SEPTEMBER 1983 $2.35* NZ $2.75

eti

ELECTRONI TODAY INTERNATI

COMPACT DISCS
Fact and Fiction
6 CD PLAYERS REVIEWED

How to

PRINT WEATHER MAPS

on your computer using our radio facsimile decoder project.

TO BUILD:

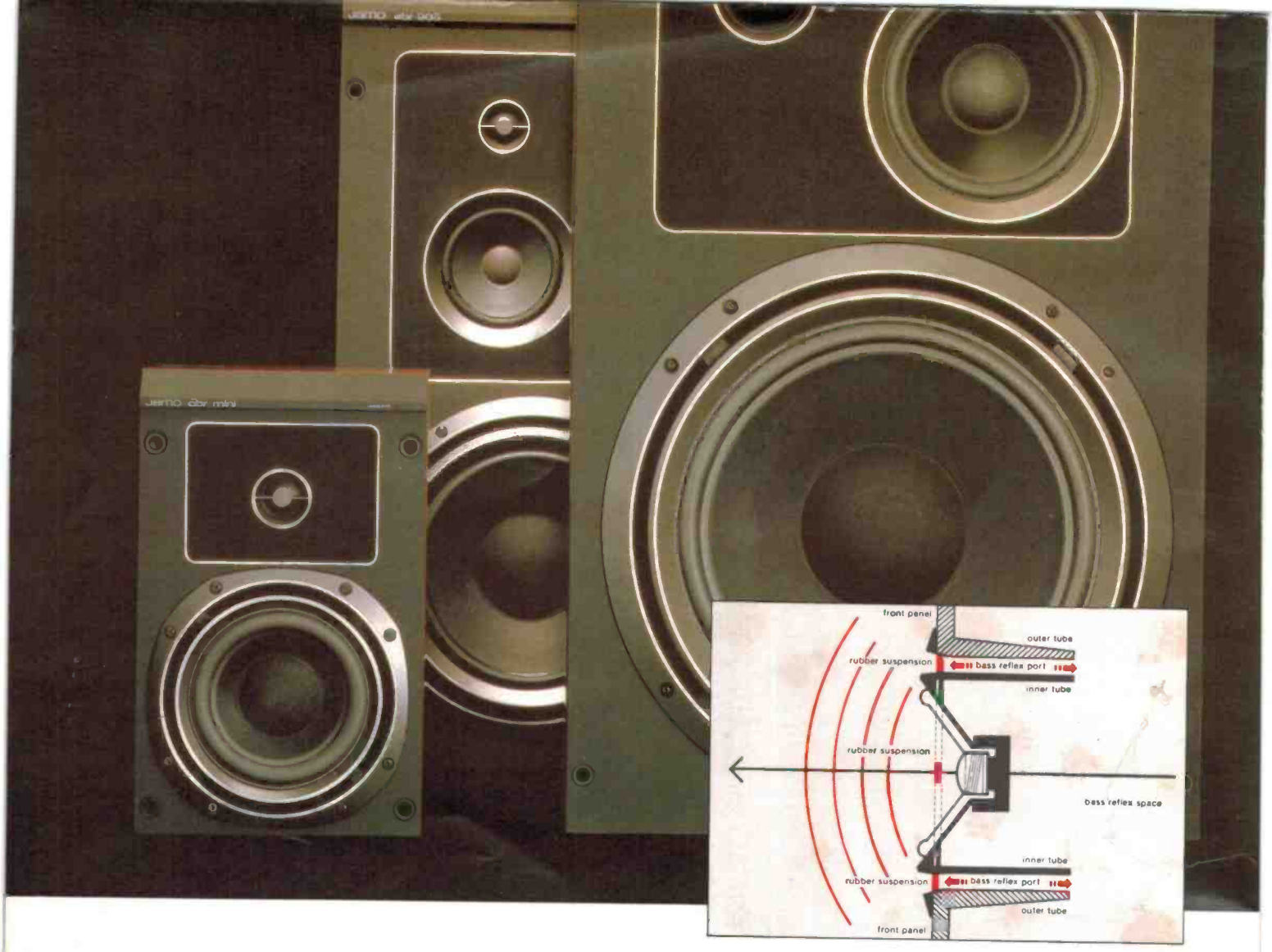
3-WAY SPEAKERS

HANDHELD DIGITAL FREQUENCY METER

VIDEO DISTRIBUTION AMPLIFIER

FUNCTION/PULSE GENERATOR

32-PAGE FET COOKBOOK BONUS



Are your speakers prepared for Digital Audio? Jamo are.

The new range of JAMO loudspeakers from Denmark's leading loudspeaker manufacturer has been designed with the **digital audio** in mind.

Digital Audio is here. It will expose the limitations in all hi-fi systems, especially the loudspeakers. So why buy speakers, which are outdated tomorrow. **Be part of the future of JAMO.**

JAMO offers high power handling capacity, wide dynamic range and extended frequency response. Features which digital audio demands.

With JAMO you will get excellent sensitivity, unsurpassed stereo image and phase linearity. You'll also get fully electronic overload protection and acoustic attentuators. But you won't get empty pockets . . . We quote:

"Our conclusion is that JAMO CBR-1303 is a handsome, very well constructed and finished speaker whose sound quality, high sensitivity, and ruggedness merit its serious consideration by anyone contemplating buying speakers in its price class." **(Stereo Review, USA. April 1983)**

"We do not know any loudspeaker in this price range, which at once offer an excellent performance, high sensitivity and the possibility to get the instruments up in a natural size." **(High Fidelity, Scandinavia)**

JAMO has developed and patented the unique **CBR**-system **(Centre-Bass-Reflex).** It eliminates distortion caused by cabinet resonances found in most traditional speakers. The woofer is mounted in the cabinet by means of only four rubber suspension points, which effectively absorb all vibrations from the woofer.

These JAMO developments represent excellent uncoloured sound reproduction, which has acclaimed JAMO by hi-fi critics all over the world.

For further information and nearest dealer contact: SCAN AUDIO, P.O. Box 242, Hawthorn, Vic. 3127. Phone (03) 819 5352.

Jamo HI-FI

Use Reader Information Card for full details.

EDITOR
Roger Harrison VK2ZTB

TECHNICAL EDITOR
David Tilbrook VK2YMI

ASSISTANT EDITOR
Jennifer Whyte B. App. Sc.

EDITORIAL STAFF
Geoff Nicholls B.Sc./B.E.
Jonathon Scott
B.Sc./B.E. (Hons) VK2YBN

DRAUGHTING
David Currie

PRODUCTION
John Gerrie (Manager)
Mark Davis

ADVERTISING SALES
Bob Taylor (Group Manager)
John Whalen (National)
Steve Collett

ART STAFF
Ali White B.A.
Bill Crump

READER SERVICES
Jane Nicholls

ACOUSTICAL CONSULTANTS
Louis Challis and Associates

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

ADVERTISING OFFICES AND AGENTS:

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

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

Queensland: Geoff Horne Agencies, 16 Bellbowrie Centre, Bellbowrie, Qld 4070. Phone. (07) 202-6813 Brisbane.

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

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

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

ELECTRONICS TODAY INTERNATIONAL is published monthly by the Electronics Division of the Federal Publishing Company Pty Limited, 140 Joynton Avenue, Waterloo, NSW 2017 Managing Editor Jeff Collerton. Typeset by Keyset Phototype Pty Limited, Sydney Printed by ESN-The Litho Centre, Sydney Distributed by Gordon and Gotch Limited, Sydney Cover price $2.35 (maximum and recommended Australian retail price only; recommended New Zealand price, $2.75). Registered by Australia Post, Publication No NBP0407 ISSN No 0013-5216.

FEATURES

SIGHT & SOUND

COMPUTING TODAY

TECHNICAL

COMMUNICATIONS

GENERAL

ROD IRVING ELECTRONICS

425 High Street, Northcote 3070, Melbourne, Victoria. Ph (03) 489 8131. Telex No. 38897
48-50 A'Beckett Street, Melbourne. Ph (03) 347 9251

THIS MONTHS KITS

ETI-736 Fax Picture Decoder

Print weather maps with your MicroBee. This project goes between the Audio Output of a shortwave receiver and the 8-bit port of the MicroBee and allows you to print weather maps and satellite pictures on a dot-matrix printer with quite acceptable results. Do your own forecasts.

ETI-1517 Video Distribution Amplifier

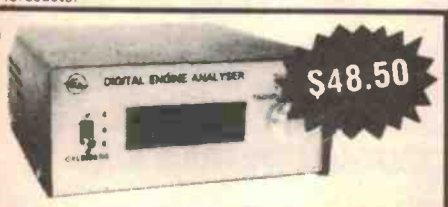
This will let you drive up to five video displays from one video source, simple to build . . . low in cost. Tons of applications—great for direct video out from computer to you, drive several displays from a video recorder, etc. etc.

ETI-175 Digital Frequency Meter

A handheld digital frequency/period counter that goes to 20MHZ and features a 4½ (and a half . . .) digital display. Low cost—simple to build, battery operated.

ETI-166 Function/pulse Generator

At last—the ETI function/pulse generator Here's how to have a top-class instrument in your lab/workshop. Covers 1 HZ to 1 MHZ, generates sine, square, triangle, ramp and pulse signals with top specs.



$48.50

Duel Tracking Power Supply

$87.50

EA ELECTRONIC STARTER FOR FLUORESCENT LAMPS

$5

OCTOBER EA 1982

EA DIGITAL READOUT FOR SW RECIEVERS

$72.00 COMPLETE

OCTOBER EA 1982

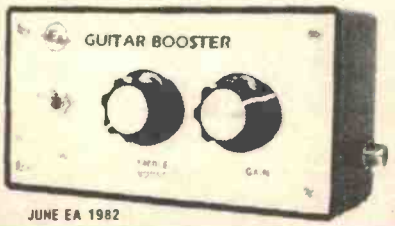
100w Sub-Woofer Amplifier

$85.00

JULY EA 1982

EA GUITAR BOOSTER

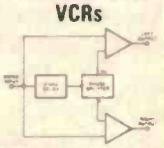
$17.50



JUNE EA 1982

STEREO SYNTHESISER FOR TUNERS AND VCRs

Enjoy the benefits of stereo sound from your video cassette recorder, TV or AM tuner with this Stereo Synthesiser. The circuit uses just four ICs and is easy to build.



$55.00

SEPTEMBER EA 1982

Eprom Programmer

$55.00

JANUARY EA 1982 INCLUDES TEXTOOL SOCKET

EA POWER UP

$38.50

EA NOV 1982

OVER 200 NOW SOLD

EA INVERTER INCLUDING TRANSFORMER 300 WATTS

$195

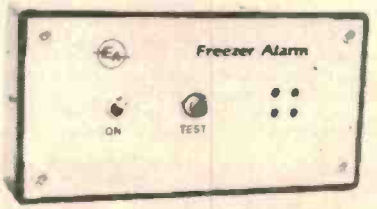
P & P $10.00 Anywhere in Australia

JUNE EA 1982

EA EASY-TO-BUILD FREEZER ALARM

$21

OCTOBER EA 1982



Led Head Lightchaser

(Battery and headband extra)

$12

PH METER

$129

with probes

BOGGLE GOGGLES

$9.60

Short form

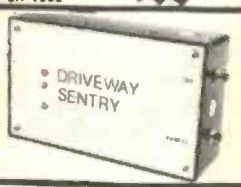
Tacho/dwell meter with digital display

$79

MAY EA 1982

Driveway Sentry

$32



12/240 volt Inverter 40 WATTS

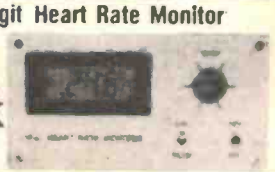
$49.50

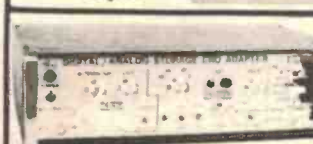
MAY EA 1982

Portable 3½ Digit Heart Rate Monitor

JULY EA 1982

$79.00





$189.00

Analogue and Digital Storage CRO Kit

ADVERTISERS' INDEX

COMMENT

I HAVE JUST returned from the Electronics Show in Perth — Australia's *only* consumer electronics show. And what a show! Virtually every major distributor of consumer electronics equipment was represented among the 90 exhibitors, and the organising committee estimated *over 100 000* people poured through the gates over the four days of the show, from August 4-7. The consumer electronics industry is alive and well — and living in Western Australia!

What is wrong with the industry that it can't organise a show in the eastern states? One would think that's where the bulk of the marketplace existed. The last consumer electronics show in the east was held in Sydney in 1980. Since then, the industry has not been able to get another one off the ground. There was a false start for a show in 1981, and again for 1982, but the support and effort just fizzled away.

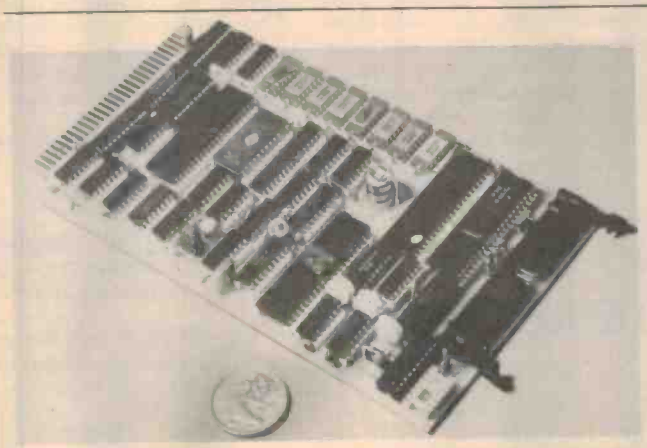
The Perth show is organised by a committee made up of managers from firms representing different sectors of the industry. Is there any barrier to the industry in the eastern states getting together and doing the same thing here? They're getting together in the west, so why not over here? I think a few very valuable lessons can be learned from the success of the Perth Electronics Show. The organisation that got it together should provide an excellent model to follow. The Perth show is now five years old and has grown enormously in the past three years. I'm not suggesting the Perth show should be transferred to the east, rather the east should emulate the west.

As there are now national industry bodies representing the various sectors of the trade, how about getting together and putting on a show? You've got all to gain and little to lose — except your inhibitions about getting together.

"Ill fares it with the flock, if shepherds wrangle when the wolf is nigh."
—Sir Walter Scott

Roger Harrison
Editor

NEXT MONTH



THE 'LITTLE BIG BOARD' COMPUTER

Here is a Z80-based single-board computer featuring 64K of RAM on board, two RS232 ports and a floppy disk controller that will handle up to four disk drives, either 5¼" or 8" double-sided double-density. It runs CP/M 2.2 and all fits on a board measuring just 115 x 204 mm! But that's not all. The CPU runs at 4 MHz, a real-time battery-backed clock is included and the RS232 ports are software configurable to suit yourself. It uses the increasingly popular and very versatile 56-pin STD buss. Our last computer was the popular Learner's Micro. This one's for the 'big boys'. Don't miss it.

GETTING PRINTOUT FROM YOUR MICROBEE

There are two ways to get it — the cheap way and the not cheap way. Either way, you'll need an interface. We show you how to build and get working two simple interfaces — one for each method. Both cheap.

WIN A SCANNER!

You could win yourself one of the most popular scanners on the Australian market, worth over $500, in our big Scanners' World Contest next month. You've got to be in it to win it, they say.

THE INS AND OUTS OF VIDEO ENHANCERS

LED AUDIO PEAK PROGRAMME METER

SANSUI 'COMPU RECEIVER' REVIEWED

SERVICES

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

GENERAL INQUIRIES: For all inquiries about back issues, subscriptions ($23.88 for 12 months/12 issues), photocopies of articles, artwork or submitting articles, call (02) 663-9999 or write to: ETI Reader Services, 140 Joynton Avenue (PO Box 227), Waterloo, NSW 2017.

CONTRIBUTIONS: Submissions must be accompanied by a stamped, self-addressed envelope for their return. The publisher accepts no responsibility for unsolicited manuscripts, illustrations or photographic material.

ELECTRONICS CONVENTION IN SYDNEY THIS MONTH

IREECON '83, the 19th International Convention and Exhibition, mounted by the Institution of Radio and Electronics Engineers Australia, will be held at the Sydney Showground from September 5-9.

IREE conventions are the recognised regular forums for engineers, technicians, scientists and management executives engaged in every field of electronics. The technical exhibition will be complemented by a comprehensive lecture program presented by leading authorities in all areas of electonics from Australia and overseas.

The Governor-General, Sir Ninian Stephen, will officially open the convention on Tuesday, September 6. The keynote address on the convention theme, World Communications Year, will be presented by the secretary-general of the International Telecommunications Union (ITU), Dick Butler.

The 260 technical papers to be presented at the convention will cover a wide cross-section of topics in the electronics field. The papers will be in lecture and poster presentations, with more than 30 overseas authors personally presenting their papers.

Two papers on studies aimed to facilitate automated sheep-shearing will be given by representatives of the research teams at the University of New South Wales and the University of Adelaide. They will discuss the feasibility of different sensing devices which will warn the fast-moving shear of obstacles in its path.

Recent research in Australia suggests that video computer games might play a role in the treatment of children with specific learning difficulties. Shirley Goodhew, an occupational therapist, reports in her paper that video computer games practice results in an upward trend in all of the four parameters of motor behaviour.

An educational experiment conducted in South Australia is the subject of another paper. The results of this experiment show that isolation in the Australian Outback need no longer be a barrier to specialist training in the latest technological developments.

The latest results of Project Jindalee, HF skywave radar which is currently collecting wind- and sea-state information from the Indian Ocean, will be presented at the conference.

Another paper which will be presented will discuss the development of the microwave radiometer by CSIRO scientists. This method of measuring temperatures below skin level without breaking the skin will be used in the heat treatment of cancer.

Contact the IREE for further information.

COVER

Be your own forecaster — print weather maps with your Microbee! Cover design by Ali White. Background weather map is a facsimile print courtesy of the Bureau of Meteorology.

Last month's cover credit was omitted, unfortunately. The background picture was of the Cone Nebula, a strong infrared source, courtesy of D.F. Malin of the Anglo-Australian Observatory, NSW. Ali White designed the layout.

NEW WAY WITH PC ASSEMBLIES

A new method of surface-mounting electronic components, combining flexible printed-circuit board and chip-carrier technology, has been devised by Welwyn Electric, the British resistor and micro-electronics manufacturer.

The technique makes use of Welwyn's range of flexible printed circuits to interconnect an array of chip carriers and other face-bonded devices. To this, the company has added a special heat-sink to create an easily assembled package that offers a high degree of mechanical strength and is suitable for a wide range of professional, defence and telecommunications applications.

The heat-sink is made of aluminium or copper with studs or pillars which protrude through the holes in the printed circuit and contact the underside of each chip carrier, providing efficient thermal conduction for the entire circuit board.

THE LARGE AND SMALL OF EXIDE BATTERIES

The biggest and the smallest of Exide's maintenance-free RE systems batteries for industrial use have been released by Chloride Batteries.

The RE6-1, with a size of 51 x 42.5 x 57.5 mm, is an ideal 6 V, 1 Ah power source where space is a premium.

The RE12-38, offering 38 Ah in 12 V circuits, meets the heavier power needs of emergency lighting, uninterruptible power supplies, communications, instrumentation and propulsion as in electric wheelchairs. It measures 177 x 165 x 170 mm.

The Exide RE range now has seven batteries of various shapes and sizes of 6 V offering 1-10 Ah, and six of 12 V, also of various shapes and sizes, offering 1.2-38 Ah.

There is a new 24-page catalogue from Chloride giving the specifications, performance data and application advice on Exide Faure-X pure lead positive grid batteries used for standby power in solar, computer or emergency situations.

In this glossy catalogue, graphs and tables illustrate text on cell selection, temperature correction, discharge data, charging, recharging and maintenance.

The Exide Faure-X range offers more than 20 different cell capacities from 50 to 3200 Ah at the 10-hour rate.

For more information, contact **Chloride Batteries Australia, 147 Woodpark Road, Smithfield NSW 2164. (02)604-0522.**

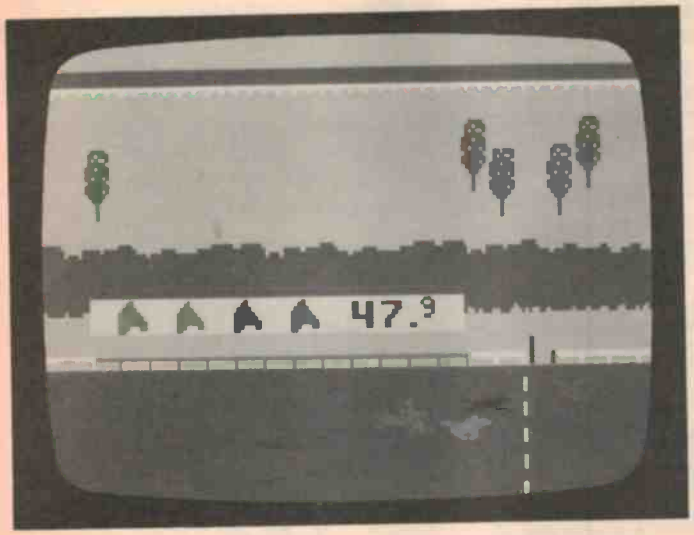
NOTES & ERRATA

Equipment News, April Issue, page 10. The price of the BWD Model 821 oscilloscope, featured on this page, was mistakenly quoted at $750 retail when it should have been given as $750 plus sales tax.

Project 1513, June issue, page 76. The Parts List shows R16 as 18k, but the circuit diagram gives it as 560R. The circuit diagram is correct.

Project 698, June Issue, page 47. At date of going to press with this project, Chuck Simmers had only tried the National bipolar PROMs so check the specifications before attempting to program other makes using this project.

'660 Software, August '83, page 68. In the item at the bottom of the page headed "Cure For Colour Problems", we goofed. The solution is to cut the track between pin 11 of the 4066 (IC21) and the junction of R16-R17, then insert a 10n capacitor across the cut. Sorry about that.



TELEGAMBLING: A SUREFIRE BET

A televised network featuring gambling at home may provide the impetus for the widespread use of interactive teleshopping services, such as Videotex and Teletext, according to a 314-page report released by International Resource Development, an independent United States consulting firm.

"Gambling services may be the answer to get consumers to use Teletext and Videotex," according to IRD.

"The average punter receives his betting information from the newspaper, and then either places a bet at the track, at an off-track betting shop or with an illegal bookmaker. The use of Teletext and Videotex could result in one-stop gambling."

Videotex is basically a consumer-oriented time-sharing network which allows two-way communications with a central computer through an interactive home terminal. Teletext involves one-way transmission of text and graphics through the vertical blanking interval (VBI) of a regular television transmission, or through a full cable channel.

According to IRD, telegambling would be a boon to advertisers on Videotex and Teletext systems, and would serve to weaken organised crime and the underground economy. The situation is also a 'natural' for the major television networks that are set to launch Teletext systems.

"These networks carry a great deal of sports programming. The provision of telegambling would surely serve to boost ratings and advertising revenues for the networks," says IRD's report.

IRD sees potential for a cable network devoted exclusively to television programmes designed around gambling.

"This telegambling network could feature dramatic shows on which the viewer could place bets as to the actions of particular characters, similar to the informal betting that occurred with the *Who Shot JR?* episode of *Dallas*," explained IRD researcher Dave Ledecky.

"People will bet on just about anything. They'll bet on the sunrise, as long as it's easy and convenient to do so."

Further information on the US$1285 report, which is entitled *Teleshopping*, including a free description and table of contents, are available from **International Resource Development, 30 High Street, Norwalk, CT 06851, United States. Telex 643452.**

BOSCH'S ELECTRONIC DRIVER

Bosch has become the first European manufacturer to market a fully electronic instrument cluster for passenger cars.

The Bosch cluster, installed in the latest production versions of the Audi Quattro, has green vacuum-fluorescence displays which are used for presenting the information.

In addition to the functions of the conventional instrument panels, such as speedometer, tachometer, fuel gauge and indicator lamps, there is an integrated trip computer. This provides instantaneous consumption, average consumption, average speed, range on tank, driving time and time of day.

The driver can also select a 'minimum-display mode' in which only the road speed, mileage indicator and trip meter are shown. In critical cases, such as high coolant temperature, less than 10 litres in the fuel tank or a continuous driving time of more than two hours, the relevant individual display automatically flashes.

For more information, contact **Robert Bosch Australia, P.O. Box 66, Clayton Vic. 3168.**

STOP SHAKING, WE'RE ON VIDEO

Fresh air has been used to guarantee a vibration-free picture from one of Australia's most sophisticated video installations, at the new Sydney Entertainment Centre.

The centre's $500,000 Swiss Eidophor projector has been mounted on a platform suspended upon inflatable rubber springs.

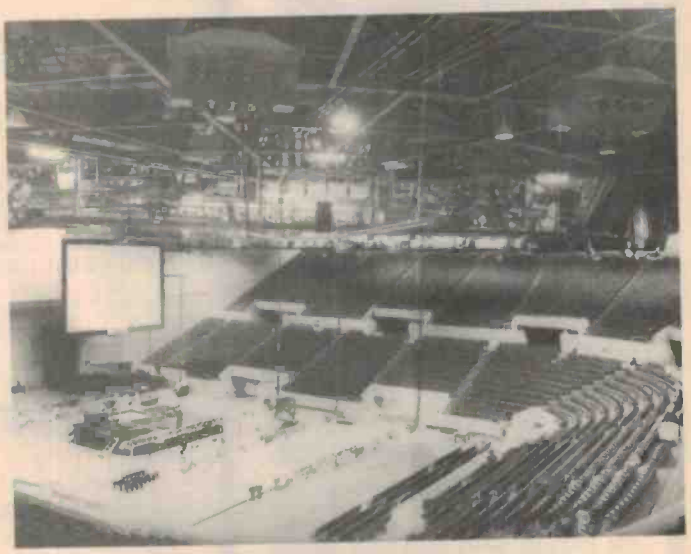
The method employs a principle which can also be used by transport companies, computer firms and industry to isolate sensitive loads and equipment from shock.

The projector is mounted on a catwalk high within the centre to throw images up to 11 metres by 7.3 metres on to a screen below.

The potential problem was that any vibration — higher frequency from footballs, or lower frequency from flexing of the box-girder roof — would have been magnified on-screen.

The solution, devised by the projector's importer, Hawker Pacific, in conjunction with Air Springs Supply, was to mount the camera on the platform incorporating air springs inflated by a compressor.

A total of six Model 116 single convoluted air springs of 228 mm diameter were used to suspend the 500 kg camera, which is used to provide spectacular backdrops, close-up and replays of performances.



For further information, contact **Air Springs Supply, 137 Bowden Street, Meadowbank NSW 2144. (02)807-4077.**

JAYCAR No.1 for Components

A minor revolution is going on around the world in the semiconductor industry at present. Many Digital IC's (i.e. 4000 series CMOS and 74LS TTL) have almost doubled in price in the past 3 months! This is bad enough but the lead time (i.e. delivery from the manufacturers) has gone from 2-3 days to 4-6 months! Linears are seriously affected also. This is very bad news for all of us — especially for our kit production. To offset this serious problem, Jaycar has allocated a massive increase in funds to finance larger stockholdings. We have had to do this to try to overcome the very long delays that are currently occuring. Unfortunately on many occasions we have had to pay much more than we normally pay for semis. We are holding our prices where we can but, inevitably, there are price rises. We have committed ourselves to pare our operating margins to the bone so that price increases cause as little hardship as possible.

But even in the middle of all of this, we are STILL able to bring bargains in semiconductors to you!!

Check the specials below and SAVE!

JAYCAR — No. 1 FOR SEMICONDUCTORS

6116 RAM

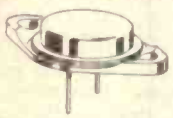
WE RE $12.50

Cat. ZZ8430

NOW $8.95
10 + $7.95 ea

6116 RAM — check us first!
The price on this one appears to have "bottomed out". Lately we have seen price increases in fact. To keep our prices to you as low as possible we have bared our margins to the bone!
Right now you can buy the 6116-P3 from us for only $8.95! 10 up $7.95 each
Remember Jaycar prices include sales tax and IC's are packed in quality Velostat foam — a must for safety!
Cat. ZZ-8430 $8.95 each — 10 up $7.95 each

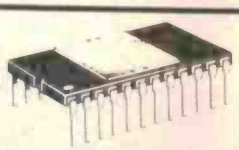
MJ802/MJ4502 POWER TRANSISTORS



VERY RARE BEASTIES!!

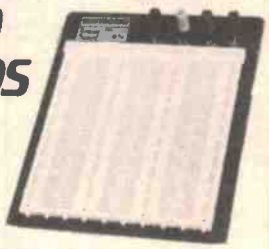
Legendary Motorola Power Transistors
The MJ802/MJ4502 are an NPN/PNP complimentary bipolar transistor pair designed for high power audio amplifier applications. They feature matched gain, 30 amp collector current and a Vce of 100V. They have a case dissipation of 200 watts. Jaycar is one of the few stockists of these devices.
MJ802 Cat. ZT-2232 $7.95 10 up $7.25
MJ4502 Cat. ZT-2234 $7.95 10 up $7.25

2764 EPROM SAVE OVER 50%



This is a quality Japanese made 64K EPROM. This is the single +5V power (for read operation).
We sold this unit recently for $35. Now they are realistically priced at only $14.95 & $12.95 10 up.
Cat. ZZ-8464

EXPERIMENTER BREAD BOARDS



FROM ONLY $3.45 EACH

Cat. PB8810 WBDN 100 holes $3.45
Cat. PB8812 WBTN 640 holes $10.95
Cat. PB8814 WB2N 840 holes $16.95
Cat. PB8816 WB4N 1680 holes $29.50
Cat. PB8818 WB6N 2420 holes $45.00

SAB0600 DOOR CHIME IC

SAVE $2.50

This is the fabulous "DOOR CHIME" IC which plays melodic chords. Normally this unit sells for $12.50 for September only — $9.95! A saving of over $2.50
For each SAE0600 sold, we will provide a free circuit diagram of a complete Door Chime!
Cat. ZK-8860 $9.95

TK-104 KNOB SAVE OVER 50%

This deluxe knob is fitted with a brass bush with grubscrew to take a ¼" diameter shaft. The knob measuring 27mm high features a wide skirt (36mm dia.) with a metal panel indicating 0 at centre and 5 units on either side of centre.
It is ideal for control or test equipment. We have a surplus quantity of these knobs. Normally they sell for $0.85 cents.
Cat. HK-7549

Sept. only $2 for 5 unbelievable price 40c EA

10 AMP/400V BRIDGE RECTIFIER

SUPER RED HOT PRICE
ONLY $2.45 each — $1.95 each 10 up
Die cast base, ¼" "Quick Connect Terminals"
Cat. ZR-1315

FROM $1.95

FROM $1.95

TAA611B

TAA611B * Low distortion * Over 2 watts RMS output! * High input impedance * 6-15 volt rail * Low quiescent current
Buy a TAA611 B for September only and receive a free spec. sheet with two recommended amplifier circuits!
LOW COST AMPLIFICATION!
Cat. ZL-3750 ONLY 50 cents!

UAA180 LED LIGHT BAND DRIVER

This device will drive up to 12 LEDs in linear fashion from an analogue voltage input. (As used in the EA/Playmaster AM Tuner). Ideal for any low cost LED driver application. Normally $3.50 each. September only $1.95 each. Save a fortune!!

TWIN SCREENED AUDIO CABLE

Twin screened round audio cable. (Two screened conductors NOT fig '8')
This cable normally sells for $0.48/metre or $42.00/roll.
For September only $20.00/roll!!!
Cat. WB-1504 $20.00/roll

SAVE OVER 50%. . .

BD677 DARLINGTON TRANSISTOR

BD677 Popular Philips Darlington Transistor
The BD677 is an NPN, TO-126, 60 volt 4 amp Darlington transistor. Its gain (hFE at 1.5A) is — would you believe 750!
We have a bulk-buy of this snappy little transistor so you save!
ONLY 75 cents each 10 up 65 cents each

FROM 65

24 VOLT CRADLE RELAY

What can we say? 24V DC coil, 4PDT gold flashed contacts. Quality brand. Complete with cradle relay socket worth $0.50 alone.
Relay normally $4.95. This month $2.95
Limit 2 per customer.
Cat. SX-4010

SAVE $2.00!!

BT151-650R

This is the 650 volt version (for extra safety) of the C122E SCR which we use in the popular 'Fluorescent Lamp Starter' Kit as described in October 1982 EA. Normally $1.50 each. This month only $0.95 each! (Minimum 5 pieces). Makes the Fluoro starter kit very cheap!
(PCB's for the kit) Cat. HP8747 ONLY $1.95

Cat. ZX7022
(8 amp 650V SCR)

1N914 DIODES — INCREDIBLE SAVINGS

The 1N914 (or 1N4148 if you like) is probably the most popular diode in the history of electronics. We probably use over 1M a year ourselves! Jaycar has made a bulk purchase of these diodes and we can pass on great savings!
We must sell these in minimum lots of 500.
Cat. ZR1100 1N914/1N4148
500 ONLY 3½ cents each
1,000 ONLY 2.8 cents each
10,000 ONLY 2 cents each and these prices include tax!!
The glass envelope is really too small to have markings, however some are branded. We reserve the right to supply units that are the same size as the 1N914/1N4148 but are electrically superior.

FROM 2 cents each!!!

RACK CABINETS

Beautifully crafted all aluminium rack cabinets with top and bottom removable panels. Plain or black finish. Ventilated lid. Deluxe brushed anodised front panel. Supplied in flat pack but take only minutes to put together. Dimensions conform to International Standard.

Cat. No.	Finish	Front panel height	Price
HB5411	Plain	44	$39.95
HB5410	Black	44	$39.95
HB5413	Plain	88	$49.50
HB5412	Black	88	$49.50
HB5415	Plain	132	$54.95
HB5420	Black	132	$54.95

JAYCAR

SEE PAGE 77 FOR JAYCAR ADDRESSES AND PHONE NUMBERS

IREECON 1983
SYDNEY SHOWGROUND
SEPTEMBER 5-9, 1983

Sony (Australia) Pty. Ltd.
has much pleasure in inviting
All IREE Delegates
to enjoy their hospitality
at the
Sony IREE exhibition in the
Ford Pavilion
and to view the release of an
exciting range of new
Broadcast, Institutional and
Pro-Audio equipment.

SONY®

CAMBRIDGE COMES TO AUSTRALIA

Cambridge Learning, the British publisher of educational books and kits, has launched an Australian subsidiary, Cambridge Learning Australia.

The parent company is well known in Britain, the United States and the Middle East for its electronics and computing self-instruction courses, all of which use the easy-to-follow 'programmed learning system'.

The company's best-seller is *Cambridge Learning Superkit*, a self-instruction course in digital electronics. It comes with a 'breadboard' on which the user can build all the circuits, without soldering, so the components can be used repeatedly. The kit, complete with manual, components and breadboard, costs $40.50, including postage and packing.

For more information, write to **Cambridge Learning Australia, P.O. Box 173, Kwinana WA 6167.**

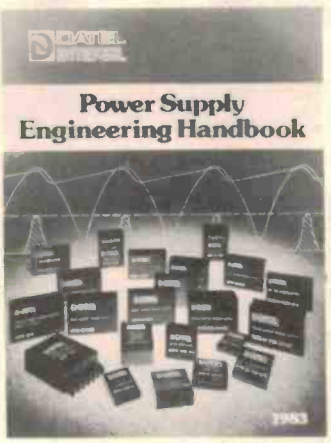
POWER-SUPPLY HANDBOOK

A new 40-page, full-colour power-supply handbook by Datel-Intersil details the electrical and mechanical parameters on more than 175 power suppliers.

The line of power conversion products includes modular encapsulated single, dual and triple output and chassis mounts; modular switching; plug-in power adaptors; dc-dc converter modules 1-10 W miniature 4.5 W dc-dc converters; and 24 V and 48 V dc-dc converter modules.

The handbook, which is free, is complete presentation to the design engineer.

Detailed specifications on Datel-Intersil's power supplies are presented in tabular form and includes complete case, pin and socket configurations. Additionally, an outline of modern power-supply principles and practices and a section on power-supply terminology have been incorporated.



For more information, contact **Elmeasco Instruments, P.O. Box 30, Concord NSW 2137. (02)736-2888.**

'ULTIMATE' POCKET PAGER

Visibeeper, claimed to be the 'ultimate' in pocket pagers, has been launched in Australia.

Visibeeper, which clips on to a belt or fits into a purse or pocket, has a small screen on which messages can be delivered in words and numbers.

Text messages of up to 80 characters are received directly by the pager. As many as four messages, totalling 160 characters, can be stored in the pager's memory.

At the user's command, the message moves across the instrument's readout screen. The readout can be stopped and held.

DataPage, which markets Visibeeper, has installed a computer and radio transmitting network which allows messages to be sent to Visibeepers anywhere in Metropolitan Sydney or Melbourne.

People wanting to send a message to a Visibeeper user phone the DataPage communications centre, where the message will be entered into a VDU terminal and transmitted. Alternatively, businesses can set up their own VDU and datalink into the computer and transmit messages without any DataPage operator intervention.

DataPage is the marketing arm of **Advanced Communications Australasia, Building C, World Trade Centre, Flinders Street, Melbourne Vic. 3000.**

BOOST FOR BIONIC EAR

The Federal Minister for Science and Technology, Mr Barry Jones, has announced that a further $2 million will be expended to develop the implantable hearing prothesis (bionic ear) through clinical trials and into commercial production.

The Department of Science and Technology will provide 75% of the amount. The rest will come from Nucleus Ltd, the Sydney-based electronics firm which will conduct the trials.

"This agreement will ensure the progress of high-technology industry in Australia, and help nerve-deaf people with a profound or total hearing loss, through the world," Mr Jones said.

The clinical trials will bring the project to the stage of determining its suitability for world marketing. The United States is the main export market for the device, and it is necessary to prove the safety and efficacy of any such product to the satisfaction of United States Food and Drug Administration.

Nucleus Ltd will co-ordinate the systematic analysis of 100 experimental human implants in centres around the world, and advance essential support systems such as training packages for patient selections, surgery and rehabilitation, moving the project closer to full commercialisation.

The Department of Science and Technology has already contributed $3 million to the project under the public-interest provisions of the Australian Industrial Research and Development Incentives Act.

The University of Melbourne initially developed the 'bionic ear', which is based on the principle of electronically receiving, processing and coding sounds on a manner similar to that which occurs naturally in the nerve fibres of people with normal hearing.

A coded signal is sent by an external worn transmitter to a miniature receiver-stimulator implanted behind the ear. This converts the signals to electrical impulses which are conducted to the inner ear, where the nerve fibres are stimulated electrically to enable the nerve-deaf to recognise speech and other sounds.

The clinical trials are expected to take about 18 months, with the device being commercially available by the mid-1980s.

For further information, contact **Nucleus Ltd, 14 Mars Road, Lane Cove NSW 2066. (02)428-1011.**

LOOK AT THESE EXTRAS YOU GET WITH FLUKE MULTIMETERS

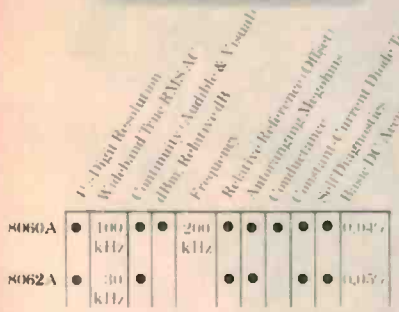
8060A OFFERS FREQUENCY, TRUE RMS & DIRECT dB

This remarkable state of the art DMM combines the accuracy and resolution of larger, more expensive instruments with the convenience of a hand-held instrument. Flukes own LSI/microcomputer design provides:

- Wideband true RMS AC measurements to 100kHz
- Frequency measurement to 200kHz
- dBm and relative dB
- 10μV sensitivity
- Direct resistance measurement to 300Meg
- Relative reference on any range or function
- Microcomputer-based self diagnostics

8062A

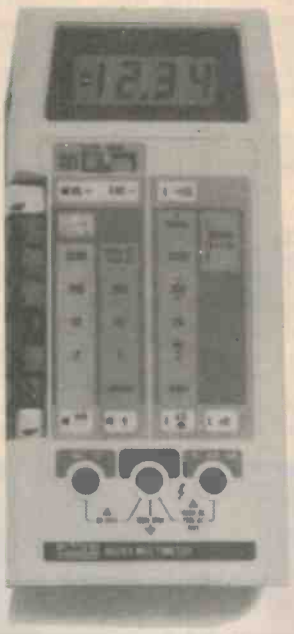
As 8060A above but without frequency and dB ranges. Provides true rms to 30kHz and relative reference functions.



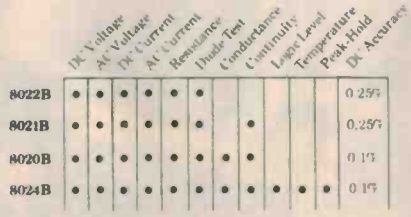
8024B OFFERS PEAK HOLD AND DIRECT TEMPERATURE

The 8024B state of the art multimeter offers two important extra features – peak hold and temperature. Peak hold is a useful tool for capturing and retaining elusive voltage or current surges long enough to check and record the displayed reading. If your work involves measuring temperature then connect a K-type thermocouple and you can get direct temperature readings (we have a range available specially to suit the 8024B).

- 11 functions including temperature with K-type thermocouples
- Peak hold on voltage and current ranges
- Logic detection and continuity
- Audible and visible indicators
- 0.1% basic accuracy. 3½ digit



CHECK THE COMPLETE FLUKE 8020B SERIES



8026A OFFERS TRUE RMS AND CONTINUITY TESTING

The 8026A is the latest addition to the Fluke range and offers the advantage of true rms readings on ac functions. While most meters measure ac voltages almost all use the average-sensing, rms-scaled technique. In many applications average sensing does not give an accurate result – especially with non-sinusoidal waveforms. If you work with motors or data transmission type circuitry, true rms is critical to your measurements. For quick circuit checking the 8026A also incorporates the Fluke high speed continuity beeper.

- 8 functions
- True rms AC measurements to 10kHz
- Conductance and diode testing
- High speed continuity beeper

FLUKE®

SOLD & SERVICED IN AUSTRALIA BY

ELMEASCO
Instruments Pty. Ltd.

All prices are plus Sales Tax if applicable and subject to change without notice.

P.O. Box 30, Concord
N.S.W. 2137
13-15 McDonald Street,
Mortlake, N.S.W.
Telephone (02) 736 2888
Telex 25887

P.O. Box 107, Mt. Waverley
Victoria 3149
21-23 Anthony Drive,
Mt. Waverley, Victoria
Telephone (03) 233 4044
Telex 36206

Adelaide: (08) 271 1839
Brisbane: (07) 369 8688
Perth: (09) 398 3362

bankcard

SEND FOR YOUR FREE MULTIMETER GUIDE

Please send me details of Fluke DMMs
☐ 8060/62 & 8050 ☐ 8020B Series

NAME _____

ADDRESS _____

_____ P CODE _____

TELEPHONE _____

N.S.W. Ames Agency 699 4524 • George Brown 519 5855 • Davred 29 6601 • DGE Systems (049) 69 1625 • Radio Despatch 211 0191 • Vimcom (042) 28 4400 ***VICTORIA*** Radio Parts 329 7888 • Browntronics 419 3986 • G.B. Telespares 328 4301 • Etanco 428 4345 • Ellistronics 602 3282 ***QUEENSLAND*** L.E. Boughen 36 1277 • Colourview Wholesale 275 3188 • Audiotronics 44 7566 • Electronic Shop (075) 32 3632 • Nortek (077) 79 8600 • W.G. Watson (079) 27 1099 ***S.A.*** Protronics 212 3111 • Trio Electrix 51 6718 ***W.A.*** Atkins Carlyle 321 0101 • Hinco Eng 381 4477 • Brookeades 276 8888 • Protronics 362 1044 ***A.C.T.*** Actiec (062) 80 6576 ***N.T.*** Thew & McCann (089) 84 4999 ***TAS.*** G.H.E. Electronics 31 6533 & 34 2233

CROWDS FLOCK TO AUSTRALIA'S ONLY CONSUMER ELECTRONICS SHOW — IN PERTH

An estimated 110 000 people flocked to Perth's Claremont Showground to see all the latest and greatest in audio, video and home electronics gear from 90 exhibitors over four days in the first week of August.

Exhibitors crowded into the three largest pavilions available, the overflow taking another six pavilions. Last year's show took up only two pavilions and attendance was around the 80 000 mark. Since the Sydney CES show folded a few years ago, Perth's Electronics Show, now in its fifth year, has taken the industry (and W.A. consumers) by storm.

A wealth of new products — not yet released to the huge eastern states market — was on show, attracting enormous attention.

Two-speed VCRs were legion. As Akai found out, first in doesn't always mean best dressed (it released its VS4 two-speed VCR last March). National Panasonic, Sharp and AWA released two-speed machines — all up-market from the Akai, but the VS4 holds the lowest price point in the market at $899.

National's NV-788 is a five-speed machine. Two are used for normal speed, a different pair for long play and the fifth head for rock-solid freeze frame without noise bars. It automatically knows what speed the tape was recorded at and switches to the correct replay speed. It will sell at $1399 retail.

Sharp's two-speed VCR has four heads and is based on its current stereo machine, although the two-speed machine will not have stereo sound. AWA's machine is a four-head stereo model.

The big attraction on almost every stand was the digital disc. New machines were legion. Arena Distributors had a Dual-model CD120 (from Falk Electrosound). This one, like most, plays the disc vertically and in typical Dual style, the player's panel layout is straightforward and pragmatic.

Arthur Muldoon, from Falk, was there, and he told me that NAD would release its CD player early next year, featuring demultiplexing and dual channel D-A conversion. Sounds interesting.

Pioneer was surrounded on two sides (true! — you had to see it to believe it) by Marantz and Hitachi. After two days of absolute furore from CD demonstrations, they decided that everybody would get a go if they took it in turns. The most-popular tracks from the Polygram demo disc were Roxy Music (all 6dB of dynamic range), Chariots of Fire (sounding like helicopters in the jungle) and the 1812 Overture (speaker cones at five paces).

I was looking forward to seeing the Luxman (is it still around?) CD player, but local importer Vince Ross unluckily missed getting one in time for the show. Rank-NEC had one display, too. I think it's black and has a digital display, but it's hard to see thorough four-deep crowds.

Philips had its (after all, it started this!) and I actually saw a National Technics CD player for the first time here since I saw it in Japan last year. Technics, you're slow. JVC followed the trend to black (Philips and Marantz having silver and gold — they gotta be different) and Sony's CDP101 also attracted a lot of attention. I was surprised K-Tel wasn't there with CD player and spin dryer (also available on cassette).

