more background or if you wish to expand your knowledge in this area.

— **Roger Harrison**

DIGITAL INSTUMENTATION by A.J. Bouwens, McGraw-Hill 1984 Hard covers, 340 pages, 160 × 237 mm. Review copy from Philips Scientific. ISBN 0-07-006712-0.

THIS BOOK is both a text and a practical reference book, covering the fundamentals of an increasingly important topic in considerable depth and with unparallelled clarity. It is part of the Philips Test and Measurement series, produced in collaboration with N. W. Philip's Gloeilampenfabrieken (Philips Industries) Eindhoven, The Netherlands.

Digital instrumentation is now a well established part of engineering testing as well as measurement in service workshops the world over, and not just in electronics. The book is divided into three parts: Part 1 covers "Basic Binary Theory and Logic Circuits", Part 2 covers "Digital Counters and Timers" and Part 3 covers "Digital Voltmeters and Multimeters". An appendix covers "Measuring Systems" and the "IEC Bus" (also known as IEEE-488, GPIB, HP-IB and IEC-625).

The book derives from a training course given to Philips Test & Measuring Instruments sales engineers. It is aimed at both students and engineers and a series of self-test questions are included at the end of each of the 19 chapters (naturally, the back of the book includes answers). Each chapter opens with a precis of what will be discussed and its relevance. The text follows in a well-considered, logical order (no pun intended), each chapter building on the concepts introduced in the previous one. Throughout the book, concepts are illustrated with practical examples. Some basic electrical and electronics knowledge is assumed by the author. If you already have some knowledge of the basics given in the early chapters, then you can 'dip in' where you need where your knowledge commences.

Coverage includes: basic number systems, binary theory, boolean algebra and logic circuitry in Part 1; Part 2 covers counters, scalers, shift registers, converters and accuracy while Part 3 covers op-amps, analogue-to-digital converters (ADCs), digital voltmeter and multimeter measurement techniques, guarding techniques plus ac and RMS measurements. The text is profusely illustrated with clear diagrams and circuits (conforming to IEC drawing standards). A comprehensive index is included. This is a reference work we can unreservedly recommend.

— **Roger Harrison**

letters

'Brightner' added to vinyl records?

Dear Roger,

The comments made in your April editorial strike a responsive chord (no pun intended) in my feelings about music from CDs.

Having agonised about the purchase of a CD player (see Letters, January this year) I bought a player a month or so later and some discs, mainly chamber music with a few orchestral. Amongst my first impressions such as, "isn't it beaut, no snap, crackle and pop", was one of disappointment. The music sounded so benign, so lacking in lustre, so colourless almost. A lot of the excitement seemed to have gone out of it.

At about the same time I went to a chamber music recital in a city church given by a visiting quartet and pianist, and soon after that I bought a compact disc of the same group playing the same music that they had played in the church. As I listened to the disc and cast my mind back to the church recital, I realised that the sound was very similar. The disc was, in fact, a very close reproduction of what I had recently heard in the flesh.

Then I started thinking of the disappointment I sometimes feel in the early part of a symphony concert at, say, the Opera House. The music does not sound as 'bright', the strings do not seem to have the sheen that is present on my vinyl recordings. Then I have to remind myself that *this is the real thing*; this is the way the music was meant to be heard.

So perhaps there is truth in the suggestion that a 'brightner' is added to vinyl pressings and that brightner is not added to discs, and perhaps the reason for this is to take advantage of a new medium to phase-out a trend (i.e: 'enhancement') that has crept into and become part of, the vinyl recording technique.

Some strength is added to this hypothesis when you consider that, when the CD system was released, the manufacturers believed their main market to be lovers of classical music, a group that would be more likely to recognise the truth of 'un-enhanced' sound than lovers of popular music, who would be accustomed to hearing sound enhanced by microphones and their placement during flesh and blood performances.

So, as I said in my earlier letter, we are well and truly in the hands of the recording engineers and I am going to keep on buying the music I enjoy, whether it be on record, tape or disc.

Don Richards,
Ebenezer, NSW

Speaker questions

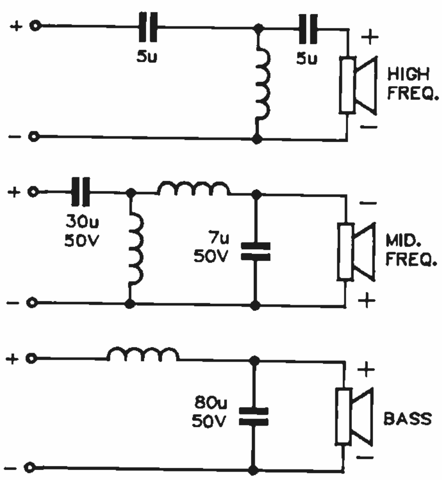
Dear Sir,

I have been following with keen interest projects on the loudspeaker designs by David Tilbrook. About 10 years ago I made myself a pair of Bailey transmission line enclosures fitted with KEF B139, B110 & T27 drivers. I am now considering two projects:

(1) Building a set of bookshelf speakers.
(2) Upgrading the transmission lines — the T27 tweeters (old type) were always a little flat and now do not work at all — open circuit on both drivers.