For something completely different, Danish hi-fi (why does that name always make me think of pig's ear pastries?) had Bang and Olufsen's 'Master Link' hi-fi system which lets you have sound in every room of the house and to be able to control it from wherever you are. The 7002 Master Link has a sophisticated microprocessor controller and a special bus cable that carries the audio wherever you want it, plus the control lines. Styling is typical B&O, as is the price.

Getting back to video, JVC was showing off its latest camera, which features a tube that works with light levels down to 10 lux — pretty well the light left after you've blown out the candles. But it couldn't seem to hold a candle to Sony's video attraction — the Betamovie camera. Maybe it was the Sony girls dressed in the leotards that did it.

Convoy, more renowned for its Nakamichi and Monster Cable products, has entered the video fray with a highly unusual product. It's a stereo sound processor for VCRs that also cleans up the noise and enhances the dynamic range. If you've got mono tapes you can give them stereo sound as well as adding considerable sparkle to the reproduction.

Hip stereos were everywhere (K-Tel, where are you?). But Sony has stolen the march on everyone again and produced a sportsman model that works underwater (and sand, and snow, and . . .).

I haven't got around to the video games, home computers and similar paraphenalia yet, room's running out and this is Sight & Sound, anyway. Watch for the Electronics Show Report in next month's ETI.

Easterners frustrated? Well, you could try National's "Shaping the Future" C.E. show at Sydney's Centrepoint from 1-9 September.

—ROGER HARRISON

KEYBOARD CASSETTE DECK

Due for release in Australia in September, AIWA's three-model AD-F triple-head cassette deck series has been designed to meet the demands of all types of programme material, whether digital or analogue.

The range features Dolby's HX Professional circuitry, a new system which ensures that signals at all volume and frequency levels receive the ideal amount of bias during recording.

Other features include a keyboard-style control panel, micro-grain dual capstan transport, automatic de-magnetising, automatic tape adaptation for bias, sensitivity and equalisation, and a tape-remaining time display.

The top-of-the-range model is the AD-F990, which will retail at $729. The mid-range model AD-F770 will have a $599 tag, and the AD-F660 will be $499.

All three models share the same dimensions, 420 x 110 x 280 mm. Weight is 5.5 kg.

A cordless remote-control handpiece, the RG-R200, will be available as a recommended optional extra.

THE COMPACT DISC GOES MOBILE

The latest advance in sound, the compact disc player, has recently arrived on the Australian market, and Mitsubishi Electric has stolen a march on the market and installed a compact disc player in a car. It will appear for the first time in Australia at this year's Sydney Motor Show.

The advanced technology of the compact disc will offer many advantages for the car sound enthusiast, including improved protection against damage. The laser-based player will provide superior music reproduction range and stereo separation, and can counteract the problems of road noise, Mitsubishi claims. The 115 mm compact disc is also easily stored.

Mitsubishi Electric's car audio digital disc player is expected to be available on the Australian market next year and will retail at approximately $1000.

BRISBANE HI-FI EXPO

Queensland's electronic enthusiasts will be kept up-to-date with the latest hi-fi and video developments at the Hi-Fi and Video Expo '83, from September 9-11 at Brisbane's Park Royal Motor Inn.

One of the largest shows of its type staged in Queensland, the Expo will be a showcase for the digital audio disc, with up to 10 manufacturers demonstrating the new laser technology.

For more information, contact the show organiser, **Robert Woodland, 50 Sherbrooke Road, Acacia Ridge Qld 4110. (07)372-3380.**

PROFILE II TONEARM

Pro-Acoustic's Profile II tonearm, now available in Australia, utilises design techniques which the Canadian manufacturer claims reduce tonearm anomolies and permit proper interface to the cartridge.

The result, Pro-Acoustics says, is maximum retrieval of information and minimal colouration.

The Profile II has an aluminium headshell, which is fitted with Litz wire leads and gold-plated cartridge tags. It is detachable, but mates tightly to the arm tube, while high-spring tension on the gold-plated pin contacts ensures ideal electrical contact.

The arm tube is stepped to break up resonances during play. Residual resonances are terminated by precision hardened bearings — two bearings for vertical movement, in a gimbal, and two for lateral movement, located inside the arm pillar.

The rear counterweight is decoupled and disc-shaped to allow close placement to the pivot point, reducing inertia and resonances further still.

Priced at $169, the Profile II is handled in Austraia by **Convoy International, 400 Botany Road, Alexandria NSW 2015. (02)698-7300.**

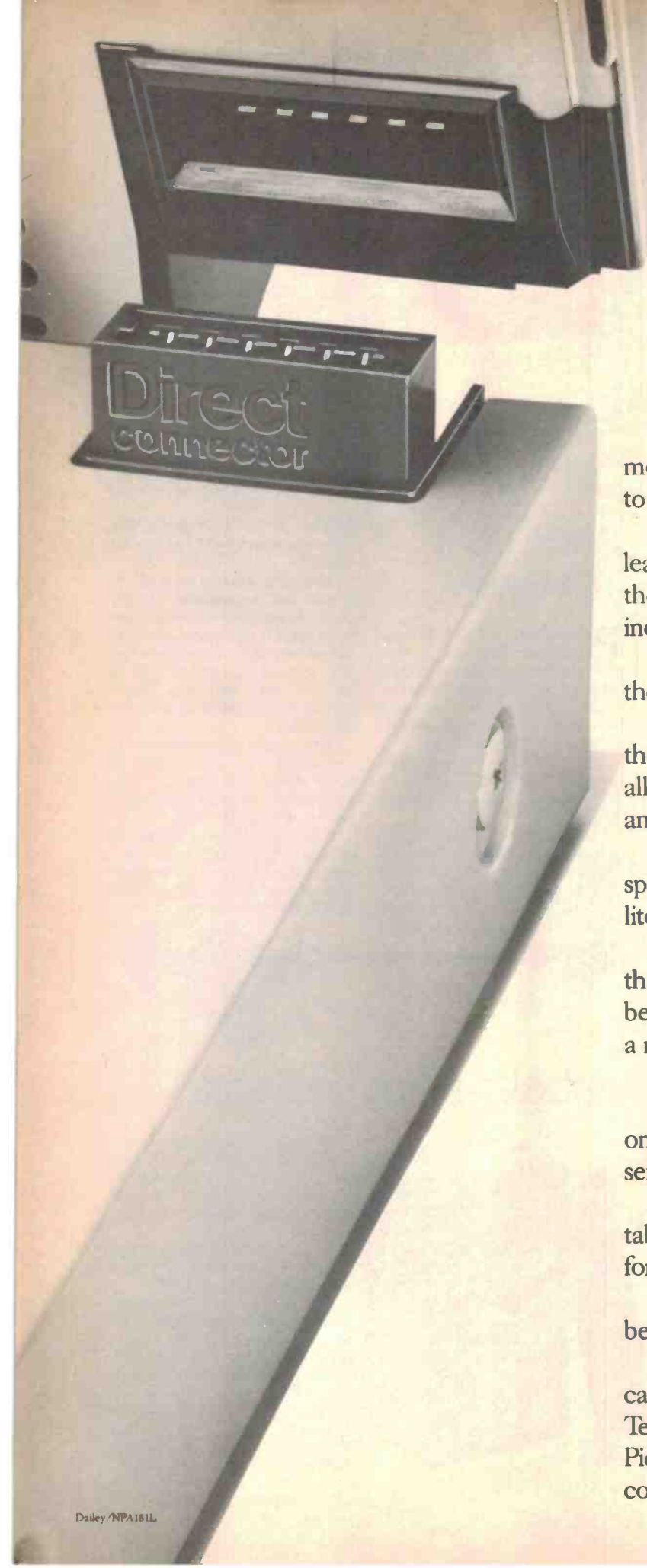
BUDGET-PRICED SPEAKER

Concept Video has introduced the MS20, a 200 mm two-way high performance unit, to its Mordaunt Short range of loudspeakers, imported from Britain.

The bottom-of-the-range MS20, which has a five-year guarantee, retails at $398.

The Mordaunt Short range now comprises the MS20, Carnival 3, Festival 3, Pageant 3 and Signifier speakers. The top-of-the-range Signifier is priced at $1998.

For further details, contact **Concept Audio, 17/98 Old Pittwater Road, Brookvale NSW 2100. (02)938-3700.**



Why Direct

Don't tangle with Technics.

The majority of audio systems – even the most beautifully designed – have something ugly to hide.

It's that mass of jumbled-up connecting leads that you find, all too easily, at the rear of the equipment. Not only are they ugly, they're inconvenient, too.

And as audio components become smaller, the problem becomes bigger and more unsightly.

To solve this problem, Technics developed their Direct Connector systems, which eliminate all audio connecting leads between the tuner, amplifier, graphic equalizer and cassette deck.

Each of these components features a special flip-up connector to allow them to be literally plugged in to each other!

It's an elegant piece of Technics technology that results in a stylish, neat installation that can be put together or taken down for re-location in a matter of seconds.

The 315 Series.

But Direct Connector capability is not the only innovative feature in this new and compact series from Technics.

The SL-5 direct-drive, linear-tracking turntable employs its own plug-in connector system for the pickup cartridge.

This unique Technics development has been adopted as a World Standard.

It means you can compare and evaluate cartridges from leading manufacturers like Audio Technica, Ortofon, Shure, Stanton, Empire, Pickering, ADC and, of course, Technics without conventional setting up procedures.

Technics developed Connector systems.

No adjustment of tracking weight or bias correction is needed.

The innovations continue in the rest of the components: the SU-5 amplifier includes a Super Bass switch to enhance the bass response of a speaker system without inducing bass boom; the ST-5 quartz synthesizer digital tuner provides random access memory for 16 pre-set stations; the SH-E5 graphic equalizer – offers adjustment of 12 audio bands from 16Hz to 32Hz on each channel; whilst the RS-5 cassette deck – has soft touch controls, auto selection of metal, CrO_2 and normal tape settings plus convenient Cue and Review functions.

Finally, a pair of SB-F5 speakers with horn-type tweeters and bass reflex porting turn the high quality electrical signals of the rest of the system into the high quality sound you expect.

Compact components, full-size warranty.

All components in this series are perfectly matched in styling and performance.

And all are covered by a full 2-year warranty backed by Technics' reputation. Visit your Technics stockist soon and experience the superb styling and brilliant sound of Technics' compact Series 315 for yourself.

Technics 2 Two Year Warranty

Technics

National Panasonic (Australia) Pty Ltd

Expanding the music experience.

Dailey/NPA181R

Compact disc players — *fact* not fiction

Are compact disc players really as incredible as they are claimed to be? Can all those amazing statements flourished by the press about these revolutionary units really be true?

Louis Challis

I DON'T WISH to be critical of some of the articles written by my fellow writers, but I must state from the outset that not all I have read about compact disc players is actually true.

I am a bit of a pedant on the need for accuracy on what goes into print (as is the editor), so I am going to try to set the record straight on some of the more outrageous statements.

THE FICTION

"Compact discs don't suffer from the scratch problems of micro-groove records because they are tracked optically by a laser, not by a stylus."

THE FACT

Well, that statement isn't really correct as you can scratch a compact disc. And if it is scratched badly then the damage will be almost as effective as a scratch on a microgroove record.

A bad scratch on a disc will cause the CD player to either reject it, stop tracking or have an apoplexy, depending on the brand of player.

We played a thoroughly scratched disc on four different players and observed four different responses. Most of the players had difficulty in tracking various sections of the scratched disc and at least two of them seemed to suffer a case of what I can only describe as 'electronic apoplexy'; they stopped tracking, stopped working and switched themselves off.

However, all is not lost if the disc is only mildly scratched as it can be gently polished back to a playable state with a mild abrasive polish, followed by careful wax polishing. This is something you cannot do with a microgroove record.

THE FICTION

"All compact discs are virtually indestructible."

THE FACT

I was quite amused when I read this statement in the Bulletin, June 21, 1983.

I had received one disc from Pioneer Australia which had been very badly scratched, and innumerable discs from other suppliers which had suffered various degrees of scratching. So I know that the discs are not indestructible. They can be damaged by mechanical handling or simply from normal abuse.

I was extremely concerned that the compact discs are liable to thermal distortion, particularly in cars where the temperature under the dashboard is known to exceed 65 °C in typical Australian summer conditions.

I was aware that such temperatures affected conventional compact cassettes, particularly the cheaper thermal plastic types, causing them to droop and seal themselves into your unsuspecting cassette player. So I felt that we should find out how compact discs reacted under these conditions.

We took a brand new and playable compact disc and placed it into our controlled temperature oven which produces temperatures up to 80 °C. We monitored the droop characteristics of the disc when it was edge-supported in a horizontal position and the best distortion we could get out of it was a 1 mm droop after 24 hours at 80 °C.

We then took the same disc and placed it in a controlled temperature bath in which the water was circulated and slowly raised to boiling point. Even at 100 °C the disc retained its shape and suffered no adverse effects. We were able to play it without any ill effects in three different CD players.

We did note, however, that at that temperature there were positive signs of surface softening on the disc, but we did not prolong the agony to find out how long you have to boil your disc to make it 'whiter than white'.

If you are prepared to store, play or subject your compact discs to temperatures of 100 °C, do so with our blessings and commiserations.

The sample disc we tried to destroy was provided by Philips, but we feel reasonably sure that Sony-CBS and the other producers have also taken the time and the trouble to specify a thermal plastic which is not going to melt in either your automotive or residential CD player.

The thermal resistance of the sample disc we tried to destroy was better than we expected but it is nonetheless clear that the CD discs are destructible. I believe that it is unwise for the manufacturers or their marketing personnel to suggest otherwise.

THE FICTION

"Different CD players sound different even when played with the same compact disc."

THE FACT

When I first read that statement I was sceptical, as you probably are too. So we put the issue to test and took four different CD players from four different manufacturers and played them through the *same equipment* in my living room.

The job was made a bit easier as three of the manufacturers had each provided a copy of the Polygram demonstration disc 800-104-2. This made it feasible to set up two machines with the music almost synchronised and it was possible to switch from one player to another in groups of up to three.

Lo and behold, I believe that I could hear small but discernible differences between the individual CD players and my family backed me up by confirming the phenomena. Unlike the other illustrious gentlemen who had rushed into print, I did not feel that I was justified in saying anything unless I could back up my statements. I believe that I should be able to explain why there was a difference and present some objective evidence.

My staff and I set out to determine *why* these differences should exist in the audible content.

We discounted the compact discs used as we believe they are a common element. So all we can possibly have left is the digital to analogue converter and the subsequent amplification stages in each CD player.

We believe that it is in these areas where there are significant differences between one manufacturer's machine and the next, and maybe between two machines of the same type.

"How can that be?" you say. Well, it's easier than you think. The problem is that each CD player uses a monolythic 16-bit or 14-bit digital to analogue conversion chip. The chip's conversion from digital format to analogue format is intended to be absolutely linear, however, this never really

occurs and each chip has some small degree of non-linearity inherent in its conversion characteristics.

Our detailed measurements on four sample machines, from four manufacturers, revealed small but measurable (and we believe audible) differences between the machines, particularly at levels between -30 dB and -90 dB relative to 0 dB (the theoretical maximum) recorded level.

The total harmonic distortion (THD) levels measured between -60 dB and -90 dB were very significant and far more so than at high signal levels where our measurements confirmed that they are *incredibly* low.

By contrast, the absolute converse is true for microgroove records which tend to have lower distortions at low signal levels and higher distortions at high signal levels.

THE FICTION

"Panels of listeners prefer the sound from conventional microgroove records to that from compact discs."

THE FACT

Well, that statement may be either right or wrong depending on how they were assessed, what software was used for this assessment and what questions were asked following the assessment. Obviously you can get any answer you want to any proposition, merely by selecting your sample (audience and software) and by posing your questions *in the appropriate manner*.

The facts are simple; if the programme content or the *same* signal is originally recorded on an *analogue* tape recorder and is then recorded on both microgroove records and compact discs, the resulting sound *is* different. Some auditors will think that the conventional records sound better and some will prefer the sound on the compact disc.

The fact of the matter is that virtually all the pre-recorded content that I have listened to on compact discs appears to incorporate a higher proportion of high frequencies than the same material recorded on either half speed masters (45 rpm microgroove records) or conventional high quality microgroove records.

The reasons for this have not yet been positively confirmed. However, I believe it may be a result of the mix-down equalisation characteristics which are selected by the record or disc producers. These characteristics obviously need to be slightly different for each format and appear to be inappropriate on a number of new compact discs recently imported into Australia.

The only sure way of confirming this will involve considerable ingenuity and, in particular, assessment of the record production facilities at one or more of the major software mix-down facilities overseas. Needless to say, I am going to follow this one through.

The assessment of the differences between compact discs and conventional microgroove records is also affected by the equipment used when the programme content is being recorded. If the software was digitally recorded before being transferred to records and discs, the differences between them can almost be paraphrased as being 'astounding' and, in my opinion, 'incomparable'.

I make this statement unabashedly after having played two different selections which I possess on two microgroove records; one of them was based on an analogue recording, the other was from a digital recording. These were subjectively compared with the same material presented as two separate recordings on compact discs.

Following this assessment, it is easy to state categorically that the compact disc is clearer and more realistic than the conventional microgroove records. More importantly, the background noise heard on conventional records, due to the interaction of the stylus with the vinyl surface and often dust as well, is completely absent.

THE FICTION

"You don't need new equipment with a CD player as all your old equipment is fully compatible."

THE FACT

Well, after testing six different CD players and using them with a wide range of consumer high fidelity equipment, I must say that I disagree with that statement. If your old equipment is good, i.e: if you have a good amplifier with a power rating of better than 100 watts peak output power ▶

A badly scratched disc. Most CD players will have difficulty tracking bad scratches, with audible results.

and your speakers are equally good, then the chances are that your system will be compatible with a CD player.

However, if your amplifier is a modest 20-40 watts unit and your speakers are nondescript then I think that you would be wasting money to buy a CD player. Not only will you be unable to extract the full dynamic range, but more significantly, chances are that the distortion and intermodulation characteristics of your speakers will stand out like a sore thumb.

I used a large number of different consumer amplifiers and loudspeakers to make up several combinations of hi-fi equipment with the CD players, to compare the sound when playing compact discs. It soon became apparent that using a low power amplifier, and especially if a set of nondescript speakers was used as well, could do terrible things to the quality of the sound.

If the amplifier is driven to peak levels anywhere near overload, which of course depends on the level at which you play your system, then the likelihood of inducing peak clipping ranges between 30 times and 100 times more often than it would occur if a microgroove record or cassette tape was the program source.

Quite apart from that, the loudspeakers are then subjected to their own 'trial by torture' as they attempt to reproduce the wide dynamic and frequency range, the likes of which they most probably have never come across before.

The results of listening to wide ranging and uncompressed music may well be to your ears what they were to mine — disturbing, to say the least. Good speakers sound good, poor ones sound terrible.

The moral of the story is, if your equipment is nondescript you should seriously consider upgrading your speakers and amplifier to better units before you spend money on buying a CD player.

THE FICTION

"Compact discs will not replace microgroove records because people will not wish to throw away their collection of records."

THE FACT

Well, I can't really argue with that statement. I know many people who still have magnificent collections of 78 rpm records and I even have quite a few myself. However, these records are rarely played, except when they are used to illustrate the works of some great singer or musician whose works have not been re-recorded on the conventional microgroove.

Ho hum! You too will sooner or later join the ranks of antique collectors. I can almost *see* the vintage microgroove collectors in the year 2052 trying to buy pristine Beatles' records recorded 'the way they were sold in 1972'.

The CD players are an astounding state-of-the-art advance in the field of electro-acoustic technology. They have more attributes than disadvantages, but by setting reproduction standards so high (which they alone can achieve) they highlight the deficiencies of their more worldly relatives such as the amplifiers, loudspeakers and even the lowly rooms in which they are installed.

The high standard of the players also determines the quality of the software and the mode, place and recording techniques chosen. This has created new and unexpected problems for the whole recording industry. What used to be good enough for the ubiquitous microgroove recording is just not good enough for a CD recording.

If you think you have problems then there are many people with longer faces than yours. They are not just faced with the cost of a new amplifier or loudspeakers but with the cost of multi-track digital recorders, new studios, new microphones and the need to introduce and master a new recording technology.

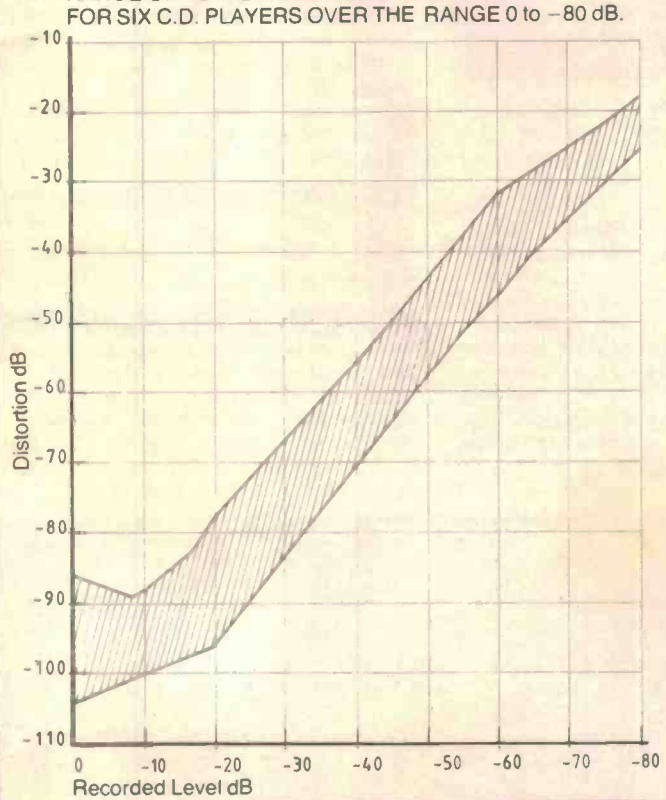
Obviously, a number of you will, in the near future, contemplate buying a CD player. This magazine will endeavour to assist you by presenting accurate objective and subjective assessments of the latest CD players in the market place. It will then be easier for you to compare their performance and features.

We have already seen in the trade literature that each manufacturer stresses the low harmonic distortion, flat frequency response, extended dynamic range and signal-to-noise ratio, as well as the immeasurable wow and flutter.

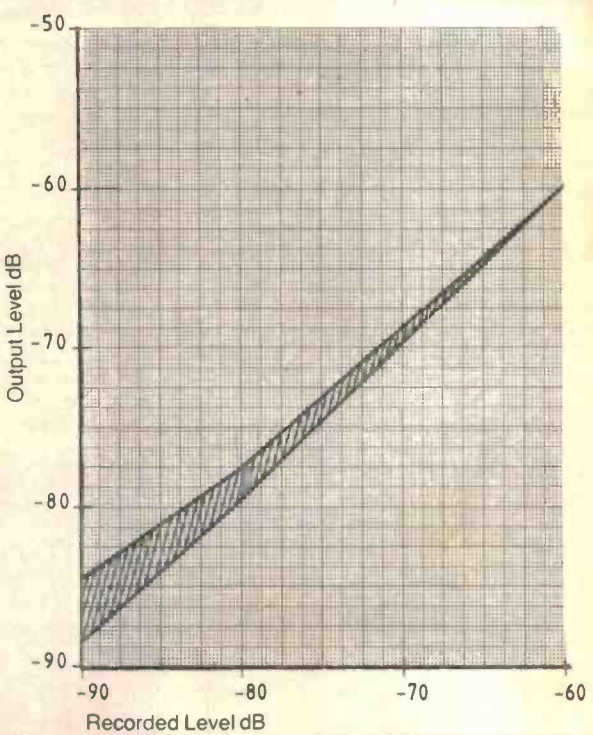
What they have all tended to ignore, so far, are the wide differences in the other important features which include shape, special control functions for replay and automatic programme selection and reliability, which is still an unknown factor.

With all this fact and fiction, the fiction will obviously dominate over the fact until you have your own CD player side by side with your youthful record player. Then you can assess whether the expense has been worth it, both to you and to the industry. ●

RANGE OF TOTAL HARMONIC DISTORTION
FOR SIX C.D. PLAYERS OVER THE RANGE 0 to −80 dB.



LINEARITY FOR SIX DIFFERENT C.D. PLAYERS
OVER CRITICAL RANGE −60 TO −90 dB.



T1 99 4A HOME COMPUTER

SAVE $50
WAS $499
INC. TAX

Now Only

$449 Inc. Tax
2 OR MORE UNITS
$429 Inc. Tax

SCOPE COMMODORE MODEL PH20 370°C

Now a Production Quality 20W Iron that air cools your fingers. . . * 240VAC

- Designed for continuous production line use
- for students
- serious hobbyists.

A professional quality non-temperature-controlled soldering tool. Earthed tip and barrel for component safety.

*Idling temperature subject to variations in line voltage and ambient conditions.

$16.95 + 7.5% TAX

80 SERIES CHIPS

8085	$ 4.00		
8086	$17.51		
8155	$ 3.77	8226	$ 1.21
8156	$ 3.69	8228	$ 2.39
8212	$ 1.21	8243	$ 2.01
8216	$ 1.21	8251	$ 3.32
8224	$ 1.35	8255	$ 2.20

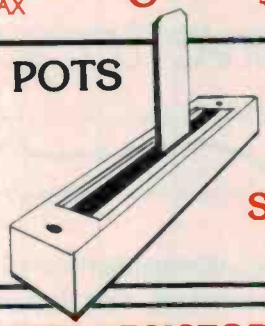
EX STOCK

8253	$ 3.69
8257	$ 3.43
8259	
8279	$ 2.77

+ 20% Tax

SLIDER POTS

1KΩ "C"
1MΩ "C"
500KΩ "C"
25KΩ "A"
100KΩ "A"
500KΩ "B"



DIMENSIONS
73mm x 7mm x 6mm
SHAFT–25mm x 8mm
TRAVEL–65mm

SUPER SPECIAL
60¢ EA.
+ 32.5% TAX

SUPER LOW PRICES

AMPHENOL 17 SERIES DB25 PLUGS & SOCKETS

Plugs $1.85 Sockets $2.45
+ 20% Tax

SOLDER BLOTTER

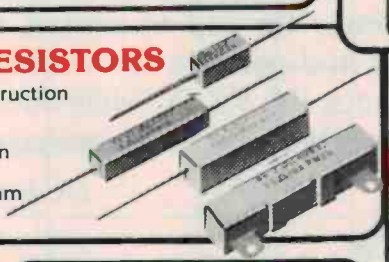
- 2 metres x 3 mm
- 30% Longer than most.
- Avoid Burnt Fingers– Metal Tipped Dispenser.

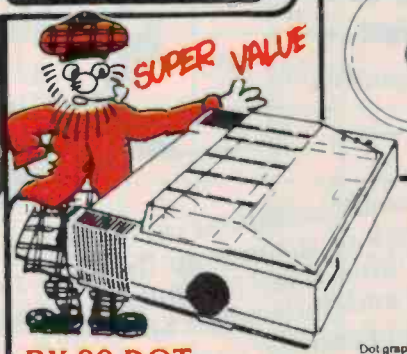
$1.96 + 7.5% TAX

POWER W/W RESISTORS

Fireproof, inorganic construction
Easy to install

PW5 0.1 ohm to 4.7K ohm
24c ea. + 32.5% TAX
PW10 1.0 ohm to 5.6K ohm
36c ea. + 32.5% TAX





BX 80 DOT MATRIX PRINTER

$419.00
+ 20% TAX

Printing method:	Serial impact dot matrix
Printing format:	Alpha-numeric – 7 x 8 in 8 x 9 dot matrix field. Semi-graphic (character graphic) 7 x 8 dot matrix. Bit image graphic – Vertical 8 dots parallel, horizontal 640 dots serial/line.
Character set:	228 ASCII characters. Normal and italic alpha-numeric fonts, symbols and semi graphics.
Printing Speed:	80CPS, 640 dots/line per second.
Printing direction:	Normal – Bidirectional logic seeking.
	Superscript and bit image graphics – Unidirectional, left to right.
Dot graphics density:	Dot graphics density up to 1280 dots per line.
	Ribbon: cartridge type.
Columns/line:	Normal size – 80 columns Double width – 40 columns Compressed print – 142 columns Compressed/double width – 71 columns. The above can be mixed in a line.
Paper feed:	Adjustable sprocket feed and friction feed.
Paper type:	Fanfold Single sheet. Thickness – 0.05mm (0.002") to 0.25mm (0.01"). Paper width – 101.6mm (4") to 254mm (10").

ARLEC PS499 PLUG PACK BATTERY ELIMINATOR 6 VOLTAGE

Suitable for 3V–4.5V–6V 7.5V –9V–12V equipment to 300mA

- Flash Guns
- Electric Models
- Toys, etc.
- 12 months guarantee
- Cassette Recorders
- Calculators

$8.96
+ 20% Tax

Eliminates batteries by running equipment direct from the mains electricity supply. SEC approved.

GREEN CAPS

.001 – 8¢	.015 – 14¢	.27 – 22¢
.0012 – 8¢	.018 – 14¢	.33 – 22¢
.0015 – 8¢	.022 – 14¢	.39 – 35¢
.0018 – 8¢	.027 – 14¢	.47 – 35¢
.0022 – 8¢	.033 – 14¢	.56 – 40¢
.0027 – 8¢	.039 – 14¢	.68 – 45¢
.0033 – 8¢	.047 – 14¢	.82 – 45¢
.0039 – 8¢	.056 – 14¢	1 – 48¢
.0047 – 8¢	.068 – 14¢	2.2 – $1.20
.0056 – 8¢	.082 – 14¢	3.3 – $1.80
.0068 – 8¢	.12 – 15¢	4.7 – $2.40
.0082 – 8¢	.15 – 15¢	6.8 – $3.50
.01 – 14¢	.18 – 15¢	10 – $4.50
.012 – 14¢	.22 – 18¢	

5 CENTS EA. +32.5% TAX
100 PCS $3.50

DISK DRIVE

- APPLE COMPATIBLE
- 5¼" DISK DRIVE
- COMPLETE WITH CONTROLLER CARD

$495.00 + 20% TAX

Apple is a trademark of Apple Computer INC.

¼W RESISTORS

12	100	1K	10K	100K	1M				
15	120	1K2	12K	120K	1M2				
18	150	1K5	15K	150K	1M5				
22	180	1K8	18K	180K	1M8				
27	220	2K2	22K	220K	2M2				
33	270	2K7	27K	270K	2M7				
39	330	3K3	33K	330K	3M3				
47	390	3K9	39K	390K	3M9				
56	470	4K7	47K	470K	4M7				
68	560	5K6	56K	560K	5M6				
82	680	6K8	68K	680K	6M8				
	820	8K2	82K	820K	8M2				
									10M

5 CENTS EA. · 32.5% TAX
100 PCS $3.00 · 32.5% TAX

½W RESISTORS

1	10	100	1K	10K	100K	1M			
1.2	12	120	1K2	12K	120K	1M2			
1.5	15	150	1K5	15K	150K	1M5			
1.8	18	180	1K8	18K	180K	1M8			
2.2	22	220	2K2	22K	220K	2M2			
2.7	27	270	2K7	27K	270K	2M7			
3.3	33	330	3K3	33K	330K	3M3			
3.9	39	390	3K9	39K	390K	3M9			
4.7	47	470	4K7	47K	470K	4M7			
5.6	56	560	5K6	56K	560K	5M6			
6.8	68	680	6K8	68K	680K	6M8			
8.2	82	820	8K2	82K	820K	8M2			
									10M

5 CENTS EA. · 32.5% TAX
100 PCS $3.00 · 32.5% TAX

1W RESISTORS

1	10	100	1K	10K	100K
1.2	12	120	1K2	12K	120K
1.5	15	150	1K5	15K	150K
1.8	18	180	1K8	18K	180K
2.2	22	220	2K2	22K	220K
2.7	27	270	2K7	27K	270K
3.3	33	330	3K3	33K	330K
3.9	39	390	3K9	39K	390K
4.7	47	470	4K7	47K	470K
5.6	56	560	5K6	56K	560K
6.8	68	680	6K8	68K	680K
8.2	82	820	8K2	82K	820K

8 CENTS EA. · 32.5% TAX
100 PCS $5.00 · 32.5% TAX

SUPER BARGAINS AT MAGRATHS

MAGRATHS

MC/M/565

MAGRATHS ELECTRONICS Phone or Mail.
55 A'BECKETT STREET, MELBOURNE. 3000
Tele (03) 347 1122, Telex AA31001

Prices subject to change without notice.

bankcard welcome here

— Mail or phone orders add $2.00 up to 1kg pack post
Special rates for heavy items on request

Personal Colour Computer less than $200

read what the experts have to say:

"I have a feeling we are going to be hearing a whole lot more of the Dick Smith VZ-200 Personal Colour Computer. . ."
– Electronics Australia July, 1983

". . . this small computer is certain to send shivers of dismay up the spines of d-lers in other small computers, such as th VIC 20 and the Sinclair Spectrum. . ."
– Australian Personal Computer, 1983

". . . we haven't yet seen anything in that price range to compete with the features and memory capacity of the VZ-200."
– ETI, July 1983

"If . . . you want a computer for playing games, for self-education, for learning about Basic and perhaps for writing your own programs, the VZ-200 has one overwhelming advantage – the number of features for its price." – EA, July, 1983

". . . this is a great machine, and one that is likely to change the face of Australian personal computing."
– Editor, APC.

"I am certainly going to buy one . . ."
– Editor, Australian Personal Computer.

"We are impressed with the excellent implementation of Microsoft Basic, full on-screen editing, repeat keys, and easy-to-use graphics features." – Creative Computing, May, 1983

want to know more? see next page

DICK SMITH VZ-200 Personal Colour Computer

less than $200

Here it is at last - the breakthrough you've been waiting for! A personal computer with all the right features: colour graphics, sound, standard Microsoft BASIC for easy programming, a whopping 8K bytes of RAM memory, the ability to work with a standard TV set, and much more. Yet thanks to modern electronics and our buying power, the Dick Smith VZ-200 will cost you only $199 - far less than any comparable computer! There'll never be a better time to invest in your family's future . . . .

AMAZING VALUE Cat No. X 7200 **$199.00**

And that's for a complete, ready-to-go computer that plugs into your TV set!
If required, these options are available:

16K Memory Expansion Module: Cat No. X 7205	**VALUE $79.00**
Colour Monitor: Cat No. X 1105	**VALUE $389.00**
Printer Interface Module: Cat No. X 7210	**ONLY $49.50**

Don't take our word for it: read what the experts at Australia's leading computer magazine had to say . . .

"Overall, this is a great little computer, and one that is likely to change the face of Australian personal computing."

And from the editor: *"I'm certainly going to buy one!"*
(May 1983 issue, Australian Personal Computer)

Now every family can afford their own personal computer!

Yes, for just $199, the Dick Smith VZ-200 gives you amazing computing power – far more than many machines two, three or even four times the price. Now *you* can find out what computers are all about. The kids can use it with their school work. It can keep track of your home budget. It can even help you in your business!

Still not convinced? *Try our exclusive 7 day money back satisfaction guarantee:*

Buy the Dick Smith VZ-200 Colour Computer and try it in your own home for up to 7 days. If you're not absolutely delighted, you can return it in original condition and packaging for a full refund.

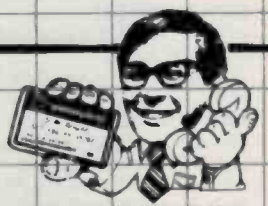
You'll owe nothing – not even an explanation!

EXCLUSIVE TO:

DICK SMITH Electronics

DSEA491/JCP

● Sydney 888 3200 ● Newcastle 61 1896 ● Wollongong 28 3800
● Tamworth 66 1961 ● Gosford 25 0235 ● Canberra 80 4944
● Melbourne 67 9834 ● Brisbane 229 9377 ● Adelaide 212 1962
● Perth 328 6944 ● Hobart 31 0800 ● Townsville 72 5722 ● Toowoomba 38 4300
Head Office & Mail Order Centre: PO Box 321, North Ryde NSW 2113. Ph (02) 888 3200



ORDER BY PHONE!
Just phone us on (02) 888 2105 and quote your Bankcard No. Your VZ-200 will be on its way the same day!!!

A discerning discourse on digital disc players

Louis Challis

AKAI CD-D1 • HITACHI DA-1000 • PIONEER P-D1 • SANYO DAD 8 • SONY CDP-101 • YAMAHA CD-1

PHILIPS AND SONY previewed the first CD players in Australia just over 12 months ago. Since then it has become obvious that CD players have 'taken off', making a tremendous impact on the hi-fi scene.

Already more than 70 firms have been licensed to produce software (the compact discs containing the programme content) and over 40 firms have been licensed to manufacture the hardware (the players).

In the market place the dealers are fighting furiously for the inadequate number of machines that are allocated by the importers to their clamouring distributors.

In the record shops that I visited most of the discs seem to sell more quickly than even the shop assistants would like. However, not one of the record shops I visited had yet installed a CD player, so the purchase of a disc would have to be based on the reputation of the musicians or the composer, and not on the proven quality of the software.

The main problem now, when you want to buy a CD player, is that you won't be able to compare the different units in the shop as the stocks of most dealers are close to zero.

An equally significant problem is the wide range of recommended retail prices and diverse range of features that the competing brands are offering.

AKAI CD-D1
Manufacturer: Akai in Tokyo, Japan
Distributor: Akai Australia Pty Ltd, Unit 11, Eden Park, 31 Waterloo Rd, North Ryde NSW 2113. (02)887-2311.

HITACHI DA-1000
Manufacturer: Hitachi Sales Corp. in Tokyo, Japan
Distributor: Hitachi Sales Australia Pty Ltd, 153 Keys Rd, Moorabbin Vic. 3189. (03)555-8722.

PIONEER P-D1
Manufacturer: Pioneer Electronic Corp. in Tokyo, Japan.
Distributor: Pioneer, 178 Boundary Rd, Braeside Vic. 3195. (03)580-9911.

SANYO DAD 8
Manufacturer: Sanyo Electric Trading Co Ltd, Osaka, Japan
Distributor: Sanyo Aust Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)428-5822.

SONY CDP-101
Manufacturer: Hi-fi audio division of Sony Corp, Japan
Distributor: Sony, 453 Kent St, Sydney NSW 2000. (02)266-0655.

YAMAHA CD-1
Manufacturer: Yamaha Nippon Gakki Co Ltd, Hamamatsu, Japan
Distributor: Rose Music, 28 Kent St, Belmore NSW 2142. (02)750-8999.

At last — a test disc

This review assesses the performance and compares the features of six of the first available CD players.

We found that nearly all of the players we tested easily exceeded most of their stated performance specifications. The trouble with these figures is that they tend to be an 'under-statement', rather than an over-statement of the real performance characteristics.

Our testing revealed that the performance varied from brand to brand and it also varied, to a lesser degree, among players of the same type.

When CD players were first released in Australia we were faced with a problem. We couldn't test them properly as there was initially a lack of special software for evaluating the players; their technical characteristics are unique.

Sony in Japan and Philips in Holland produced a series of test discs early last year but Sony withdrew the first of their discs not long after they were released. We had to wait until June '83, when the third series of Sony's test discs was released, before we could start our serious testing.

Philips also released its test discs but only received one set in Australia (test discs 3,4 and 4A) which we were not able to borrow until mid-July.

So with the first Sony test disc in Australia firmly in our hands we were able to evaluate the characteristics of each of the CD players. We made one assumption which was that the Sony software provides the precise parameters that are stated on the cover sheet. This is extremely important when trying to measure the non-linearities in the equipment without measuring the deficiencies in the software.

We didn't receive the Philips test discs until after we had finished testing the players. However, we compared the Sony test disc and the Philips test discs and we believe that the most critical of our measurements are reasonably close to the values of 'least uncertainty' for the test discs themselves, particularly where the distortions or linearities are approaching five-digit resolution.

With some of the test material available for testing turntables and cassette recorders the manufacturer will provide, when requested, data in terms of the value of 'least uncertainty'. However, Sony has not yet provided comparable data.

But we have found that the Sony test disc does provide adequate precision and resolution for us to be able to measure and quantify the differences between each of the CD players reviewed.

The CD players that we reviewed are the first releases from Akai, Hitachi, Pioneer, Sanyo, Sony and Yamaha. We did have the Marantz player prior to receiving the test software, but it was recalled for an interstate demonstration and was so much in demand that we didn't see it again.

These machines are intended to do the same job and have general mechanical characteristics in common, but after that all similarity ends.

It is not the frequency response or the dynamic range that create the differences between one player and the next, but the facilities provided for handling, processing and selecting the programmes and playing the disc.

As these machines perform so well we have paid particular attention in the evaluation to refinements of performance, user controls and unusual features.

The machines are reviewed in alphabetical order which does not necessarily indicate a rating of performance or preference.

Akai CD-D1

The AKAI CD-D1 incorporates a large number of well designed ergonomic features. One feature that I particularly liked is that the disc holder is manually closed rather than electronically closed; this relies on the natural response of most users to 'push the darn thing closed' and not to look for another switch with which to close it.

In the centre of the panel is the display module which is divided into four horizontal layers. The top layer provides mode information, telling you whether the unit is in standby, pause or play mode.

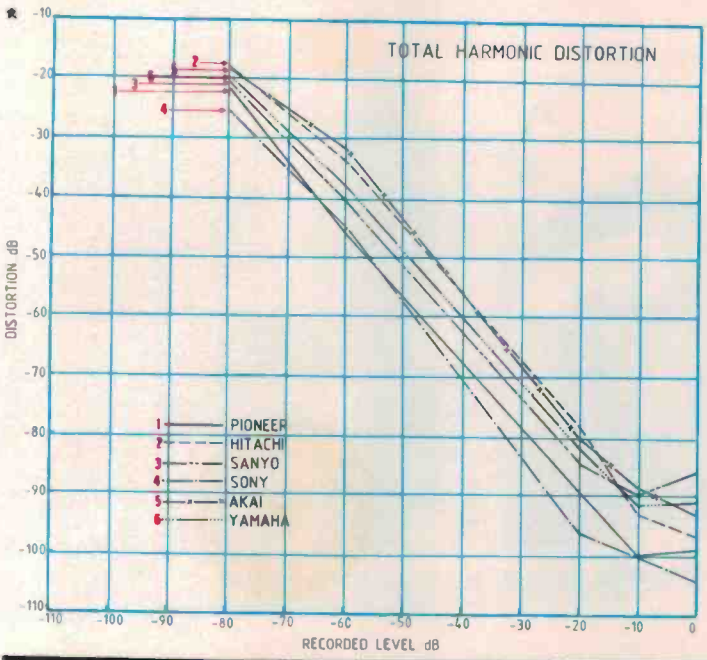
The second level of the digital display tells you the number of the selection that is actually playing. If the unit is not playing a zero is displayed.

The third row provides the elapsed playing time in minutes and seconds. The programming keys on the right hand side of the panel also tell you the time in minutes and seconds at which the start of a cycle or sequence should commence.

The bottom section is a quasi-analogue display which shows the position of the recording head using an array of light emitting diodes.

The control switches consist of one double sized 'play' button with its own self indicating LED, four buttons for 'stop-eject', 'pause', 'fast forward' and 'fast rewind' and two buttons labelled 'PLS' for automatic location of either the previous selection or next selection on the disc.

TABLE 1	Compact disc player Priced at approx. $1300	Conventional turntable Priced at approx. $1300
Number of channels	2	2
Digital to analogue conversion	16-bit linear (except Philips)	not applicable
Frequency response	5 Hz to 20 kHz ±0.5 dB	20 Hz to 20 kHz +1 dB −2 dB
Harmonic distortion	less than 0.004% (1 kHz 0 VU)	typically 1% (1 kHz 0 VU)
Dynamic range	more than 90 dB	60 dB
Signal-to-noise ratio	more than 90 dB	60 dB on a clean record
Channel separation	more than 90 dB	28 dB at 1 kHz
Wow and flutter	below measurable limits	0.03% RMS



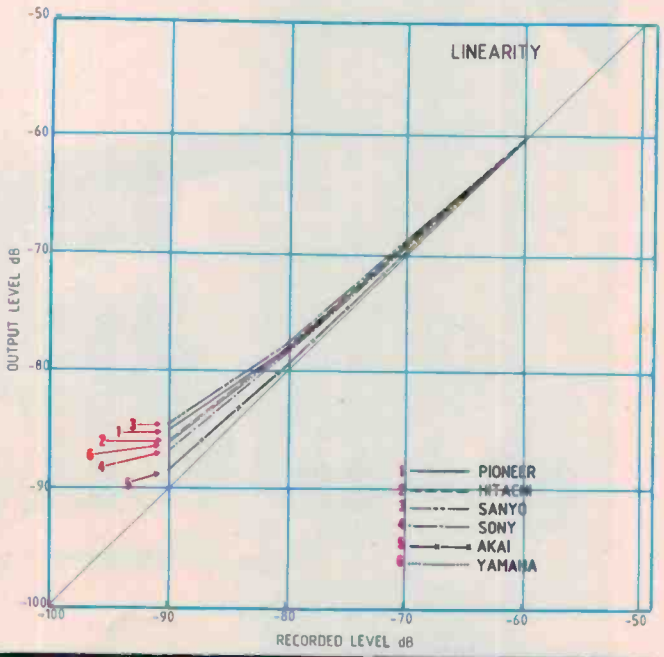


Table 2

Make and Model	Recom. Retail Price	Dimensions W x H x D mm	Weight kg	Remote Control	Disc Rotation	Electronic Open/Close	Dynamic Range With Emphasis	Distortion @ 1 kHz re 0 VU	Distortion @ −60 dB re max recorded level
AKAI CD-D1	$1329	440 x 145 x320	7.4	No	Vertical	Open only	95.9 dB Lin 106.4 dB(A)	0.0021%	−31.9 dB
HITACHI DA-1000	$1150	320 x 145 x 234	5.6	No	Vertical	Open & close	100.4 dB Lin 103.3 dB(A)	0.0014%	−33.9 dB
PIONEER P-D1	$1399	420 x 140 x 330	12.1	No	Vertical	Open only	96.0 dB Lin 100.5 dB(A)	0.0011%	−46 dB
SANYO DAD 8	$1099	335 x 145 x 285	7.3	No	Vertical	Open & close	95.0 dB Lin 97.5 dB(A)	0.005 %	−40.6 dB
SONY CDP-101	$1199	355 x 105 x 325	7.6	Infrared unit	Horizontal	Open & close	109.9 dB Lin 113.0 dB(A)	0.006 %	−45 dB
YAMAHA CD-1	$1999	435 x 116.5 x 357	13.5	No	Horizontal	Open & close	99.0 dB Lin 104.0 dB(A)	0.0028%	−38.3 dB

On the right hand side of the console are ten keys for keying in numerical data, a 'set' switch, a 'cancel' switch and six elongated keys.

The top elongated key is for the selection of 'phrase', a term commonly used by all the manufacturers meaning the selection of the time or section in seconds.

The 'index control' is used on those compact discs that have the display IN:DEX. These discs, which are not currently available, will allow you to select the music sequence number and select a particular segment within that sequence. This is achieved by selectively pressing the 'index' key then pressing the sequence number. As none of the discs that I was playing had the IN:DEX display I could not check this function.

The 'time' switch tells you the residual playing time on the disc, the 'memo call' allows you to check what you have stored as memory instructions, the 'repeat' switch allows you to repeat one sequence over and over again and the 'total time' switch tells you the total time on the disc.

On the back of the unit is a volume control with which you can adjust the player's output level to match your amplifier's auxiliary input requirements. This unit also has a pair of gold plated phono sockets which is a common feature on all the CD players reviewed.

The performance characteristics of the Akai player are excellent. The frequency response is ±0.2 dB from 20 Hz to 20 kHz and the replay linearity is almost perfect from 0 dB to −60 dB, 0.5 dB high at −80 dB and 1.4 dB high at −90dB.

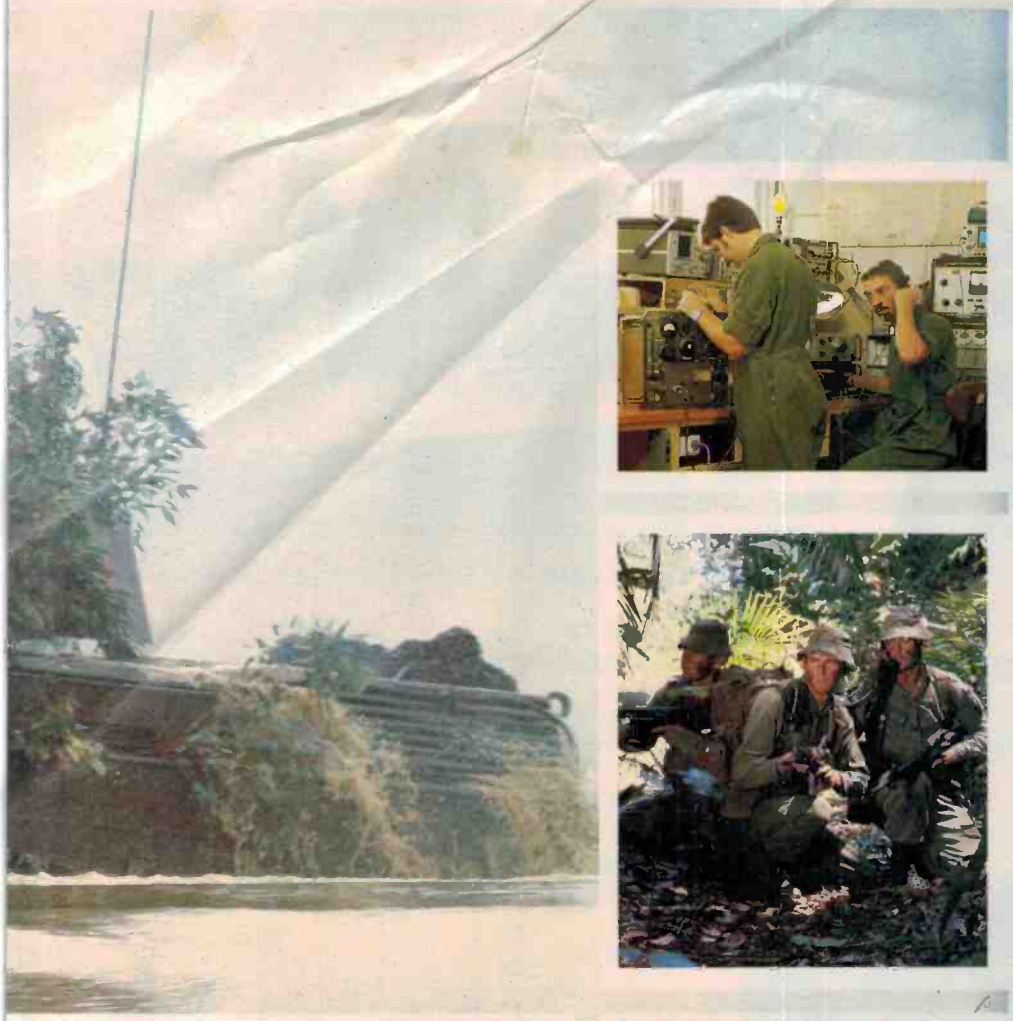
The A-weighted signal-to-noise ratio both with and without emphasis is 106.4 dB which is significantly better than claimed for the unit by Akai.

The channel separation from right to left is better than −103.9 dB at 100 Hz, better than −95 dB at 1 kHz, better than −89 dB at 10 kHz and better than −92 dB at 20 kHz. ▶

"I'm a soldier."
No. 1 IN A SERIES

"Not every bloke who wants to drive

Sydney 212 1011; Parramatta 635 1511; Newcastle 2 5476; Wollongong 28 6492;
Adelaide 212 1455 (Also Northern Territory); Lismore 21 6111; Melbourne 61 3731; Geelong 21 1588;



ARMY

Australian Regular Army

joins the Army a Leopard Tank."

These days the Army can train you in one or more of 150 different jobs, from Plant Operator to Computer Operator; from Electronic Technician to Assault Pioneer.

First they assess your ability and potential, then they give you the skills to do the job that's right for you.

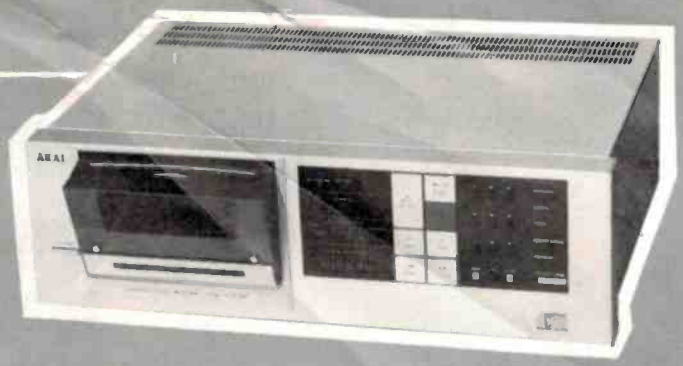
And because the Army is one of the country's biggest employers, you have the challenge of a rewarding career plus a better-than-average chance for further training and promotion.

If you'd like to know more, phone your nearest Army Careers Adviser.

Bendigo 43 8008; Ballarat 31 1240; Brisbane 226 2626; Townsville 72 4566; Albury 55 2248; Hobart 34 7077; Launceston 31 1005; Canberra 82 2333; Perth 325 6222.

AGE130.DPS.63ET

AKAI CD-D1



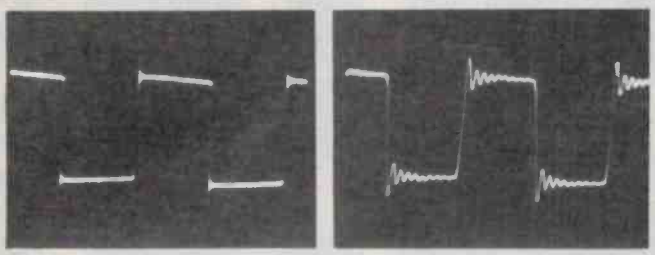
Distributor:
Akai Australia Pty Ltd
Unit 11, Eden Park
31 Waterloo Rd
North Ryde NSW 2113
(20)887-2311

SIGNAL-TO-NOISE RATIO

Without Emphasis	95.0dB(Lin) 106.4dB(A)
With Emphasis	95.0dB(Lin) 106.4dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	-119.4	-103.9
1kHz	-104.3	-95.0
10kHz	-89.6	-93.0
20kHz	-92.3	-99.3



100 Hz 1 kHz

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB

	100Hz	1kHz	10kHz	
2nd	-96.7	-93.7	-90.5	dB
3rd	-90.4	-110.6	out	dB
4th	-103.7	-107.6	of	dB
5th	-110.4	-111.6	Range	dB
T.H.D.	0.0034	0.0021	0.0027	%
T.dB	-89.3	-93.4	-90.5	dB

AT INDICATED LEVELS FREQUENCY = 1kHz

	Level = - 10dB	Level = -20dB	Level = -60dB	Level = -80 dB	
2nd	-90.0	-81.8	-34.5	-12.5	dB
3rd	-95.2	-88.5	-37.3	-13.2	dB
4th	-106.9	-89.1	-41.2	-18.5	dB
5th	-102.9	-101.4	-46.6	-28.6	dB
T.H.D.	0.0037	0.0096	2.53	12.0	%
T.dB	-88.6	-80.3	-31.9	-18.4	dB

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.4	dB	-0.3	dB
5kHz	-4.53dB	-4.5	dB	-4.3	dB
16kHz	-9.04dB	-9.3	dB	-9.1	dB

The distortion levels at 0 dB are 0.0034% at 100 Hz, 0.0021% at 1 kHz and 0.0027% at 10 kHz. The distortion level increases as the signal level decreases, so that at −80 dB (reference 0 dB level) the distortion level is 12%. This was just about the highest level of distortion recorded from any machine, although I must make it clear that these distortion levels would be totally inaudible and during the subjective testing we could not detect them.

Functionally, the performance of the Akai CD-D1 could not be faulted and I really liked the neat control format and the multiple design features. The best demonstration discs produced a scintillating sound which impressed everybody who heard it.

Hitachi DA-1000

The Hitachi DA-1000, the smallest CD player I reviewed, has a layout for the controls which is quite different to the other machines.

The disc is loaded into the disc holder in the centre of the front panel using an electronic switch for opening and closing the holder.

At the extreme left hand side of the fascia is a triangular power on-off switch with the visual displays located in four rows below. At the top is the quasi-analogue digital display which indicates the position of the laser pickup in units of five minutes. Below this is the time counter with a display in minutes and seconds showing either total playing time or elapsed time.

Further down are two LEDs which indicate programme 'play' or 'repeat'. Adjacent to this are two numerical displays indicating the total number of programmes on the disc and the programme number which shows the programme sequence that has been selected or is being searched for by the random memory programme.

The bottom row of lights is a unique feature. Ten LEDs indicate the output volume into either the headphones or the coaxial line sockets so that you can see not only the level of sound but also if the amplifier is likely to distort or overload.

Immediately to the right of the hinged disc-well door is a vertical array of eight push-buttons. The top one is the 'programme' button which is for programming the random memory search function. Below this are two buttons labelled '10' and '1'. The idea is that you press the '1' button as many times as the number that you want and press both the '10' and '1' buttons for numbers from 11 upwards.

The 'clear' button will delete a selected programmed track. The 'call' button allows you to check the numbers of the programmed tracks and pressing the 'repeat' button will repeat the whole disc.

The bottom two buttons replace the conventional volume control, allowing you to electronically increase or decrease the amplification which is indicated on the array of LEDs at the bottom left hand corner of the unit.

The only controls which I did not appreciate were the '10' and '1' buttons

HITACHI DA-1000

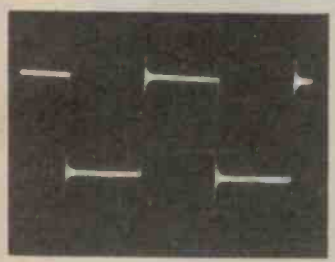
Distributor:
Hitachi Sales Australia Pty Ltd
153 Keys Rd
Moorabbin Vic. 3189
(03)555-8722

SIGNAL-TO-NOISE RATIO

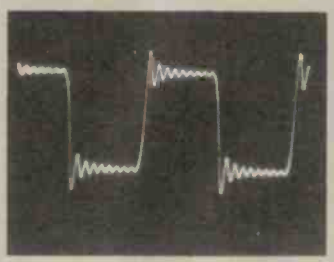
Without Emphasis	94.0dB(Lin) 98.5dB(A)
With Emphasis	100.4dB(Lin) 103.3dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	-91.6	-93.8
1kHz	-97.1	-98.6
10kHz	-91.1	-93.1
20kHz	-83.6	-88.9



100 Hz



1 kHz

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB

	100Hz	1kHz	10kHz	
2nd	-94.8	-99.2	-86.5	dB
3rd	-84.2	-105.1	out	dB
4th	-122.0	-116.9	of	dB
5th	-101.0	-103.8	Range	dB
T.H.D.	0.0064	0.0014	0.0047	%

AT INDICATED LEVELS FREQUENCY = 1kHz

	Level = -10dB	Level = -20dB	Level = -60dB	Level =-80 dB	
2nd	-101.4	-97.4	-	-	dB
3rd	- 98.4	-79.5	-34.3	-21.7	dB
4th	-104.7	-95.9	-	-	dB
5th	- 96.4	-87.5	-44.6	-20.5	dB
T.H.D.	0.0022	0.012	2.01	12.5	%
T.dB	-93.15	-78.4	-33.9	-18.06	dB

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.4	dB	-0.3	dB
5kHz	-4.53dB	-4.9	dB	-5.0	dB
16kHz	-9.04dB	-8.7	dB	-8.8	dB

which create more work than the equivalent key pad display used on the other CD players.

On the right hand side of the unit is a rocker-bar which provides 'fast back' and 'fast forward' for searching out sections of the track. Immediately below is a very large 'play' control and another rocker bar. One end of the rocker bar allows you to memorise any point on the track to which you can return at any time by pressing the 'fast back' control. The disc will then continue playing from that position which is noted by the memory control.

At the other end of the lower rocker bar is the 'pause' control and below it is the 'stop' button. In the bottom quadrant of the unit is the electronic 'open' and 'close' button with a tip-ring-and-sleeve socket inserted into it for the headphones.

On the back of the unit are two sets of gold plated contacts; one is for fixed level output and the other is for variable level output which is controlled by the electronic volume controls on the front panels.

The performance of this unit is also very good with a frequency response of ±0.2 dB from 20 Hz to 20 kHz. The total harmonic distortion levels at 0 VU are 0.0064% at 100 Hz, 0.0014% at 1 kHz and 0.0047% at 10 kHz. The distortion level increases slowly down to −60 dB where it reaches a significant level of 2%, which then rises to 12.5% at −80 dB.

The signal-to-noise performance is 98.5 dB(A) without emphasis and 103.3 dB(A) with emphasis. The channel separations up to 10 kHz are all better than −90 dB while at 20 kHz the separation drops down to −83.6 dB and −88.9 dB for the left and right channels respectively.

I was impressed by the way in which this small, neat unit can sit on a shelf next to a bed, so that with a set of headphones it can create a delightful bedroom music centre. If I was to buy a CD player for this specific role then the Hitachi unit would be my first choice as its visual indications and controls really lend themselves to this particular role.

Pioneer P-D1

The Pioneer P-D1 offers a wide range of ergonomic features which I liked. Pioneer, like Akai, have also chosen to electronically open the disc door but to manually close it, a concept which I strongly support.

By placing the disc door at the extreme left hand side of the player the designers have achieved a very pragmatic fascia layout. In the middle of the fascia is an illuminated power on-off switch while to the right are the display and control modules.

The display module features 'programme check' and 'total time' switches at the top. Below these are LEDs indicating the function of the switches and a numeric display indicating the programme sequence number.

Immediately below this are two, double digit displays to show the time in minutes and seconds and the phrase numerals for a section of a number. These are dependent on the settings on the controls on the right hand side. ▶

PIONEER P-D1

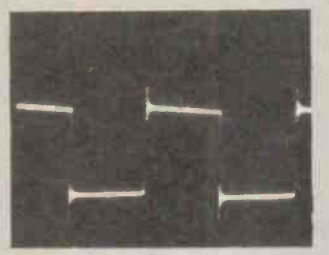
Distributor:
Pioneer
178 Boundary Rd
Braeside Vic. 3195
(03)580-9911

SIGNAL-TO NOISE-RATIO

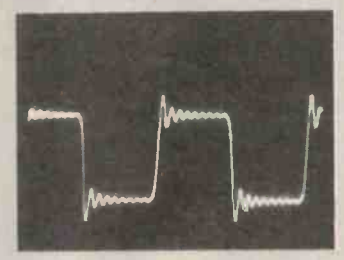
Without Emphasis	90.0dB(Lin) 96.5dB(A)
With Emphasis	96.0dB(Lin) 100.5dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	-114	-100.5
1kHz	-114	-99.9
10kHz	-95.5	-89.5
20kHz	-87.3	-83.7



100 Hz



1 kHz

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB

	100Hz	1kHz	10kHz	
2nd	-96.7	-99.7	-89.3	dB
3rd	-93.8	-	out	dB
4th	-114.9	-112.4	of	dB
5th	-117.0	-118.3	Range	dB
T.H.D.	0.0025	0.0011	0.0034	%

AT INDICATED LEVELS FREQUENCY = 1kHz

	Level = - 10dB	Level = -20dB	Level = -60dB	Level = -80 dB	
2nd	-109.4	-	-	-	dB
3rd	-101.4	-90.7	-47.0	-26.8	dB
4th	-113.2	-	-	-	dB
5th	-111.1	-95.2	-53.2	-23.8	dB
T.H.D.	0.00098	0.0034	0.49	7.9	%

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.3	dB	-0.3	dB
5kHz	-4.53dB	-4.7	dB	-4.6	dB
16kHz	-9.94dB	-9.6	dB	-9.8	dB

At the bottom of the visual display section are five rectangular LEDs to display the play-back mode. The functions offered are matched by the controls on the right hand side of the console. 'Index scan' allows you to sample the first seven seconds of each song on the disc, 'music repeat' just plays one song, 'one side repeat' is self explanatory, 'searching' illuminates during the searching or 'skipping' sequence and 'programme' indicates normal playing.

Four main controls, located in the middle of the display/control module, are the 'eject', 'play,' 'pause' and 'stop' buttons.

This group of simple controls means that anyone can use the player without reference to the other controls or displays. They constitute an excellent ergonomic feature and their position and layout will endear themselves to sales people wishing to make a strong and sensible sales pitch to someone who is not quite 'with it' in the digital technology age.

A 10-button key pad is for entering song numbers or time and 'phrase' data for searching and finding an exact spot within a section of the disc. The 'skip forward' and 'backwards' button allows you to advance forward or backwards to the start of the next or previous number.

The technical performance of the Pioneer player is excellent with extremely low distortion levels; measured at 0 VU they are 0.0025% at 100 Hz, 0.0011% at 1 kHz and 0.0034% at 10 kHz. At −60 dB the distortion figures are still less than 0.5% and they only climb to 7.9% at −80 dB.

The frequency response is flat from 20 Hz to 20 kHz except for an excursion of −0.7 dB at 18 kHz.

The signal-to-noise ratio without emphasis is 96.5 dB(A) and with emphasis is 100.5 dB(A). The channel separation is typically −100 dB to 1 kHz, just under −90 dB to 10 kHz and −83.7 dB at 20 kHz.

When we received the new Philips compact test discs we evaluated three of the machines for intermodulation distortion, using the Philips test discs. The Pioneer player produced the best results with an intermodulation distortion which was at least 3 dB lower than the next best unit, under any test condition and at any level or frequency.

I spent a lot of time listening to compact discs on the P-D1, set up with either a complete Pioneer System or with my monitoring system at home. I found it a delight to use and a great pleasure to listen to.

Sanyo DAD 8

The Sanyo DAD 8 is a very small, lightweight player.

The front fascia is dominated by the disc holder door on the left hand side with a power on-off switch at the top left hand corner. To the right of the door is a display module, flanked on the right by the control module.

The display module has three separate display areas. At the top is the real time counter which indicates the time of each

SANYO DAD 8

Distributor:
Sanyo Australia Pty Ltd
225 Miller St
North Sydney NSW 2060
(02)428-5822

SIGNAL-TO-NOISE RATIO

Without Emphasis	90.0dB(Lin) 93.6dB(A)
With Emphasis	95.0dB(Lin) 97.5dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	-104.0	-102.0
1kHz	-94.6	-93.1
10kHz	-75.8	-74.5
20kHz	-70.4	-69.3

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB(Maximum)

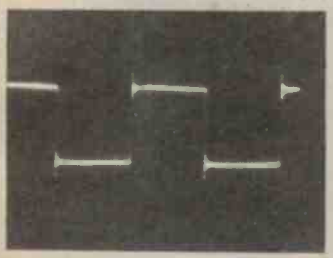
	100Hz	1kHz	10kHz	
2nd	-86.9	-86.2	-85.0	dB
3rd	-87.9	-98.8	out	dB
4th	-	-	of	dB
5th	-111.6	-109.0	Range	dB
T.H.D.	0.005	0.005	0.0056	%

AT INDICATED LEVELS FREQUENCY = 1kHz

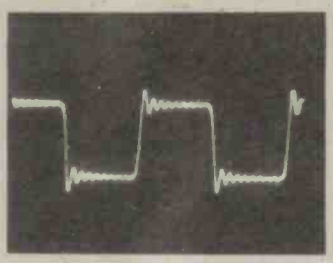
	Level = - 10dB	Level = -20dB	Level = -60dB	Level = -80 dB	
2nd	-97.5	-	-	-	dB
3rd	-91.4	-86.0	-40.6	-27.0	dB
4th	-	-	-	-	dB
5th	-99.9	-90.3	-	-22.0	dB
T.H.D.	0.00032	0.0059	0.93	9.1	%
T.dB	-89.9	-84.6	-40.6	-20.8	dB

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.1	dB	-0.1	dB
5kHz	-4.53dB	-4.3	dB	-4.4	dB
16kHz	-9.04dB	-9.5	dB	-9.5	dB



100 Hz



1 kHz

selection or the total playing time in minutes and seconds.

Below this is the multi-display window which provides information on the third-level display. This will be either the music number and index number of the music being played now, the music number being played now and the next number to be played, or during programming, the music number to be played and the order in which it will be played.

Below the display module are the ten soft touch keys used to designate the selection number when programming your music sequence.

On the extreme right hand side of the fascia are the primary and secondary controls: 'real time counter' switch; 'open/close' switch; 'fast forward' switch; 'return' switch that allows you to jump to the next or previous number.

Below these are controls that only a few of the other units offer: 'fast forward'; 'fast reverse'; 'play'; 'pause'; 'stop'; repeat.

At the bottom right hand corner are the soft touch switches for 'recall', 'memory' to accept the encoded numerical number, 'programme play', 'programme write/display', 'memory clear', and 'programme clear'. There is also a volume control and a headphone socket.

The functional performance of the Sanyo unit is generally good although the measured values just exceed the typical values stated in Table 1. The distortion figures are typically 0.005% at 100 Hz, 1 kHz and 10 kHz, measured at 0 VU. These figures climb to 0.93% at −60 dB but are still only 9.1% at −80 dB.

The frequency response is flat except for two excursions, +0.3 dB at 100 Hz and −0.8 dB at 18 kHz.

The signal-to-noise ratio is 93.6 dB(A) without emphasis and 97.5 dB(A) with emphasis. The channel separation droops quite noticeably with increasing frequency, being greater than −102 dB at 100 Hz, −93 dB at 1 kHz, −74.5 dB at 10 kHz and −69.3 dB at 20 kHz.

The performance of the unit is good although I believe I could hear a difference in the characteristics of the sound when compared to some of the other units during A-B testing.

The Sanyo unit is a particularly neat unit which most people would appreciate but the layout and functions are not quite as straightforward as some of the other units. It is, however, the least expensive of the six units and consequently still has an awful lot to offer in terms of value for money.

Sony CDP-101

The Sony CDP-101 is a most impressive CD player and is different to the other five CD players in a number of discrete ways. It has a horizontal playing format for the disc and, except for Yamaha, the other four units reviewed have a vertical format.

The Sony CDP-101 also has an infrared remote control which is a delight to use.

The neat, black unit has an interesting appearance. The cassette well slides out with a gentle whirring sound rather than ▶

SONY CDP-101

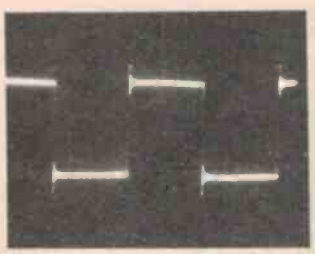
Distributor:
Sony
453 Kent St
Sydney NSW 2000
(02)266-0655

SIGNAL-TO-NOISE RATIO

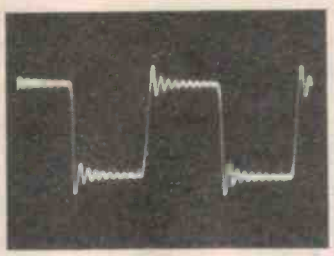
Without Emphasis	92.5dB(Lin) 99.0dB(A)
With Emphasis	109.0dB(Lin) 113.0dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	>-114.0	-100.5
1kHz	>-114.0	-99.0
10kHz	-95.5	-89.4
20kHz	-87.3	-83.7



100 Hz



1 kHz

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB(Maximum)

	100Hz	1kHz	10kHz	
2nd	-101.8	-109.5	-97.1	dB
3rd	-86.5	-106.3	out	dB
4th	-112.3-	-	of	dB
5th	-112.5	-	Range	dB
T.H.D.	0.0048	0.0059	0.0014	%

AT INDICATED LEVELS FREQUENCY = 1kHz

	Level = -10dB	Level = -20dB	Level = -60dB	Level =-80 dB	
2nd	None	-	-	- dB	
3rd	Detectable	-	-46.6	-34.3	dB
4th	at this-	96.5	-	-	dB
5th	level	-	-58.3	-26.1	dB
T.H.D.	-	0.0015	0.56	5.3	%
T.dB	-	-96.5	-45.0	-25.5	dB

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.1	dB	-0.1	dB
5kHz	-4.53dB	-4.6	dB	-4.5	dB
16kHz	-9.04dB	-9.8	dB	-9.6	dB

opening out on a hinge, as do the other units. All you need to do is touch the 'open-close' button on the front of the sliding shelf and the tray slowly slides out. You then gently drop the compact disc onto the specially shaped tray with its hollow centre, touch the 'open-close' button again, or touch the 'play' button, and the tray closes to complete the sequence.

To the left of the tray is the power on-off switch, the 'timer play' switch, the 'headphone level' control and the headphone tip-ring-and-sleeve socket.

On the right hand side of the disc compartment is a display window which provides four sets of information. The 'disc set' indicator flickers while the disc compartment is moving and illuminates the 'disc set' wording when the disc is ready to play. Next to this display is the 'track number' indicator and the time counter which shows elapsed time or remaining time on the disc.

To the right of these displays is the remote senser detector for the remote control, displaying a light to indicate that it has responded to a remote instruction.

Below the display window is the 'reset' button and some of the most unusual controls found on any of the CD players. One button will repeat the program actually being played and the next button will repeat the whole disc on a single cycle basis.

The 'A-B' button allows the replay of selected sections between any point designated 'A' and any other point designated 'B'. I must admit that after you have used this function the first time you may never want to use it again. However, it does provide a powerful facility for those people who want such an unusual capability.

Actually the 'A-B' facility was very useful at the beginning of this year when we tested the first Sony CD player in the country (see ETI Feb 1983). It was long before the Sony test discs became available, so the 'A-B' facility was used to help us assess the dynamic characteristics of small samples of recorded material.

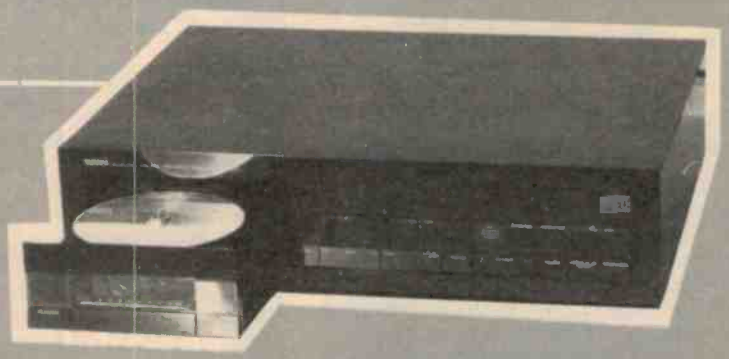
The 'clear' button will clear the 'A-B' function.

Below these special controls are the normal main controls of 'play' and 'pause'. There are two large keys with double arrows for fast forward and fast reverse. Below these are four smaller buttons which can be used while the programme is being played to provide rapid forward or reverse searching at three times and at ten times the normal playing speed. None of the other CD players reviewed offered this facility. Conversely, most users may not appreciate or want to use this facility.

On the rear panel of the unit there is an 'auto pause' switch to automatically produce pauses between numbers and an 'anti-shock' switch to provide additional compensation for locations subject to high vibration. A 'beep buzzer' on-off switch under the player responds to the remote control unit.

Unlike all the other units, the Sony unit does not incorporate a transit screw system for locking down the laser disc traversing head.

YAMAHA CD-1



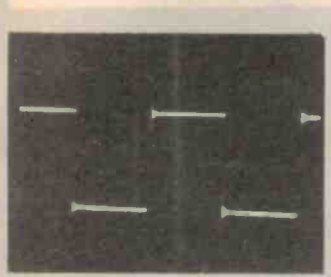
Distributor:
Rose Music
28 Kent St
Belmore NSW 2142
(02)750-8999

SIGNAL-TO-NOISE RATIO

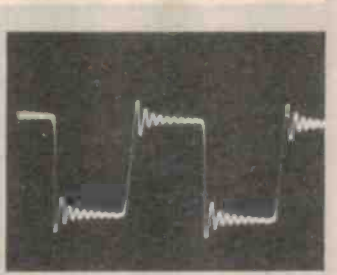
Without Emphasis	94.0dB(Lin) 99.0dB(A)
With Emphasis	99.0dB(Lin) 104.0dB(A)

CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100Hz	-100.8	-98.3
1kHz	-101.1	-99.2
10kHz	-86.5	-90.9
20kHz	-78.1	-90.6



100 Hz



1 kHz

DISTORTION

AT MAXIMUM OUTPUT LEVEL = 0dB(Maximum)

	100Hz	1kHz	10kHz	
2nd	-91.3	-91.0	-85.3	dB
3rd	-89.3	-	out	dB
4th	-	-	of	dB
5th	-	-	Range	dB
T.H.D.	0.0044	0.0028	0.0054	%
T.dB	-87.2	-91.0	-85.3	dB

AT INDICATED LEVELS FREQUENCY = 1kHz

	Level = -10dB	Level = -20dB	Level = -60dB	Level = -80 dB	
2nd	-92.4	-88.5	-	-29.5	dB
3rd	-	-85.2	-39.1	-23.5	dB
4th	-99.8	-96.4	-	-33.6	dB
5th	-	-88.2	-46.3	-23.5	dB
T.H.D.	0.0026	0.0078	1.21	10.2	%
T.dB	-91.6	-82.1	-38.3	-19.8	dB

EMPHASIS

Frequency	Recorded Level	Output Level (Left)		Output Level (Right)	
1kHz	-0.37dB	-0.2	dB	-0.3	dB
5kHz	-4.53dB	-4.8	dB	-5.0	dB
16kHz	-9.04dB	-8.9	dB	-9.2	dB

The technical performance of the Sony player is particularly good. The distortion figures, measured at 0 VU, are 0.0048% at 100 Hz, 0.0059% at 1 kHz and 0.0014% at 10 kHz. The measured distortion levels are still exceptionally good at −60 dB where a very low figure of 0.56% is produced, and at −80 dB the distortion is only 5.3%. The intermodulation distortion is better than −73 dB re 0 VU.

The frequency response is flat until 5 kHz and then it gradually drops down to −1.7 dB at 18 kHz.

The signal-to-noise ratio without emphasis is 99 dB(A) and with emphasis it is good at 113 dB(A). The channel separation is better than −100 dB at 100 Hz, better than −99 dB at 1 kHz, better than −89 dB at 10 kHz and better than −83 dB at 20 kHz.

The Sony player is delightfully easy to use and has an exhilarating sound. It is clear that Sony has gone to extreme lengths to develop and produce what I consider to be an outstanding piece of engineering design.

Yamaha CD-1

The Yamaha CD-1 is based on an entirely different design philosophy to the other CD players. The major difference, and what the manufacturer claims is its most important feature, is the total duplication of the digital circuitry to achieve, say Yamaha, superior technical performance.

Other brands of CD players apparently use a single digital to analogue converter to convert the multiplexed analogue (audio) signal, which must then be demultiplexed into the left and right channels. Yamaha, however, uses a digital demultiplexing circuit prior to feeding the digital signals to two separate digital to analogue converters.

The major attribute claimed for this circuitry is a reduction of switching noise and distortion in the output. The disadvantage of this approach is more circuitry and the result is a much higher price for this unit, when compared to all of the other units reviewed.

The frontal appearance of the CD-1 is striking and attractive. Like the Sony player, it has a horizontal disc compartment which slides out under full electronic control, but it is even quieter than the Sony unit.

The front panel has the power on-off switch on the left hand side of the disc compartment. Adjacent to the switch is a direct analogue-type display showing the position of the recording head in terms of ten, six-minute increments.

To the right of the disc compartment are a series of bright red numerical displays showing the music sequence number and the time in minutes and seconds. The pre-programming data displays the next programming number, the music number and also the time in minutes and seconds for the following sections.

The primary controls, simpler and more straight forward than those on the other players are 'stop', 'play' that also doubles for 'forward' and 'reverse', 'fast forward' or 'fast rewind' and 'pause'. ▶

The other controls provided for pre-programming are incorporated in an entirely separate motorised key tray which is located on the right hand side of the unit. These controls are recessed, right out of harm's way until you need them, and are opened by a separate 'open/close' button located on the right hand end of the fascia.

The added controls make it possible to programme up to fifteen selections in any sequence or combination. Unlike many of the other players, there are no long delays with this system, even when skipping from the first to the last selection on the disc. The unit also provides a very easy 'check' function for both verification of the programme sequence or for reprogramming that sequence to suit.

Like a few of the other units, in particular the Sony CDP-101 player, this unit provides a 'phrase' play-back capability where any segment of the disc, several selections of the disc or even a small section of a selection, can be programmed to play singly or repeatedly.

The performance of this unit is very good but is not, however, demonstrably superior to the other players. The measured frequency response is flat except for a +0.5 dB excursion at 7 kHz.

The distortion levels of 0 VU are 0.0044% at 100 Hz, 0.0028% at 1 kHz and 0.0054% at 10 kHz. These levels are still good at −60 dB where the distortion is 1.2% and at −80 dB the distortion rises to 10.2%.

The signal-to-noise ratio without emphasis is 99 dB(A) and with emphasis it is a very respectable 104 dB(A). The channel separation is better than −98 dB at 100 Hz and 1 kHz, better than −86 dB at 10 kHz and is −78 dB at 20 kHz.

The digital to analogue converter linearity is very good all the way to −60 dB and then has a slow but gradual droop to −90 dB. The unit has an excellent performance. However, the double digital conversion system does not seem to provide a measurable improvement in overall performance, compared with the other units evaluated.

The subjective performance and the practical use of this unit is absolutely first class. Hiding away the auxilliary programming and pre-programming functions is very sensible, but obviously an expensive approach.

Summary

The engineers at Philips in Eindhoven had a brilliant vision when they conceived the idea of the compact disc player. Fortunately, they realised that for it to work in practice they would need a Japanese partner to make sure that the concept became an industry standard.

The review has shown that there are considerable differences between each brand of player, in terms of functions, performance and flexibility in using the machines.

However, the cheapest player, which sells at a recommended retail price of $1099, and the most expensive player, selling at almost twice that price, have objective performance figures which are disproportionately small, considering the difference in price.●

TABLE 1

Track number	Signal	Level	Ch	Contents min sec, phrase	Purpose
1	1 kHz	0 dBv	L&R	00M02S00F	Reference
2	20 Hz	"	"	02 02 00	
3	40 Hz	"	"	03 02 00	
4	100 Hz	"	"	04 02 00	Frequency
5	200 Hz	"	"	05 02 00	Response
6	500 Hz	"	"	06 02 00	
7	1 kHz	"	"	07 02 00	THD vs. Freq
8	5 kHz	"	"	08 02 00	
9	7 kHz	"	"	09 02 00	Modulation
10	10 kHz	"	"	10 02 00	Noise
11	16 kHz	"	"	11 02 00	
12	18 kHz	"	"	12 02 00	
13	20 kHz	"	"	13 02 00	
14	1 kHz	0 dB	L&R	14 02 00	
15	"	- 1 dB	"	15 02 00	
16	"	- 3 dB	"	16 02 00	
17	"	- 6 dB	"	17 02 00	Linearity
18	"	-10 dB	"	18 02 00	
19	"	-20 dB	"	19 02 00	
20	"	-60 dB	"	20 02 00	THD vs.
21	"	-80 dB	"	21 02 00	Level
22	"	-90 dB	"	22 02 00	
23	Infinity Zero w/o emphasis		L&R	23 02 00	S N
24	" with emphasis		"	24 02 00	
25	400 Hz + 7 kHz (4:1)	0 dB	L&R	25 02 00	1 M of 2
26	"	-10 dB	"	26 02 00	Signals
27	19 kHz + 20 kHz (1:1)	0 dB	"	27 02 00	
28	"	-10 dB	"	28 02 00	
29	100 Hz	0 dB	L	29 02 00	Channel
30	1 kHz	"	"	30 02 00	Separation
31	10 kHz	"	"	31 02 00	
32	20 kHz	"	"	32 02 00	
33	100 Hz	0 dB	R	33 02 00	
34	1 kHz	"	"	34 02 00	
35	10 KHz	"	"	35 02 00	
36	20 kHz	"	"	36 02 00	
37	100 Hz Square Wave		L&R	37 02 00	Translent
38	1 kHz Square Wave		"	38 02 00	Response
39	1 kHz w/emphasis	- 0.37 dB	L&R	39 02 00	
40	5 kHz w/emphasis	- 4.53 dB	"	40 02 00	Emphasis
41	16 kHz w/emphasis	- 9.04 dB	"	41 02 00	
42.99	1 kHz	0 dB	L&R	42 02 00	Reference and TNO check
(each TNO is same signal, with duration of 4 seconds)					
				45 54 00	LEAD OUT SIGNAL

RECORDING TIME: TNO 1) 1min 56sec: TNO 2.41) 56sec each;
TNO 42.99) 4sec each, total 3min 52sec.
PAUSE TIME: TNO 1) 2sec: TNO 2.42) 4sec each; 43.99) none.
*other channel is infinity zero

Sony Test Disc. Signal performance section.

TEST DISCS EXPOSED

If there's one thing that's harder to get at the moment than a compact-disc player, it's a compact-disc test record. Philips released its latest three-disc set, *Audio Frequency Test Samples, Numbers 3, 4 and 4A*, in Europe last November, and Sony released its improved *CD Test Disc Type 3 for Signal Performance Testing and Optical Readout Testing* in Japan only a few months later. We finally managed to get hold of all of them . . .

The Sony Test Disc Type 3 has a series of formatted signal bands, designed to test the CD player's audio output specifications. The material used in the disc and the designated measurements are those specified in the CD digital audio system Red Book, resolved and accepted by Sony and Philips in May 1982.

The test signals have been recorded from digital sources whose frequency accuracy is precise to one part in 10^9. Both companies claim the level setting accuracy for 16-bit resolution is accurate to ±0.1 dB. The discs have time signal data from the starting position of each track, even during the pause signals. Therefore, the time in minutes and seconds from start to finish and from the start of any track is also encoded for those CD players which provide time, number and phrase information.

Both Sony and Philips use spot frequency checks, starting at 20 Hz and finishing at 20 kHz, to evaluate frequency response, total harmonic distortion and modulation noise of a player. Philips also provides a sweep covering 20 Hz to 20 kHz. Spot frequencies suit a technician better than sweep frequencies, however, most laboratories would prefer a swept signal format covering the range 10 Hz to 20 kHz. This would be more suitable as there are thousands of level recorders from Bruel and Kjaer, General Radio and Neutrik available world wide, which could track a continuous logarithmically swept signal.

While the evaluation of frequency response is very straighforward, given the availability of an audio analyser, precision audio voltmeter or a level recorder, the same cannot be said for the ease of measuring total harmonic distortion and certainly not for measuring modulation noise. Our tests have shown that at 0 VU the best of the CD players produces distortion components as low as 0.0002%, which can also be expressed as two parts per million THD, or distortion products to the order of -114 dB. There are very few systems available which enable you to measure distortion components as low as these.

Our approach is to use a special multiple notch filter, calibrated at

the fundamental, second, third, fourth, fifth and sixth harmonics. Its fundamental rejection is 100 dB while the rejection at the second and higher order harmonics ranges between 10 dB and 3 dB. This approach enables us to measure the distortion components as low as -130 dB, which is approaching what I regard as the ultimate figure for measurable distortion.

The signal track numbers 14 to 22 on the Sony test disc provide reference signals at 1 kHz with simultaneous left and right channel modulation at 0, -1, -3, -6, -10, -20, -60, -80 and -90 dB. It is important to note that with a dynamic range in excess of 90 dB encoded on the disc, and with insignificant distortion at the highest possible sound levels, it is only in the realm of encoding linearity or decoding linearity that you are likely to have your first order differences between one CD player and the next.

That is, if the CD player displays a significant non-linearity in the digital decoding circuitry, then there is a possibility when comparing the same programme content played by two CD players, that you will hear a subjective difference.

All CD players show varying degrees of non-linearity in the dynamic region from -60 dB to -90 dB. It is in this region that both the Sony and Philips test discs have provided too few bands for testing. Both manufacturers can argue that the resolution I would like to see on the test discs is commercially unwarranted, but I would still like to see the additional data encoded.

It is particularly important to note that at -90 dB the residual dynamic range available on the CD players' and the linearity of the encoding system originally used to manufacture these test discs, must be severely limited. Therefore, any CD player that provides a total harmonic distortion level of better than five or six per cent at the -80 dB level (relative to 0 VU) is an exceptional piece of equipment.

Compact disc players which achieve an encoding error of less than 1 dB at the -80 dB level and less than 2 dB at the -90 dB level are an exceptional piece of equipment.

Tracks 23 and 24 and 39 to 41 on the Sony disc provide test signals with and without emphasis. This enables us to determine whether the de-emphasis circuits are responding accurately to the original pre-emphasis encoded on the discs. This is an important requirement as if the de-emphasis is wrong then the second order colouration of the test signals will also affect your ability to discriminate between one CD player and the next.

Tracks 29 to 36 on the Sony disc provide a series of left and right channel encodings to allow the direct evaluation of channel separation. This is important for evaluating the overall decoding quality of the CD player. With distortions of parts per million and dynamic ranges of greater than 90 dB, one must expect channel separations approaching the dynamic range of the disc, even if the original commerical software signal content does not approach half those figures.

Though similar in many ways, there are also striking differences between the Philips and Sony test discs. The first difference is that track No 2 on the Phlips disc provides a 20 Hz to 20 kHz sweep. This matches the capability of Bruel & Kjaer level recorders, enabling direct recording of frequency response on a frequency calibrated level recorder.

The second difference between the Philips and Sony test discs is their choice of frequencies for evaluating harmonic distortion. Philips uses frequencies of 41, 101, 997, 3163, 6363, 10 007, 16 001 and 19 997 Hz instead of the conventional rounded-off figures to which we have become accustomed.

The advantage of using these frequencies lies in their ability to reject and discriminate against main hum components and other interacting frequency components associated with the typical CD player. These particular signals and frequencies are repeated at -24 dB and also at -30 dB.

Linearity measurements are provided with a frequency of 997 Hz at 0, -1, -6, -12, -24, -60, -80 and -90 dB, for the left and separately for the right channel. These levels are included on both the Sony and Philips discs which we tested on three CD players with very similar results.

The feature I was most impressed with was that tracks 12, 13, 14 and 15 provide a swept test signal with a logarithmic sweep rate extending from 300 Hz to 20 kHz. These tracks contain two frequencies recorded at the same level so that the value of $F_2 - F_1$ is a constant 70 Hz. By passing this signal through a heterodyne analyser with a 3 Hz band width (and a signal-to-noise ratio of better than 70 dB) I was able to compare the performance of three CD players.

This signal showed how good the CD players really are at medium to high signal levels. It is in the range of -60 dB to -90 dB re 0 VU that we are aware of the increase in non-linearity of the digital to analogue encoders, and of the increase in total harmonic distortion (THD).

Philips provide more general information on the importance of the test equipment to be used by their technical staff in conjunction with the CD test record No 3. They provide block schematics of this equipment, as well as nominating the types of analysers for intermodulation distortion.

One statement that continually catches my eye is "because the rotational control on CD players uses circuitry with crystal accuracy, no measurements are required or necessary for wow and flutter". Though this may be true with a new and functional CD player, it is questionable whether it would apply to an old and tired CD player.

Aside from the technical importance of the discs, I found the Philips disc No 4 to be a collector's delight. It contains a range of exquisitely recorded classical and pop music, from Handels Water Music to Elton John and the Bee Gees.

Philips' disc No 4A has the same content but is supplemented by 'encoded defects'. These are printed on the surface as strips of thin black lines which simulate fingerprints and black spots of varying diameter. The intention is to test the ability of CD players to play over interruptions to their content without audible error. Unfortunately, this disc arrived too late for this month's test programme, and we couldn't evaluate this feature in all the players. However, both the Sony CDP-101 and the Pioneer P-D1 were able to track all of these man-made faults without problems. A badly scratched disc provided by Pioneer Australia wouldn't track in the worst scratched areas.

In future test discs I would like to see an expanded number of reference test levels between -60 dB and -90 dB, and the introduction of test frequency signals as specified for the IEC 'total difference frequency distortion meter'. Many laboratories now use this Australian system to measure the distortion characteristics of the latest generation of advanced performance amplifiers and tape recorders. It has obvious applications to testing CD players and the Sony and Philips organisations should take note of its advantages. With these refinements I believe that Sony and Phllips will have 'covered all the bases'.

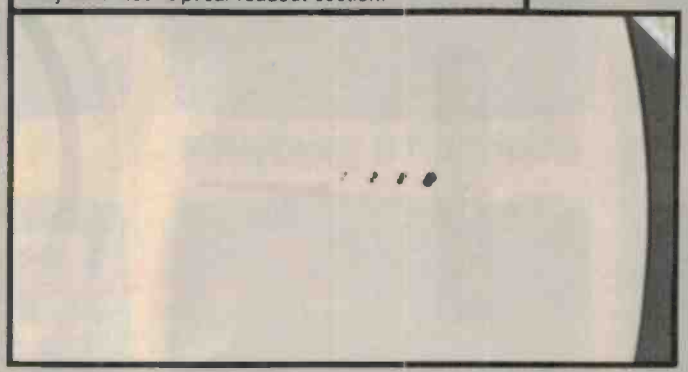
Compact disc players have not yet revealed any unusual faults, but it is clear new test records will be released which will make it easier to find those faults, as well as making the complex evaluation task more simple and straightforward.