I would appreciate your advice on what options I should consider:

(1) Is you magazine planning to publish a bookshelf design?
(2) Would the D19TD-05 Vifa tweeters be a suitable substitute for the KEF T27s? I believe the DN12 crossover units made by KEF, which I have, have crossover points of 400 Hz and 3.5 kHz.
(3) Could I improve on the KEF crossovers, circuit as follows:



I obtained details on the Vifa M70 bookshelf speaker kit design from a speaker distributor in Brisbane and suspect that any design from David Tilbrook might possibly be based on the same drivers (D19TD and C17WG — Ed.) Would this be so?

One other option I might have is to use my KEF B110s with a Vifa D19 for a small bookshelf unit.

As I am no great expert on electronics I have found David Tilbrook's articles to be very informative and easy to follow. Any advice which you are able to offer would be most appreciated.

B.W. Campbell,
Slacks Creek, Qld.

(1) We have a small pair of two-way loudspeakers under development at the present time. These are based on a remarkable 6½-inch Vifa polycone woofer and the 25 mm dome tweeter. These are eminently suitable for use in bookshelf applications.

(2) The D19TD-05 tweeter is a good replacement for the T27. The crossover point of 3.5 kHz is suitable allowing good leeway between the crossover point and the tweeter's fundamental resonance.

(3) The KEF crossovers are good quality units and the third-order section for the tweeter is suitable for use with the Vifa tweeter. The B110 is an excellent driver for use as a woofer/midrange in small enclosures. Some years ago I experimented with a small bass-reflex design based on the B110 and a Philips tweeter, which unfortunately is no longer available, and the bass performance was really quite impressive.

David Tilbrook

Sensible amateur licence requirements

AEM,

Special thanks to Roger Harrison for his recent Discussion Paper submitted to the WIA for sensible amateur radio licence requirements. Current requirements and restrictions are ridiculous in this day and age in Australia and are unfairly and unnecessarily denying amateur radio communications to many responsible operators.

All members of our small amateur radio net sincerely thank you.

Thanks as well to all the team for a great magazine.

Hugh Hawkins VK2KHH
M.V. Iolanthe

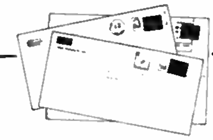
Active x-over query

Dear Sir,

Although a virtual novice with transistor projects, I intend to attempt the active crossover project AEM6503 (Feb. '86), using it to feed Quad electrostatics from about 200 Hz up, with the 15 Hz to 200 Hz region being fed to a cone speaker.

The parts list for the project seems to contain a few eccentricities, presumably in the typesetting department. i.e: R51-R62 remain anonymous (470n?!), and R3-8 are given in R units — are these ohms or have I been left behind by nomenclature?

Finally, am I right in thinking the high-pass capacitors of one section will be the



same value as those in the low-pass section below it?

Thanks for your help; I look forward to subsequent editions of your magazine.

John Hogben,
Moonta, S.A.

The correct values for resistors R51-R62 depend on the particular drivers with which the active crossover is to be used. The purpose of these resistors is to correct for the differences in sensitivities of the different drivers. The intention is that either these resistors can be used or the preset potentiometers can be fitted to allow variable adjustment in more general purpose applications. We will be using this active crossover in various projects in the near future and we will detail the correct values for the resistors in those articles.

The "R" units you refer to do represent ohms just as "k" represents kilo-ohms and "M" represents megohms. We adopted this nomenclature since it obviates the necessity of using decimal points which we have found from experience can easily disappear during the printing of the magazine. This nomenclature is an International Electrotechnical Committee (IEC) standard.

With reference to the crossover capacitors, you are right in thinking that the high-pass capacitors of one section should be the same value as the low-pass capacitors of the section below it. In fact, the main reason we chose this particular version of Butterworth filter was to ensure that this would be the case.

David Tilbrook

Headphones and the 6010 preamp

Dear Sir,

I was pleasantly surprised when I made my first purchase — and not my last — of your magazine with the November issue last year, which carried the AEM6010 preamplifier project.