▲
Above: The Philips set of test discs.
Below: Disc with 'encoded defects'.
▼

Radial length	Signal Information
0.5 mm	Mirror
1 mm	Multiburst Signal 100 kHz, 1.4 MHz, 200 kHz, 1.3 MHz, 300 kHz, 1.2 MHz, 400 kHz, 1.1 MHz, 500 kHz, 1 MHz, 600 kHz, 700 kHz, 800 kHz (repeat signals from 100 kHz to 800 kHz) Duration of each signal is 8.2msec.
0.5 mm	Mirror
1 mm	Duty Cycle Measurement Signal F_0: 750 kHz, F_1: 100 kHz, with different amplitude of - 20 dB after limiter
Outer Section	Mirror

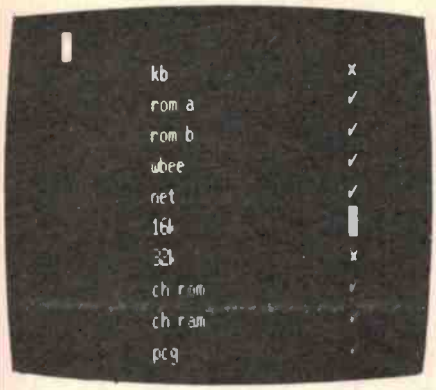
TABLE 2

Sony test disc. Optical readout section.

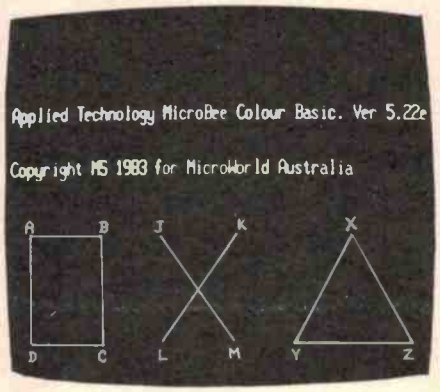


Now! Australia's leading ahead with totally operation.

microbee®

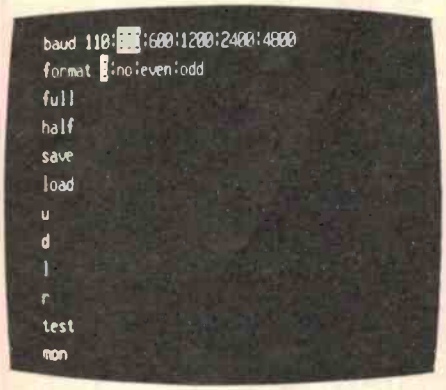


SELF TEST.

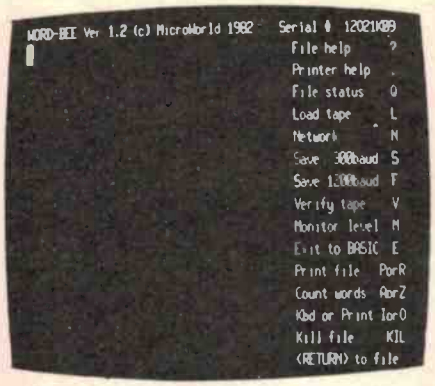


BASIC WITH GRAPHICS

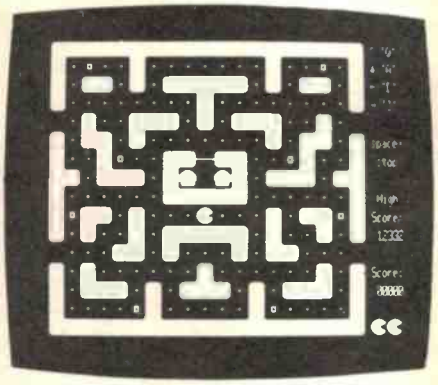
MONITOR



NETWORK



WORDBEE



ARCADE GAMES

Microbee features:

- 16K and 32K.
- Non-Volatile CMOS RAM.
- Programmable RS232 Serial Port.
- Programmable 8 Bit I/O Port.
- Display 64 x 16 and 80 x 24 screen format.
- 6545 Programmable VDU Driver.
- Cassette Interface, 300 and 1200 baud.

personal Computer moves further integrated software and faster

microbee®

First in the world with all these software features integrated into one computer —

MICROWORLD COLOUR BASIC 5.22e
WORDBEE WORD PROCESSOR
NETWORKING
TERMINAL COMMUNICATIONS
MACHINE CODE MONITOR
SELF TESTING

Here's why **microbee** has become Australia's biggest selling personal/educational computer. Over 3000 **microbees** are already helping teaching in Australian schools, T.A.F.E.'s and Universities.

New enhanced MICROWORLD BASIC 5.22e allows easy programming of colour into educational software and games with high resolution graphics. 16 Background and 26 Foreground colours. Wordbee in ROM means you can connect your **microbee** to a printer and have a complete word processor in your home for letters, school and Uni assignments and accounts.

Add a low cost modem or accoustic coupler and you can exchange BASIC and WORDBEE files with other **microbees OR** you can talk to the popular bulletin boards and sources around the world. Select the Terminal Mode to give you standard ADM3A or Televideo 912C terminal emulation in 80 x 24 format. Your **microbee** becomes a personal terminal to communicate with mainframe computers — your window to the world! Select the machine code monitor and you can program the Z80 microprocessor directly.

Your microbee *IC* even has a built in self test facility so you can be sure its not the machine but possibly your program that has the bug!

EDUCATION APPROVED DEPARTMENT

microbee 16K IC — $499.
microbee 32K IC — $599.

Recommended Retail Price Only. Prices may vary beyond Sydney.

PHONE ORDERS
(02) 487 2711

bankcard welcome here

Available from your microbee computer shops:

1 Pattison Ave, Waitara, Sydney. Phone (02) 487 2711

729 Glenferrie Rd, Hawthorn, Melbourne. Phone 818 2244

141 Stirling Highway, Nedlands, Perth. Phone 386 8250

Cooleman Court, Weston. Phone 88 6384

Microbee dealers:

NSW: **Electronic Agencies,** 117 York Street, Sydney. 115 Parramatta Road, Concord. **Compu-K,** 7 Casino Street, South Lismore. **Comput/Ed,** 8 Park Arcade, Park Avenue, Coffs Harbour.

ACT: **Computech,** Belconnen Churches Centre, Benjamin Way, Belconnen.

VIC: **Computerland South Melbourne,** 37 Albert Road, Melbourne.

S.A.: **Key Computers,** 1061 South Road, Edwardstown. 77 Grenfell Street, Adelaide.

W.A.: **Altronics,** 105 Stirling Street, Perth.

QLD: **Software 80,** 200 Moggill Road, Taringa. **Electrographic Office Systems,** 25 Grafton Street, Cairns.

Town and Country Computers, CTL Centre, Anne Street, Aitkenvale, Townsville.

TAS: **Central Data,** 14A Goodwin Street, Launceston.

PHONE ORDERS
(02) 487-2711
Applied Technology Retail Pty Ltd

microbee®

CEAT0582

EVERYTHING IN BREADBOARDS

B-29T Terminal strip
58 groups of 5 tie points
$5 + S.T.

B-512 390 tie points
$6.50 + S.T.

B-124 1680 tie point
$23+ S.T.

- All modules will accept all DIP sizes
- B-111 & B-112 with aluminium back plate
- Will accept all components with leads and solid wire AWG No. 22-30
- B-123 to B-212 with aluminium back plate, binding posts and rubber feet.

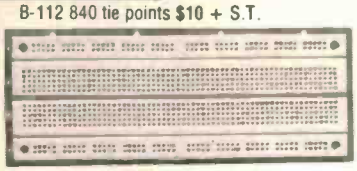
B-135 2420 tie points
$33 + S.T.

B-147 3260 tie points
$44.50 + S.T.

As supplied under Government contract

B-212 840 tie points
$16 + S.T.

B-112 840 tie points $10 + S.T.



Plus

B-64T Terminal Strip, 128 groups of 5 tie points . . . $6.95 + S.T.
B-64T Distribution strip, 4 bus of 25 tie points . . . $1.65 +S.T.
B-111 740 tie points . . . $8.35 + S.T.
B-123 1580 tie points . . . $22.00 + S.T.

Analogue & Digital Circuit Designer

AT-101 ANALOG LAB
$384 + S.T.

AT-102 DIGITAL LAB
$494 + S.T.

Features

- 1680 solderless, plug-in tie points with B-124 bread boards
- Breadboard elements are mounted on ground planes
- DC power supply with short circuit protection
- Sine, Square and Triangle waveform generator (1Hz - 100 KHz) Operates on 240 V AC
- Plus a host of individual features on each model.

Wire Cutter & Stripper
For wire from 0.5 to 8 mm². An essential tool for breadboarding **$6.50** + S.T.

Breadboard Jumper Wire
Four reels of 5m each. Colours: red, black, green, white.
$4.50 + S.T.

Use A-Tek® Circuit Designers for faster and easier prototyping of all types of electronic circuits

EMONA ENTERPRISES P/L Suite 204/661 George St, Sydney 2000 Ph (02) 212 4815 Telex AA 74500
Distributors in all States. See our range of Instruments on IREE Stand No. 28

HARD STORAGE

with the

HDU-1001

10Mb HARD DRIVE/FLOPPY SUBSYSTEM.

SME presents the HDU-1001 a hard working hard drive unit with 10 Megabytes of Winchester based disk storage backed up by a 1 Megabyte 8" double sided floppy.

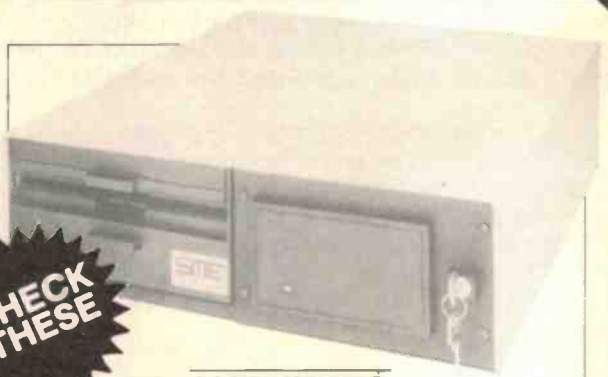
Built around Tandem's sturdy TM603S mini-Winchester drive coupled to an 8" QUME floppy the HDU-1001 gives you the storage capacity you need to handle large data base applications; the ability to transfer data to and from the hard disk; and back up facilities all in one compact package.

Employing the latest bit slice technology the HDU-1001's Winchester drive controller offers rapid reliable data collection, micro diagnostics for fault finding and error detection, plus the option to add another 10Mb of storage with the addition of another Winchester drive.

Housed in a rugged steel based, aluminium bodied enclosure the HDU1001 is rack-mount compatible and is supplied fully tested and ready to go to work for you ... hard.

SME SYSTEMS

22 Queen Street,
Mitcham,
Victoria, 3132.
Telex:
SMELEC AA37213



FEATURES

- 10Mbyte Winchester Storage.
- 1Mbyte 8" double sided floppy disk.
- Internal Winchester controller.
- High speed data throughput.
- Very quiet operation.
- Separate 50 way connector interface.
- CP/M 2.2 and MP/M 2.2 available.
- Designed and manufactured in Australia.

SME 448

MAN ALIVE! ADAM RE-INVENTED

As Adam was the first man, CBS Records is hoping that Coleco's Adam will be the beginning of a whole new era in home entertainment and home management when it makes its Australian début next March.

Adam is a home computer that Coleco unveiled at the international electronics show in Chicago in June. It stopped every other manufacturer in its tracks and set them re-evaluating the whole market.

While most computer manufacturers sell market a keyboard with memory, and then printers, cassette drive, joysticks and software as add-ons, Coleco plans to present a complete package.

The Adam package has an 80K memory, joysticks and paddles, a digital storage-pack system that uses ordinary cassettes but is as fast as a floppy disk, and a daisywheel printer.

The home computer will accept standard Coleco game cartridges, and will have a word-processing capability built into the system.

The whole system is expected to sell for under $1000 when it is launched in Australia next March by CBS Records.

The digital storage-pack systems is particularly interesting. Currently, cassette drives are extremely slow, and floppy disks very expensive. However, Coleco seems to have come up with the perfect compromise — a cassette drive system that is as fast as a disk drive.

The cassette has a multi-track format for storing data, all of which can be accessed almost as quickly as a floppy disk drive. Each cassette can hold up to 500K of memory.

The Coleco name was launched on to the Australian market at the Perth electronics show, early in August, with the release of the Coleco game centre.

Until now, Atari has been the king of the video games scene, with Intellivision snapping at its heels. However, Coleco is looking for 40 per cent of the Australian market by this Christmas.

The Coleco game centre was launched in the United States at a time when Atari and Mattell were having a big punch-up in the market place, and the new-comer got under both the giants' guards.

This initial gain was consolidated when Coleco offered add-on modules that enabled people to use Atari and Intellivision cartridges in the Coleco game centre.

Coleco's game console, which it describes as 'the Rolls-Royce of the game centres', has 16K of memory. It will sell for $299, including one game.

QDP MULTI-USER SYSTEM

A computer system that 'offers more user friendliness' and better computing power for a lower cost for both single- and multiple-terminal systems, is the positioning claimed for the QDP 300 series microcomputer, released in Australia by Insystems.

The QDP, manufactured by Quasar Data Products, of Cleveland, Ohio, is possibly the fastest Z80 computer yet released, but sidesteps many of the complexities normally associated with the CP/M and MP/M operating systems.

The QDP system options include one to four terminals, twin 20 cm 1.2-megabyte floppy disk drives, or a floppy and a 10- or 15-megabyte internal Winchester drive and both CP/M and MP/M operating systems, with expansion boards for extra RAM and 16-bit processors. It also has a battery backed real-time clock.

The CP/M QDP comes with its own word-processing, spelling, data base and financial spreadsheet software, along with a number of other utility programs.

One of these is Systat which, apart from telling the user how the system is set up, also keeps a record of all disk errors during normal disk operations.

The system is fully CP/M and MP/M compatible, allowing it to use most software written under these common systems, but it also contains an extremely friendly menu program to buffer new users from the more complicated aspects of the operating system.

Expansion slots have been left for new boards which will be available later this year. These will include a high-capacity RAM card, which will simulate an extremely fast disk drive, and a 16-bit computer card built on the 80186 chip.

For further details, contact **Insystems, 337 Moray Street, South Melbourne Vic. 3205. (03)690-2899.**

HIGH-SPEED JOYSTICK

Discwasher, the American company previously associated with record-cleaning accessories, has expanded its product range to cater for the video game and computer accessory market.

Heading the new range is the Pointmaster, a joystick that plugs into Atari and Commodore VIC-20 game centres. It features a high-speed thumb trigger, comfortable handgrip, self-centring mechanism and a 1.5 m cord. It costs about $29.99.

The manufacturer claims the Pointsmaster has a very fast reaction time, enabling the operator to achieve much higher game scores than normal.

Also available is a rapid-fire adaptor ($14.99) which allows the joystick to be fired continuously, like a machine gun.

The Discwasher range is handled in Australia by Arena **Distributors, 642 Albany Highway, Victoria Park WA 6100. (09)361-5422.**

MYER LOOKS TO FUTURE

The Myer Emporium, which started its computer and business centres with the opening of the Melbourne centre last February, has confirmed that it will be opening more centres in the coming months.

Centres have already been opened in Sydney, Brisbane, Adelaide and Perth, as well as Melbourne.

Since the initial five centres were opened, Myer has closely observed their own operation, while enjoying "excellent" trading. In the four and a half months of trading up until the end of June, the Myer Computer and Business Centres reported a turnover of more than $2.25 million.

Sales were 90% computer-related products and 10% business equipment products.

The main market thrust has been to corporations, small businesses and middle management.

Recently, Myer has been negotiating to secure a hand-held computer of "excellent quality and for extremely good value". The company hopes to make the computer available by mid-September.

For further details, contact **Myer Computer and Business Centre, 275 Lonsdale Street, Melbourne Vic. 3000. (03) 661-3342.**

NEW SLANT ON VDUs

AED Microcomputer Products now supplies a general-purpose swivel and tilt VDU monitor base.

The rugged unit, which is designed to improve the ergonomic presentation of existing monitors, in particular BMC and Sanyo styles, can be used with the majority of popular video monitors.

For more details, contact **AED Microcomputer Products, 130 Military Road, Guildford NSW 2161. (02) 681-4966.**

ZILOG DEVELOPS NEW 32-BIT MICROPROCESSOR

A new 32-bit microprocessor that offers on-chip cache and memory management, and which can execute up to five million instructions per second, has been announced by Zilog.

The Z80,000 CPU features full 32-bit architecture and implementation, a complete 32-bit instruction set, 32-bit internal and external data paths, and full support for all 32-bit data types. The chip is fully compatible with Zilog's Z8000 CPU family, but offers greater computer power and applications flexibility.

The chip also has four gigabytes of directly addressable memory, and features three selectable modes of address representation: 32-bit linear, 32-bit segmented and 16-bit compact.

According to Zilog, the Z80,000 CPU can execute up to five million instructions per second via a 'pipelined' scheme which allows more than one instruction to be executed at a time.

Designed for clock speeds ranging from 10 to 25 MHz, the chip can operate as fast as one instruction per processor cycle. Prototype performance tests have yielded an average of 2.2 cycles to execute all instructions, including jumps, multiples and divides, and an average speed of 3.4 cycles in instances of cache misses and memory bus transactions.

The Z80,000 gives users of Zilog's Z8000 family of 16-bit microprocessors a natural migration path to a 32-bit performance, because the new chip's software is a binary-compatible extension of the Z8000 CPU's, and upgrading to the new chip requires no recompiling or program changes.

It uses the Zilog Z-BUS, an advanced chip interconnect protocol used by all Zilog devices introduced since 1979, and works with all Z8000 peripherals.

For more information, contact **Zilog Corporation, 1315 Dell Avenue, Campbell, CA 95008, United States.**

DIRECT-CONNECT MODEM

A new direct-connect 300 bps modem that is no taller than a 50-cent piece, and fits under the base of a telephone, has been released by Electromed.

Called the Sendata 300, the modem is installed simply and does not require any operator training. It attaches to the existing telephone wall-socket plug and becomes fully operational with the flick of a switch by the operator.

The Sendata 300, which contains operating lights on the front panel, indicating when it is receiving or transmitting data, comes in a small rectangular casing, the samed size as a conventional telephone base and only 30 mm high. It has been field-tested for almost a year by an independent evaluator and has received Telecom approval.

The recommended retail price is $240, which includes tax.

For more information, contact **Electro Medical Engineering, 69 Sutherland Road, Armadale, Vic. 3143. (03)509-5844.**

WE'VE SHOT DOWN OUR PRICES

SEMIS

NPN UNMARKED TO-5 TRANSISTORS
40v 500mA SILICON
20 FOR $1.100 FOR $4.1K/$30

BC547	10 FOR 90¢
BC558	10 FOR $1
BC559	10 FOR $1
BC328	10 FOR 90¢
BC204 (BC557)	10 FOR 50¢
BD237 80V 2A 25 WATT	2 FOR $1
TT800	2 FOR $1
TT801	2 FOR $1
2SC1307	2 FOR $6

RECTIFIERS, DIODES ETC.

OA91	5 FOR 70¢
1N914/1N4148	10 FOR 60¢
1N4002	10 FOR 60¢
100P1V 3AMP	6 FOR $2
400P1V 6AMP	4 FOR $3
1N5626 600P1V 3AMP	5 FOR $2

BRIDGE RECTIFIERS
W02 200v 1.5A 5 FOR $2.65
400VOLT 6AMP 2 FOR $3.95

GREENCAPS

GREENCAPS 100V POLYESTER

0.001uF, 0.0022uF, 0.0033uF,	
0.0047uF, 0.0068uF	25 FOR $2.00
0.01uF, 0.022uF	20 FOR $2.00
0.033uF, 0.047uF	14 FOR $2.00
0.056uF, 0.068uF	13 FOR $2.00
0.082uF	15 FOR $2.00
0.1uF	10 FOR $2.00
0.22uF	9 FOR $2.00
0.39uF	8 FOR $2.00
0.47uF	6 FOR $2.00

ELECTROS

220uF	25v	pcb	10 FOR $2
220uF	25v	ax	12 FOR $2
330uF	63v	ax	5 FOR $2
400uF	40v	ax	6 FOR $2
470uF	25v	pcb	8 FOR $2
470uF	25v	ax	10 FOR $2
470uF	63v	ax	4 FOR $2
640uF	16v	pcb	9 FOR $2
1000uF	16v	ax	6 FOR $2
1000uF	25v	pcb	5 FOR $2
2200uF	16v	pcb	4 FOR $2
2500uF	25v	ax	2 FOR $2
3300uF	6.3v	ax	4 FOR $2
2000uF	64v	can	2 FOR $4
5500uF	25v	can	2 FOR $8
15000uF	75v	can	1 EA $12

PAKS OF ASSORTED POTS
20 MIXED VALUES $3
100 MIXED VALUES $10
Dual, switched, all new
250 MIXED VALUES $20
Bonza bulk package!

CAPACITORS

100pF ceramic	15 FOR $1.00
0.001uF ceramic	15 FOR $1.00
0.01uF 50v cer	15 FOR $1.00
0.01uF 500v cer	8 FOR $1.00
0.047uF ceramic	12 FOR $1.00
0.1uF ceramic	12 FOR $1.00
0.001uF 630v poly	8 FOR $1.00
0.001uF 1Kv styro	5 FOR $1.00
0.0068uF 600v styro.	6 FOR $1.00
0.01uF 400v poly	10 FOR $1.00
0.015uF 200v poly	12 FOR $1.00
0.022uF 250v poly	9 FOR $1.00
0.047uF 200v poly	8 FOR $1.00
0.056uF 1Kv poly	2 FOR $1.00
0.068uF 100v poly	7 FOR $1.00
0.068uF 400v poly	5 FOR $1.00
0.1uF 100v poly	5 FOR $1.00
0.1uF 630v GC poly	3 FOR $1.00
0.15uF 100v poly	6 FOR $1.00
0.15uF 250v poly	5 FOR $1.00
0.22uF 100v poly	5 FOR $1.00
0.22uF 250v poly	5 FOR $1.00
0.27uF 250V GC poly	5 FOR $1.00
0.33uF 100v poly	4 FOR $1.00
0.33uF 250v poly	4 FOR $1.00

TAKE YOUR PICK!

$2 EACH PACK

LUCKY-DIP PACKS $2EA
- 500 ¼WATT RESISTORS
- 200 1WATT RESISTORS
- 50 1% HI-STAB RESISTORS
- 20 MIXED POTENTIOMETERS
- 25 PRESET POTS ASST.
- 30 POLY. GREENCAPS
- 100 CERAMIC CAPACITORS
- 45 ELECTROLYTIC CAPS
- 12 VARIOUS SWITCHES
- 40 RADIO/TV KNOBS
- 50 ASST TAGSTRIPS

RESISTORS

¼ WATT 5% TOLERANCE

ALL E12 VALUES, 1OHM TO 10MEG.

PAKS OF 10 EACH VALUE.....25¢
PAKS OF 100 EACH VALUE.....$1.25
PAKS OF 1000 EA. VALUE.....$10

Philips TRIPLERS

FOR COLOUR TV BEST QUALITY SIEMENS/VARO

$12

As used in Pye, Philips, Kriesler and most German colour TV's.

EHT Trans

Brand new Philips EHT Transformers, NOW REDUCED $1.50

$4

NT3100
NT3101
NT3122

IC's

"SWEEPINGS OFF THE FACTORY FLOOR"

Approx 100 ASST. FOR $10.00 1000 for $90

Power Transformers 1/2 PRICE

240V Inputs

AUST. MADE. AT HALF NORMAL PRICE

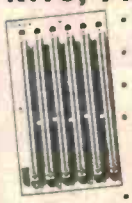
TYPE	INPUT	OUTPUT/S
A	0-120, 0-120	0-24V, 4A
	PRICE $15.00	0-10V, 1A 0-20V, 1A
B	0-120, 0-110-130	0-25V, 5A
	PRICE $15.00	0-20V, 1A 0-110V, 200mA
C	0-110, 0-110-130	0-24V, 1A
	PRICE $10.00	0-24-28-30V 1Amp
D	0-110, 0-110-130	0-22-24V 2A
	PRICE $10.00	0-27V, 1A 0-12V, 1A
E	0-240	0-18V, 400mA
	17.5-0-17.5-60-180	
	PRICE $8.00	-300V, 100mA
F	0-240	0-18V, 2A
	PRICE $7.00	0-8.5V, 3A
G	0-110-240	0-33V, 1.25A
	PRICE $4.50	
H	0-240	0-12.6V, 1A
	PRICE $4.00	
I	0-240	0-12.6V, 500mA
	PRICE $3.50	
J	0-240	20-0-20V
	PRICE $15.00	2 Amps
K	0-240	0-24V
	PRICE $7.50	1.25 Amps
L	0-240	0-24V
	PRICE $12.50	4.2 Amps

QT COMPUTER SYSTEMS (AUST.) Quality Products

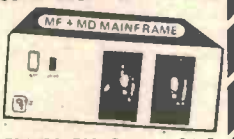
$100 IEEE BASED COMPUTER CARDS and SYSTEMS

- Z80A 2/4MHz CPU BOARD...$249 Complete, built and tested computer (+S/T)
- DISK CONTROLLER BOARD...$495 Controls 4 SS or DD 5¼" or 8" drives (+S/T)
- 64K STATIC RAM BOARD....$430 Expandable as 16K, 32K, 48K, 64K (+S/T)
- 256K DYNAMIC MEM BOARD. $995 Expandable 16K to 256K. (64K..$795) (+S/T)

KITS, PARTS, METALWORK EX-STOCK



- QT MOTHERBOARDS FROM..$34 Silence - , 4 up to 18 Slot, also ACT
- QT CARD CAGES FROM....$33 For 6, 8 or 12 Slot Motherboards
- DISK DRIVE CABINETS AVAIL. For single or dual 5¼" or 8" drives
- POWER SUPPLIES FOR DRIVES Assembled and tested or in kit form



- MAINFRAMES FOR 5¼" OR 8" D Available as bare metalwork, with or without power supplies, card cages, fan, motherboards, etc. From .....$195+S/T
- $100 SOCKETS..$6.90 ea

TERMINALS, PRINTERS, PLOTTERS ETC

SEIKOSHA GP100A PRINTER
$415 +S/T
OR
$575 +S/T
MICROLINE 80

C.ITOH 8510 parallel (serial opt) $825+
C.ITOH 1550 parallel (serial opt) $1375+S/T
C.ITOH F-10 DAISY WHEEL parall $1795+

VIDEO TERMINALS with detachable keyboards +S/T $875

WATANABE INTELLIGENT X-Y PLOTTERS 6 Colour Parallel model $998

DISCOUNT DISK DRIVES

Our prices are TOO LOW to advertise! We have Teac and MPI 5¼" drives upto 1M bytes and Mitsubishi and YE-Data drives up to 1.6M bytes. CALL US NOW.

OVERNIGHT DELIVERY TO MOST AREAS. S/T IS 20%. BANKCARD & PHONE ORDERS OK. A GOVT. ORDER IS OK!

QT PRODUCTS DISTRIBUTED BY:

1983 CATALOGUE NOW AVAILABLE

SENT FREE TO SCHOOLS, GOVT. DEPTS, COMPANIES ETC. OTHERWISE SEND 70c TO COVER POSTAGE.

PRE-PAK electronics p/l

1a West St, LEWISHAM NSW 2049 569-9797

ELECTROLYTIC CAPACITORS FROM TWO CENTS!

4.7uF	100v	PT...5¢	100uF	160v	PT..20¢
10 uF	16v	PC...2¢	220uF	16v	PT..10¢
22 uF	63v	PT...7¢	220uF	63v	PT..20¢
47 uF	10v	PC...3¢	330uF	35v	PT..20¢
47 uF	25v	PT..10¢	470uF	10v	PC..10¢
50 uF	100v	PT..10¢	470uF	50v	PT..40¢
100uF	10v	PT...3¢	640uF	16V	PT..15¢
100uF	16v	PC...4¢	1000uF	10v	PT..30¢

EX-COMPUTER TESTED FANS
25% DISCOUNT
5" NOW ONLY 110V $6 OR 220V $7.50

REED SWITCH, COILS

	1-9	10+
12v SUPER-MINI COIL.	$1.20	$1.00
REED SWITCH.....	0.60	0.50
6v MINI COIL.....	$2.00	$1.75
12v MINI COIL.....	$2.00	$1.75
REED SWITCH.....	$1.10	0.95
24v MINI COIL.....	$2.90	$2.45
STD. REED SWITCH	$1.15	$1.00

DISCO STROBE $12.50

NORMAL PRICE $29.95 SAVE NEARLY $17.50
REWORKED WARRANTY STOCK
"Freeze" the action at your next party or theatrical show! Mains operated with a continually variable flash rate, housed in an attractive black vinyl box 150mm

LAST STOCKS AT THIS PRICE!

UNDER ½ PRICE!

TWO BOO-BOO'S IN PURCHASING LAST FINANCIAL YEAR HAVE LEFT US WITH AN EXCESS OF STOCK WE MUST CLEAR!

MOVING COIL CARTRIDGE

MODEL MC100

WAS $49.50 NOW ONLY.... $24 EA

- Standard ½" mounting.
- Samarium Cobalt magnets for high output- transformer not needed.
- Freq. response 15Hz-35KHz.
- Huge 2.5mV output (1KHZ/50mm/s)
- Tracking Force: 2.0 grams.
- 0.6mm Diamond stylus.
- Complete mounting kit incl.
- Stylus easily replaced ($15.00)

49 MHz FM Wireless Microphone System

Clearance of professional wireless mikes in two versions. MUSIC and PA APPLICATIONS: Type R1- Ideal for Churches, halls, theatre and school use, comprises miniature electret mike and belt-clip FM transmitter with a xtal-controlled receiver base with separate signal strength, tuning and audio VU meters. Features easy connection to most amplifiers with 25mV (mike) and 580mV (aux) outputs, T.H.D. 2% and 9V DC operation, mains power-pack supplied.

WAS $151.20 NOW ½ PRICE $75

WAS $90.20 NOW ½ PRICE $45

MOBILE APPLICATIONS: Type R2- Uses the same mike and belt-clip FM transmitter with a similar belt-clip receiver fitted with a special ear-piece speaker. Ideal for athletic coaching, bike and car racing, student training exercises and video camera recording. Full technical data avail with SAE.

FREE GIFT!

WITH EVERY ORDER OVER $30.00, WE WILL OFFER A CHOICE OF-
A) 12VDC 100MA AC ADAPTER,
B) 24VAC 1AMP AC ADAPTER,
C) CAR CB OR STEREO MTG. BRACKET.

PACK/POST

$2 PLUS 5% OF ORDER VALUE.

60 WATT HORN TWEETERS

Imported "NOVIK" tweeters 4-20KHz with X'over capacitor

$8 each

Square or rect.

Worth around $16.00!

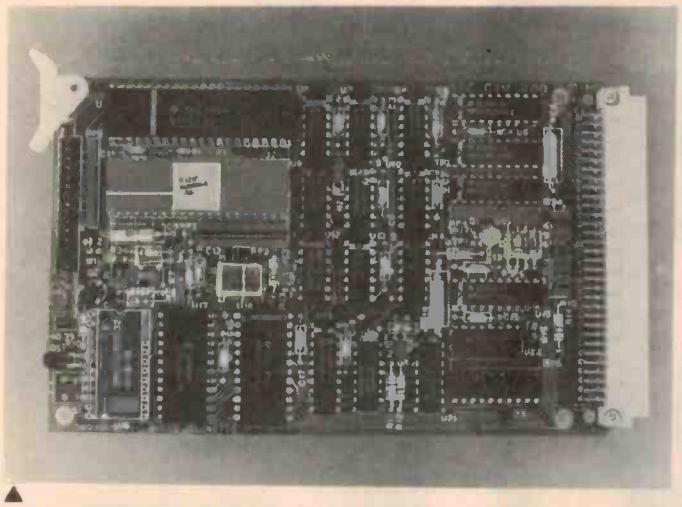
DC MOTORS 6-12V

LARGE SIZE! IDEAL FOR TOYS, MODEL BOATS, CARS, HOBBY ETC. OPERATES FROM 4.5V TO 12V. POWERFULL AND RUGGED. SIZE 47MM DIAM x 60MM

$3 ea 10 for $25

PRE-PAK electronics p/l | 1a WEST ST, LEWISHAM, NSW | 569-9797 24 HR PHONE ORDER SERVICE

SEE THE HUGE RANGE IN-STORE!
IF YOU THINK WE PACK A LOT INTO OUR ADS. YOU SHOULD SEE WHAT'S IN OUR SHOP !



HIGH-SPEED BOARD FROM NATIONAL

National Semiconductor has added two models to its range of industrial computer boards: the CMOS Industrial Microcomputer CIM-804 and the CIM-802A.

The top-of-the-range CIM-804 is a high-speed 4 MHz central processing unit board, while the CIM-802A is an enhanced version of the company's proven 2 MHz CIM-802.

Both new boards operate in ambient temperatures, from −40°C to +85°C at low power-consumption levels for remote station and process-control applications, such as industrial instrumentation, numeric machine control, pipeline monitoring and control, robotics and uninterruptable power supplies.

The high-speed CIM-804 is a board-level computer featuring 2K of static RAM, provision for 4K of 'shadow' PROM, up to 22 programmable input/output lines, 12 vectored interrupts and two 16-bit counter/timers with pre-scalers.

New features of the upgraded CIM-208A include a PROM "shadowing" capability.

Both CPUs are based on the eight-bit NSC800 microprocessor.

For further details, contact **National Semiconductor, Cnr Stud Road and Mountain Highway, Bayswater Vic. 3153. (03)729-6333.**

VERSATILE PLOTTER FOR MICROCOMPUTERS

A versatile graphic plotter, designed for use with personal and small-business computers, has been released by Sourceware, the Sydney computer-products distributor.

The Sweet-P personal plotter, which is plug-compatible with the IBM, Apple, Osborne and Kaypro personal computers, is suitable for graph processing, engineering graphics and overhead transparencies.

Sweet-P is provided with its own software for plotting standard and business graphics and fits into a slim briefcase. It is priced at $1499.

One of the plotter's main advantages is its ability to interface automatically to all the major graphics software, such as Lotus 1-2-3, Fastgraphs and BPS Graphs.

Sweet-P can be used to create, store and draw coloured pie charts, bar graphs, line graphs and illustrations on any type of paper or overhead transparency materials from 21 x 27 cm up to three metres long.

The plotter, which has a drawing speed of 15 cm per second, also can give a resolution of 250-line segments in 2.5 cm.

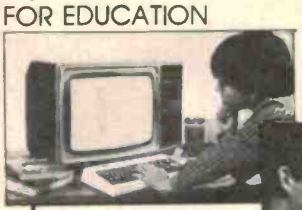
For more information, contact **Sourceware, 4/73 Albert Avenue, Chatswood NSW 2067. (02)411-5711.**

The **Clever** Computer

Comx 35

- 16 KB of ROM
- 35 KB of RAM
- Built-in joystick
- Built-in speaker
- High Resolution Colour Graphics
- Super Enhanced BASIC
- Uses Home Cassette Recorders
- Uses Home TVs

FOR EDUCATION



BUSINESS

PERSONAL

HOME

FUN

ALL FOR ONLY $299

- Comx 35 is really compact and light—making it ideal on a desk top or for carrying anywhere in a briefcase.
- Save more on our complete software packages for all uses.
- Comx 35 has an 8-colour display of 24 lines by 40 characters and utilises the complete screen.
- The built-in joystick is specially designed so it is more responsive and easier to use than conventional cursor keys and it is not only for games.
- Memory size can be expanded from standard 35K to 67K and expansion connector for serial ports, printers, disk drive to be added.

For Catalogue and Further Information Write To:

COMX AUSTRALIA SALES

1310 Centre Rd., Clayton, Vic. 3168

Phone: (03) 543-6286, Telex: 36776 FELUFA

TWO NEW TRS-80 MODELS

The Tandy TRS-80 Micro Colour Computer Model MC-10, aimed primarily at first-time computers buyers, will be available in October, for $199.95.

The Model MC-10, which has a 4K capacity, features a standard keyboard with true moving keys. Key word input can be accomplished with only two key strokes. Low-resolution graphics also can be generated with two key strokes.

A serial port allows use of modems and printers, and there is a cassette port for loading and saving of programs on cassette tape.

The 836 g Model MC-10 measures 5 x 20 x 18 cm — small, but still considerably larger than Tandy's new pocket computer, the TRS-80 PC-4, which retails for $99.95.

The PC-4 measures just 1 x 16.5 x 7 cm and has a typewriter-style keyboard of 53 keys for alphabetic input, plus a 10-key numeric data-entry keypad. A 12-character LCD scrolls horizontally to up to 62 characters, including lower-case.

The PC-4 operates on two lithium batteries and has an automatic power-off feature to preserve battery life.

An optional user-installable 1K RAM memory module, costing $29.95, expands the PC-4's 544-step, 26 variable-memory RAM to a maximum of 1568 possible steps or up to 222 memories.

A cassette interface ($59.95) allows the user to store and load programs at 300 baud, using an optional cassette recorder. The lightweight interface, which plugs into the back of the PC-4, operates on two "AA" alkaline batteries.

Tandy also offers a PC-4 printer ($109.95) which prints 20 characters per line (60 lpm) in an electro-thermal 5 x 7 dot matrix.

For more details, contact **Tandy Electronics, 91 Kurrajong Avenue, Mount Druitt NSW 2770. (02)675-1222.**

SOME COMPUTERS ARE BETTER THAN OTHERS

COMPUTER COMPARISON CHART

	SPECTRAVIDEO SV-318	APPLE II PLUS	ATARI 800	COMMODORE 64	COMMODORE VIC 20	TANDY TRS-80
BASE PRICE	**$499**	**$2100**	**$1100**	**$699**	**$299**	**$549**
COMPUTING POWER FEATURES						
BUILT-IN ROM	32K	12K	10K	20K	20K	8K
EXPANDABLE TO	96K	N/A	42K	N/A	N/A	14K
BUILT-IN EXTENDED MICROSOFT BASIC	YES	YES	ADDITIONAL COST	NO	NO	NO
BUILT-IN RAM	32K*	48K	16K	64K	5K	4K
EXPANDABLE TO	144K**	64K	48K	N/A	32K	32K
KEYBOARD FEATURES						
NUMBER OF KEYS	71	51	61	66	66	53
USER DEFINE FUNCTIONS	10	N/A	4	8	8	N/A
SPECIAL WORD PROCESSING	YES	NO	NO	NO	NO	NO
GENERATED GRAPHICS (FROM KEYBOARD)	YES	NO	YES	YES	YES	YES
UPPER/LOWER CASE	YES	UPPER ONLY	YES	YES	YES	UPPER ONLY
GAME/AUDIO FEATURES						
SEPARATE CARTRIDGE SLOTS	YES	NO	YES	NO	NO	NO
BUILT-IN JOYSTICK	YES	NO	NO	NO	YES	NO
COLORS	16	15	128	16	16	8
RESOLUTION (PIXELS)	256 x 192	280 x 160	320 x 192	320 x 200	196 x 184	192 x 256
SPRITES	32	N/A	4	8	8	N/A
SOUND CHANNELS	3	1	4	3	3	1
OCTAVES PER CHANNEL	8	4	4	9	9	3
A.D.S.R. ENVELOPE	YES	NO	NO	YES	YES	NO
PERIPHERAL SPECIFICATIONS						
CASSETTE	2 CHANNEL	1 CHANNEL	2 CHANNEL	1 CHANNEL	1 CHANNEL	1 CHANNEL
AUDIO IO	YES	NO	YES	NO	NO	NO
BUILT-IN MIC	YES	NO	NO	NO	NO	NO
DISK DRIVE CAPACITY (LOW PROFILE)	256K	143K	96K	170K	190K	156K
	YES	NO	NO	NO	NO	NO
CP/M COMPATIBILITY (80 column programs)						
CP/M® 2.2	YES	NO***	NO	NO****	NO	NO
CP/M® 3.0	YES	NO	NO	NO	NO	NO

* 16K user addressable plus 16K graphic support
** 128K user addressable plus 16K graphic support
*** Apple II can accept modified 40 or 80 column CP/M
**** Commodore 64 accepts 40 column CP/M

Microsoft is a registered trademark of Microsoft Corporation
CP/M is a trademark of Digital Research, Inc.

OURS IS MUCH BETTER

When you start comparing Spectravideo's SV-318 to other personal computers, you'll find there really is no comparison. The SV-318 is the only logical choice, because it does more than some computers costing 4 times as much. And its abilities simply embarrass other computers in this price range.

The SV-318 isn't just more capable. It's much more capable. No other computer at even twice the price comes near its 32K ROM expandable to 96K. Or to its 32K RAM expandable to 144K. And no other computer has a built-in joystick/cursor control—an immeasurably useful feature when it comes to playing your favorite video game. Further, the SV-318 has, as its resident "language" Extended Microsoft Basic, the industry standard. It even has built-in CP/M (standard 80-column program), so you can immediately utilize over 10,000 existing software programs.

The SV-318 isn't just more expandable. It's much more expandable. Unlike many other so-called computer systems, all our important peripherals are available at once. That means you can get almost full usage out of your SV-318 from the day you buy it. With the Super Expander, Data Cassette, Floppy Disk Drive, Dot Matrix Printer, Graphic Tablet and SV-800 Series Expansion Cartridges, there's almost no end to the work you can do. Or to the fun you can have. The SV-318 is well designed to interface with new options as they become available, too. All this adds up to a computer you'll grow into, not out of.

The SV-318 is not only eminently affordable, it's the first real bargain of the computer age! Besides business application, home budgeting, word processing, programming and self-teaching, the SV-318 is the best entertainment value in town. Not only can you use it with your TV or color monitor to play hundreds of different video games,

FOR UNDER $500

with the optional SV-105 Graphic Tablet you can draw pictures, graphs, charts and other visual images on your TV screen. Considering what you get for what little you pay, the SV-318 is once again the only logical choice.

Whether you're investing in your first computer, or are already well versed in today's most important machine, you'll find that the SV-318 is the only logical choice for you.

SPECTRAVIDEO™

SV-318

PERSONAL COMPUTER

VIDEOACTIV ELECTRONICS

70 St. Kilda Road, St. Kilda, Vic. 3182. Ph: (03) 537-2000
P.O. Box 474, Edgecliffe, N.S.W. 2027. Ph: (02) 328-1190
Franklin Agencies, 3 Marie St., Milton, Qld. 4064. Ph: (07) 369-0496
Jerdon Agencies, 25 Gladstone St., E. Perth, W.A. 6000. Ph: (09) 328-5299

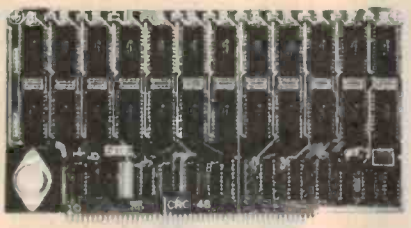
S100 Z80 System Cards

CP/M3 USERS

DRC-II.
The board for multi-user installations. 256K dynamic RAM card, bank select, fast 4 Mhz operation, on-board memory prom, dip-switch selectable boundaries, bank mode allows up to 2 boards on bus, hidden refresh, phantom disable.
List Price $995.
OUR PRICE
$795

SBC-800.
4 Mhz Z-80 CPU, two serial RS232 ports, software programmable Baud rate gen., Centronics parallel port, 22 prog. I/O lines, real time clock (battery backed), 2K CMOS RAM, power on reset/power fail detect, battery backed as standard, etc. List Price $495.
OUR PRICE
$395

CRC-64.
Fool-proof memory system. State-of-the-art 64K CMOS memory card with memory protection, on board battery back-up, compatible with DRC-II, write protection enable/disable.
List Price $675.
OUR PRICE
$565



To K-NAR Computer Cards
Please send me product data sheets.
(I enclose 4 stamps).

I wish to order _____

My cheque/order form for _____ is enclosed

Please debit my Bankcard No. _____

Name _____

Address _____

_____

Signature _____

Please include me on your new product mailing list.
I am mainly interested in systems for:
☐ Hobby, ☐ Industrial use, ☐ Education,
☐ Process control, ☐ Business ☐ Other.

K-NAR
COMPUTER CARDS

P.O. Box 412, Dandenong, 3175. Phone (03) 795 5858.
Authorised distributor of SME Systems products.
*Prices subject to change without notice. All prices excluding tax. For retail prices add 20%
All boards fully assembled and tested and backed by 90-day guarantee.

Sendata 300 Modem Direct Connect

A new direct connect 300 bps modem that is no taller than a 50c piece and fits snugly under the base of a telephone, has been released by Australian communications manufacturer, Electromed. Called the Sendata 300 the modem is simple to operate and does not require operator training. It attaches to the existing telephone wall socket plug and becomes fully operational with the flick of a switch by the operator.

$199 Plus Tax

- No installation costs.
- Simple operation.
- Fits under telephone base.
- Attaches to existing telephone plug.

SENDATA

OEM AND DEALER ENQUIRIES WELCOME

ELECTRO-MED
ELECTRO-MEDICAL ENGINEERING P/L

69 SUTHERLAND ROAD, ARMADALE,
VICTORIA 3143, AUSTRALIA
TELEPHONE: (03) 509 5844.
TELEX: AA34008

AUSTRALIAN MICROCOMPUTER BOASTS MANY ADVANCED FEATURES

This column in July looked closely at AED's unique Instant Program Selection feature 'MPS'. In August we examined the UNIVERSE's advanced dual 8 & 16 bit high speed CPU, and intelligent DMA floppy controller. This month we look in depth at two more of the technology leading features that make this machine the fastest, most flexible and expandable, S100 CP/M and CP/M-86 based system available.