I would like to ask why the project does not have a headphone socket? I think a simple headphone socket would easily enhance this project. That is to say that I don't think a headphone socket would be difficult to place in the circuit. Would you please publish my letter showing where the headphone socket would be placed?

I wish you luck with the continuance of a fine magazine.

Ben Brown,
Nedlands W.A.

The installation of a headphone socket is not as easy as it at first may seem if consistence with the "Ultra-Fidelity" specification is to be maintained. The two common "standards" for headphones, that of high and low impedance types, have different requirements.

In order for high quality reproduction to be achieved, the headphone amp must be able to deliver amply large transient signals to prevent the onset of clipping. In the case of the high-impedance types, this implies a relatively high voltage supply rail, whereas in the case of the low-impedance types, it necessitates a reasonable output drive current capability. To facilitate use with both these types of headphones an ultra-high fidelity headphone amp must be capable of driving an 8 ohm load while also being capable of delivering around 20 V RMS. Although the circuit developed for the preamps is capable of meeting these requirements, some modifications must be made and the power supply ratings would have to be increased in power.

We have a high quality headphone power amp under development and will be describing it in the magazine as soon as practicable.

David Tilbrook

NOTES & ERRATA

AEM5505 Hash Harrier, April '86: For the capacitors specified in this project, it would be better to use metallised polyester (MKT or PETP) or metallised paper types, which have a 'self-healing' dielectric. Capacitors for this application are commonly known as 'X' and 'Y' types, produced by Rifa and Siemens, among others. Some polypropylene capacitors are occasionally prone to failing by short-circuiting.

Also note there are some wrongly numbered capacitors on the overlay. C15 should read C16, C16 should read C17 and C17 should read C15.

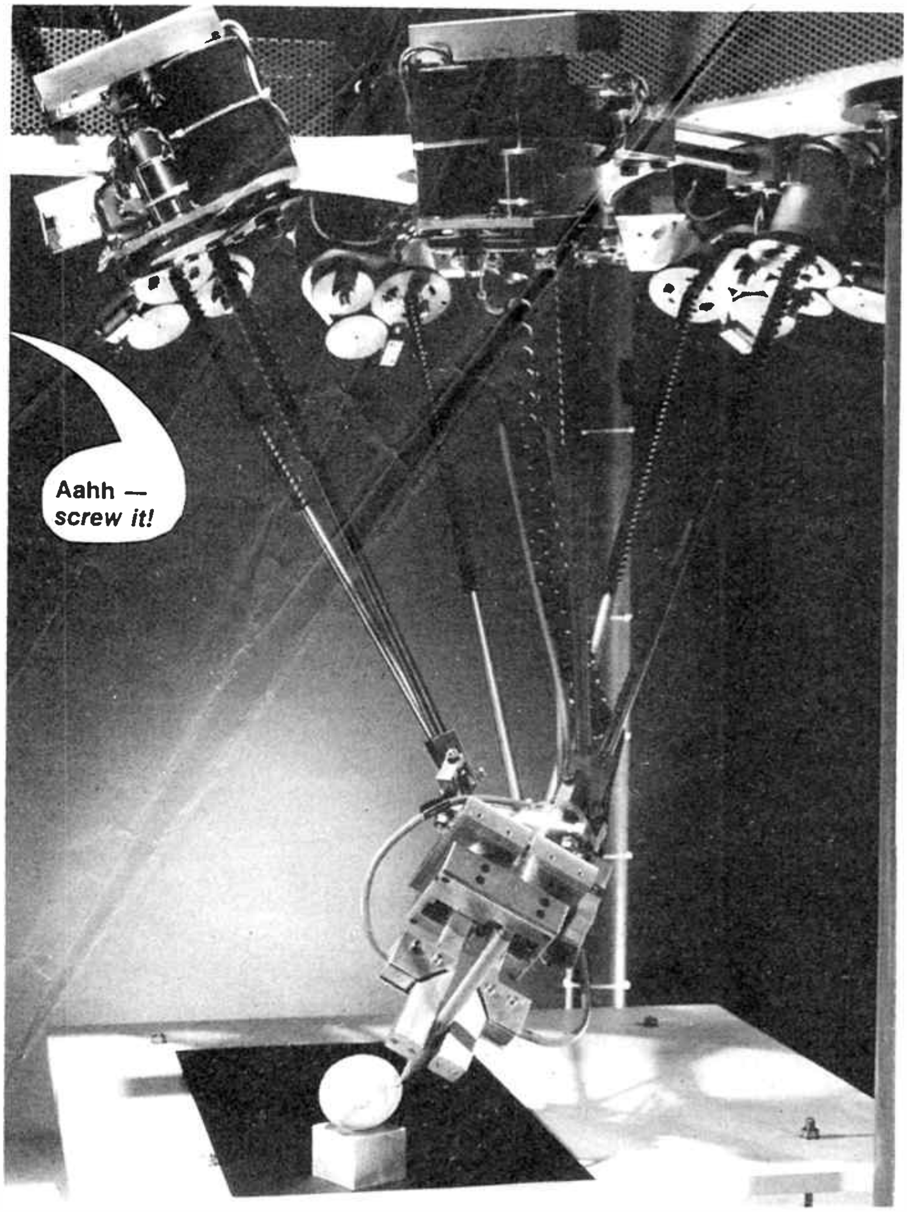
AEM4610 Super Modem, May '86: Two resistors should be different values to that specified — R5 should be 470R (not 4K7) and R19 should be 1k (not 100R).