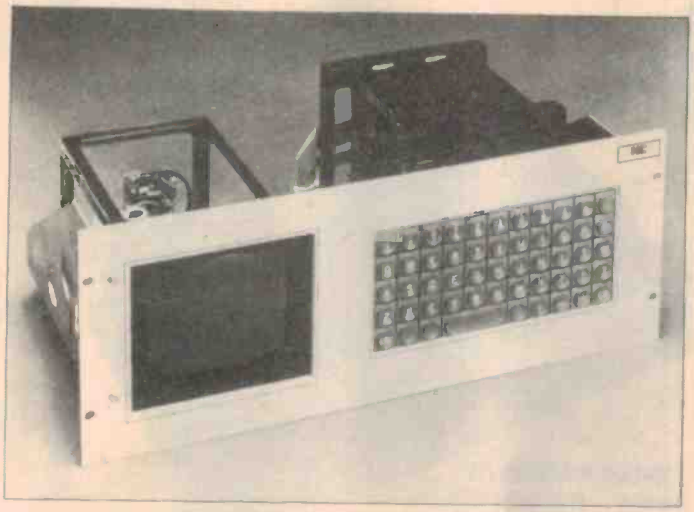
UN-SERIAL TERMINAL

Unlike typical computers the AED UNIVERSE incorporates a memory mapped intelligent terminal. This non serial terminal provides higher speed than serial types, combined with the special factilities required by powerful operating system features such as SUPERAED and MPS. The keyboard is a high reliability Honeywell Hall effect data entry and word processing type with 17 user definable keys, numeric pad, and 12 special cursor control keys. The keyboard is separable from the screen unit for optimum user comfort. The screen is a high resolution, green or amber, anti-glare, monitor mounted in an attractive and functional swivel and tilt housing. The terminal electronics are driven by intelligent video driver software which is incorporated in the AED CP/M extensions 'SUPERAED' and 'MPS'. This standard terminal driver responds to the usual codes and escape sequences of serial types, however, instead of being locked in, the driver, lends itself to code modification or extension. The sheer speed and direct driving capability of the 'UN-SERIAL' terminal makes it extremely suitable to word processing systems such as 'WORDSTAR' under which it performs more like a sophisticated dedicated wordprocessing machine than the normal computer fitted with a serial terminal.

INTELLIGENT D.M.A. HARD DISK CONTROLLER

The hard disk controller in the UNIVERSE computer incorporates many advanced features to compliment the design of the floppy controller described last month. Unlike many inferior interfaces this controller cashes in on all of the increased transfer speed of the Winchester hard disk mechanisms. The controller has its own 7.16 Meg 8x300 Bipolar processor, therefore the data arrangement on the disk is not limited by special purpose LSI controller chips. This intelligence relieves the main CPU of time consuming processes such as head positioning and rotational delays, etc. The main processor is further freed by the DMA system which independently transfers the data bytes directly from the disk into the system memory. This "channel" concept allows the controller to communicate with S100 memory by 'stealing' bus cycles from the main CPU or using the bus in "burst mode" for ultra-fast transfer. This idea of an intelligent channel was first implemented on mainframes, now, this powerful concept has been implemented on an S100 bus microcomputer system. The interface can drive the full 24 address line space and has priority logic allowing it to contend with up to 15 other temporary bus masters.

The AED UNIVERSE combines many more technology leading features in one system than nearly all other microcomputer systems. Over the last few months we have looked at several of them and more will be detailed in this column next month.



ANCA INDUSTRIAL TERMINAL

Australian NC Automation, the Melbourne-based company specialising in the design and manufacture of microcomputer-based industrial control systems and subassemblies, has released its Model VT5 industrial VDU terminal.

Designed specifically for industrial applications where clear, precise messages need to be displayed, and where input data is required from factory personnel, the ANCA VT5's features include a solid-state hall-effect QWERTY keyboard, a 13 cm green phospor display with 32 characters by 16 rows, 20 mA and RS232 interface to 9600 baud, and both dc and ac operation.

Programmable aspects of the VT5 are double-size characters, reverse video characters, flashing characters, cursor blank, blink and box, cursor addressing, and underlining.

The unit measures 178 x 482 x 230 mm and weighs 6 kg.

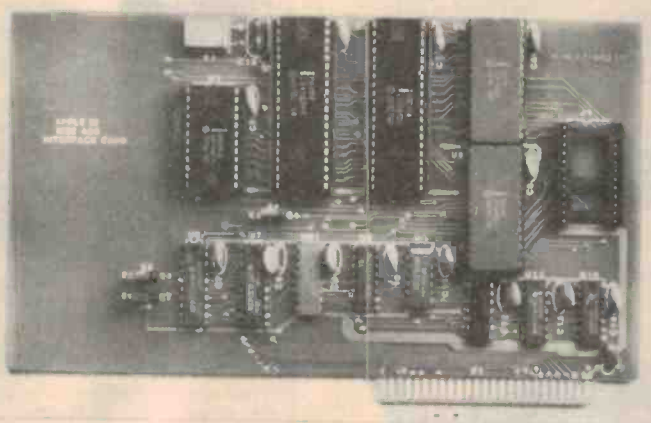
For further details, contact **ANCA, 204-206 Bell Street, Preston Vic. 3072. (03)44-0722.**

SPELLBINDER NETWORK GROWS

Sydney's Software Source has signed a sub-distribution agreement with Sky Systems for Oasis versions of the Spellbinder word-processing and office management system.

While Software Source remains the sole Australasian distributor for Spellbinder, Sky Systems — located at 36 Second Avenue, Willoughby NSW 2068; phone (02)95-5503 — will enhance the backup and service aspect for the package.

For further information, contact **Software Source, 344-348 Oxford Street, Bondi Junction NSW 2022. (02)389-6388.**



CONTROLLER FOR APPLE III

Innovated Peripheral Systems, a leading American manufacturer of magnetic tape controllers and peripherals for the data-processing industry, has introduced a new IEEE-488 controller for the Apple III series of computers.

The APL-488CT requires a single slot in the Apple III, and provides the users with IEEE-488 Standard 1978.

The controller's driver is SOS compatible, allowing the user to use simple print or input statements to control the bus function. Because the driver is within the SOS, all high-level languages are supported, making it very user-friendly.

Using the APL-488CT, more than 2000 IEEE-488 compatible instruments, peripherals and other devices can be added to the Apple III.

For further information, contact the Australian agent, **Mostyn Enterprises, 35 Alexander Street, Dundas NSW 2117. (02)871-6297.**

THE WIZARDRY OF OZ1

OZtronics Australia has announced the release of OZ1, a data-acquisition system that allows almost any computer to gather analogue and digital information from 'the real world'.

A supervising computer communicates with OZ1 *via* the serial port. Consequently, many portable computers, small business computers and personal computers may be used with OZ1 for data acquisition without modification or addition of special interface cards, requiring only that a serial interface be available.

The unit can be connected to the serial port of the host computer, either as a single unit or as a network of up to 16 units.

It provides for 30 single-ended or 15 differential analogue channels and two digital channels, and a fully implemented network provides for 480 single-ended or 240 differential analogue channels and 32 digital channels.

For additional details, contact **OZtronics Australia, 8 Glenfern Avenue, Upwey Vic. 3150. (03)438-2638.**

SENSATIONAL SCOOPS

ALTRONICS • BANKCARD JETSERVICE DELIVERY NEXT DAY • ALTRONICS • BANKCARD JETSERVICE DELIVERY NEXT DAY • ALTRONICS

HUGE BULK IMPORT NOW UNDER $600

BRILLIANT NEW SUPER 80
DOT MATRIX PRINTER
ADJUSTABLE SPROCKET FEED AND FRICTION FEED

14 DAY MONEY-BACK GUARANTEE

Just a few short months ago we were selling printers of comparable quality and specification for around $1000. With the release of the exciting new SUPER-80 and our bulk purchase powers we are offering these for sale at just

$499.50

HURRY — LIMITED STOCKS!

Operating under direct software control from any general purpose micro-computer, office computer, etc, the Super 80 is capable of **13 different print types** including emphasized **(letter quality)**. Bit image graphic capabilities enable **extensive formating** and reproduction of **high resolution graphic images.**

Interfaced specifications
Interface: Standard Centronics parallel. Optional RS-232C. (SERIAL)
Data transfer rate: 4,000 CPS max.

Functional specifications
Printing method: Serial impact dot matrix
Printing format: Alpha-numeric — 7 x 8 in 8 x 9 dot matrix field. Semi-graphic (character graphic) — 7 x 8 dot matrix. Bit image graphic — vertical 8 dots parallel, horizontal 640 dots serial/line
Character size: 2.1mm (0.083 ") W x 2.4mm (0.09 ") H/7 x 8 dot matrix
Character set: 228 ASCII characters; Normal and italic alpha-numeric font, symbols and semi-graphics
Printing speed: 80 CPS, 640 dots/line per second.
Printing direction: Normal — Bidirectional, logic seeking. Superscript and bit image graphics — unidirectional, left to right
Line spacing: Normal — 4.23mm (1/6 "). Programmable in increments of 0.35mm (1/72 ") and 0.118mm (1/216 ")
Columns/line: Normal size — 80 columns, double width — 40 columns. Compressed print — 142 columns. Compressed/double width — 71 columns. The above can be mixed in a line.
Paper feed: Adjustable sprocket feed and friction feed
Paper type: Fanfold. Single sheet. Paper width — 101.6mm (4 ") to 254mm (10 ")

VALUE PACKED AT
D1170... **$499.50**

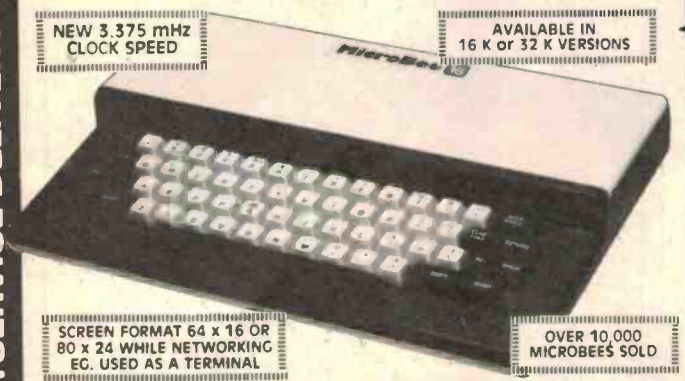
Printer Cable Interface Kit to suit Microbee
D1190..... **$49.95**

MADE IN JAPAN QUALITY

THE FANTASTIC MICROBEE IC HAS ARRIVED

NEW 3.375 mHz CLOCK SPEED

AVAILABLE IN 16 K or 32 K VERSIONS



SCREEN FORMAT 64 x 16 OR 80 x 24 WHILE NETWORKING EG. USED AS A TERMINAL

OVER 10,000 MICROBEES SOLD

The all new Microbee IC has got to be the most value packed ROM based personal computer available today. **New enhanced basic** enables 64 x 16 or 80 x 24 screen format while networking and the clock speed is now a **zippy 3.375 MHZ** and over **$110** worth of software integrated in ROM i.e. the absolutely delightful **Wordbee** word processor package or **Editor Assembly** plus all the other exciting features that have made the Microbee famous.

D 1020..... 16 K..... **$499.00**
D 1035..... 32 K..... **$599.00**

HIGH RESOLUTION MONITOR

NOW WITH SCREEN INVERT FUNCTION AT NO EXTRA COST

OVER 1000 SOLD

NO MORE HEADACHES! AND BLURRED VISION

One of the hassles of sitting there for countless hours operating your computer is *eye strain* (anyone who has just spent 10 hours solid will agree!!) Well our fantastic new MICRON 12 High Resolution Green Phosphor Monitor has a'reverse' or invert screen function where by simply rotating the contrast control anti-clockwise the screen information and background are reversed. This is especially valuable in poor lighting conditions.

MICRON 12

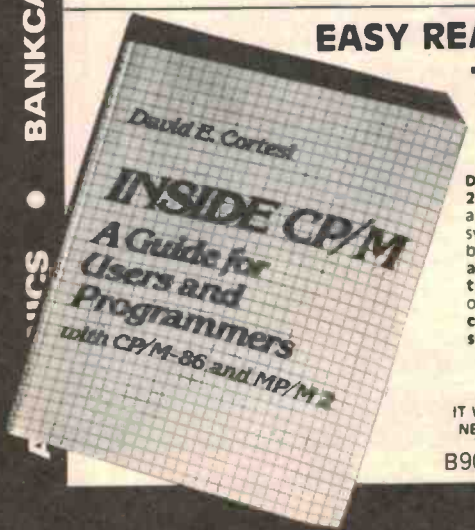
See Review June EA, p.137.

Green Phosphor Monitor
Features 12" screen. Front controls, on/off, contrast/reverse, brightness. Power 240V/50Hz or 12V DC. Input RCA type. DC Output Jack: 12V/1.1 Amp — power your Micro direct without a power pack. Bandwidth: 10Hz to 20MHz the resultant definition is truly amazing for a low cost monitor.

Guaranteed by ALTRONICS!
Incredible Value.

D1112.. **$199.50**

EASY READING GUIDE TO CP/M 2.2



FOR THE NOVICE AND EXPERIENCED PROGRAMMER ALIKE

Devoted primarily to CP/M 2.2 this manual is equally applicable to most other CP/M systems. Cortesi divides the book in two sections, an **absorbing, explanative, tutorial** covering setup and operating procedures and a **comprehensive reference section.**

As a learning tool — IT'S INVALUABLE
As a Reference — IT WILL TAKE PRIDE OF PLACE NEXT TO ANY CP/M SYSTEM

B9080.. ONLY **$41.95**

SAVE LOAD AT 1200 BAUD EVERY TIME

WHY PAY OVER $80?

Adjustable Azimuth DATA CASSETTE

At last a Data Cassette Recorder/Player you can afford. The Micron D 1120 **is fully adjustable azimuth** (absolutely essential in our opinion) and incorporates tailored audio frequency response audio stage together with low distortion.

Now you can save and load software in your Micro with confidence.

D1140...C10 Data Cassette Tape..... **$1.10**
D1141...C20 Data Cassette Tape..... **$1.20**

D1120 Micron Data Cassette **$49.50**

Using Soundex codes for approximate matching

If your spelling is not the best, your filing methods are a bit haphazard and, worse still, you can't remember things like you used to, don't panic. This program will sort you out — it sorts words that sound alike.

Tom Moffat

39 Pillinger Drive, Fern Tree, Tasmania 7101

IMAGINE A SMALL data base system in a newspaper office. A reporter remembers an interview done about three years ago, with a fellow named Franz. He would now like to contact this person again, and asks the computer to search out the name and provide details of where the person works, and how he can be contacted.

The computer responds: NAME NOT FOUND. And a potentially good story bites the dust. Well, three years is a long time to remember a name.

Now consider the same computer, with a little option included in its data base program. The reporter types in 'Franz' and the computer responds with FRANS, FRANCS, FRANKS, FRANCE. Aha! It was Franks. That's the one, call up the information on him.

In the first case the computer was looking for an *exact* match, and it bombed out when it didn't find one. In the second case, near enough was close enough, thanks to the 'Soundex' algorithm.

The Soundex scheme has been around for some time, but for some reason it hasn't been widely used, especially in micro systems. What it does is sort words into certain categories that sound alike, although their spellings can differ widely. Each word entered into the system is assigned a code which describes its sound. When a match is asked for, words with identical Soundex codes are displayed.

Works amazingly well

Soundex codes are developed as follows: When a word is entered, its first letter becomes the letter portion of the code. Then each succeeding letter is inspected and assigned a group number as per Table 1. Everything in group 0, the vowels and 'H', is disgarded, leaving the other group designators 1 through 6 where the letters were. Double group numbers are disgarded, that is, 34455 would become 345. Finally every number after the fourth is chopped off. This leaves a code consisting of a letter and up to four numbers.

The Soundex algorithm is one of those strange procedures that work a lot better than it has any right to. It's quite amazing to see what horrible mis-spellings it will accept, to come up with the right answers. The person who cooked up the scheme must have been a really clever thinker.

Listing 1 is a BASIC program that will let you play around with a Soundex algorithm. You type in a name, and the program checks to find if it's seen that word before. If not it computes the word's Soundex code, and stores both the word and the code. The word, and others with the same code, are then displayed, along with the codes themselves.

Although not necessary in this demonstration program, the actual Soundex code generation process is given as a

```
00100 REM Demonstration of SOUNDEX algorithm; prints previous
00110 REM entries that sound like the new word. If not in the
00120 REM table, the new word is stored. Maximum 100 words.
00130 REM            by Tom Moffat, 28/4/83
00140 REM
00150 CLS: E=0
00160 STRS (2000)
00170 DIM A0(99): FOR A=0 TO 99: A0$(A)="": NEXT A
00180 DIM B0(99): FOR A=0 TO 99: B0$(A)="": NEXT A
00190 DIM D(25)
00200 FOR F=0 TO 25: READ D(F): NEXT F
00210 PRINT: INPUT "ENTER A WORD: ";A1$: PRINT
00220 GOSUB 340
00230 FOR F=0 TO E
00240 IF A1$=A0$(F) THEN NEXT* F 280
00250 NEXT F
00260 A0$(E)=A1$
00270 B0$(E)=B1$
00280 FOR G=0 TO E
00290 IF B0$(G)=B1$ THEN PRINT A0$(G), B0$(G)
00300 NEXT G
00310 E=E+1
00320 GOTO 210
00330 REM Soundex sub: Input = WORD (A1$), Output = CODE (B1$)
00340 K=LEN(A1$)
00350 C1$=""
00360 B1$=A1$(;1,1)
00370 H=0
00380 IF K<2 THEN RETURN
00390 FOR F=2 TO K
00400 I=ASC(A1$(;F))
00410 IF I<65 OR I>90 THEN 450
00420 I=I-65
00430 J=D(I)
00440 IF J<>0 THEN LET C1$=C1$+CHR$(J+48)
00450 NEXT F
00460 K=LEN(C1$)
00470 IF K=0 THEN 540
00480 FOR F=1 TO K
00490 I=ASC(C1$(;F,F))
00500 IF I<>H THEN LET B1$=B1$+C1$(;F,F)
00510 H=I
00520 NEXT F
00530 IF LEN(B1$)>5 THEN LET B1$=B1$(;1,5)
00540 RETURN
00550 DATA 0,1,2,3,0,1,2,0,0,2,2,4,5,5,0,1,2,6,2,3,0,1,0,2,0,2
00560 END
```

subroutine, so you can pinch it word for word and use it in your own program. You also need to load up a 26 character array with group numbers for each letter, as line 200 loads data from line 550.

To get an idea of what to expect, have a look at the sample run containing some well known names with alternative spellings, nicely matched up by Soundex codes.

Although the BASIC version of the program is a bit messy with all that breaking apart of strings, a machine code version should be dead easy. By the time you read this I should have a small 'newsroom data base' program up and running, in machine code, using the Soundex algorithm.

All this probably sounds a bit far out, too good to be true. You may suspect it's another con job like that 'Gutenberg Transform' program in the April issue. But rest assured, this one is fair dinkum, really.

TABLE 1

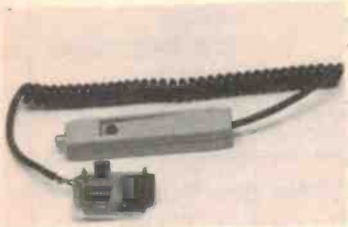
Group	Letters
0	A E I O U Y W H
1	B F P V
2	C G J K Q S X Z
3	D T
4	L
5	M N
6	R

```
ENTER A WORD:   HAWKE

HAWKE   H2
HAWK    H2
HAAWK   H2
HAUK    H2
HWACK   H2

ENTER A WORD:   PEACOCK

PEACOCK         P2
POECOCK         P2
PEECOCK         P2
PEEKOOK         P2
ENTER A WORD:   HAYDEN

HAYDEN H35
HAADNE H35
HEYDNE H35
HAIDINN         H35

ENTER A WORD:   FRASER

FRASER F626
FRAESEUR        F626
FROESUR         F626
FRASSRE         F626
FRASSEARE       F626
ENTER A WORD: DRACULA

DRACKULAE       D624
DRACKYOULAH     D624
DRACULA         D624
DRAKOOLA        D624

ENTER A WORD: FRANKENSTEIN

FRANKENSTEIN F6525
FRUENKINSTINE F6525
FRANCINSTENE F6525
FRANKENSTEEN F6525
```

ROD IRVING ELECTRONICS

425 HIGH STREET, NORTHCOTE 3070, MELBOURNE, VICTORIA. Ph (03) 489 8131. Telex No. 38897

KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS — KITS



ETI-649 LIGHT PEN FOR THE MICROBEE

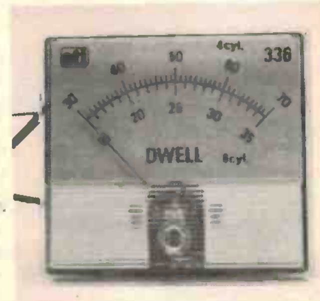
Another for the 'Bee bugs! This simple, low-cost device just plugs into the parallel port and works on the lo-res graphics.

ETI Aug. **$18-50**

ETI-336 DWELL METER

Save money and tune-up your own car. This simple to build project can be used on engines with 3-4-5-6-8 or 12 cylinders with the appropriate meter scale.

ETI Aug. **$18-50**



ETI-268 NICAD FLOAT CHARGER

$9.00 ETI MARCH '83

Keep your NiCad batteries in tip-top condition with this cheap, simple charger.

ETI-1512 ELECTRIC FENCE TESTER

$24.50

ETI FEB '83

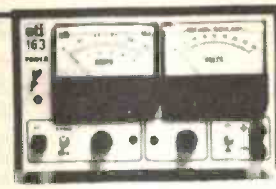
No more checking the 'feel' of a fence with a blade of grass (and maybe ending on your . . .). This project tells you how much your fence energiser delivers and can be used for fault-finding on a fence.

ETI-1516 MODEL ENGINE IGNITION SYSTEM

$41.50

ETI JUNE '83

Get sure starts every time and no more glow plug burnouts on your model engines.



ETI MAY '83

ETI-163 LAB SUPPLY

$159

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

ETI-668 MICROBEE EPROM PROGRAMMER

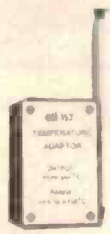
$47.50

ETI FEB '83

Simple, low cost programmer for the MicroBee can program 2716s, 2732s and 2764s.

ETI-153 TEMP PROBE

$19.95



ETI JUNE '83

Can measure temperature from −50°C to +150°C. It simply plugs into your multimeter—great for digital multimeters. Accuracy of 0.1°C resolution of 0.1°C.

ETI MAY '83

ETI-323 HEADLIGHT DELAY UNIT

$17.50

Park your car and turn off the lights. Can't see where you're going? Press the button and the headlights come on to light your way, switching off automatically after 50 seconds. This is a simple, easy to build, low cost project.

ETI APRIL '83

ETI-1515 DRILL/BLENDER SPEED CONTROLLER

$27.50

This project provides a full range of speed control for appliances having 'universal' ac motors. Once the speed is set, the motor will maintain that speed from no-load to heavy-load. Great for drills, blenders, grinders, etc.

ETI-162 30 V/1 A FULLY PROTECTED POWER SUPPLY

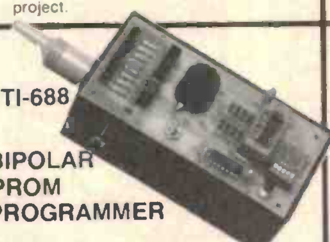
ETI DEC '83 **$47.50**

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0 V to 30 V and selectable current limit. Both voltage and current metering is provided.

ETI-654 APPLE II ANALOGUE/DIGITAL INTERFACE

$159.00 ETI MARCH '83

This project will give your Apple a set of 8-bit digital inputs and outputs plus one analogue input and one analogue output. Applications include: driving a robot, recording science experiment results, etc. (digital only shown).



ETI-688 BIPOLAR PROM PROGRAMMER

$47.50 ETI JUNE '83

Every digital workshop should have one! Can be used to program the popular fusible-link PROMs like the 74S188/288, 82S23 and 82S123 etc.

ETI-461 GENERAL PURPOSE BALANCED INPUT PREAMP

$20.00

ETI DEC '83

This project can be used as a balanced mic amp. with low impedance input, a low or high impedance input differential amplifier or a balanced input instrumentation amplifier.

ETI-164 ZENER TESTER

$9.50 ETI MAY '83

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

ETI-334 AUTO TESTER

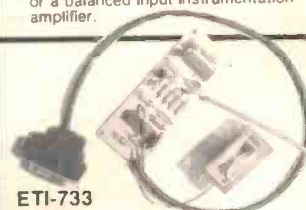
$17.00 ETI JAN '83

Just the thing to keep in the glovebox or toolkit to find those nasty electrical bugaboos that occur at awkward times. Simple to build, simple to use.

ETI-335 PUSHBUTTON-PROGRAMMABLE WIPER CONTROLLER

$28.50 ETI MARCH '83

No more fiddling with knobs and not getting the delay between wipes that you want—this windscreen wiper controller is simply 'programmed' with two pushbuttons to provide the wiping delay you need.



ETI-733 RADIOTELETYPE CONVERTER FOR THE MICROBEE

$20.00

ETI APRIL '83

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

at the leading edge

CMOS CTCSS ENCODER/DECODER MEETS EIA SPECS

(U.K.) Sub audio tone squelch systems will get a boost from C.M.L.'s FX315, FX325 crystal locked chips. The FX325 boasts 38 Field programmable tones, on-chip filtering to attenuate incoming CTCSS signals, audio switch and a choice of either DIL or Flat-Pack housing.

SHARP SCORES WITH 20MM DIAMETER "JUMBO" LEDS

(JAPAN) Coloured red, green or yellow, these outsized domed devices are an ideal replacement for filament lamps in electrical or control panels. Indoor scoreboards will also benefit from their wide viewing angle and high brightness.

WHISTLE, BEEP, HONK, CHEEP, CHIME, TICK, RING, CLICK .. .. ZOUNDS - WHAT SOUNDS!

(U.S.A.) General Instrument's Sound Synthesizer, I.C. AY-3-8910, will add new dimensions to your computer's audio repertoir. For less than $9.00 you could have your computer express itself in sounds, symphonic or even naughty.

INDUSTRIAL ACTION EXPECTED FROM SINGLE CHIP PROGRAMMABLE CONTROLLER

(U.S.A.) L.S.I. Computer Systems LS7270 Programmable Logic Controller (PLC) could grab a large chunk of the timer, sequencer and relay combinational logic action. At around $28.00 this 40 pin part has features which rival top-drawer packaged PLC's costing hundreds of dollars, Summarizing:- 12 latched outputs, 20 debounced inputs including 12 discretes, 4 downcounters, 4 priority interupts, on-chip clock generator and up to 2048 instructions from an external ROM or PROM. This device is geared to individual bit processing, Boolean processing, turn-on turn-off functions, counting and timing operations, not numeric computation - so don't confuse the LS7270 with your common or garden variety micro.

SAVE ON A GREAT SOUND

Replace your existing speakers or "ADD ON" to enjoy superb stereo sound in other rooms in your home.

The Dick Smith SERIES 200

build yourself at a large saving on comparable speakers

Designed in Australia by our own technical staff, the Series 200 speakers can actually be built by you in just a few hours. The result is a superbly handsome pair of speakers which sound like you spent a fortune.

Dick's worldwide buying power, coupled with new sound technology and the fact that you build these speakers yourself enables you to enjoy the sound quality of big home speakers at a fraction of the cost!

Compare the quality features and specifications:

- Fine Woodgrain Finish
- Fully Imported Contoured Grilles
- Top Quality Speakers

Peak power handling – 40W, Impedance – 8ohms, Freq. response – 45Hz to 20kHz, Speakers – 200mm woofer, 125mm mid-range & 64mm tweeter, Crossover – 3 way, at 1.5kHz & 5kHz, Dimensions: (cm) 64x38x29.6 (26 litres).

Included in the Series 200 kit are:

Speaker Grilles (Cat C-2608)	$31.50
Enclosure Kit (Cat C-2636)	$128.50
Speaker Kit (Cat C-2046)	$89.50

Complete Series 200 Kit **$249.50** per pair

Haven't time to build them yourself? The Dick Smith Series 200 Speakers are also available in built-up form for only:

AMAZING VALUE **$299.00** Per. Pair

Cat A-2370

As featured in September ETI.

EXCLUSIVELY FROM DICK SMITH Electronics

See our other ads this issue for full address details

A589AW

IMPROVING THE ZX81

P.M. Connor, Kuranda Qld.

Many owners of the ZX81 and similar simple computers may have been irritated by some of the limitations of the machine — such as lack of 'feedback' when pressing keys; no sound output; a tricky cassette interface; and, greatest of all problems, loss of hours of typing when a power failure occurs (a common problem in some parts of Australia). However, all of these problems can be solved quite cheaply.

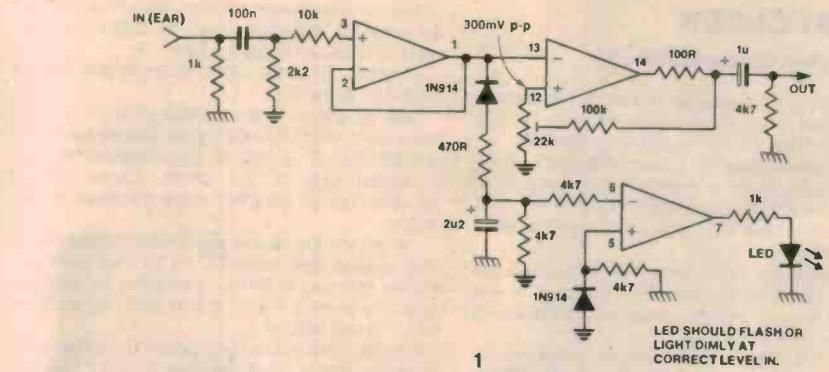
Simply glueing a small AM transistor radio (about $4 worth) on top of your ZX81 with "Bluetack" will give you good audio feedback from the keyboard and can provide musical sound output if a suitable machine language program is used. The radio should be tuned to about 1600 kHz ('top' end of the dial).

The cassette interface can be greatly improved by adding a Schmitt trigger and a visible level indicator LED, as shown in Figure 1. The LED should flash and/or light dimly at the correct playback level.

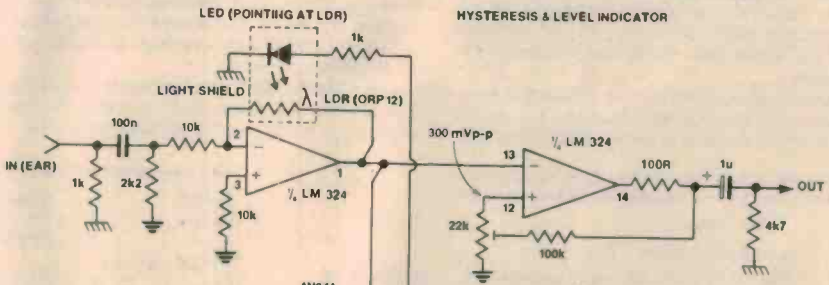
A greater improvement still can be achieved with the circuit shown in Figure 2. This provides automatic gain control (AGC) which reduces level variation problems arising from variations that occur in tape coating density and original recording level. Use of the AGC is limited, however, by the fact that the ZX81 requires a noise-free leader just before the start of the first byte of the program on tape, so the gain cannot be boosted too much. Hence, a preset pot. has been included to allow setting of the maximum gain by trial and error to achieve best results.

The last major problem — loss of data when the power fails — can be solved with a simple battery backup, as in Figure 3. This system can be used for most computers which use a plugback to supply a single, unregulated dc voltage. The other great advantage of the battery backup is that you achieve a limited 'continuous memory' and a program can be left in memory for quite a length of time. The limit is the capacity of the NiCad batteries. The AA-size NiCads (generally 450-500 mAh) will run a ZX81 with 16K RAM for over half an hour. This is plenty of time to save anything in memory onto a battery-operated tape recorder. The circuit is trivial.

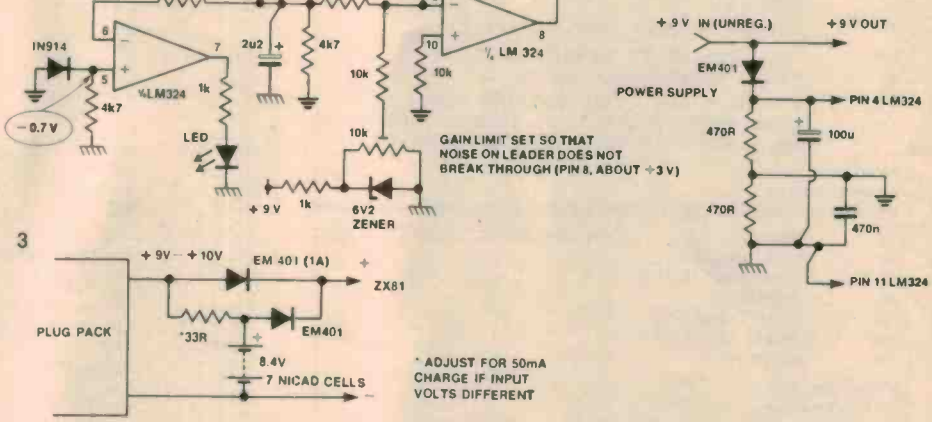
The methods I have outlined to improve the ZX81 can just as easily be used on many other simple computers with 'funny' keyboards and no sound output — the MicroAce, for example.



1 HYSTERESIS & LEVEL INDICATOR



2 AGC & SCHMITT LEVEL INDICATOR



3

SIMPSON'S RULE INTEGRATION

Ralph E. Morgan, Killarney Heights NSW

This program calculates the integral of a function entered as a string (via the VAL function) between the upper and lower bounds specified, using Simpson's method (see a calculus text for details).

The routine will fail if (a) function causes division by zero to occur, (b) function is discontinuous, or (c) excessive accuracy is required.

Input lower bounds. Input upper bound 1.5707963. Input error limit 0.0001. Input F(X) = SIN(X).

Insufficient accuracy with 1024 intervals. Best approximation = 0.98231129.

```
1001 LET N=1
1002 LET I1=0
1003 LET K=0
1004 LET EVEN=0
1005 PRINT " INPUT LOWER BOUND";
1006 INPUT A
1007 PRINT A
1008 PRINT " INPUT UPPER BOUND";
1009 INPUT B
1010 PRINT B
1011 PRINT " INPUT ERROR LIMIT";
1012 INPUT ERROR
1013 PRINT ERROR
1014 PRINT " INPUT F(X) =";
1015 INPUT F$
1016 PRINT F$
1017 IF A>=B THEN STOP
1018 LET X=(B-A)/2
1019 LET ODD=VAL F$
1020 LET X=A
1021 LET FA=VAL F$
1022 LET X=B
1023 LET FB=VAL F$
1024 LET H=B-A
1025 LET H=H/2
1026 LET K=K+1
1027 LET N=N*2
1028 LET ODD=ODD+EVEN
1029 LET EVEN=0
1030 IF N=2 THEN GOTO 1035
1031 FOR J=1 TO N-2 STEP 2
1032 LET X=J*H+A
1033 LET EVEN=EVEN+VAL F$
1034 NEXT J
1035 LET I=(FA+FB+2*EVEN+4*ODD)*
(H/3)
1040 IF ABS (I-I1)<=ERROR THEN
GOTO 1044
1041 IF K=10 THEN GOTO 1046
1042 LET I1=I
1043 GOTO 1025
1044 PRINT '''"INTEGRATION FROM
";A;" TO ";B;"OF ";F$;" =";I;"+
/- ";ERROR
1045 STOP
1046 PRINT '''"INSUFFICIENT ACC
URACY WITH ";N;"INTERVALS.",,"BE
ST APPROX.=";I
1047 STOP
```

ZX COLUMN

A ZX81 CLOCK

Jack Creasy, Elizabeth Park, SA

The following program was written to overcome a severe case of frustration with the way Sinclair implemented the PAUSE command on the ZX81.

One would imagine the implementation of a clock would be easy given a counter that decrements at 50 Hz — nothing could be further from the truth!

Two main problems manifest when implementation is attempted:

1) Exit from a PAUSE causes the ZX81 to go into FAST mode while pointers are updated — this causes a momentary loss of synch and an infuriating flash on the screen.
2) While PAUSE is executing nothing else can be done, the CPU simply counts frames — and any alteration to the length of the program will affect the pause count needed to get the time reasonably accurate.

Allied with the above is the inability to easily adjust the time-keeping to give long term accuracy and the difficulty of getting the clock to run at a one second rate.

The obvious answer to these restrictions is to use an assembly language routine to update the clock, and this is the solution submitted.

Program 'B' is the clock program and can be described as follows:

Line 10 is a 64 byte assembly program with one entry point which maintains a six digit 24 hour clock (HH:MM:SS). This routine also controls the least significant byte of the frames counter that is decremented by the ZX81 every TV frame in slow mode.

On entry to this routine the clock is incremented by one second, then corrected for 24 hour operation. Before returning to BASIC, it waits for the frames to reach its terminal count (205 or 204), signalling the expiry of one second.

Line 20 contains the clock locations updated by the assembly routine. Note that lines 10 and 20 must be together and the first two statements in the program.

Lines 20 and 30 form a subroutine used to update T$ on the variable stack.

Line 40 is the initial start line, it sets frames low to 255. Line 50 calls routine (20,30) to update T$. Line 60 prints the time (T$) near the centre of the screen.

Lines 70 and 80 correct the long-term accuracy of the clock by increasing the 1s period by 50 ms to slow the clock down. The time in line 80 can be altered to suit individual ZX81s.

Line 90 calls the assembly routine to update the time. Line 100 is the loop back to line 50 after 1s expires.

The program will run in a 1K or larger ZX81. BASIC statements can be added without affecting time-keeping, providing the loop time of the program does not exceed one second.

To test programs, POKE 16567,201 and the clock will run at maximum speed, so revealing loop time. Ensure your programs run at least 10% fast when testing to ensure that all contingencies are allowed for.

For those adept at assembly routines, the listing is provided. This can be easily altered to provide elapsed time to 99 hours, or 12 hour timekeeping if desired.

The counter maintenance routine is a general purpose 8-digit software counter with the overflow and reset values for each digit set in a table. You will notice that the ':'s in the clock are treated as digits and toggle between ':' and '?', although T$ only every contains ':'.

```
METHOD OF LOADING ZX81 CLOCK PROGRAM
************************************
1)      TYPE 'NEW'
2)      LOAD PROGRAM (A)
3)      'RUN' PROGRAM (A) AND ENTER VALUES FOR
        ASSEMBLY LANGUAGE PROGRAM FROM LISTING
4)      TYPE 'CLEAR'
5)      TYPE IN LINES 20 TO 100 OF PROGRAM (B)
6)      'LIST' PROGRAM AND ENSURE THERE ARE NO
        ERRORS
7)      'SAVE' "CLOCK" ONTO CASSETTE
8)      'EDIT' LINE 20 TO CURRENT TIME
9)      'RUN' 40 TO START CLOCK
10)     LINES 70 AND 80 ADJUST THE CLOCK'S
        LONG TERM ACCURACY --- LINE 80 CAN
        BE ALTERED TO SUIT INDIVIDUAL NEEDS

PROGRAM (A)
***********
******* PROGRAM TO ENTER ASSY CODES ************
10      REM..........TYPE 64 DOTS.............
20      LET X=16513
30      FOR Y=1 TO 64
40      INPUT D
50      PRINT D;",";
60      POKE (X+Y),D
70      NEXT Y

PROGRAM (B)
***********
******* CLOCK PROGRAM WITH CORRECTION ***********
10      REM (-------64 BYTE ASSY PROGRAM--------)
20      LET T$="00:00:00"
30      RETURN
40      POKE 16436,255
50      GOSUB 20
60      PRINT AT 5,10;T$;
70      IF T$(4 TO 8)="30:00" THEN POKE 16571,204
80      IF T$(4 TO 8)="33:41" THEN POKE 16571,205
90      LET A=USR 16530
100     GOTO 50

*************************************************
******* DECIMAL VALUES FOR ENTRY BY PROGRAM (A) *****
*************************************************

16514                   38,28,34,28,15,14
16520           38,28,34,28,15,14,38,28,38,28
16530           6,8,33,211,64,17,130,64,52,26
16540           19,190,32,6,26,119,43,19,16,244
16550           42,204,64,69,76,33,224,225,9,48
16560           6,33,28,28,34,204,64,33,52,64
16570           62,205,190,32,253,54,255,201

TOTAL 64 BYTES
```

```
********ASSY LANGUAGE ROUTINE********************
NOTE !!!  ALL NUMERICS IN DECIMAL FOR THE EASE
====      OF THE ZX81 USER AND FRUSTRATION OF
          THE HEXAMANIACS
.LOC 16514                          ;START LOCATION
_______CLOCK DIGIT CONTROL TABLE_____________
        38                          ;SECONDS O'FLO=A
        28                          ;SECONDS RESET=0
        ??                          ;X10 SEC O'FLO=6
        28                          ;X10 SEC RESET=0
        15                          ; -):(-  O'FLO=?
        14                          ; -):(-  RESET=:
        38                          ;MINUTE  O'FLO=A
        28                          ;MINUTE  RESET=0
        34                          ;X10 MIN O'FLO=6
        28                          ;X10 MIN RESET=0
        15                          ; -):(-  O'FLO=?
        14                          ; -):(-  RESET=:
        38                          ;HOURS   O'FLO=A
        28                          ;HOURS   RESET=0
        38                          ;X10 HRS O'FLO=A
        28                          ;X10 HRS RESET=0
.LOC 16530                          ;PROGRAM START
_______COUNTER MAINTENANCE ROUTINE_____________
        LD B,8          6,8         ;LOOP COUNT - # OF DIGITS
        LD HL,16595     33,211,64   ;POINTER TO END OF CLOCK
        LD DE 16514     17,130,64   ;POINTER TO DIGIT TABLE
BEGIN:  INC (HL)        52          ;INCREMENT DIGIT
        LD A(DE)        26          ;GET O'FLO CONSTANT
        INC DE          19          ;POINT TO RESET VALUE
        CP (HL)         190         ;HAS IT O'FLOWED
        JRNZ CHECK      32,6        ;NO - SO EXIT
        LD A(DE)        26          ;YES - LOAD RESET VALUE
        LD (HL)A        119         ;RESET DIGIT
        DEC HL          43          ;POINT TO NEXT DIGIT
        INC DE          19          ;POINT TO NEXT O'FLO
        DJNZ BEGIN      16,244      ;LOOP IF MORE DIGITS
_______24 HR CLOCK CORRECTION ROUTINE_____________
CHECK:  LD HL (16588)   33,204,64   ;LOAD X10 HRS INTO HL
        LD B,L          69          ;SWAP X10 HRS INTO BC
        LD C,H          76          ;
        LD HL 57824     33,224,225  ;LOAD HRS TEST VALUE
        JR NC,END1      48,6        ;TEST IF HRS=24
        LD HL 7196      33,28,28    ;LOAD CODE 00 FOR HRS
        LD (16588) HL   34,204,64   ;RESET HRS TO 00
_______FRAMES MONITOR ROUTINE_____________
                                    ;THIS IS LOCATION 16567
                                    ;SET IT TO 201 TO RUN
                                    ;AT MAX SPEED
END1:   LD HL 16436     33,52,64    ;POINTER TO FRAMES
        LD A,205        62,205      ;TIMEOUT VALUE FOR FRAMES
TEST:   CP (HL)         190         ;HAS FRAMES EXPIRED
        JRNZ TEST       32,253      ;NO - SO GO TEST AGAIN
        LD (HL)255      54,255      ;RESET FRAMES VALUE
        RET             201         ;GO BACK TO BASIC ----)
```

ETI BOOK SALES

electronics textbooks

ELEMENTS OF ELECTRONICS — BOOK 1
A0003B *$7.95*
This five-book series is an introduction to modern electronics. All the maths is taught as the reader progresses. The course concentrates on the understanding of concepts central to electronics, rather than digressing over the whole field. The author anticipates where difficulties lie and guides the reader. Book 1 covers all fundamental theory necessary to full understanding of simple electronic circuits and components.

ELEMENTS OF ELECTRONICS — BOOK 2
A0004B *$7.95*
Alternating current theory — see Book 1.

ELEMENTS OF ELECTRONICS — BOOK 3
A0005B *$7.95*
Semiconductors technology leading to transistors and ICs — see Book 1.

ELEMENTS OF ELECTRONICS — BOOK 4
A0006B *$9.95*
Microprocessing systems — see Book 1.

ELEMENTS OF ELECTRONICS — BOOK 5
A0007B *$9.95*
Communications — see Book 1.

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
A0013B *$4.75*
Supplies the electronics hobbyist with the background knowledge which will exactly suit his specific requirements. Minimum maths.

INTRODUCTION TO AUTOMOTIVE SOLID-STATE ELECTRONICS
A0015P *$14.95*
For the professional as well as the home mechanic — explains the functions of most on-board automotive black boxes and logic systems, including anti-skid braking, electronic spark control and diagnostic systems.

ELECTRONICS: IT'S EASY — VOL 1
A0016E *$12.95*
Meters, resistance, capacitance and inductance, emitter followers, op-amps, power supplies and electronic filters. Hardcover.

ELECTRONICS: IT'S EASY — VOL 2
A0017E *$12.95*
Digital sub-systems, counters and shift registers, A-D and D-A conversion, digital instruments and test equipment, computers, transmission links and oscilloscopes. Hardcover.

reference and data handbooks

CONTEMPORARY MATHEMATICS FOR ELECTRONICS
B0024P *$29.75*
This book is split into three sections. Direct current maths introduces the student to the calculator, fractions and dimensional analysis. Alternating current maths covers phasors, quadratics and RMS in both sine and digital waveforms. Active device maths introduces number systems and boolean.

FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
B0025B *$5.95*
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Britain, Japan, United States, Europe and Hong Kong, and includes types produced by more than 120 different manufacturers.

SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
B0026B *$6.25*
Interchangeability data covers semiconductors manufactured all over the world. Immediate equivalents are shown and possible substitutes are included.

PRACTICAL ELECTRONIC CALCULATIONS AND FORMULAE
B0027B *$9.95*
For the practical person's workbench. Bridges the gap between technical theory and cut-and-dried methods which work but leave the experimenter unfulfilled. There's a strong practical bias. High maths avoided where possible.

electronics for beginners

SOLID-STATE SHORTWAVE RECEIVERS FOR BEGINNERS
C0044B *$4.50*
Design and construction of several solid-state shortwave receivers giving high level of performance yet utilising few components.

ELECTRONIC GAMES
C0040B *$5.95*
How to build many interesting electronic games using modern ICs. Covers both simple and complex circuits for beginner and advanced builder alike.

ELECTRONIC PROJECTS FOR BEGINNERS
C0038B *$4.75*
This book gives the newcomer to electronics a wide range of easily built projects. Actual components and wiring layouts aid the beginner. Some of the projects may be built without using soldering techniques.

EASY ELECTRONICS: CRYSTAL SET CONSTRUCTION
C0041B *$6.75*
For those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. The circuits are based on those from earlier publications but have been modified to use modern components and home-wound coils.

IC PROJECTS FOR BEGINNERS
C0042B *$6.75*
Especially written for the less experienced hobbyist, and offers a range of fairly simple projects based around a number of popular and inexpensive linear and digital ICs. Complete layout and point-to-point wiring diagrams.

POPULAR ELECTRONIC PROJECTS — BOOK 1
C0039B *$5.25*
A collection of the most popular types of circuits and projects to interest most electronics constructors. The projects cover a wide range and are divided into four basic types: radio, audio, household and test equipment.

constructional projects

DIGITAL IC PROJECTS
D0050B *$6.75*
The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams included.

HOW TO MAKE WALKIE-TALKIES
D0056B *$5.50*
This treatise on low-power transmitter-receivers (walkie-talkies) covers many aspects, from licensing requirements and bands, through practical circuitry and construction to the types of aerials that may be used.

28 TESTED TRANSISTOR PROJECTS
D0053B *$4.50*
Some circuits are new, others are familiar designs. Projects can be split and/or combined.

CB PROJECTS
D0055B *$6.75*
A number of useful designs include a speech processor, interference filters and a simple CB radio receiver. Stripboard layouts, wiring diagrams and notes on construction are provided.

PROJECTS IN OPTO-ELECTRONICS
D0057B *$6.75*
Included are simple circuits using ordinary LEDs as well as more sophisticated designs such as infra-red transmitters and detectors, modulated light transmission and also photographic projects, etc.

SINGLE IC PROJECTS
D0058B *$5.50*
Simple to build projects based on a single IC. A few projects use one or two transistors as well. A stripboard layout is given for each project plus special constructional and setting up info. Contents include low-level audio circuits, audio power amps, timers, op-amps and miscellaneous circuits.

ELECTRONIC SECURITY DEVICES
D0059B *$5.95*
Besides including both simple and more sophisticated burglar alarm circuits using light, infra-red and ultra-sonics, this book also gives circuits for gas and smoke detectors, flood alarms, fire alarms, doorphones, etc.

POPULAR ELECTRONIC CIRCUITS — BOOK 1
D0060B *$6.75*
Includes audio, radio, test gear, music projects, household projects and many more. An extremely useful book for all hobbyists, offering remarkable value.

POPULAR ELECTRONICS CIRCUITS — BOOK 2
D0061B *$7.75*
A wide range of designs for electronics enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed information.

MULTI-CIRCUIT BOARD PROJECTS
D0063B *$6.75*
All circuits are based on one specially designed pc board. Recommended to the less experienced hobbyist.

MODERN OP-AMP CIRCUITS
D0065B *$6.75*
A collection of widely varying circuits and projects based on the op-amp ICs.

Save time and trouble with mail order — simply fill out the reply-paid coupon!

140 Joynton Avenue, Waterloo, NSW 2017, Australia. Phone (02) 663-9999 Sydney. Telex 74488.

Postal Address: ETI Book Sales, PO Box 227, Waterloo, NSW 2017.

ELECTRONIC PROJECTS FOR CARS
D0261E *$3.95*
Projects include car alarm, reversing alarm, over-rev alarm, twin-range tachometer, break-down beacon, intelligent battery charger, etc.

ELECTRONIC PROJECTS FOR CAR AND BOATS
D0067B *$6.75*
Fifteen fairly simple projects designed for use with 12 V electrical systems but in some cases can also be employed with 6 V and/or positive earth systems.

test equipment and fault-finding

TROUBLESHOOTING WITH THE OSCILLOSCOPE
F0121P *$16.95*
Excellent for the professional service technician or the serious hobbyist, as it combines step-by-step procedures for using the scope with the specific nuts and bolts of television receiver troubleshooting.

ELECTRONIC TROUBLESHOOTING HANDBOOK
F0257P *$10.50*
This workbench guide shows you how to pinpoint transistor troubles in minutes, how to test almost everything electronic and how to get the most out of low-cost test equipment.

EFFECTIVELY USING THE OSCILLOSCOPE
F0258P *$16.95*
Describes the potential uses of the scope, ranging from audio and television tests and measurements to performance tests.

USE OF THE DUAL-TRACE OSCILLOSCOPE
F0259P *$23.75*
This programmed text breaks down the process of operating a scope into a series of logical steps, starting with the deflection of the electron beam and continuing through proper use of the triggering controls to measure the phase difference between two waveforms.

ELECTRONIC TEST EQUIPMENT CONSTRUCTION
F0122B *$5.95*
Describes construction wide range of test gear, including FET amplified voltmeter, resistance bridge, field strength indicator, heterodyne frequency meter, etc.

circuit techniques and design

DESIGN OF TRANSISTOR CIRCUITS, WITH EXPERIMENTS
E0051P *$22.75*
A self-teaching course in transistor circuits — seven chapters explore the fundamentals of active semi-conductors and their operating principles and procedures. Experiments in design and semiconductor testing provide hands-on experience.

COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS
E0082B *$5.95*
Author F.G. Rayer features applications and projects using various types of numerical displays, popular counter and driver ICs, etc.

CMOS COOKBOOK
E0086P *$21.00*
This book explains CMOS technology and its application to 'real world' circuitry. A mini-catalogue is included, which lists more than 100 devices, giving pinouts and application notes.

IC OP-AMP COOKBOOK
E0088P *$25.75*
Basic op-amp theory in detail, with 200 practical, illustrated circuit applications: JFET and MOSFET units are featured, plus manufacturers' data sheets and company addresses.

IC CONVERTER COOKBOOK
E0139P *$22.75*
Written for the practising engineer, technician, hobbyist or student, this book will be an invaluable working guide to the understanding and use of IC analogue/digital and digital/analogue converters.

DESIGN OF OP-AMP CIRCUITS, WITH EXPERIMENTS
E0089P *$17.50*
The design of the fundamental circuits that are the basic building blocks of more sophisticated systems. A series of 35 experiments illustrates the design and operation of linear amps, differentiators and integrators, voltage and current converters, active filters, and lots more.

ELECTRIC CIRCUITS AND NETWORKS
E0091P *$18.75*
Comprehensive explanation of the theory, with numerous examples and solved illustrative problems.

HOW TO USE OP-AMPS
E0092B *$7.75*
Design notes and applications on many topics including basic theory, amplifiers, power supplies, audio circuits, oscillators, filters, computers and control engineering. It's written around the 741 IC but includes design notes for most of the common op-amps.

LEARNING TO WORK WITH INTEGRATED CIRCUITS
E0318R *$2.35*
Discover the basics of integrated circuits while building a simple and useful electronics project. A complete collection of the popular American *QST* series.

ANALOG INSTRUMENTATION FUNDAMENTALS
E0097P *$29.75*
Numerous practical, hands-on lab experiments and solved problems are included, plus discussions of movements, dc ammeters, voltmeters, ohmmeters, bridges, filters and attenuators. No calculus is required.

ELECTRONIC DESIGN WITH OFF-THE-SHELF ICs
E0099P *$14.70*
It contains virtually all the information you need to design and build electronic circuits, systems and subsystems with readily available ICs. Shows how to interface them into highly complex systems.

50 PROJECTS USING CA3130 ICs
E0101B *$4.50*
The CA3130 is an advanced operational amplifier capable of higher performance than many others: circuits often need ancillary components. Audio projects, RF projects, test equipment, household projects.

SCRs AND RELATED THYRISTOR DEVICES
E0095P *$19.25*
Written for experimenters, technicians and engineers, this book is a practical and comprehensive guide to the theory, operation, specifications and applications of silicon-controlled rectifiers (SCRs) and related thyristor devices.

50 CIRCUITS USING GERMANIUM, SILICON AND ZENER DIODES
E0103B *$5.50*
Fifty interesting and useful circuits and applications using the germanium and silicon signal diodes, silicon rectifier diodes and zener diodes, etc.

DESIGN OF VMOS CIRCUITS, WITH EXPERIMENTS
E0104P *$17.75*
The authors look at the technology which makes dramatic advancements possible with VMOS, and show how these components can easily be integrated into common circuit designs to enhance their responses.

UNDERSTANDING CMOS INTEGRATED CIRCUITS
E0105P *$9.95*
This book tells you what CMOS ICs are, how they work, and how they can be used in electronic circuit designs. Practical circuits, with parts values, are included.

LM 3900 IC PROJECTS
E0110B *$4.75*
Unlike conventional op-amps, the LM 3900 can be used for all the usual applications as well as many new ones. It's one of the most versatile, freely obtainable and inexpensive devices around. This book provides the groundwork for simple and advanced uses — it's much more than a collection of projects. Recommended.

GUIDE TO CMOS BASICS, CIRCUITS, AND EXPERIMENTS
E0107P *$14.95*
If you are already familiar with TTL devices and are ready to examine the benefits of CMOS, this book is your complete source. It tells you what CMOS devices are, their characteristics and design rules. Experiments demonstrate the concepts discussed.

IC 555 PROJECTS
E0109B *$6.75*
One wonders how life went on before the 555! Included are basic and general circuits, car and railway circuits, alarms and noise makers plus section on subsequent 556, 558 and 559s.

50 CIRCUITS USING 7400 SERIES ICs
E0111B *$5.25*
Fifty interesting and useful circuits and applications using these versatile devices.

VMOS PROJECTS
E0112B *$6.75*
Though primarily concerned with VMOS power FETs and their applications, power MOSFETs are dealt with, too, in a chapter on audio circuits. Projects include audio circuits, sound generator circuits and signal circuits.

electronic music and audio/video

CHEAP VIDEO COOKBOOK
G0123P *$11.75*
Complete discussion of a new, low-cost way to get words, pictures and opcode out of your computer and onto any ordinary television screen, using a seven-IC easy-to-build circuit which you can build for $20

AUDIO CYCLOPEDIA
G0125P *$71.95*
A complete in-depth look at the art of audio — from the basic principles of sound to solid-state and integrated circuits. More than 3000 entries and hundreds of illustrations and circuit diagrams cover acoustics, amplifiers, recording, reproduction, test equipment, audio measurements, and much more.

ELECTRONIC SYNTHESISER PROJECTS
G0133B *$5.95*
For the electronic music enthusiast, an invaluable reference. This book is full of circuits and information on how to build analogue delay lines, sequencers, VCOs, envelope shapers, etc, etc. The author takes a clear and logical approach to the subject that should enable the average enthusiast to understand and build up what appears to be a quite complex instrument.

MOBILE DISCO HANDBOOK
G0093B *$4.95*
Most people who start mobile discos know little about equipment or what to buy. This book assumes no preliminary knowledge and gives enough info to enable you to have a reasonable understanding of disco gear.

PRACTICAL CONSTRUCTION OF PREAMPS, TONE CONTROLS, FILTERS, ATTENUATORS
G0137B *$5.00*
This book shows the enthusiast how to construct a variety of magnetic tape recording, microphone and disc preamplifiers, and also a number of tone control circuits, rumble and scratch filters, attenuators and pads.

AUDIO IC OP-AMP APPLICATIONS
G0138P *$15.25*
This book discusses IC op-amps and their application in audio systems, and describes the numerous advantages of using op-amps, including low power consumption, reliable performance and low cost. Assumes a basic understanding of op-amp theory.

computers for beginners

YOUR FIRST COMPUTER
H0271A *$15.25*
An easy-to-understand beginner's book to small computers. Understanding them; buying them and using them for personal and business applications.

COMPUTERS FOR EVERYBODY
H0270A *$8.95*
In this easy-to-understand book it is explained how a computer can be used at home, in the office or at school. Includes a consumer's guide to computer equipment that will help the reader decide what to buy and who to buy it from.

BIG THINGS FROM LITTLE COMPUTERS
H0142P *$19.25*
A layperson's guide to personal computing with all the basic information and lots of examples of how personal computers can be used.

A MICROPROCESSOR PRIMER
H0144B *$5.95*
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set.

INTRODUCTION TO WORD-PROCESSING
H0151A *$17.95*
Written for the non-technical reader, this book tells about the concepts common to all word-processing systems, then analyses all features.

DON'T (OR, HOW TO CARE FOR YOUR COMPUTER)
H0153A *$19.95*
A guide to computer and peripheral preservation. Specific advice for the computer, floppy disks, hard disks, the CRT terminal, the printer, tape units, the computer room, software and documentation.

computer hardware and techniques

IAPX 88 BOOK
J0162P *$20.25*
This book from Intel itself describes the unique Intel 8088 microprocessor in total detail. Invaluable for all involved with the 8088.

MICROPROCESSOR INTERFACING TECHNIQUES
J0167A *$29.95*
Teaches you how to interconnect a complete microprocessor system and interface it to the usual peripherals. The hardware and software skills needed to effectively interface peripheral devices are covered along with various buss standards and A/D conversion. Third edition.

EXPERIMENTS IN ARTIFICIAL INTELLIGENCE FOR SMALL COMPUTERS
J0168P *$13.25*
Artificial intelligence is the capability of a device to perform functions normally associated with human intelligence. With this book, a small computer with extended BASIC and some knowledge of BASIC language, you can conduct experiments in artificial intelligence.

Z80 MICROCOMPUTER HANDBOOK
J0171P *$17.50*
This handbook covers hardware, software and microcomputers built around the Z80.

6809 MICROCOMPUTER PROGRAMMING AND INTERFACING, WITH EXPERIMENTS
J0170P *$21.95*
Gives a solid understanding of how to program and interface the high-performance 6809 microprocessor.

PET INTERFACING
J0169P *$25.25*
Demonstrates how to build numerous interfacing devices for PET hardware. BASIC language programs are used throughout, and the book includes a discussion of the microprocessor's internal architecture and general hardware/software interfacing.

APPLE INTERFACING
J0273P *$15.95*
Using this book, you will be able to perform useful experiments which will provide a much clearer understanding of the fundamentals of computer interfacing and computer electronics.

PRACTICAL COMPUTER EXPERIMENTS
J0172B *$5.95*
How to build typical computer circuits using discrete logic. Useful intro to devices such as adders and storers as well as a general source book of logic circuits.

computing software

AUSTRALIAN MICROCOMPUTER HANDBOOK
K0175E *$15.00*
A detailed buyer's guide to microcomputer systems and application packages in commercial, industrial, scientific, educational and home/hobby areas.

HOW TO WRITE AN APPLE PROGRAM
K0182P *$23.25*
Very much a 'how-to' book. Author assumes only a minimal familiarity with computer and BASIC. The book covers every aspect of simple program writing from initial concepts to final debugging — wittily illustrated.

HOW TO WRITE A TRS-80 PROGRAM
K0183P *$23.25*
Virtually identical to *How to Write an Apple Program*. Changes have been made to allow for differences in the two machines and variations in BASIC.

HOW TO WRITE AN IBM-PC PROGRAM
K0184P *$23.25*
Virtually identical to *How to Write an Apple/TRS-80 Program*. Changes have been made to allow for differences in the two machines and variations in BASIC.

BASIC FOR EVERYONE
K0187P *$19.75*
Some 350 pages of BASIC information for all purposes.

INSIDE BASIC GAMES
K0189A *$19.95*
The medium of games teaches readers how to design error-free, interactive BASIC programs. Rules, algorithms and coding differences for the PET, Apple II and TRS-80 are also included.

PASCAL
K0199A *$19.95*
For people with little or no programming experience, this book gives lots of examples that clearly explain proper usage of language features. Discusses top-down programming, debugging, self-documentation, etc.

THE PASCAL HANDBOOK
K0200A *$23.50*
Summarises the entire Pascal vocabulary, including the variations introduced by different commercial versions of Pascal. All in dictionary format.

INTRODUCTION TO THE UCSD P-SYSTEM
K0106A *$22.45*
Explains the UCSD Pascal operating system, or "p-system". You will learn how to enter a Pascal program in the computer, edit it, store it on a file and then manipulate files.

COMPUTER PROGRAMS IN BASIC
K0192P *$18.25*
Fully indexed guide to more than 1600 BASIC computer programs published in personal computer magazines for microcomputers, minicomputers and mainframe computers. Compiled by Paul Friedmann, first published in 1981.

APPLE PASCAL GAMES
K0216A *$19.95*
Explore all the essential elements of UCSD Pascal and learn the important Apple Pascal extensions.

APPLE II ASSEMBLY LANGUAGE
K0195P *$23.45*
Teaches assembly-language programming at the beginning level — no prior knowledge of 6502 assembly language is needed. Includes hands-on computer exercises and experiments, with both software and hardware. Provides interfacing circuits and programs that can be used on the Apple II without modification.

QWIKTRAN
K0196A *$19.95*
Quick Fortran for micros, minis and mainframes. Starts with the basic concepts of computing and Qwiktran, a fundamental subset of Fortran IV. Lots of examples to increase the reader's proficiency.

THE UCSD PASCAL HANDBOOK
K0197P *$23.75*
Language descriptions organised in a quick and easy reference are given in this book for readers with no prior experience of Pascal programming.

THE C PROGRAMMING LANGUAGE
K0272P *$24.95*
C is a general purpose 'low-level' programming language. It is not specialised to any particular area of application, but its absence of restrictions make it convenient and effective for many tasks.

INTRODUCTION TO PASCAL, INCLUDING UCSD PASCAL
K0113A *$26.95*
For both beginners and experienced programmers, this book covers all aspects of Pascal, from the basic concepts to program development. Extensive appendices. Second edition.

TRS-80 COLOUR COMPUTER GRAPHICS
K0201P *$21.95*
Explore the creative and imaginative blending of computers and colour. Shows how to create dynamic and interesting graphics to enhance your programs.

INTRODUCTION TO TRS-80 GRAPHICS
K0202A *$22.95*
It begins with the basic concepts of line drawing and leads the reader on to geometric shapes, moving figure animation and other more advanced topics.

INTERFACE PROJECTS FOR THE TRS-80 (MODEL III)
K0203P *$19.25*
This practical manual describes how TRS-80 Model III users can better utilise their micros. Written for the TRS-80 user with some computer experience, it provides a series of easily built interface projects that enable the user to discover the computer's capabilities as each project is constructed.

ENHANCING YOUR APPLE II
K0206P *$27.95*
Contains fast and easy method for taking apart and understanding machine-language programs. Gives hardware and software modifications. Features programs and other hints for creating hundreds of colours or many patterns on the screen, plus ideas to improve text on high-resolution displays.

TRS-80 — MORE THAN BASIC
K0207P *$15.95*
Learn to program in Z80 mnemonics by using the book's error-tolerant interactive monitor program. More than 26 commands available, with documentation that helps you change commands to meet specific applications.

PROGRAMMING THE TRS-80 POCKET COMPUTER
K0209P *$13.25*
This book explains all aspects of problem-solving in BASIC, and covers cassette machine interfacing and how to make the best use of the keyboard and display

32 BASIC PROGRAMS FOR THE TRS-80 COMPUTER
K0211A *$29.50*
Programs for the TRS-80 Level II or Model III BASIC (with 16K or more user memory).

PASCAL PROGRAMMING FOR THE APPLE
K0217P *$17.95*
Teaches UCSD Pascal on the Apple II. Many examples, programs for financial applications,

THE ART OF PROGRAMMING THE 16K ZX81
K0213B *$8.75*
A sequel to *The Art of Programming the 1K ZX81* (ETI Book Sales No K0226B), this book sets out to help you use your 16K RAM pack and ZX printer to the full. It concentrates on good programming style and introduces some interesting programs that are both fun and useful.

32 BASIC PROGRAMS FOR THE APPLE COMPUTER
K0218A *$29.50*
Full of programs with practical applications, educational uses, games and graphics.

PET/CBM BASIC
K0219P *$19.25*
Provides a thorough introduction to BASIC programming on a Commodore PET computer, explaining programming concepts for graphics, including three-dimensional letters, bar graphs and the use of sound effects.

PET BASIC 1
K0220P *$19.25*
For users of the Commodore PET computer, this book covers such topics as creative graphics, humour and interesting small programs.

PET GAMES AND RECREATIONS
K0221P *$18.85*
Presenting an interesting mixture of diversions guaranteed to entertain and educate. Ideal for beginners, yet also challenging to computer veterans, the book features progressive levels of difficulty.

32 BASIC PROGRAMS FOR THE PET COMPUTER
K0222A *$29.50*
Each chapter fully documents a different bug-free program. If readers have a good working knowledge of BASIC, they can devise their own program changes.

BASIC PROGRAMMING PRIMER
K0223P *$27.95*
Invaluable aid to anyone who wants to learn BASIC. Covers 16-bit BASIC statements, key words and commands, with self-tests and answers plus non-numeric progam examples. Compatible with IBM BASIC, but applicable to any computer that runs MicroSoft BASIC.

ATARI GAMES AND RECREATIONS
K0224P *$19.25*
Beginners and advanced users can use the pre-programmed games in this book to improve their skill. Charts, flash cards, an error dictionary and graph paper designs are among the features.

THE ART OF PROGRAMMING THE 1K ZX81
K0226B *$6.75*
This book explains how to use the features of the ZX81 including its random number generator, graphics and timer. PEEK and POKE are explained and you should learn enough to develop programs of your own.

PROGRAMMING THE 6502
K0227A *$22.95*
Principles of assembly-language programming for the 6502 microprocessor are taught in this introductory text. Includes a discussion of trade-offs between hardware and software and detailed explanations of the 6502's internal registers and buss operation. Third edition.

6502 APPLICATIONS BOOK
K0228A *$20.95*
Use this book and a few low-cost components to build a complete home alarm system, an electric piano, a motor speed-regulator, a time-of-day clock, a simulated traffic control system and a Morse code generator, etc.

6502 GAMES
K0229A *$17.95*
You learn how to play 10 sophisticated games and also learn assembly language programming. Also learn the techniques of algorithm design and data structures.

START WITH BASIC ON COMMODORE VIC-20
K0233P *$14.75*
Helpful exercises and step-by-step instructions show you how to program in BASIC utilising all the graphic functions on the VIC-20.

electronic calculators

ELECTRONIC CALCULATOR USER'S HANDBOOK
M0245B *$5.50*
Presents formulae, data, methods of calculation, conversion factors, etc, for use with the simplest or most sophisticated calculators. Includes the way to calculate using only a simple four-function calculator, trigonometric function, hyperbolic functions, logarithms, square roots and powers.

YOUR ELECTRONIC CALCULATOR AND YOUR MONEY
M0246B *$4.75*
Starts with a basic revision of percentages and decimals, then deals with mortgages, cars, insurance, fuel, shopping, tax, etc. There's a section on investment and one on the calculator in a small business.

PROGRAMMABLE CALCULATORS
M0247A *$24.95*
Which calculators to buy, their possibilities and limitations, and the how-tos of programming them.

TAKE A CHANCE WITH YOUR CALCULATOR
M0248A *$14.95*
An introduction to modern mathematics, this book deals with programming of programmable calculators and includes probability problems.

computing for business

BASIC FOR ACCOUNTANTS
L0234P *$9.95*
Shows accountancy students and accountants how to use a computer to perform the repetitive tasks associated with record keeping, calculating and report writing. Using the BASIC language attention is concentrated on debtors, inventory and general ledger systems.

COMPUTER-BASED BUSINESS SYSTEMS
L0235P *$10.95*
A short introduction to the sorts of systems used by a typical business to handle its typical activities. The book aims at providing a general understanding and, therefore, avoids technological detail.

THE COMPUTER SOLUTION
L0236P *$13.50*
This should be of interested to business people contemplating implementing or already using computer data processing or to any non-technical person curious to know why and how computers are used in Australian businesses and organisations.

THE SMALL-BUSINESS COMPUTER GUIDE
L0237P *$14.95*
Ideal for the inexperienced user, this text emphasises management considerations in determining the feasibility, economics, evaluation, selection, contracts and practicality of installing a computer.

SMALL-BUSINESS COMPUTER SYSTEMS
L0238P *$14.95*
Provides a bridge between the accountant and the data-processing professional by explaining every step of the trading and reporting process in data-processing terms. It is especially useful to people engaged in the specification process or in auditing dataprocessing accounting systems.

BASIC BUSINESS SOFTWARE
L0242P *$18.45*
A basic insight into how business software is designed. Aimed at the small-business operator.

SMALL COMPUTERS FOR THE SMALL BUSINESSMAN
L0240A *$27.95*
How and where to shop for a computer successfully; what to expect their computer to do for them; how to select software; whether or not to use a consultant; how to introduce the computer to the staff and how much computer is necessary.

THE VISICALC BOOK — APPLE EDITION
L0239P *$22.25*
If you are using VisiCalc on your Apple II and want to learn more about its expanded uses then this book will show you how to build a model, enter your data and solve problems about profit/loss projections, pricing/costing estimates, etc.

INVENTORY MANAGEMENT FOR SMALL COMPUTERS
L0241A *$27.95*
Owners of retail businesses and their employees need this book. The program provides an inventory control system what stock is on hand, where it is located, what price was paid for it and the selling price.

FROM THE COUNTER TO THE BOTTOM LINE
L0243A *$24.95*
Guide to basic accounting needs and computer use. Includes inventory and purchasing, billing, accounts receivable, accounts payable and general ledger.

THE OFFICE AUTOMATION PRIMER
L0244P *$15.50*
Guides the user step by step through all aspects of planning, evaluating and installing stages. Lively vignettes illustrate how automation increases productivity in word and data processing, electronic mail, photocomposition, telecommunications, scheduling and message switching. Probably the most comprehensive guide of it kind for every manager seeking to maximise productivity and profitability.

amateur radio, dx communications

COMPUTERS AND THE RADIO AMATEUR
N0249P *$31.25*
For the radio operator who wants to know how computers function and how they can be used with other equipment.

LONG-DISTANCE TELEVISION RECEPTION (TV-DX)
N0250B *$6.95*
Written by the British authority, the book includes many units and devices made by active enthusiasts. A practical and authoritative introduction this unusual aspect of electronics.

HANDBOOK OF RADIO, TELEVISION, INDUSTRIAL AND TRANSMITTING TUBE AND VALVE EQUIVALENTS
N0251B *$2.25*
The equivalents book for amateurs and servicemen. More than 18,000 old and new valves from United States, Britain, Europe, Japan. CV (military) listings with commercial equivalents included.

RADIO STATIONS GUIDE
N0252B *$5.95*
An aid for all those who have a radio receiver. Shows the station site, country, frequency and/or wavelength, as well as Effective Radiation Power of the transmitter and, in some cases, the station's call sign as well.

AN INTRODUCTION TO RADIO DXING
N0253B *$6.75*
One section is devoted to amateur brand reception and the other section covers broadcast band reception, with advice on suitable equipment and the techniques employed when using that equipment. The construction of a number of useful accessories is described.

TELEMATIC SOCIETY
N0254P *$17.50*
Demonstrates how developments in telecommunications will affect the way we live.

All prices of publications in this catalogue listing are subject to change without notice.

BS0136

CALENDAR Noel Bailey, Maryland NSW

This program will print out a calendar for you, either for years ahead of the present, or years past. The program should work for any date from 1753 onwards since our modern calendar dates from this time. I believe that our calendar will be out of phase with the seasons by one whole day around 10 000 AD. I don't think that I'll be worried when the time comes.

The listing was done on a Model 15 teleprinter which does not have the relational operators 'greater than' and 'less than' and most importantly, semicolons which have been used a lot in this program. Consequently I have penned them in (and hope not to have missed any!).

Lines 160 and 560 may be removed from the program or altered for whatever configuration of printer is being used. My system uses 1200 baud output to a 2650 microprocessor which converts 1200 baud ASCII to 50 baud baudot. The 2650 sends back a 'ready' flag to hold the MicroBee until the machine is ready to accept the next character. To the ear, the baudot seems to be going at full speed, but it is still slow in this age of line printers.

Note that the 'pound' sign (£) equates to the 'hash' symbol (#) on the MicroBee.

```
00100 REM 'CALEND' PROGRAM - THIS PROGRAM WILL PRINT OUT A
00110 REM CALENDAR FOR ALL YEARS PAST 1752
00120 REM THE FIRST PART OF THIS PROGRAM CALCULATES THE DAY
00130 REM THAT NEW YEAR'S DAY FALLS ON. WRITTEN BY NOEL BAILEY
00140 REM ON THE 6TH FEB 1983.
00150 DIM B(12),D(12)
00160 OUT £5 ON:REM DIRECTS OUTPUT STREAM TO 1200 BAUD PRINTER.
00170 REM YOU MAY NEED TO CHANGE THIS FOR YOUR OWN PRINTER.
00180 PRINT'WHAT YEAR WOULD YOU LIKE?'
00190 INPUT Y
00200 IF Y<1753 THEN PRINT'YEAR MUST BE AFTER 1752':GOTO 180
00210 PRINT'CALENDAR FOR ';Y
00220 PRINT'------------------'
00230 PRINT
00240 L=Y-1
00250 P=L/100
00260 A=P/4:Z=(5XL)/4
00270 Z=36+Z-P+A
00280 D(1)=Z-7X(Z/7)
00290 GOSUB 680
00300 REM A IS THE COUNTER FOR EACH PAIR OF MONTHS.
00310 FOR A=1 TO 6
00320 REM PRINT MONTH HEADINGS.
00330 ON A GOSUB 620,630,640,650,660,670
00340 REM PRINT WEEKDAY HEADINGS.
00350 GOSUB 580
00360 REM R IS THE COUNTER FOR HORIZONTAL ROWS.
00370 FOR R=1 TO 6
00380 REM C IS A COUNTER FOR VERTICAL COLUMNS FOR ODD MONTHS.
00390 FOR C=1 TO 7
00400 IF R=1 AND D(AX2-1)=>C THEN PRINT'    ';:GOTO 430
00410 IF C-D(AX2-1)+(RX7-7)>B(AX2-1)THEN PRINT'    ';:GOTO 430
00420 PRINT TAB(CX4-3);C-D(AX2-1)+(RX7-7);
00430 NEXT C
00440 REM K IS A COUNTER FOR VERTICAL COLUMNS FOR EVEN MONTHS.
00450 FOR K=1 TO 7
00460 IF R=1 AND D(AX2)=>K THEN PRINT'    ';:GOTO 490
00470 IF K-D(AX2)+(RX7-7)>B(AX2)THEN PRINT'    ';:GOTO 490
00480 PRINT TAB(KX4-3+34);K-D(AX2)+(RX7-7);
00490 NEXT K
00500 PRINT
00510 NEXT R
00520 FOR L=1 TO 7:REM 7 LINE FEEDS
00530 PRINT
00540 NEXT L
00550 NEXT A
00560 OUT £5 OFF
00570 END
00580 GOSUB 600:PRINT TAB(35);:GOSUB 600:PRINT
00590 RETURN
00600 PRINT'SUN MON TUE WED THU FRI SAT';
00610 RETURN
00620 PRINT TAB(11);'JANUARY';TAB(45);'FEBRUARY':RETURN
00630 PRINT TAB(12);'MARCH';TAB(46);'APRIL':RETURN
00640 PRINT TAB(13);'MAY';TAB(47);'JUNE':RETURN
00650 PRINT TAB(13);'JULY';TAB(46);'AUGUST':RETURN
00660 PRINT TAB(10);'SEPTEMBER';TAB(45);'OCTOBER':RETURN
00670 PRINT TAB(11);'NOVEMBER';TAB(45);'DECEMBER':RETURN
00680 IF Y-Y/4X4=0 THEN 700
00690 L=0:GOTO 730
00700 IF Y-Y/400X400=0 THEN LET L=0:GOTO 730
00710 L=1
00720 REM L=1 FOR LEAP YEAR ELSE L=0
00730 FOR M=2 TO 12
00740 IF M>2 THEN 790
00750 A=M-1
00760 IF L=0 THEN LET A=AX63 ELSE LET A=AX62
00770 A=A/2
00780 GOTO 820
00790 A=M+1
00800 A=INT(FLT(A)X30.6)
00810 IF L=0 THEN LET A=A-63 ELSE LET A=A-62
00820 A=A+D(1)
00830 D(M)=A
00840 REM THIS IS THE DAY NUMBER OF THE YEAR FOR THE
00850 REM FIRST DAY OF EACH MONTH
00860 NEXT M
00870 REM TO CALC THE DAY NO THAT THE 1ST OF EACH MONTH
00880 REM FALLS ON
00890 FOR I=2 TO 12
00900 D(I)=D(I)-D(I)/7X7
00910 NEXT I
00920 REM NOW TO GET THE NUMBER OF DAYS PER MONTH.
00930 FOR I=1 TO 12
00940 READ B(I)
00950 NEXTI
00960 IF L=1 THEN LET B(2)=29
00970 RETURN
00980 DATA 31,28,31,30,31,30,31,31,30,31,30,31
```

SEPTEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

OCTOBER

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

PROGRAM DATA GENERATOR Hans Beilharz, Kareela NSW

I was pleased to see the Character Generator program in the June issue. The program is very good but if large shapes are generated a lot of work is required to transfer the data, if you want to use the shape in another program.

This program can be added to the Character Generator program or any similar program, to automatically generate DATA statements and store them on tape so that they can be merged to another program. This saves having to write down the values from the screen and then typing the lot.

The DATA line numbers start at 10000 although this can be changed to any value; see line 540. When the shape is finished press tab and then follow the instructions for using the tape recorder.

To merge DATA to another program first load the other program, making sure no lines conflict with the DATA line numbers. Then type IN#2 return, start the tape and the DATA lines will be added to the program.

It is best to set SPEED to 0 for all merge operations. Press reset (warm start) to get control back when finished.

Add line 285 to the Character Generator program then add the lines 500 to 620.

285 IF ASC (A1$) = 9 THEN 500.

```
505 CLS
510 PRINT "Set up tape recorder, press RETURN when ready"
520 A1$=KEY$: IF ASC(A1$)=13 THEN 530 ELSE 520
530 PRINT" recording DATA"
540 OUT#2 ON: L=10000
550 X=USED-1:FOR A=63488 TO 63488+X*16 STEP 16
560 PRINT L; " DATA";PEEK(A);
570 FOR B= 1 TO 15
580 PRINT ",";PEEK(A+B);
590 NEXT B: PRINT " "
600 L=L+10:NEXT A
610 OUT#2 OFF:PRINT"Finished switch off tape recorder"
620 END
```

MICROBEE COLUMN

SCREEN DUMPER

Jon McCormack, Brighton East Vic.

This program in machine language can be assembled anywhere in memory, provided it does not overlap with your current BASIC program.

To call in the program use the following statements in your program:

OUT#1
X=USR(decimal address of program)
OUT#0

The OUT#1 outputs the screen to the I/O port, however, output could be directed to the RS232 port or the cassette port or even all three. This enables the screen to be dumped to a printer, cassette, modem or any other output device.

Since the program was intended for my Dick Smith graphics printer there are several changes that can be made to suit individual requirements.

1. Characters greater than CHR$(128) are replaced by an asterisk ('*'). This portion of the program can be removed by deleting lines 160-180 and 300-310 of the assembler listing.

2. The character for my printer to do a carriage return and line feed is CHR$(10) (0A hex); change this value (line 230) to suit your output device.

The routine at 8024 hex (in the BASIC ROMs) sends the contents of the A register to the current output device(s) which is defined by the OUT# instruction.

SCREEN DUMPER

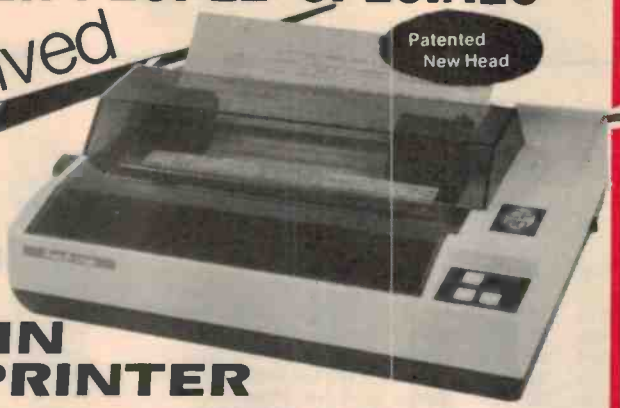
```
0400             00110          ORG     400H        ;CHANGE TO SUIT PROGRAM
0400 2100F0      00120          LD      HL,0F000H   ;PUT SCREEN START ADD. IN HL
0403 0E0F        00130          LD      C,15        ;PUT NO. OF LINES IN C
0405 0640        00140 OLOOP    LD      B,64        ;PUT SCREEN WIDTH IN B
0407 7E          00150 LOOP     LD      A,(HL)      ;PUT CURRENT SCREEN POS. IN A
0408 57          00160          LD      D,A         ;STORE BYTE IN D
0409 DE80        00170          SBC     A,128       ;CHECK IIF GRAPHICS CHAR.
040B 3013        00180          JR      NC,AST      ;IF YES THEN GOTO AST
040D 7A          00190          LD      A,D         ;PUT BYTE BACK IN A
040E CD4280      00200 PRINT    CALL    8042H       ;OUTPUT BYTE TO PRINTER
0411 23          00210          INC     HL          ;MOVE TO NEXT SCREEN POSITION
0412 10F3        00220          DJNZ    LOOP        ;DEC COUNTER FOR LINE
0414 3E0A        00230          LD      A,0AH       ;LOAD A WITH LINE FEED CHAR.
0416 CD4280      00240          CALL    8042H       ;OUTPUT BYTE TO PRINTER
0419 0D          00250          DEC     C           ;DECREMENT LINE POINTER
041A 79          00260          LD      A,C         ;PUT NO OF LINES IN A
041B FE00        00270          CP      0           ;CHECK IF END OF SCREEN
041D 20E6        00280          JR      NZ,OLOOP    ;IF NOT END THEN BACK FOR MORE
041F C9          00290          RET                 ;END OF PROGRAM
0420 3E2A        00300 AST      LD      A,2AH       ;PUT A " * " IN A
0422 18EA        00310          JR      PRINT       ;PRINT IT!!!
0000             00320          END
00000 Total errors

PRINT   040E    AST     0420    LOOP    0407    OLOOP   0405
```

AFTER STOCKTAKE SALE — BE QUICK AND YOU WILL REAP THE BARGAINS

PRINTER SPECIALISTS

THE PRINTER PEOPLE SPECIALS

Just Arrived



A NEW PRINTER NOW!

CP-80/I, 80-COLUMN IMPACT PRINTER

SPECIFICATIONS

Functional Specifications

Printing method — Serial impact dot matrix
Printing format — Alpha-numeric — 7 x 8 in 8 x 9 dot matrix field. Semi-graphic (character graphic) — 7 x 8 dot matrix. Bit image graphic — Vertical 8 dots parallel horizontal: 640 dots serial/line
Character size — 2.1mm (0.083")-W x 2.4mm (0.09")-H/7 x 8 dot matrix
Character set — 228 ASCII characters; Normal and italic alpha-numeric fonts, symbols and semi-graphics
Printing speed — 80 CPS. 640 dots/line per second
Line feed time — Approximately 200 msec at 4.23mm (1/6") line feed.
Printing direction — Normal — Bidirectional, logic seeking. Superscript and bit image graphics — Unidirectional, left to right
Dot graphics intensity — Normal — 640 dots/190.5mm (7.5") line horizontal. Compressed characters — 1,280 dots/190mm (7.5") line horizontal
Line spacing — Normal — 4.23mm (1/6").
Programmable in increments of 0.35mm (1/72") and 0.118mm (1/216")
Columns/line — Normal size — 80 columns. Double width — 40 columns. Compressed print — 142 columns. Compressed/double width — 71 columns.
The aboves can be mixed in a line.
Paper feed — Adjustable sprocket feed and friction feed.
Paper type — Fanfold. Single sheet. Thickness — 0.05mm (0.002") to 0.25mm (0.01"). Paper width — 101.6mm (4") to 254mm (10").
Number of copies — Original plus 3 copies by normal thickness paper.

Mechanical Specifications

Ribbon — Cartridge ribbon (exclusive use), black
MTBF — 5 million lines (excluding print head life)
Print head life — Approximately 30 million characters (replaceable).
Dimensions — 377mm (14.8")-W x 295mm (11.6")-D x 125mm (4.9")-H incl. sprocket cover.

Parallel CP80 $495 plus tax **Serial CP80 $595 plus tax**

ALL VERBATIM DISCS 20% OFF LISTED PRICE THIS MONTH

VERBATIM DISCS 5 YEAR DATALIFE GUARANTEE		Per Box of 10
MD525-01	Single Sided, Double Density	44.00
MD525-10	SSDD 10 Sectors 40 Tracks	45.00
MD525-16	SSDD 16 Sectors 40 Tracks	45.10
MD550-01	Double Sided, Double Density	47.50
MD550-01	DSDD 10 Sectors 40 Tracks	49.50
MD550-16	DSDD 16 Sectors 40 Tracks	49.50
MD557-01	SSDD Soft Sect 80 Tracks	49.50
MD577-10	SSDD 10 Sectors 80 Tracks	57.00
MD577-16	SSDD 16 Sectors 80 Tracks	57.00
MD557-01	DSDD Soft Sect 80 Tracks.	59.00
MD557-16	DSDD 16 Sectors 80 Tracks	59.00
8" VERBATIM		
FD32-1000	Single Sided, Single Density	45.00
FD32-8000	Single Sided, Double Density	54.00
FD32-9000	SSDD Critically Certified	51.00
FD34-1000	Single Sided, Single Density	45.00
FD34-8000	Single Sided, Double Density	51.00
FD10-4008	Double Sided, Single Density	59.00
FD10-4015	Double Sided, Single Density	59.00
FD10-4026	Double Sided, Single Density	59.00
FF32-2000	SD FLIPPY FLOPPY	62.00
FF34-2000	SD FLIPPY FLOPPY	62.00
DD32-4000	Double Sided, Double Density	54.00
DD34-4001	Double Sided, Double Density	49.00
DD34-4008	Double Sided, Double Density	51.00
DD34-4015	Double Sided, Double Density	53.00
DD34-4026	Double Sided, Double Density	55.00

ALL PRICES PLUS 20% SALES TAX
WE WILL NOT BE BEATEN ON DISC PRICES

CPM SYSTEMS

VIC 20 IS HERE

Twin 8"
4MHz Double Density
Big Board (2) $2950.00 + tax
Twin 5" Drives
4MHz Double Density
Big Board (2) $1950.00 + tax

MPI DISC DRIVES

to suit Tandy & System 80 computers)
with Box & Power supplies

	1 DRIVE	2 DRIVES
B 51	$265 + tax	$525 + tax
B 52	$395 + tax	$625 + tax
B 91	$470 + tax	P.O.A.
B 92	$560 + tax	P.O.A.

DISCOUNT DISKETTES WELL KNOWN BRAND 12 MONTH WARRANTY (CONTROL DATA)

5¼ SOFT SECTORED

—S—Side Double Density	$30.00/10
—D—Side Double Density	$47.50/10

8" SOFT SECTORED

—S—Sided Single Density	$32.00/10
—D—Sided Double Density	$49.00/10

ALL PRICES PLUS 20% SALES TAX

HARD DISC DRIVES ARE HERE!

5 Megabyte	$1000 + tax
10 Megabyte	$1250 + tax
Controller to suit	$450 + tax
Box and Power Supply	$225 + tax

CHECK THE PRICES THIS MONTH ONLY
THE MITSUBISHI RANGE OF DISK DRIVES

M2896-63

Slimline 8" Disk Drive, Double Sided, Double Density, No AC Power Required, 3ms track to track, 1.6 mbytes unformatted, 77 track/side, 10^9 bit soft error rate.

$515 + tax Box & Power Supply to Suit $95 + tax

M2894 5 or more $450 + tax

Standard size 8" drive, Double Sided, Double Density, 3ms track to track access, 1.6 mbytes unformatted, 77 track/side, 10^8 bit soft error rate.

$515 + tax Box & Power Supply $95 + tax

M4854

Slimline 5¼" disk drive, Double Sided, Double Density, 96 track/inch, 9621 bits/inch, 1.6 mbytes unformatted, 3ms track to track access, 77 track/side.

$395 + tax Box & Power Supply $65 + tax

M4853

Slimline 5¼" disk drive, Double Sided, Double Density, 1 mbyte unformatted, 3ms track to track, 80 track/side, 5922 bits/inch, Steel band drive system.

$375 + tax Box & Power Supply $65 + tax

BIG BOARD (1) NEWS

Double Density add on.
$195 + tax (incl. Software & Hardware)
Hard Disc Interface $195 + tax

PROWRITER PRINTERS

	Tax Exempt	Tax Paid
8510P	$775	$895
8510S	$990	$1095
1550P	$1025	$1195
1550S	$1125	$1295
F10P	$1700	$2095
F10S	$1850	$2195

TERMINALS

Come in and see them working

1—5	$995 + tax
6—24	$850 + tax
24—99	$750 + tax
100 +	$695 + tax

HI TECHNOLOGY PRODUCTS AND EXPERIENCE

VIC 20, VIC 64 TAX EXEMPT ASK OUR PRICE

RITRONICS WHOLESALE PTY LTD

48 -- 50 A'BECKETT STREET, MELBOURNE 3001. Telephone: (03) 347 9251
425 HIGH STREET, NORTHCOTE, VICTORIA 3070. Telephone: (03) 489 7099

MAIL ORDERS TO P.O. BOX 235 NORTHCOTE 3070. P&P MINIMUM $3.00

PAKMAN

W.F.Kreykes, St Alban s Vic.

This program has been designed to run as fast as possible at the expense of memory.

Due to the restrictions of the colour display of the 660, the game is in black and white. However, the colour of the background will change indicating the level you are currently playing at and the number of men that are left. Initially the screen will be green (three men), then red (two men) and then blue (last man).

After the last man has been eaten the screen goes black and the score flashes indicating the end of the game. To restart the game press any key, except 'reset' and 'step', and the game will start again.

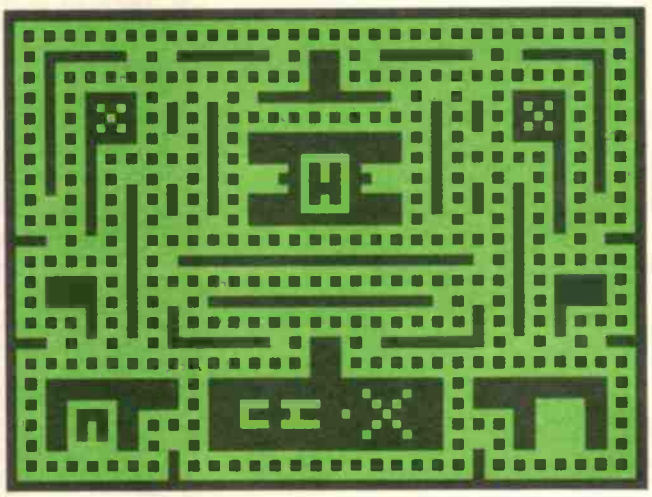
For those who like to 'roll their own', the whole screen is recorded at 0988. Individuals can change the maze, but not the homes or the score box, provided they keep the dots on the same horizontal and vertical lines and there are not open spaces i.e: a wall three dots wide all over the screen. The walls control the Pakmen; they travel in the same direction until they hit a wall, but they never double back.