Star Project, UHF GaAsFET Preamp: The circuit drawing supplied by DSE had some minor inconsistencies. The overlay, however, is correct. Capacitor C5 is actually between the +12 Vdc input (at the anode of D9) and ground. The 'out' and 'in' terminals of the 7805, IC1, are transposed. The contacts of RLC actually connect between the +5 V output of IC1 and the junction of RFC2 and C9.

In Circuit Operation, C7 is given as 100 μF when it's 220 μF, while R3 is given as 100k, when it's 33k. The parts list shows the 10 μH RF chokes as L1, L2 when the circuit and overlay shows them as RFC1, RFC2.

Practicalities, May '86: In Figure 1, the resistor in series with the cathode of D2 is R6, not R8.

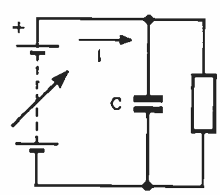
The Last Laugh



THIS MONTH's column has been contributed, after considerable research of the topic, by reader Lance Wilson, who is, by way of profession, a lecturer in electronics. His hobby is fluid mechanics and he's managed to find a petite (as opposed to grand) unifying theory linking the two fields.

Electronics, charging and the stop function

For the benefit of those noephytic purveyors of knowledge who wish to implement obscure examples of mushroom farm technology such as "relevance" in the jungle we know as the classroom, the following piece of research is offered. To stir some vestige of interest in RC circuits, it is suggested that one resort to the "booze analogy". This is the irrelevant and inexact proposition that the effect of alcohol on the human body can be represented by the following electrical circuit:

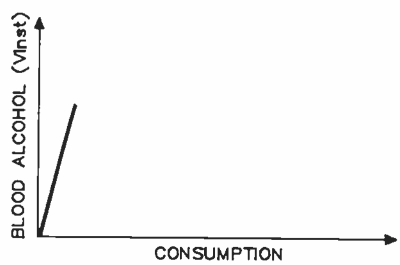


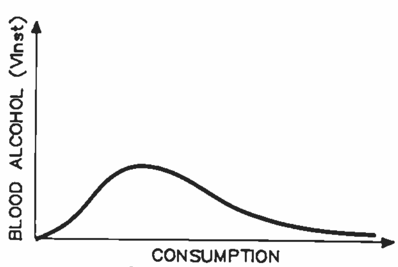
The various parameters represent as follows:

- **I** rate of flow of amber fluid past the lips.
- **C** capacity of various shapes and size of human body to absorb such alcohol.
- **R** related to the rate of disappearance of C_2H_5OH from the bloodstream.

RC gives a time constant for the sobering-up curve. Blood alcohol level is measured in terms of instantaneous voltage across the parallel RC. Note that, to accord with the current physiological theories, R should really be a constant current sink, but unfortunately these are not yet covered by our syllabus.

Justification for the hypothesis will be verified by a quick glance at published breath-test data. A constant high flow of the necessary down the gullet will produce a linear increase of blood alcohol, leading to the well-known unfortunate consequences. Similarly, a constant flow of significant current from the source will produce a roughly linear increase in voltage across the capacitor. Pulsed input, (analogous to the few quick middies required after work, to lubricate a throat, parched by the constant drone necessary to embed even the most fundamental concept into the budding electrician's brain) results in the response diagrammed below, where after the initial surge there is a steady fall back to somnambulant sobriety. The falloff is roughly 0.1 percentage points per hour, a linear drop which may, in reality, be closer to the exponential form of the electric circuit.





In summary, it is easy for the experienced teacher to see the natural correspondence between those wonderful intricacies of electrical circuits which fascinate us so totally and the more mundane, boring activities with which we are prone to fill our evenings and weekends. Herewith an initiation for those newly-arrived from the innocence of the industrial world.