The extra dot space between the dot and the thin walls is necessary so the man cannot eat the ends off the walls. A bit of experimenting may be required and when this is done the dots on the screen must be counted and the data at 06C1 changed.

If we take my program as an example, there are 328 dots; subtracting 256 leaves 72 which is 48 in Hex and this is the data at 06C1. 346 dots = 90 = 5A.

If you run this on a B&W monitor and the colour gives an unclear picture then you can

```
0600  0963 0963 A637 6012 F055 6803 6D00 6E00
0610  26D2 7901 49F0 28BC 49A0 2638 A94A F365
0620  E3A1 6300 E2A1 6302 E1A1 6305 E0A1 6303
0630  330C 267A 2842 1612 3BCC 00EE 6B00 1818
0640  2654 6912 F900 F918 7901 4970 1640 E99E
0650  1648 1602 A985 FE33 A983 FD33 A984 F365
0660  6917 6526 F029 2674 7901 F129 2674 F229
0670  2674 F329 D955 7905 00EE A970 FA1E D673
0680  8A30 A970 FA1E 4A00 7602 4A05 76FE 4A02
0690  7702 4A03 77FE D673 3F00 1828 4BCC 00EE
06A0  A952 D672 3F01 183A FF18 7E01 7C01 3CFF
06B0  16B8 A6C5 60FF F055 3B00 2922 4E64 290E
06C0  3C48 00EE 00EE 6BA0 FB00 FB18 7BFD 3B00
06D0  16C8 0934 2654 288C 60EE A6C5 F055 6B00
06E0  6C00 2764 6400 2904 28CA 6404 1904 A637
06F0  6040 F055 601D A97C F055 A980 1872 28F2

0700  3BCC 179A 2818 6B02 28A4 F300 F318 7303
0710  3321 170A 8DB4 28A4 6B00 00EE 76FE 1722
0720  70FE 70FD 7001 4B00 173C 6305 4218 6303
0730  4210 6302 4208 6300 93A0 16FE 286E 4BCC
0740  263C 3B00 2916 2654 6B70 FB00 FB15 FB07
0750  FB18 3B00 174E A970 FA1E D673 78FF 0963
0760  4800 16EE 2876 60F0 3803 60B0 4801 6070
0770  A615 F055 60A0 3803 6080 4801 6060 A619
0780  F055 6042 4801 603E A635 F055 6900 C608
0790  3608 6636 6726 6A02 1682 2916 6B01 1708
07A0  7102 9170 6F00 71FE 9170 6F00 4210 17B8
07B0  7702 9170 6F00 77FE 3F00 17D8 7004 9060
07C0  1720 70FE 9060 1722 7602 9060 171C 76FE
07D0  70FD 9060 1724 7001 D015 4210 7102 6310
07E0  8323 C208 8233 4210 71FE A94E F21E D015
07F0  3F01 186E D015 4210 7102 6308 8233 4210

0800  71FE 4208 70FE A94E F21E D015 3F01 186E
0810  28F2 3B00 00EE 6BCC 6318 6526 A95A D354
0820  7309 A96B D355 00EE D673 4A00 76FE 4A05
0830  7602 4A02 77FE 4A03 7702 D673 00EE C404
0840  2848 6400 2848 6404 A97C F41E F265 401D
0850  00EE A94E F21E D015 4200 7002 4208 70FE
0860  4210 71FE 4218 7102 D015 4F01 17A0 A97C
0870  F41E F255 00EE 2654 287A 8080 A970 6119
0880  6227 D123 70FF 7106 3000 1882 6050 6212
0890  F000 F218 F215 F207 3200 1896 70F0 3010
08A0  188E 00EE A945 6316 6426 D345 631D FB29
08B0  28B6 A118 28B6 D345 7305 00EE 4B00 18C4
08C0  2916 6B00 6404 28CA 6400 A97C F41E F265
08D0  301D 00EE A966 D015 6020 F000 F018 6110
08E0  C208 3200 601A A94E F21E D015 186E 00FF
08F0  00FF D015 8540 28C4 8450 F500 F518 7502

0900  3520 18FA 6218 601D 6110 6900 17EA 7D01
0910  6E00 6900 6B0A 292A 631A F318 A95A D344
0920  00EE 292A 7BFF 4B00 1918 6325 6426 FB29
0930  D345 00EE 93BD F888 ADAF 96BF 4D5F 1F9F
0940  FF06 3A3C D420 20F8 2020 030A 0B0C 3C08
```



```
0950  3C00 0040 0000 7820 7800 00EF 84EF 0028
0960  3828 28E9 61D4 2828 3828 0011 0A44 0A11
0970  E080 E0A0 A0E0 20E0 0000 0000 ---- ----
0980  ---- ---- ---- ---- 7FFF FFFF FFFF FFFF
0990  4000 0000 0000 0001 5555 5555 5555 5555
09A0  4000 0000 0000 0001 57F9 3FE5 D3FE 4FF5
09B0  4400 0001 C000 0011 5555 5555 D555 5555
09C0  4400 0001 C000 0011 557D 113F FE44 5F55
09D0  4454 4400 0011 1511 556D 5555 5555 5B55
09E0  4454 4400 0011 1511 557D 157F FF54 5F55
09F0  4440 047F FF10 0111 5555 557C 1F55 5555

0A00  4440 0404 1010 0111 5551 150C 1854 4555
0A10  4444 4404 1011 1111 5155 557C 1F55 5545
0A20  4044 447C 1F11 1101 5555 117F FF44 5555
0A30  4044 0000 0000 1101 7915 5555 5555 544F
0A40  4004 0000 0000 1001 5555 3FFF FFFE 5555
0A50  4004 0000 0000 1001 57D5 5555 5555 55F5
0A60  47C4 0000 0000 11F1 57D5 13FF FFE4 55F5
0A70  4044 4000 0001 1101 5555 5555 5555 5555
0A80  4044 4000 0001 1101 7911 7FE5 D3FF 444F
0A90  4000 0001 C000 0001 5555 5555 D555 5555
0AA0  4000 0001 C000 0001 57FF D7FF FFF5 FFF5
0AB0  47FF C7FF FFF1 FFF1 56FF D7FF FFF5 F835
0AC0  460C 07FF FFF0 1831 560D 57FF FFF5 5835
0AD0  460C 07FF FFF0 1831 560D 17FF FFF4 5835
0AE0  4000 4000 0001 0001 5555 5555 5555 5555
0AF0  4000 4000 0001 0001 7FFF FFFF FFFF FFFF
```

Data underlined is altered by the programe.

"----" = Work area.

disable it by changing 0963 to D4.

The object of the game is to reach the highest score by moving your man around the maze as he eats all the specks, while avoiding the Pakmen. He must attack the Pakmen at each opportunity when he is supercharged to obtain a bonus of points.

When the game starts the maze comes up on the screen and shows your score (0000) and the number of men (three). The colour of the background is green and there are two homes at the bottom of the screen where your man will start, moving either left or right. The Pakmen's home is centre top and this is where they start and return when eaten.

You have to move your man around the maze as he eats all the specks while keeping out of the Pakmen's way. If all the specks are eaten before you lose your last man a new set of specks will come up. There are 328 specks in each maze.

At each count of 100 specks eaten a sign will come up in the score box with the letter A next to it. Then your man is supercharged and you can attack a Pakman to obtain a 100 point bonus, but you must attack *head on*. You must not eat more than nine specks or you will no longer be supercharged. There is also a time limit and when that expires the sign will disappear and you will no longer be supercharged.

Each time the Pakmen collide with each other one will return home and the sign in the score box will be a speck and cross. Once again you will be supercharged and you can attack the Pakman *head on* to obtain a bonus of 200 points. This time you will not be able to eat any specks and when the time limit expires the sign will disappear and you will no longer be supercharged.

Each time a man is eaten by the Pakmen your score will be displayed with the number of remaining men. The screen colour will change and the game will continue. When you are down to your last man, and the screen is blue, the Pakmen take one-and-a-half steps to your one; the timing periods shorten each time you lose a man.

You'll occasionally get a free supercharged 200 points. The game ends when your last man is eaten. The screen will go black and the score will flash until you press a key to restart the game.

UP key 3; DOWN key B; LEFT key A; RIGHT key C.

V0, V1 is the position of the Pakman; V2 is the direction currently travelling; V4 is the Pakman you are dealing with; V6, V7 is the position of the man; V8 sets number of men at start of game; V9 is for the timing periods to release Pakman and cancels supercharge; VA is the direction the man is travelling; VB detects bonuses, and if supercharged; VC counts number of specks eaten; VD, VE is the score; VD = 100s; VE = 0-99 count at 100 triggers VD.

There is no 00E0 in the program because the machine code subroutine at 0934 transfers the data from 0988 onwards direct to the video refresh at 0488 until register F (of the 1802) is equal to 0600 (register D = 0B00). ●

THE VIC-20 COLUMN

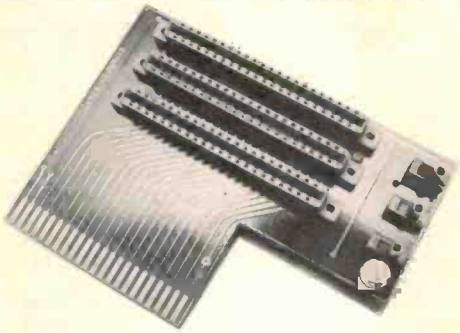
☆ ENCOURAGEMENT ☆

Ozi-Soft, in conjunction with Computer Technics, is offering to donate a VIC-20 expansion board for the best software item submitted to this column every month.

The board is Australian designed and manufactured and simply plugs into the VIC-20's expansion slot. It features three sockets that can be independently switch-selected, plus an on-board reset switch. With it you can plug in up to three separate expansion units to your VIC-20 and avoid the hassle of plugging things in and out and turning the computer on and off each time. It is distributed by **Computer Technics, P.O. Box 25 Kogarah NSW 2217** and costs $59.95.

All submissions must be accompanied by a signed letter from you stating that it's your original work. The winning submission will be judged by the Editor and no correspondence will be entered into. All published submissions will be paid for.

Send entires to: **The Editor, VIC-20 Column, ETI Magazine, P.O. Box 21, Waterloo NSW 2017.**



You don't have to be good with numbers to figure out who won the VIC-20 expansion board this month. Add it up and the result is N.R.Sheehan of Riddells Creek Vic. who wrote Multiplication, and that's the name of the game. But this is no game.

MULTIPLICATION N.R. Sheehan, Riddells Creek Vic

There are two problems which continually confront people who attempt to use small micros for complex scientific or mathematical purposes: small memories and limited precision (nine digits on the VIC-20).

This program, although slow, performs multiplication with up to 255 digit precision (the maximum length of a string variable), while minimising memory usage.

The program comprises an I/O routine (lines 10 to 220) which passes two string paramaters (A$ and B$) to a subroutine (lines 5000 to 5170).

This subroutine counts and stores the number of decimal places in the two numbers, converts them to integers and passes them to a second subroutine (lines 6000 to 6190).

The second subroutine carries out a form of integer multiplication which results in a reversed answer (X$). The answer is changed to the correct order (Y$) and passed back to the calling subroutine which restores the decimal point (if required) and returns the answer to the I/O routine.

Running times and memory usage are demonstrated in the test results.

The two subroutines can operate independent of the calling routine and could be included in any program.

The subroutines carry out no checking of either input format or overflow conditions.

MULTIPLICATION

```
100 XM=19967-FRE(1): OPEN 3,4
110 INPUT A$,B$
120 XT=TI
130 REM PASS A$, B$ TO SUBROUTINE
140 GOSUB 5000
150 REM ANSWER RETURNED IN Y$
160 PRINT#3,(TI-XT)/60;" SECONDS ELAPSED"
170 PRINT#3,A$;" * ";B$
180 PRINT#3,"   = ";Y$
190 PRINT#3,"PROGRAM : ";XM;" BYTES"
200 PRINT#3,"VARIABLES : ";19967-FRE(1)-XM;" BYTES"
210 PRINT#3:CLOSE 3
220 END
5000 PF=0:DP=0:LA=LEN(A$)
5010 PF=PF+1:IF MID$(A$,PF,1)<>"." AND PF<LA THEN 5010
5020 IF MID$(A$,PF,1)<>"." THEN AI$=A$:GOTO 5060
5030 I=PF-1:AI$=LEFT$(A$,I)
5040 IF PF=LA THEN LA=LA-1:GOTO 5060
5050 DP=LA-PF:AI$=AI$+RIGHT$(A$,DP):LA=LA-1
5060 PF=0:LB=LEN(B$)
5070 PF=PF+1:IF MID$(B$,PF,1)<>"." AND PF<LB THEN 5070
5080 IF MID$(B$,PF,1)<>"." THEN BI$=B$:GOTO 5120
5090 I=PF-1:BI$=LEFT$(B$,I)
5100 IF PF=LB THEN LB=LB-1:GOTO 5120
5110 BI$=BI$+RIGHT$(B$,LB-PF):DP=DP+LB-PF:LB=LB-1
5120 GOSUB 6000
5130 REM INPUT ARGUMENTS = AI$,LA,BI$,LB
5140 REM OUTPUT = Y$
5145 IF DP=0 THEN 5170
5150 I=LEN(Y$)-DP
5160 Y$=LEFT$(Y$,I)+"."+RIGHT$(Y$,DP)
5170 RETURN
6000 X$="":Y$=""
6010 FOR K=0 TO LB-1
6020 CA=0:I=LB-K
6030 FOR H=0 TO LA-1
6035 J=LA-H
6040 M=VAL(MID$(BI$,I,1))*VAL(MID$(AI$,J,1))+CA:CA=0
6050 IF M>9 THEN CA=INT(M/10):M=M-CA*10
6060 TC=H+K+1
6070 IF LEN(X$)<TC THEN X$=X$+RIGHT$(STR$(M),1):GOTO 6120
6080 XI=VAL(MID$(X$,TC,1))+M
6090 IF XI>9 THEN XC=INT(XI/10):XI=XI-XC*10:CA=CA+XC
6100 LE=TC-1:RI=LEN(X$)-TC
6110 X$=LEFT$(X$,LE)+RIGHT$(STR$(XI),1)+RIGHT$(X$,RI)
6120 NEXT H
6130 IF CA>0 THEN X$=X$+RIGHT$(STR$(CA),1)
6140 NEXT K
6150 I=LEN(X$)
6160 FOR K=0 TO I-1
6170 J=I-K:Y$=Y$+MID$(X$,J,1)
6180 NEXT K
6190 RETURN

READY.

 .166666667  SECONDS ELAPSED
3 * 3
   = 9
PROGRAM :  1376  BYTES
VARIABLES :  132  BYTES

 .25  SECONDS ELAPSED
3 * 33
   = 99
PROGRAM :  1376  BYTES
VARIABLES :  136  BYTES

 .25  SECONDS ELAPSED
33 * 3
   = 99
PROGRAM :  1376  BYTES
VARIABLES :  136  BYTES

 .45  SECONDS ELAPSED
33 * 33
   = 1089
PROGRAM :  1376  BYTES
VARIABLES :  170  BYTES

 .616666667  SECONDS ELAPSED
333 * 33
   = 10989
PROGRAM :  1376  BYTES
VARIABLES :  174  BYTES

 .783333333  SECONDS ELAPSED
3333 * 33
   = 109989
PROGRAM :  1376  BYTES
VARIABLES :  178  BYTES

 .95  SECONDS ELAPSED
33333 * 33
   = 1099989
PROGRAM :  1376  BYTES
VARIABLES :  182  BYTES

 1.1  SECONDS ELAPSED
33 * 33333
   = 1099989
PROGRAM :  1376  BYTES
VARIABLES :  182  BYTES

 .966666667  SECONDS ELAPSED
33.333 * 3.3
   = 109.9989
PROGRAM :  1376  BYTES
VARIABLES :  185  BYTES
```

FERGUSON TRANSFORMERS

PRINTED CIRCUIT BOARD MOUNTING TRANSFORMERS

PL9/5VA	$7.95	PL24/5VA	$7.95	PL18/12VA	$10.50
PL12/5VA	$7.95	PL30/5VA	$7.95	PL24/12VA	$10.50
PL15/5VA	$7.95	PL40/5VA	$7.95	PL30/12VA	$10.50
PL18/5VA	$7.95	PL161/5VA	$10.50		

LOW PROFILE CHASSIS MOUNTING TRANSFORMERS

PL12/20VA	$14.75	PL12/60VA	$19.50	PL24/40VA	$16.50
PL15/20VA	$14.75	PL15/60VA	$19.50	PL30/40VA	$16.50
PL18/20VA	$14.75	PL18/60VA	$21.50	PL40/40VA	$16.50
PL24/20VA	$14.75	PL24/60VA	$21.50	PL30-9/40VA	$23.50
PL30/20VA	$14.75	PL12/40VA	$16.50		
PL40/20VA	$14.75	PL15/40VA	$16.50	PL30/60VA	$21.50
PL1.5-18/20VA	$23.50	PL18/40VA	$16.50	PL30-9/60VA	$25.50

CONVENTIONAL CHASSIS MOUNTING TRANSFORMERS

PF3577	$33.90	PF3993	$23.90	PF4362	$57.90
PF3783	$79.50	PF4244	$46.50	PF4363	$57.90
PF3787	$21.50	PF4354	$49.50	PF4405	$44.50
PF3788	$43.50	PF4361/1	$49.50		

BELL TRANSFORMERS

PPB4/1000 $15.50 PPB8/1000 $15.50 PPB12/500 $15.50

AUDIO TRANSFORMERS

MT552 $28.50 OP590 $46.50 OP592 $36.90

D.C. POWER SUPPLIES

PPA30C	$12.90	PPA6DC	$12.90	PPA9DC $12.90
PPA4.5DC	$12.90	PPA7.5DC	$12.90	

BUILD YOUR OWN SPEAKERS WITH PHILIPS

Part No.	Price
ADO 1610 T8	$16.95
ADO 2160 SQ8	$49.50
AD70601 W8/620	$28.50
AD 12250 W8	$83.00

P.C. EDGE CONNECTORS

S100 gold plated wire wrap	$8.50
S100 solder tail	$7.90
D2 Motorola bus	
43 86 solder tail	$8.50
43 86 gold plated wire wrap	$11.50

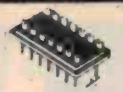
10 TURN POTENTIOMETERS

Stock resistance values

50R 100R 200R
500R 1K 2K 5K
10K 20K 50K
100k

Spectrol model 534 ¼" shaft
Price 1 9 **$12.50**
10 + values may be mixed **$11.50**

DIP PLUGS



Ideal for use with flat ribbon cable or to mount components on

14 pin $1.50 24 pin $2.90
16 pin $1.90 40 pins $5

POWER TRANSFORMERS

SPECIALLY DESIGNED FOR MICROCOMPUTERS

- Good regulation electrostatic shield
- RI 810 8V @ 10A x 15V @ 1A **$36.50**
- RI 820 8V @ 20A 15V @ 1A 15V @ 3A **$43.50**

20 TURN CERMET TRIM POT

SPECTROL 43P ACTUAL SIZE

STOCK RESISTANCE VALUES
10R 20R 50R 100R 200R 500R 1K 2K 5K 10K 20K 50K 100K 200K 500K 1M 2M

1 9	$1.80
10 99	$1.60
100	$1.30

Values may be mixed

Hexadecimal Keypad

$42.50

19-key pad includes 1-10 keys A8LDEF and 2 optional keys and a shift key

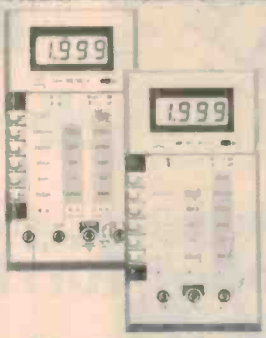
Ideal for dream project

MULTIDIALS

Dials to suit 10 T Pots

Model 21 1.8" dia	$24.50
Model 16 .9" dia	$19.50
Model 18 1" x 1.75" dia	$27.50

RITRON DIGITAL MULTIMETERS



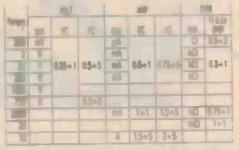
- 28 Ranges
- Push Button Operation
- Auto Polarity
- Low Battery Indicator
- Full Overload Protection
- Finger Guards on Probes and Shrouded Plugs for Safety
- Accuracy: 1 year 18°C to 28°C (+ % of reading + No. of Digits) 200 hour battery life

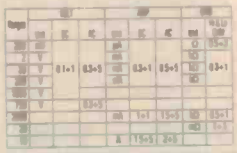
Q16010 specifications

1-4	5+
$59.95	$54.95

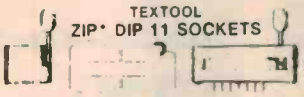
Q17040 specifications

1-4	5+
$89.95	$84.95





TEXTOOL ZIP* DIP 11 SOCKETS



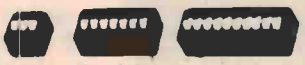
16 Pin Zip* Dip 11	$11.50
24 Pin Zip* Dip 11	12.50
40 Pin Zip* Dip 11	17.50

*Zero Insertion Pressure

DIP SWITCHES SPST

P N	No of Switches	Price
SD3	3	$1.60
SD4	4	1.70
SD5	5	1.90
SD6	6	2.30
SD7	7	2.40
SD8	8	2.50
SD9	9	2.70
SD10	10	3.00

DIP SWITCHES SPST



cermet single TURN TRIM POT

Spectrol model 63P ACTUAL SIZE

STOCK VALUES
10R 20R 50R 100R 200R 500R 1K 2K 5K 10K 20K 50K 200K 500K 1M 2M

1 9	$1.20
10 99	$1.00
100	$0.90

Values may be mixed

HEATSINKS

High Thermal Capacity Black Anodised

	1-4 $	5-9 $	10-49 $	50-99 $	100-499 $	500 plus $
HS1 — 38mm	1.85	1.75	1.50	1.35	1.00	0.90
HS2 — 75mm	3.00	2.90	2.50	2.00	2.00	1.50
HS3 — 150mm	5.80	5.40	4.90	3.80	2.90	2.70
HS4 — 225mm	8.10	7.60	7.10	5.90	4.50	4.30
HS5 — 300mm	8.90	8.40	7.90	6.50	4.90	4.60

Unanodised

HS11 — 38mm	1.40	1.20	1.00	0.90	0.80	0.70
HS12 — 75mm	2.50	2.20	1.90	1.60	1.25	1.20
HS13 — 150mm	4.90	4.50	4.00	3.20	2.45	2.40

RS232 & "D" TYPE CONNECTORS

PART NO	DESCRIPTION	1 9	10 25	25+
DE 9P	9 PIN MALE	$3.50	$3.50	$3.10
DE 9S	9 PIN F MALE	4.50	4.20	3.90
DE 9C	9 PIN COVER	2.20	2.10	1.90
DA 15P	15 PIN MALE	4.50	4.20	3.90
DA 15S	15 PIN F MALE	5.10	4.90	4.70
DA 15C	15 PIN COVER	2.30	2.10	2.00
DB 25P	25 PIN MALE	5.90	5.60	5.10
DB 25S	25 PIN F MALE	6.90	6.60	6.10
DB 25C	1 pc Grey Hood	2.40	2.20	2.00
DB 25C2B	2 pc Black Hood	2.80	2.70	2.50
DB 25C2G	2 pc Grey Hood	2.70	2.50	2.40
DC 37P	37 PIN MALE	7.90	7.50	7.10
DC 37S	37 PIN F MALE	10.90	9.90	9.10
DC 37C	37 PIN COVER	4.90	4.50	4.10
DH S	Hardware set (2 Pairs)	2.10	1.90	1.80

BLANK CASSETTES T.D.K.

TDK ADC60	1 for $3.60	10 for $26.00
TDK DC60	1 for $2.10	10 for $18.00
TDK DDC60	1 for $3.50	10 for $31.00
TDK SAC60	1 for $3.50	10 for $31.00
TDK SAXC60	1 for $5.70	10 for $46.00
TDK DC90	1 for $2.40	10 for $21.00
TDK ADC 90	1 for $3.50	10 for $30.00
TDK SAC 90	1 for $4.20	10 for $39.00
TDK DDC90	1 for $4.70	10 for $45.00
TDK SAXC90	1 for $5.50	10 for $49.00
TDK DC120	1 for $4.50	10 for $37.00
TDK ADC120	1 for $5.40	10 for $46.50

Bankcard Mail Orders Welcome

Please debit my Bankcard.
Bankcard No.
Expiry Date
Name
Signature

Post & Pack $2.50 small kits, heavier kits add extra postage.
Prices subject to change without notice. Send 60c and SAE for free price list and inclusion on all future mailing lists.
MAIL ORDERS: PO Box 235, Northcote, Vic 3070. Min P & P $1.00.
Ph: (03) 489 8131. ERRORS AND OMISSIONS EXCEPTED

ROD IRVING ELECTRONICS

425 HIGH STREET, NORTHCOTE 3070, MELBOURNE, VICTORIA. Ph (03) 489 8131 Telex No. 38897

48–50 A'BECKETT STREET, MELBOURNE (03) 347-9251

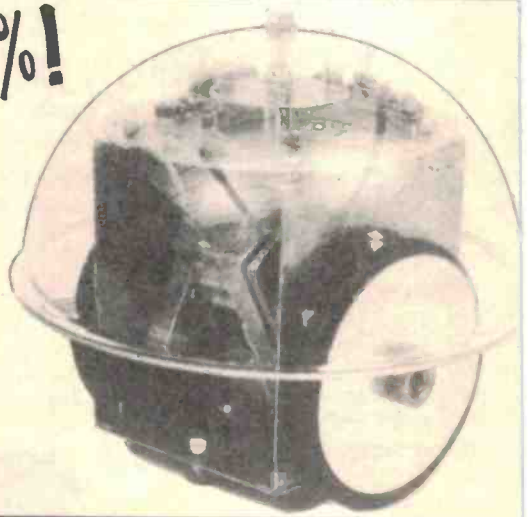
NEW STORE opening September HURSTVILLE

NEW STORE CHECK

* * *

WE ARE PROUD TO ANNOUNCE THE OPENING OF HURSTVILLE. TO CELEBRATE THE EVENT, WE ARE HAVING A GIANT SALE!

Robot Turtle Hebot II Save 20%!



The HEBOT 11 turtle is not just a fun device, it is a positive aid to education, It takes programming out into the real 3 dimensional world instead of the flat two dimensional world of the VOU. When connected to the I/O ports of your computer and given a DC supply of 9–15V the turtle runs around under computer control moving forwards, backwards, right and left with independent control of each wheel, it has blinking eyes, will bleep with a choice of two tones and when ordered by the computer, presses down a pen to chart its progress and provide hard copy of the results of the program. When set free to run around the turtle discovers its enviroment. When the turtles shell bumps into an unmovable obstacle touch sensors send back data to the computer for it to calculate evasive or exploratory action.
If the computer has no I/O ports It doubtless has an expansion bus and the turtle can be controlled and listened to using this bus together with the universal computer interface board. This board enables the turtle to be treated as a memory mapped I/O device.

COMPLETE "HEBOT II" KIT INCLUDING ALL HARDWARE, DOME, WHEELS etc. Cat. XR1020

UNIVERSAL INTERFACE CARD KIT Cat. XR1022 $39.50

SEPTEMBER ONLY

~~$399~~ inc tax $319

¼" TAPE

2500' – 1.5 mil
Cat. AL-1560

3600' – 1.0 mil
Cat. AL-1561

FABULOUS TAPE SENSATION

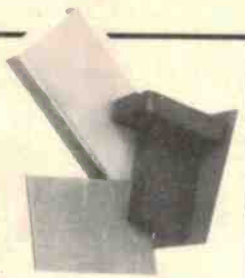
$19.95 Amazing **Quality**

Jaycar has done it again – for all of the Hi Fi buffs who have professional NAB centre reel-to-reel tape recorders – a superb METAL spool complete with either 2500' or 3600' of quality tape. Both tapes are priced the same, the only difference between tape lengths is the thickness of the tape itself. The 3600' tape is 1.0 mil thick and the 2500' tape is 1.5 mil thick. You make your choice from these two superb bargains.
The spool size is 10¾"

Only a few left!

EXPERIMENTER'S MAGNET KIT

Magnets never cease to amaze – yet most of us know very little about them.
With this in mind Jaycar has had a special "Magnet Kit" produced.
The kit contains: 2 very powerful Ceramic magnets, flux concentrator, pole pieces and a short manual written by experts in magnetism.
Magnet experiments are also shown as well as a technique to actually make your magnets stronger!!
Cat. KJ6512



ONLY $4.95

SEPTEMBER ONLY

$3.95 SAVE $1

MAGAZINE BINDER

LOW IMPORT PRICE

Keep your precious (and expensive) magazines in order for easy references.
Smart blue colour with gold lettering.
Heavy gauge and richly chromed metal fittings.
Cat. BB7000

ONLY ~~$4.95~~ $3.96
4 up ~~$4.60~~ ea $3.60

LESS 20% SEPT.ONLY

EA PHOTON TORPEDO KIT

EA 'Photon Torpedo' Kit – NEW LOW PRICE
Ref: EA September 1981
This great kit comes complete with Jiffy box and front panel featuring "Deep Space" background. We've seen this kit selling for up to $29.95 – NOT from this month!!
ONLY $19.95. Be quick. Why not buy one, build it, and give it as a gift to a young one?
Cat. KA-1370 $19.95

$19.95

SPECIALS-US OUT! * * *

NEW STORE opening September HURSTVILLE

OUR NEW SHOWROOM AT 121 FOREST ROAD
YOU CAN GRAB THESE BARGAINS AT ANY OF OUR STORES THOUGH!

low cost hi fi

FROM $19.98

That's right a 3 – WAY HI FI speaker kit from only $19.98!!
Each kit contains a massive 10" (250mm) woofer, cone midrange and DOME tweeter!! You also get, at no extra charge, the special cross-over capacitors!
The system is rated at approximately 20 watts RMS so it is ideal as an economical but reasonably powerful main Hi Fi unit or as a second system for another room or outdoors.
Each 3-way kit comes with a recommended enclosure design which you can build yourself easily!
You would normally pay well over $60 for the equivalent from major kit speaker suppliers so this is an outstanding bargain. Sensitivity of system 93dB/1m/1 watt. Cat. AK3700
HURRY LIMITED STOCKS and they are made in JAPAN!!

Woofer not to same scale as other components

3–WAY SYSTEM
$24.95 a set
2 SETS FOR STEREO (6 spkrs)
ONLY $39.95

codemaster

Many of you know the clever parlour game that uses coloured tokens to stretch the brain to work out a hidden code in a minimum number of moves.
The people that came up with the game used a descriptive name which no-one else can use. It is a popular game and is well known under this name. Our game is similar to this game but - naturally - its electronic!! And, what's more, you can play against the machine - alone. Each XM7015 Codemaster measures 140(l)x85(w)x25(d) looks similar to a pocket calculator and runs off a standard 9V cell. Provision is made for a mains adaptor as well.
The Codemaster once sold for $29.50 but Jaycar has made a huge scoop purchase. You save a fortune!
Grab one now for only $4.98
* (For a further clue to the origin of this game read this page carefully)

WERE $9.95
ONLY $4.98

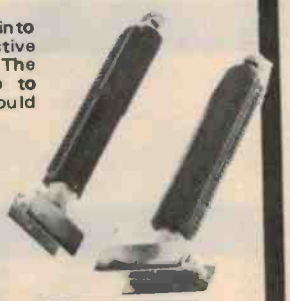
low cost IC inserters AND EXTRACTORS

Up until now these have cost a fortune!!
Features:
– CMOS SAFE conductive plastic
– Exclusive bent pin alignment guides in handle . 8 to 40 pins.
– Ground strap can be connected.
– One hand operation.

IMPORTANT!!
Don't be conned into buying a non conductive inserter/extractor. The possible static damage to your MOS I.C.'s could cost you a fortune!!

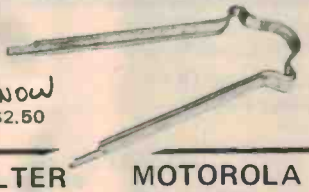
INSERTERS

Cat. No	Model	Description	Normally	Sept. Only
TH1810	CIT820	8 – 20 pin	$5.95	$4.95
TH1812	CIT22	22 pin	$6.50	$5.50
TH1814	CIT2428	24 – 28 pin	$6.95	$5.95
TH1816	CIT3640	36 – 40 pin	$8.95	$7.50



EXTRACTOR
Deceptively simple looking device. One piece metal construction. 8-40 pins

		WAS	NOW
TH1818	ET480	$2.95	$2.50



HEAVY DUTY MAINS FILTER

There are an enormous number of Desk-top micros now having problems with mains borne interference. Our MS4004 filter has been invaluable where mains interference is a problem. When a free standing unit is required the MS4004 is ideal. It will pass 2 amps (conservative) at 240V AC. This unit is a grey painted metal case that plugs into a standard mains socket. On one end of the case is an unswitched 240V outlet. Virtually the only thing that comes out of this socket is mains. All frequencies above 50Hz are very heavily attenuated. Ideal for problem areas.
Cat. MS-4004 $99.00

MOTOROLA SILICON RECTIFIER MANUAL

This totally underated book of around 500 pages & 17 chapters describes diode and rectifier theory in great detail. Typical chapter headings include; Basic Electrical Characteristics of Diodes, Basic Thermal Properties of Semiconductors, Rectifier Specifications & Ratings, Rectifier Filter Systems, Rectifier Voltage Multiplier Ccts, Transient Protection of Rectifier Diodes, Selector Guide, Data Sheets and more. A must for the serious electronic enthusiast as well as the design engineer. Cover dimensions: 235 x 177mm
Cat. BM-4208 SONLY $5.95

VOYAGER CAR COMPUTER ICE WARNING UNIT

SAVE $10!

ONLY $19.95

Do you buy a hot water bottle in December?
Hundreds of 'Voyager' Car Computers are now operating all over Australia. A feature of the European model was an 'Ice Warning' unit. This device, fitted in the engine bay near the radiator grille, detected conditions that led to icy roads – particularly dangerous 'black ice'. We felt that the extra cost of this unit was not justified in the standard Australian model. Many people have asked for it however.
We should have advertised these 3 months ago in the winter but we forgot!! Now its almost summer and Voyager users in the colder areas probably won't need one for another 6 months!! So we've slashed $10 (or 1/3rd) off the normal price to encourage you to buy now.
Normally $29.95. This month $19.95 – instructions included. Easy fitting. Can be used as basis for ice warning system without Voyager car computer.
Cat. XC-2028 $19.95

Jaycar NUMBER 1 FOR KITS

SYDNEY SHOWROOM
125 YORK STREET – PHONE: (02) 264 6688
TELEX: 72293
HURSTVILLE SHOWROOM
121 FOREST ROAD – PHONE: (02) 570 7000
CARLINGFORD SHOWROOM
Cnr. CARLINGFORD & PENNANT HILLS ROAD
PHONE: (02) 872 4444

MAIL ORDERS & CORRESPONDENCE
BOX K-39 HAYMARKET, SYDNEY 2000
POST AND PACKING CHARGES
$5 – $9.99 ($1.50) $10 – $24.99 ($3.20)
$25 – $49.99 ($4.50) $50 – $99.99 ($6.50)
$100 – $198 ($8.00) Over $199 ($10)
"Free Insurance for Road & Registered post over $200"
SHOP HOURS CARLINGFORD & HURSTVILLE
Mon – Fri 9am – 5.30pm: Sat – 9am – 12pm: Thurs night 8.30pm
SHOP HOURS SYDNEY
Mon – Fri 8.30am – 5.30pm: Sat – 8.30am – 12pm: Thurs night 8.30pm

Mail Order By BANKCARD Via Your Phone

BACK ISSUES, eti SUBSCRIPTIONS, BINDERS AND PHOTOCOPIES

Send orders to: **ETI Reader Services, PO Box 227, Waterloo, NSW 2017.**

☐ **BACK ISSUES** $2.50 each, available from Nov 1978

Month .....Year.....$ .....

Month .....Year.....$ .....

Month .....Year.....$ .....

Please attach a list if more than three required.

☐ **PHOTOCOPIES** $2.50 per article per issue

Project No .....Month .....Year.....$ .....

Project No .....Month .....Year.....$ .....

Project No .....Month .....Year.....$ .....

Please attach a list if more than three required.

☐ **SUBSCRIPTIONS**

$23.88 for one year (12 issues) in Australia $ .....

$32.00 for one year (12 issues) in New Zealand $ .....

Other rates on application.

☐ **BINDERS**

No..... @ $7.10 in in New South Wales $ .....

No..... @ $8.50 in other states $ .....

TOTAL $ _____

All prices include postage and packaging.

Tick box to indicate payment:

American Express† ☐ Bankcard† ☐ Cheque* ☐

†Minimum credit card order, $10.

*Please make cheques payable to the Federal Publishing Company Pty Ltd.

Credit Card No:

Card Expiry Date:

Name

Address

Postcode

Signature

Unsigned orders cannot be accepted.

NEOTRONICS MARKETS HIGH-PERFORMANCE 'SCOPE

Neotronics OS620 high-performance oscilloscope, just released on the market, features dual-trace operation and incorporates a 150 mm square CRT with internal graticule.

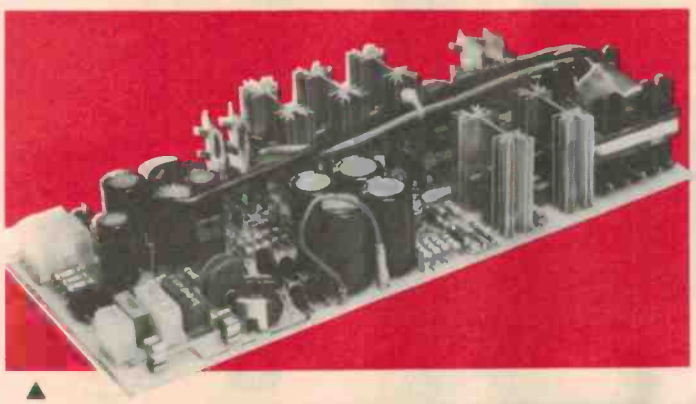
The acceleration voltage of the South Korean-made unit, specially built for Neotronics, is 2 kV.

Ideal for television work, the trigger circuit incorporates a line and frame synch separator, allowing both frame and line pulses to be displayed.

The component tester is a special circuit which checks components either in or out of circuit without the need for external voltages. The results are displayed on the screen.

A sensitivity of 5 mV/cm and a maximum input voltage of 600V p-p allows a large range of voltages to be measured. Also featured are an add mode, which can be used to add or subtract A and B input signals, and a Z-modulation mode.

For further information, contact **Neotronics P.O. Box 289, Newport, NSW 2106. (02) 918-8220.**



MULTI-RAIL POWER SUPPLY

Power-supply specialist firm Scientific Electronics has two new multi-rail power supplies, the five-rail SM80AE1 and the four-rail SM80AE2.

Designed and manufactured by Scientific Electronics to meet Telecom specification 1302, the new multi-rail switch-mode supplies offer 80 W total output and high reliability in small packages.

Standard output voltages are available, as well as output rails to customer specifications.

The five rails on the standard-model SM80AE1 are +5 V at 8 A continuous, +12 V at 2.5 A continuous, +24 V at 0.2 A continuous, −5 V at 0.5 A continuous and −12 V at 1.0 A continuous.

The four rails on the standard-model SM80AE2 are +5 V at 8 A continuous, +12 V at 2.5 A continuous, −5 V at 0.5 A continuous and −12 V at 1.0 A continuous.

All outputs on both units are short-circuit protected, and the +5 V and the +12 V outputs have overvoltage protection.

Total allowable output power is 80 W continuous, 100 W peak. Isolation is greater than 3.5 KV and efficiency greater than 60% at full load.

The units measure 108 x 240 x 45 mm and are fully supported by a five-year warranty and complete local technical back up.

For further information, contact **Scientific Electronics, 6 Holloway Drive, Bayswater Vic. 3153. (03)762-5777.**

POWERFUL TWO-CHANNEL FFT ANALYSER FROM SD

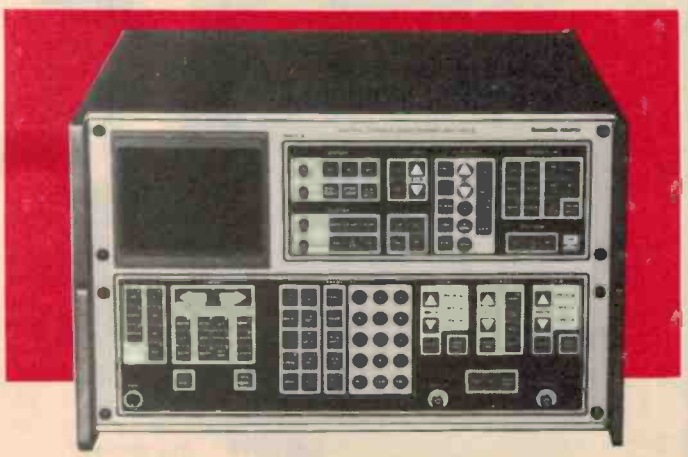
Menu-driven with full annotation facilities, Spectral Dynamics' new SD375 two-channel FFT analyser can be used as a signal correlator for time, amplitude and frequency up to 100 kHz.

The SD375 FFT is also a transfer function analyser for mechanical, electrical, acoustic and hydraulic measurements, while Modal Analysis Engineering software programs can utilise it as a processor.

Options available are a digital translator (up to x100 zoom), 1/3 and 1/1 octave analysis, digital I/O and a synchronous signal generator for external system or network excitation.

Vipac Instruments provides full service support for the SD375 and training and application support is readily available.

For further details, contact **Vipac Instruments, 30 Claremont Street, South Yarra, Vic. 3141. (03)240-8471.**



JAYCAR

Sparkrite

The Brandleaders in Auto Electronics

Sparkrite SX2000

A Reactive Discharge System combines all features of the SX500 plus:

- Reactive Discharge electronics combining all the advantages of both Inductive and Capacitive Discharge for maximum spark performance.
- Gives the most thorough combustion of air/fuel ratios especially current lean mixture emission controlled engines.
- Voted 'Accessory of the Year' and the best as tested by Popular Motoring Magazine.
- Patented clip-to-coil fitting.
- Systems Function Light as well as Static Timing Light.
- The ultimate brand leading contact-breaker triggered system.

~~$59~~ SAVE $10 **$49**

Quartz Crystal Clock movement

Cat. XC6000

$14.95

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

Complete with data sheet, instructions and wall hanger bracket.

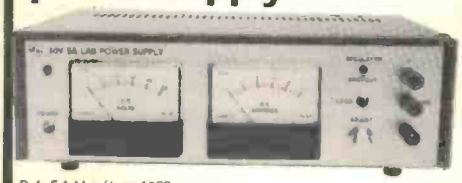
IEC Cable Connectors

INCREASED RANGE

Most imported equipment these days now uses IEC-320 style AC power inlet connectors. Indeed, the electronics mags will soon be specifying these connectors on many of their mains-powered projects to simplify (and therefore make safer) mains wiring. Jaycar now stocks a range of ELECTRICITY AUTHORITY APPROVED mains line cords. We have them in straight entry, left and right entry with and without standard 240V mains moulded plug. Each cord is a generous 2 metres long and is rated at 7.5 amp continuous.

Cat. No	Description	Price
PS4302	LINE CORD STRAIGHT ENTRY 2M	$3.95
PS4304	LINE CORD R/HAND ENTRY - 2M	$3.95
PS4305	LINE CORD L/HAND - 2M	$3.95
PS4306	LINE CORD STRAIGHT ENTRY WITH 240V PLUG - 2M	$4.95
PP2302	IEC 320 CHASSIS PLUG	$2.95
WM4530	2 PIN 240V PLUG MOULDED TO 2M FIG. 8 7.5 AMP CORD - BLACK IN COLOUR (Note: the first 5 items are grey in colour)	$2.95

50V/5A laboratory power supply



Ref: EA May/June 1983

By far the most exciting high power supply we have seen! Using the latest switch mode principle, very little energy is wasted with high dissipation in the regulators – a cause of considerable heat dissipation and high hardware costs.

The Jaycar kit comes with every originally specified component down to the last nut and bolt. Also included are special Scotchcal meter scales. Beware of inferior kits that do not supply such components. (Not for sale as a separate item).

Cat. KE-1520 $149.00

This handy 200 gram spray enables you to do all manner of things. You can spray sheets of Styrene foam and make them suitable for storing your MOS IC's. Far cheaper than other methods!! You can make conducting screens inside plastic boxes to shield RF. You can re-coat the back of CRT's. You can make conductive parts of equipment cabinets to reduce static. The paint dries to a hard varnish like film. Non-inflammable and Non toxic. Grab a can now. You never know when you will need it!

Cat. NA-1010 – $6.95

SPRAY ON CONDUCTIVE PLASTIC...

$6.95

Digital Delay Line KIT

400ms VERSION ONLY **$449** COMPLETE

The Digital Delay Line is designed to produce a huge variety of electronic effects. It works very well but the amazing thing is the low low price! The effects depend on the time delay selected and some of those included are: Phasing, Flanging, Chorous, ADT (Automatic Double Tracking), Echo, and Vibrato. The delay time can be varied from 0.32ms to 1.6 seconds! Because the signal is stored in digital form there is, unlike analog systems, no degeneration of the signal with time and unlimited repetition is provided by use of the freeze control.

All the controls mount directly upon PCB's to eliminate wiring and to further simplify construction the main board is 'plated through' i.e. there are no wire links or link-through pins. The whole of the memory whether for the basic 400ms machine or the fully expanded 1.6 second model all fits on the main board. The cabinet which is free standing but also suitable for 19" rack mounting, is fully finished to a very high standard. The panel is deep blue whilst the cover is sprayed with a durable black enamel. The kit is available for only $449 – compare that with inferior uints that can cost over $2,000!!

Cat. KJ-6621 $449.00

FM Transmitter Module

We have been working on this one for years!!

Basically we wanted something akin to the $6.50 kit "wireless microphone" transmitter but with greater signal strength and far, far greater frequency stability.

WE NOW HAVE IT!

Basically the (potted) unit measures a small 90 x 22 x 15mm and has connections for power, antenna and input. An AC signal between 20 and 15kHz will modulate the transmitter. The signal can be coded single or multiple frequency tone bursts etc.

FEATURES

- Ultra low noise output (–60dB or better attainable with a suitable tuner)
- Excellent frequency stability
- Not a kit – ready for immediate use
- Connections required
  (a) Power supply or battery
  (b) Antenna
  (c) Audio input
- Full instructions supplied
- Suits any application where a stable low noise FM link is required

SPECIFICATIONS

- Frequency – 88 - 108MHz adjustable
- Useable range – 50 metres
- Supply – 6 to 9V at 20mA
- Input sensitivity – adjustable – maximum 30mV
- Pre-emphasis – 50µ/second standard
- Dimensions – 90 x 22 x 15mm (approx)

$49.95 Cat. DT5450

LOW COST DIGITAL MULTIMETER KIT

ONLY **$45**

Feb EA March 1983 (This month)
Almost everyday we are asked for a multimeter kit. Up until now we thought that it was just not worth it considering the fine low-cost built-up units available. The DP2010 changed all that.
This kit, fully imported from the UK uses the famous DPM-08 custom LCD/Voltmeter to achieve phenomenal accuracy at very modest cost!
All parts are included to complete the meter including an attractive and colourful front panel (a 9V battery is required)

Set of test probes to suit $2.95
Probe to suit Cat. WT5312 ONLY $2.50
Eveready 216 (red) 9V Battery Cat. SB2370 ONLY $1.40

$39.95

SAVE OVER $5.00!

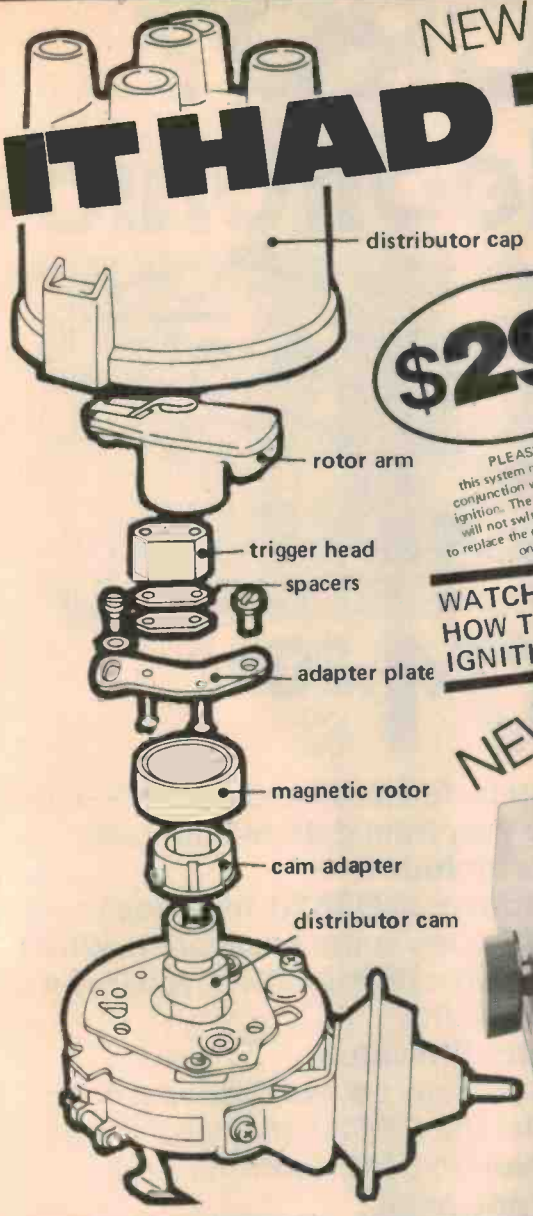
DP2010 kit Cat. KJ7010 ONLY $45

SPECIFICATIONS

Function	f.s.d.	Resolution	Accuracy	Protection
Volts (d.c.)	2V	1mV	1%±1 digit	500V for
	20V	10mV	1%±1 digit	one minute
	200V	100mV	1%±1 digit	
	500V	1V	1%±1 digit	
Current (d.c.)	2mA	1uA	1%±1 digit	1A/250V
	20mA	10uA	1%±1 digit	
	200mA	100uA	3%±1 digit	
	2000mA	1mA	5%±1 digit	
Volts (a.c.)	2V	1mV	2%±5 digit	500V for
	20V	10mV	2%±5 digit	one minute
	200V	100mV	2%±5 digit	
	500V	1V	2%±5 digit	
Current (a.c.)	2mA	1uA	2%±5 digit	1A/250V
	20mA	10uA	2%±5 digit	
	200mA	100uA	4%±5 digit	
	2000mA	1mA	7%±5 digit	
Resistance	2K	1	1%±1 digit	260V
	20K	10	1%±1 digit	r.m.s.
	200K	100	1%±1 digit	
	2000K	1K	1%±1 digit	
Diode Test	2V	1mV	1%±1 digit	260V r.m.s.

AC VOLTAGE AND CURRENT RANGES
When S3a selects a.c. functions the output from either the voltage attenuator or current shunts is fed through C1 to remove any d.c. component.

NEW IT HAD TO HAPPEN



$29.95

PLEASE NOTE
this system must be used in conjunction with an electronic ignition. The Hall Effect device will not switch enough current to replace the contact breaker points on their own!

A professionally-engineered electronic ("breakerless") contact breaker system.
Yes, only Jaycar has a complete Hall-effect triggerhead assembly designed to adapt to an extensive number of cars. Each kit contains the following:

- HALL EFFECT TRIGGER HEAD
- MAGNETIC ROTORS FOR BOTH 4 & 6 CYLINDER CARS
- OVER 6 CAM-LOBE ADAPTORS
- OVER A DOZEN DIFFERENT ADAPTOR PLATES FOR YOUR PARTICULAR DISTRIBUTOR
- OTHER HARDWARE (i.e. SCREWS etc.)
- YOU CAN REMOVE THIS SYSTEM AND RE-EQUIP YOUR CAR WITH THE ORIGINAL BREAKER POINTS WHEN YOU SELL THE CAR!
- AS EASY TO INSTALL AS A SET OF POINTS!
- INSTRUCTIONS (SIMPLE-TO-FOLLOW) INCLUDED!

This set is designed to fit most European and Japanese cars. In fact it will also fit many Australian cars fitted with Lucas, Bosch, Motorcraft, AC Delco or Autolite electrics. If you wish to check first, please send SAE for car/distributor list.
Because we have no way of knowing, you get the fitting set for ALL of the distributors available. Basically you end up with a jar full of parts that you don't need to use! (Perhaps for your next car?)
Quite frankly, we are amazed that we can supply such a comprehensive kit for this price. To produce a kit that will adapt to the dozens of different distributors around is amazing!
Remember, once you have installed a breakerless system it will never wear out and that part of your system will remain in tune FOR EVER.
We expect this kit to sell well. To ensure that you receive one, check with us early!
Cat. KJ6655

WATCH FOR NEWS IN "ELECTRONICS AUSTRALIA" TO SHOW YOU HOW TO ADAPT THIS KIT TO YOUR TRANSISTOR ASSISTED IGNITION – SIMPLE!!

NEW 80CPS Matrix Printer

SAVE $100

ONLY $599

NORMALLY $699

Magnificent 80 Character/Second Matrix Printer! – WITH GRAPHICS CAPABILITY.
INCREDIBLE PRICE BREAKTHROUGH!!
We DARE you to compare with other units selling for well over $900!!
WHERE ELSE will you buy an 80 column (142 compressed mode) printer for under $700? Check the specs below and you must agree!!

FUNCTIONAL SPECIFICATIONS

Printing method:	Serial impact dot matrix
Printing format:	Alpha-numeric – 7 x 8 in 8 x 9 dot matrix field Semi-graphic (character graphic) – 7 x 8 dot matrix Bit image graphic – Vertical 8 dots parallel, horizontal 640 dots serial/line
Character size:	2.1mm (0.083") W x 2.4mm (0.09") H/7 x 8 dot matrix
Character set:	228 ASCII characters, Normal and Italic alpha-numeric fonts, symbols and semi-graphics
Printing speed.	80 CPS, 640 dots/line per second
Line feed time:	Approximately 200msec at 4.23mm (1/16") line feed
Printing direction:	Normal – Bidirectional, logic seeking Superscript and bit image graphics – Unidirectional, left to right
Dot graphics density:	Normal - 640 dots/190.5mm (7.5") line horizontal, Compressed characters – 1,280 dots/190mm (7.5") line horizontal
Line spacing:	Normal – 4.23mm (1/16") Programmable in increments of 0.35mm (1/72") and 0.118mm (1/216")
Columns/line:	Normal size – 80 columns Double width – 40 columns Compressed print – 142 columns Compressed/double width – 71 columns The above can be mixed in a line
Paper feed:	Adjustable sprocket feed and friction feed
Paper type:	Fanfold. Single sheet. Paper width – 101.6mm (4") to 254mm (10")
Number of copies:	Original plus 3 copies by normal thickness paper

MECHANICAL SPECIFICATIONS

Ribbon:	Cartridge ribbon (exclusive use), black
MTBF:	5 million lines (excluding print head life)
Print head life:	Approximately 30 million characters (replaceable)

INTERFACE SPECIFICATIONS

Interface:	Standard Centronics parallel
Data transfer rate.	4,000 CPS max.
Synchronization:	By external supplied $TROBE pulses
Handshaking.	By ACKNLG or BUSY signals
Logic level.'	Input data and all interface control signals are TTL level

SUPPLIED WITH 48 PAGE MANUAL
AND 13 DIFFERENT PRINTING MODES
e.g. normal, condensed, enlarged, emphasised, underlined, italic, etc. And remember – GRAPHICS as well!
CALL IN NOW FOR A DEMO!
Cat. YM2400

COMPUTER SENSATION!

SPECIFICATIONS

CPU		R6502
ROM		16K Bytes
RAM		64K Bytes
BASIC	Interpreter	More than 90 instructions stronger than those for Apple II
Video Display	Type	Memory mapped into system RAM
	Mode	Text, low-resolution graphics, high resolution graphics (3 modes are mixed)
	Screen Format	960 characters (24 lines, 40 columns)
	Character Set	Upper case ASCII, 64 characters
	Character Type	8 x 7 dot matrix
	Graphics Capability	1920 blocks (low resolution) in 40 x 48 array, 53760 dots (high resolution) in 280 x 192 array
	Number of Colors	8 colors
Keyboard		49 alphanumeric and function keys
Cassette	Interface	Use various cassette tapes and cartridges
Software	Cartridge Interface	as data storage units
Printer	Interface	Connects to printers with Centronics I/F
Display	Interface	Connects to color TV or video display
Remote	Control Paddle	Used for education & entertainment
Speaker		8 ohm, 55mm, 0.25W
Power		A switching power supply is provided to convert AC power to required power supply
Dimensions		241 x 178 x 30mm

* 64K OF RAM SUPPLIED STANDARD all that you are ever likely to need.
* Text, Lo and Hi resolution graphics STANDARD
* Video AND TV (RF) output STANDARD
* Easy-to-use manual included in the price (over 248 pages)
* Power supply included as STANDARD.
* Centronics printer interface STANDARD
* Multitech BASIC is compatible with APPLE II BASIC. Most APPLE software will run on the Micro Professor MkII

Only $499

MICRO–PROFESSOR II OUTSTANDING!

Low cost colour computer with APPLE compatibility*

Normally $658

SAVE $159

*Most Apple Soft II BASIC programs will run on the MPF II

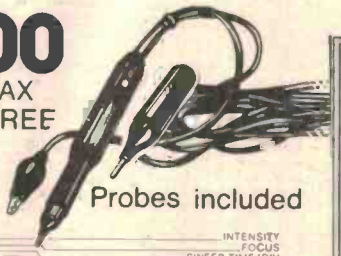
6 Colours

Cat. YC1300

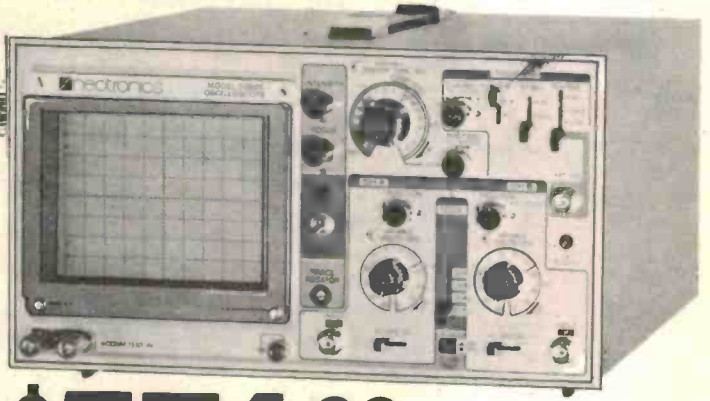
SEE PAGE 77 FOR JAYCAR ADDRESSES AND PHONE NUMBERS

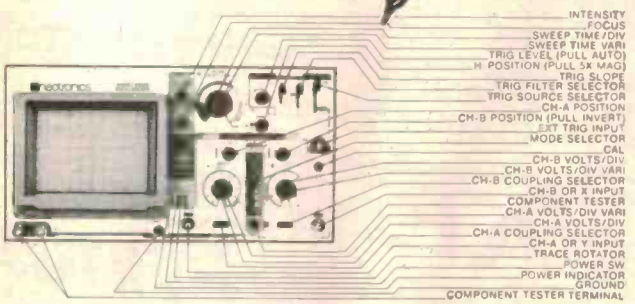
Need a CRO?
Check out Neotronics

$495.00 TAX FREE



Probes included





$571.30 INC. TAX

Virtually everyone involved in electronics needs an oscilloscope. The problem is that it's hard to get the performance you need at a price you can afford.

Introducing the Neotronics OS620. The OS620 is a powerful 20MHz dual trace 'scope with features and performance you'd never expect at the price.

Compare the features

- 150mm flat screen internal graticule screen.
- 2kV acceleration potential.
- 20MHz bandwidth on both channels.
- Inbuilt component tester tests resistors, capacitors, zeners, diodes as well as trouble shoot solid state circuits.

12 month warranty

Your Neotronics oscilloscope is covered by full parts and labour service for one year from date of purchase.

Probes included

The Neotronics OS620, includes two quality probes in the basic price. When you buy a Neotronics CRO, you buy a complete CRO.

Compare the value

Before you buy an oscilloscope, check it against the OS620 checklist. You'll find it hard to beat Neotronics for quality and price.

	OS620
20MHz bandwidth	☑
Flat screen CRT	☑
Internal graticule	☑
Component tester	☑
2 probes included in price	☑
Price including tax & two probes	$571.30

neotronics

FOR HIGH TECHNOLOGY ELECTRONICS

314 Lower Plateau Road, Avalon NSW 2107 Australia | PO Box 289, Newport NSW 2106. Phone: (02) 918 8220. Telex: AA 70842

DELIVERED ANYWHERE IN AUSTRALIA FOR $5.00

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

AMERICAN EXPRESS

bankcard

BUY DIRECT AND SAVE

Phone on the Hotline

(02) 918 8220

Avoid disappointment. Order your OS620 by Bankcard or American Express on the phone. Just call up, reverse the charges and we'll take your order. Shipping is only $5.00 anywhere in Australia – including packing and insurance.

LOW-DROPOUT DUAL VOLTAGE REGULATOR

National Semiconductor's linear products group has released the LM2935 low-dropout dual regulator, the first dual-output regulator of its kind to provide up to 750 mA.

The LM2935 regulator operates with extremely low input-output differentials (less than 0.6 V to 0.5 A) and maintains a low quiescent current of 3 mA or less when supplying 10 mA loads from the standby regulator output.

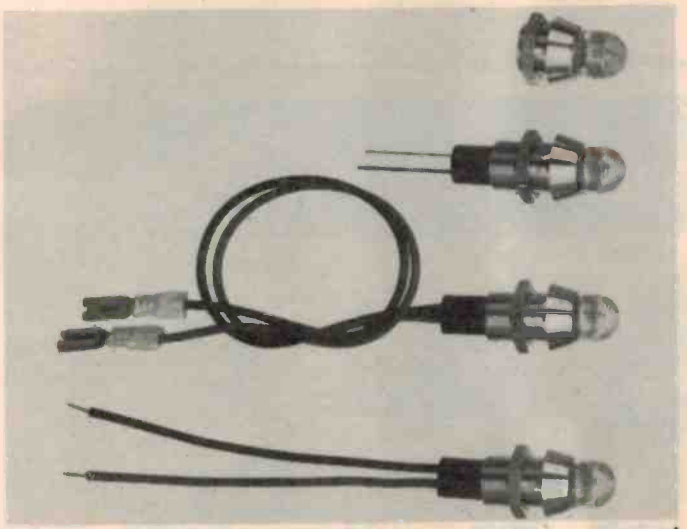
The LM2935 is equipped with two regulated 5 V outputs. The first output is capable of regulating 750 mA and the second provides standby low-current of 10 mA. The device has an on/off switch for the high-current output.

Other features include short-circuit protection and thermal overload protection.

Suited for applications in the automotive industry, the regulator safeguards against reverse battery installations and two-battery jumps, and provides 60 V load dump and −50 V reverse transient protection.

During line transients, the LM2935 will automatically shut down to protect both the internal circuit and the load while the standby regulator continues to power any standby load. The device cannot be harmed by temporary mirror-image insertion.

For more information, contact **National Semiconductor, Cnr Stud Road and Mountain Highway, Bayswater Vic. 3153. (03)729-6333.**



ULTRABRIGHT INDICATOR LAMP FROM SLOAN

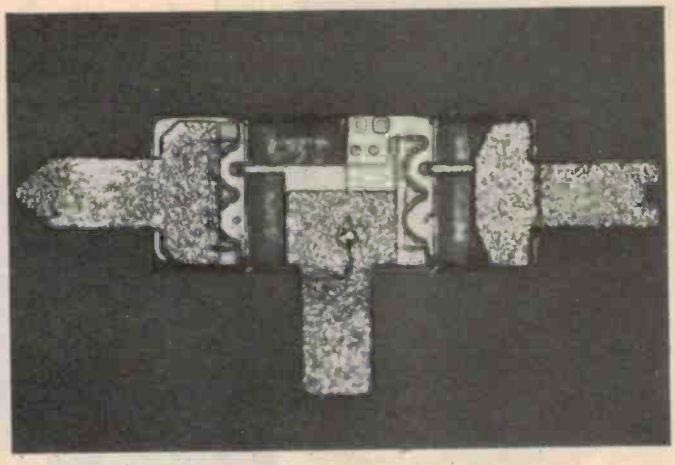
Sloan of Switzerland has released its new Series 176 indicator lamp range.

The indicator's front-panel presentation has a machined, chrome-plated body and bezel with high-dome plastic lens. The lens, designed with Fresnel Rings, allows 180° visibility and the ultrabright version offers brightness levels of up to 500 mcd.

The standard terminals are 0.6 mm square-section wire wrap, though insulated stranded-wire variations are available to customer specification.

The operating voltage is nominally about 1.7 V to 2 V; 'built-in' resistor versions can be obtained for a range of voltages from 5 V to 28 V.

For further information, contact **C&K Electronics, 15 Cowper Street, Parramatta NSW 2150. (02)635-0799.**



MICROWAVE SCHOTTKY BEAM LEADS IN PAIRS

Microwave Schottky beam leads in pair configuration, with a guaranteed maximum capacitance of 0.10 pf, are now being offered by Hewlett-Packard.

The low capacitance enables the designer to achieve a low-noise figure (7.0 dB maximum at 16 GHz) for systems operating at high frequencies.

The Hewlett-Packard beam leads utilise a tri-metallisation process that produces repeatable, reliable diodes capable of operating within a temperature range of −60 to +200°C.

Exceptional beam strength is achieved without sacrificing capacitance, using a glass-fill process that produces beam-pull results of six grams (typical).

Intended for use in balanced and double-balanced mixers, the HSCH-5500 series beam-lead pairs are designed to address the needs of the high-performance/high-frequency mixer marketplace.

Some typical applications include satellites, microwave receivers, EW wide-band signal processing and guidance control.

For more information, contact **Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn Vic. 3130. (03) 890-6351.**

HIGH-SPEED DIGITAL SPEED CONTROLLER

A new digital motor speed-controller circuit designed to maintain brushless three-phase dc motors at their required speed with an accuracy of 0.1%, and to bring them up to that speed at maximum torque, has been announced by LSI Computer Systems.

The circuit's voltage range is 10-28 V, covering the range of most popular brushless dc motors, such as those used in rotating memories.

The new chip, designated the LS7263, is optimised for motors operating at 3600 rpm when used with a 3.58 MHz crystal. By using a 2.6 MHz crystal, it can be used to control motors operating at 5400 rpm.

The chip is also mask programmable for a wide range of loads, speeds and motor drive characteristics.

The LS7263 is an ion-implanted PMOS integrated circuit in an 18-pin dual-in-line package. It is available in a plastic (0° to 70°C) or ceramic (−25 to +125°C) package.

For more details, contact **Daneva Australia, 66 Bay Road, Sandringham Vic. 3191. (03)598-5622.**

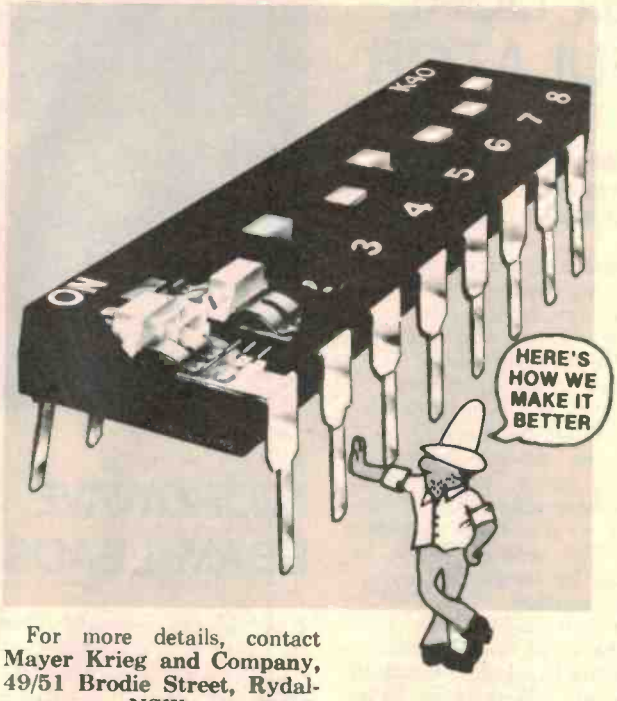
COMPACT DIP SWITCH

American Research and Engineering has incorporated three new patent designs, representing 40% less parts, into its eight-position K40 DIP switch.

The K40, which is the same size as an ic, has slide contacts that make a full wipe, aiding low-current contact.

The slides are split, with two separate slides for each contact point. This doubles the contact reliability, as there are two independent contacts at each switch point.

The slides are made from berylium copper, heat-tempered to a full hardness, spring-formed, plated in a 100 ml nickel bath and then spot gold-plated 30 ml deep at all contact points. All the switch contact surfaces on the main lead frame are plated with 30 ml gold and more than 50 ml nickel.



For more details, contact **Mayer Krieg and Company, 49/51 Brodie Street, Rydalmere NSW 2116. (02)684-1900.**

FAIRCHILD'S JK NEGATIVE FLIP-FLOPS

Fairchild's new 74F112 flip-flop contains two independent high-speed JK flip-flops with direct set and clear inputs.

Synchronous-state changes are initiated by the falling edge of the clock. Triggering occurs at a voltage level of the clock and is not directly related to the transition time.

The J and K inputs can change when the clock is in either state without affecting the flip-flop, provided they are in the desired state during the recommended setup-and-hold times relative to the falling edge of the clock.

For more details, contact **Fairchild Australia, 366 Whitehorse Road, Nunawading Vic. 3131. (03)877-5444.**

These compact three-way speakers are easy to build and provide a wide-range response

Since we published a number of economical hi-fi amplifiers over the past few years, we have had increasing requests for speakers to suit. With the cooperation of Dick Smith Electronics, here is a three-way design that is compact and gives good performance at an economical price.

Roger Harrison

NOT EVERYONE likes the loudspeakers of a stereo hi-fi system to dominate the loungeroom furniture. Indeed, 'bookshelf' and 'compact' loudspeakers have long been popular, particularly amongst those who live in units or townhouses. While these speakers are certainly compact, they aren't quite as small as many bookshelf models on the market. They stand two-thirds of a metre tall and measure a little over 300 mm wide by 230 mm deep overall.

Tiny bookshelf loudspeakers may have a significant drawback. It is extremely difficult to achieve reasonable bass response in a small cabinet. Since much popular music, and certainly much classical music, has a great deal of bass content, a bass response extending below 100 Hz is important.

Design aspects

This loudspeaker employs a 'pressure box' or 'infinite baffle' design. That is, the box is completely sealed. It is sometimes called an 'acoustic suspension' system, too. Such an enclosure prevents sound radiated from the front of the drivers being coupled to the sound radiated from the rear of the drivers and causing constructive and destructive interference which produces big peaks and dips in the frequency response.

Why use three drivers? Well, a loudspeaker of the type used here — that is, the moving coil type — will only operate over a limited frequency range where the cone acts as a 'piston'. Below a certain frequency, the area of the cone will not move enough air to create audible sound waves. At the other end of the range, the sound commences to travel out *along* the cone, which no longer acts as a piston and the sound output drops off because compression and rarefraction waves are generated which tend to cancel each other.

Ideally, in designing a loudspeaker, any driver should be used only over its 'piston operating range'. The problem is, all but the most expensive and/or specially constructed drivers only have a piston operating range of three to four octaves (an octave is a 2:1 frequency range). You can use a driver over a greater range if some compromises are accepted — otherwise you'd end up with a speaker having five drivers to cover the 10 octaves of the audio spectrum! Expensive.

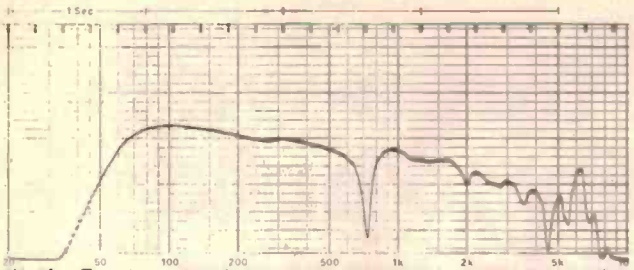
A popular technique is to use three drivers (hence 'three-way'); one to cover the bass end (the 'woofer') below 1 kHz, one to cover the mid-range from 1 kHz to 4 kHz or 5 kHz and one (usually called the 'tweeter') to cover the top end above that. Acknowledging that the most sensitive portion of the ear's frequency response is in the mid-range, three-way designs generally concentrate on using the mid-range driver over its piston operating range and accepting compromise operation with the other two drivers. That's what has been done with this project — and it achieves quite an acceptable result.

The bass response in a pressure box design is very dependant on the internal volume of the box. The bass driver, the air contained within the box, and the box's volume and shape all interact in a very complex way and it's a bit of a juggling act to make the best of things.

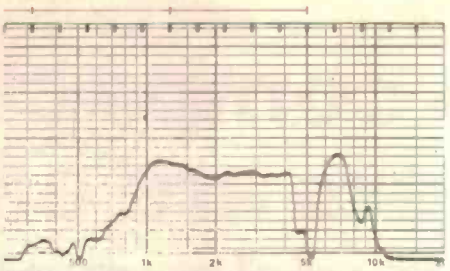
Basically, a sealed box with a driver in it acts like a high-pass filter. That is, the frequency response drops off rapidly below a certain frequency — the 'rolloff' or the 'corner' frequency. The greater the internal volume of the box, the lower the corner

NOMINAL SPECIFICATIONS ETI-421 3-WAY SPEAKERS

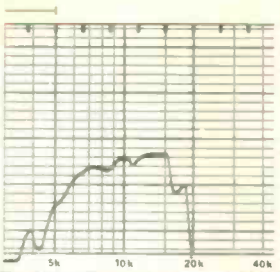
Nominal impedance	8 ohms
Frequency response	45 Hz to 17 kHz (−6 dB) 45 Hz to 19 kHz (−10 dB)
Nominal power handling	40 watts
Box volume	30 litres



Woofer. The piston operating range extends over at least three octaves. The 'dip' near 700 Hz does not show up in the overall response. Vertical scale: 1 dB/increment.



Mid-range. Its piston operating range extends from about 1 kHz to about 4.5 kHz.



Tweeter. This shows reasonable response from about 5-15 kHz.

frequency — and vice versa. But there's a limit to the size of the speaker enclosure that "... s/he who must be obeyed" will accept in the loungeroom. Another compromise — but this one's easy to satisfy and still get good bass response.

The enclosure dimensions settled on for this project result in quite a compact box having an internal volume of near as damn to 30 litres which, together with the 200 mm bass driver selected, delivers a bass end which extends to 60 Hz. Not a bad result. Many compact and bookshelf speakers barely make it to 100 Hz.

The mid-range and tweeter both have a sealed rear so that sound pressure inside the box, from the bass driver, does not interfere with their operation.

The piston operating range of the mid-range driver chosen appears to extend from about 1 kHz to 4.5 kHz or thereabouts. Hence, this determines where the operation of the other two drivers has to 'cross-over', from bass to mid-range and mid-range to tweeter. A filter system is used to effect this, rather than just connecting all the drivers in parallel. This filter is called the 'crossover network'.

The response of the bass driver is 'roled off' at the frequency where you want it to cross-over into the mid-range. Thus, a low pass filter is employed. In this case, a simple inductor (L2) has been used connected in series with the bass driver. A series capacitor (C2) 'rolls in' the mid-range in the same region. A simple inductor-capacitor high pass filter (L1-C1) rolls in the tweeter at around 4.5 kHz.

A fairly simple crossover network like this avoids difficulties with phase response and driver-network interactions, resulting in no 'little surprises' in the general response of the loudspeaker.

The resistors connected to the mid-range and tweeter are there to attenuate their output levels so that the three drivers have generally equal output. The mid-range and tweeter are more sensitive than the bass driver employed.

The capacitors used are 'bipolar' electrolytic types. That is, they are manufactured so that they are not polarised — no positive or negative terminal. This allows them to be used in purely ac applications.

Construction

The box supplied by Dick Smith Electronics is generally constructed of 15 mm chipboard with a base made from 18 mm chipboard — the base is likely to take more punishment during handling! The outside faces are covered in plastic wood veneer. The front panel, with the three cutouts for mounting the drivers, is set flush with the front of the cabinet and the front surface is covered in black vinyl, for appearance's sake.

Four 'sockets' are set into the front panel near the corners. The grille cloth is stretched over a polycarbonate moulding which has four pins projecting from the rear that set into the sockets on the front panel, providing a simple, yet effective, method of securing the front grille.

The rear panel is recessed slightly. The crossover network pc board is screwed on the inside to this and speaker connecting terminals pass through from the outer rear.

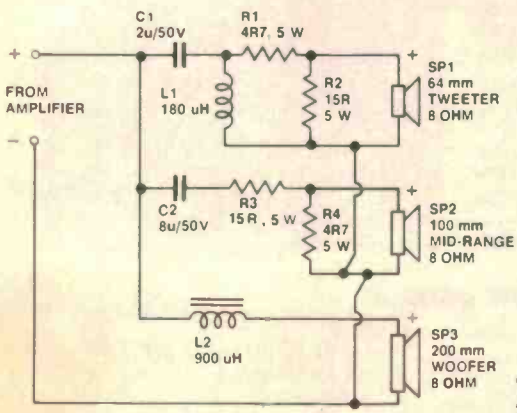
As Dick Smith Electronics will be providing precut box panels, construction is quite simple. Fold the top-bottom-side panels around the rear panel, running generous quantities of PVA glue (Aquadhere, or similar) in the folds as you go. Position the rear panel so that it's recessed about 10 mm (not critical) from the rear of the box and run a bead of glue around the joint on the *inside* of the cabinet. Small 'chocks' are used to strengthen the rear panel and these should be positioned around the joint on all four sides and thoroughly glued in place. Lay the box on its back to do this and leave it there while the glue cures.

When the box is ready to handle again, take some sealing or caulking compound (Silastic is very good) and run a bead around all the joints. All joints must be

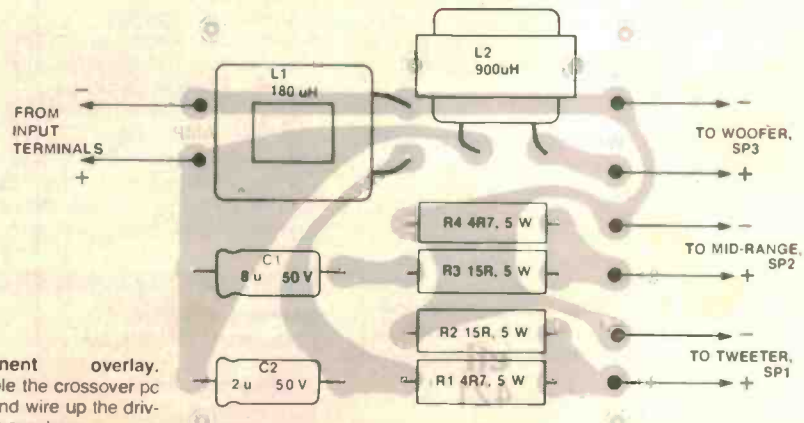
PARTS LIST ETI-421

Resistors	all 5 W, 10%
R1, R4	4R7
R2, R3	15R
Capacitors	
C1	2u/50 V non-polarised electro.
C2	8u/50 V non-polarised electro.
Inductors	
L1	180 uH air-cored
L2	900 uH iron-cored, open-end
Miscellaneous	
SP1	8 ohm, 64 mm tweeter (parg of D.S.E. C-2046)
SP2	8 ohm 100 mm mid-range (part of D.S.E. C-2046)
SP3	8 ohm 200 mm woofer (part of D.S.E. C-2046)

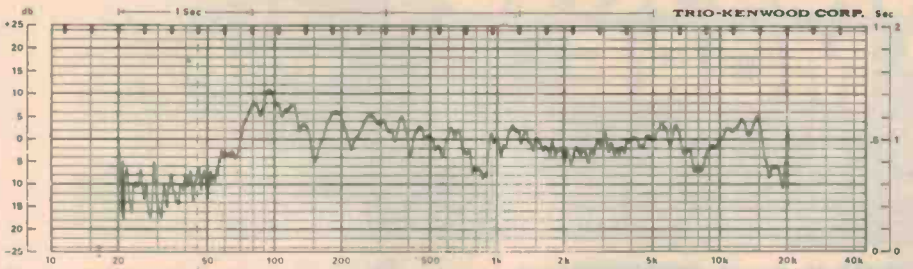
ETI-421 pc board for crossover; box to dimensions in drawings; speaker terminals; wire, speaker box lining, etc.



Circuit. How the drivers and crossover are connected.



Component overlay. Assemble the crossover pc board and wire up the drivers as shown here.



The result. No speaker has a truly 'flat' response and this speaker is no exception! But, the result is very good, achieving a frequency response from 45 Hz to 17 kHz (−6 dB from average).

airtight if the pressure box is to work properly.

Now, run a generous amount of glue around the rabbet at the front of the box, where the front panel will set in. Make sure it's generous as this will have to seal the front panel. Run more glue around the edges of the front panel and then set it in place. Wipe off any excess glue that may be on the outside faces of the box. Allow the glue to cure before proceeding.

Stand the box on its top and assemble the base, carefully gluing it in place. Run the glue on the mating surfaces of the base pieces. Leave the box while the glue cures.

Now for the crossover. This is assembled on a small pc board. The overlay diagram shows the general layout. It can be constructed in any order, but I'd suggest you start by mounting the resistors and capacitors first. Stand the resistors a few millimetres off the board so that heat can escape. The resistors will sure get hot at party time!

Mount the inductors last of all. Both are supplied prewound. The 900 uH inductor has a set of 'E' laminations to obtain the inductance required on the small bobbin. This inductor is secured to the board passing the lugs through two holes drilled in the board for them, and bending over them at the rear. The other inductor is simply wound on a bobbin which can be glued to the board in the place indicated.

Solder pc stakes in place for terminating the input and speaker wires.

Now, back to the cabinets. The speaker terminals need to be mounted. Two holes are drilled in the rear of the cabinet somewhere near the middle. The lugs of the speaker terminals will pass through these. But first, solder a 400 mm length of *red* insulated hookup wire (heavy duty, 24 x 0.2 mm, wire is best) to the terminal marked with a *red spot*. This is the "positive" terminal (marked with a plus on the circuit). Solder a 400 mm length of *black* insulated hookup wire to the other terminal.

Pass the wires almost right through the holes in the cabinet rear and then put caulking compound in the holes to seal them. Press the terminal strip in place and screw it down. Go to the inside of the cabinet and caulk the holes again just to be sure.

Wires should now be soldered to each driver. Use heavy duty hookup wire (24 x 0.2 mm, at least). Each driver will have the positive terminal marked in some way — maybe with a '+', with a red spot or with a red-coloured insulating washer. Attach a 400 mm length of *black* insulated hookup wire to each driver's negative terminal. Then, attach a 400 mm length of coloured wire to each driver's positive terminal — using a different colour for each driver (say, white for the tweeter, yellow for the mid-range and blue for the woofer).

Next, place the crossover pc board on the inside of the rear panel, opposite the woofer's hole (it's easier to get at through the large hole). Screw it in place. Solder the input wires to the two input terminals on the board. *Be careful to observe the correct polarity.* Place each driver on the front face, adjacent to its mounting hole. Pass the wires from each driver, through its mounting hole, and solder them to their respective terminations on the crossover board. Be careful, once again, to *observe correct polarity.*

Now, completely stuff the inside of the cabinet with innerbond.

Before screwing each driver in place, attach adhesive foam tape (available from hardware stores, used for sealing cupboards, etc) around the lip of each driver hole so that a good seal is made. Then screw the drivers in place.

Powering up

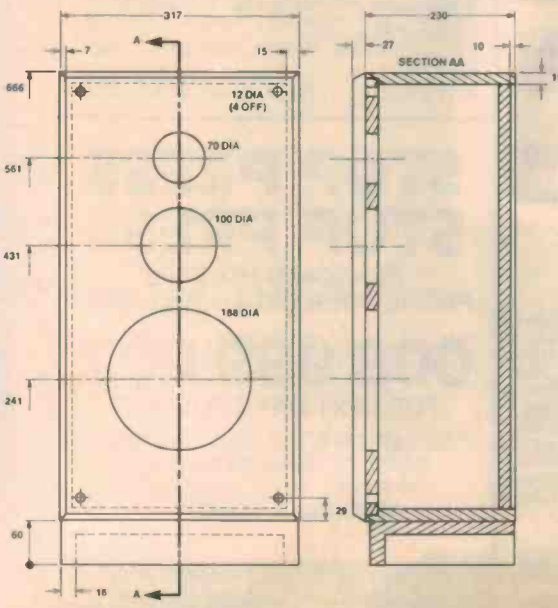
Before connecting the speakers to an amplifier, take a *single* 1.5 V cell and briefly touch its terminals to each speaker's input terminals — positive to the terminal marked with a red spot. The woofer cone should move *forward* as you do this, and the loudspeaker should make a loud thump. *Do not* use a battery any larger than a 1.5 V cell for this test or you could damage the woofer.

If all is well, connected the speakers to an amplifier, select your favourite record or tape, turn the volume up slowly and sit back and enjoy the satisfaction of having built your own speakers!

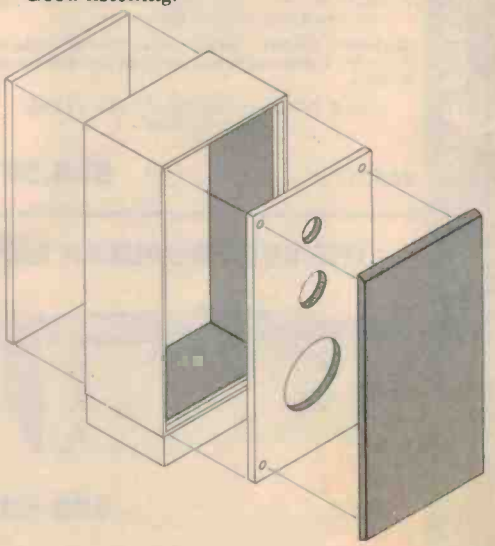
A word of caution. These speakers should be able to comfortably handle 40 W of power. This is not a peak rating. In fact, transients up to 100 W should cause no ill effects. The most dangerous condition for using any speaker is when the amplifier is clipping heavily. Under these conditions, the amplifier's output approaches dc and even a 20 W amp is capable of doing irreparable damage if clipping operation is prolonged.

For safety's sake (and to save the expense of replacing drivers), you might add our Signal-Powered Loudspeaker Protector, ETI-494, published in the October 1982 issue. This will protect your speakers from both overpower abuse and from amplifier faults that might apply dc to the speakers.

Good listening.



Cabinet details. All the cabinet dimensions are shown on the left and an exploded view of the assembly is shown at right. Dick Smith Electronics supplies precut panels with kits, which makes the assembly job a breeze. The front grille is an open weave black cloth stretched over a polycarbonate frame.



ALTRONICS KITS COST MORE

[Around $1 more]

REASONS ★ PREMIUM COMPONENTS USED eg. MOTOROLA, FAIRCHILD etc. ★ QUALITY INSTRUMENT CASES SUPPLIED WHERE INDICATED ★ EVERY LAST NUT AND BOLT SUPPLIED, EVEN SOLDER ★ IC SOCKETS SUPPLIED WHERE INDICATED.

Your finished product will look so good your friends won't believe you built it.

PROTECT YOUR VALUABLE CAR AND CONTENTS

CURRENT TRIP CAR ALARM

Exit / entry delay
No false alarms
State of the Art
Design by ETI

Protect Your Valuable Car and Contents

Circuit detects minutest voltage drop across vehicle's battery earth strap, tripping the alarm * uses Milspec LM394 * Quality diecast box * genuine fujitsu relay * automatic reset after pre set time period * installs in minutes * includes dash mounting LED flashes to deter thieves.

K4330..... **$29.50**

CAR ALARM ETI 084

A staggering number of cars are stolen each year. Install an Altronics Alarm Kit and yours won't be one of them.

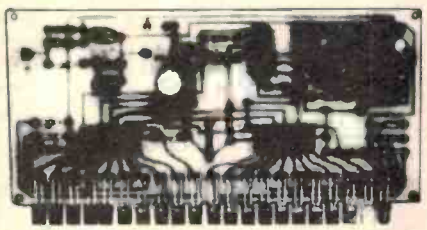
Circuit operates by detection of voltage drops in the electrical system and features a flashing LED for dash mounting as a deterrent to would be vandals and thieves.

K4084..... **$12.00**

MONITOR AND IMPROVE VEHICLE PERFORMANCE

TWIN RANGE LED TACHO

(SEE ETI AUGUST 1980)



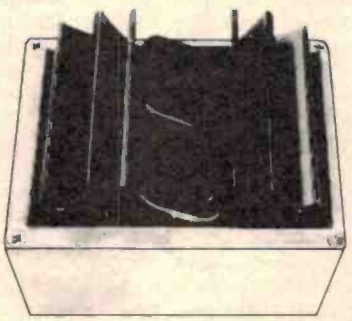
Unit suitable for 1, 2, 3, 4, 6 and 8 cylinder vehicles, 2 stroke or 4 stroke * fully compatible with conventional, CDI and transistorized ignition systems * includes protection circuitry to prevent noise and high voltage spikes from the points and coil circuit damaging the electronics. *

Display flashes when over-reving occurs * only 3 connections required to electrical system.

Check The Performance of Your Vehicle At A Glance!

K4324..... **$24.50**

TRANSISTOR ASSISTED IGNITION WITH DWELL EXTENSION

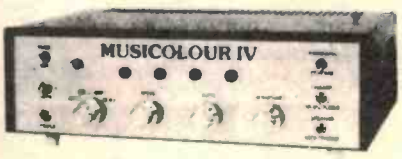


The Altronics Kit includes all components for the modifications, detailed by Electronics Australia Feb. 1983.

Yes, it's bad enough paying $2.00 a gallon for petrol without wasting a fortune on an out of tune engine. Fit this transistor assisted ignition kit in minutes and start saving money from the very next petrol stop. Easy to build!

K4010..... **$35.00**

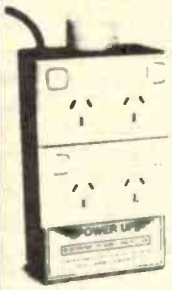
THE EVER POPULAR MUSICOLOUR IV EA PROJECT



Combination Colour Organ and Light Chaser. Four channel colour organ. Internal microphone or connect to speakers for colour organ operation. (The lights connected to each channel pulse in beat to the music proportional to portion of frequency spectrum concerned.) Four chaser modes forward and reverse. Output lamp load capacity a massive 2400 watts — that's 100 party globes. Full instructions and every last nut and bolt included. Great for parties, shop signs, display windows etc.

K5800..... **$89.50**

See EA November, 1982



POWER UP

A MUST FOR YOUR COMPUTER SYSTEM

This great new Project from EA is the answer to a Maidens Prayer.

What Does it Do?

A single 240v mains plug and lead feeds one unswitched master 240v outlet plus 4 switched 240v outlets. With say a hi-fi system, plug your main equipment item (e.g. Amp) into the master outlet and whenever you "switch on" your amp — presto — mains power is applied to the other 4 outlets i.e. simply "turning on" your amp turns on your tape cassette, tuner, turntable, graphic equaliser without mains spikes, plops etc.

Just the shot for your Computer System. The Altronics Kit includes case and all outlets.

K6000..... **$39.50**

MICROWAVE OVEN LEAK DETECTOR

ETI PROJECT

Completely passive project receives microwaves via an antenna which develops a voltage across a detector diode driving the meter.

Monitor your microwave oven with this easy to build kit. All components mount on single PCB, including the meter.

Genuine Hewlett Packard Hot Carrier Diode supplied.

K1724..... (still only) **$14.50**

STOP PRESS STOP PRESS

BANKCARD HOLDERS PHONE YOUR ORDER TOLL FREE

008 999 007

FOR NEXT DAY DELIVERY*

*All Capital Cities and Suburbs — Country areas allow extra 24 hours. Offer applies to Altronics JET SERVICE.

• FOR DESPATCH P&P CHARGES AND ADDRESS DETAILS PLEASE REFER TO OUR AD. ON PAGE 57 •

DIRECT IMPORT PRICES

AMAZING ACCURACY AT A LOW PRICE!

That's the Sabtronics

600MHz FREQUENCY COUNTER

This American -developed Sabtronics 9 digit 600MHz Frequency Counter is a top quality instrument with more features and better accuracy than any other comparable unit on the market today. And it costs surprisingly less! Just look at the features.

Features:

- 9 digit resolution for more precise readings
- Excellent 30mV sensitivity up to 600MHz
- 3 position switch-selectable gate times
- 10MHz crystal controlled time base for great accuracy
- 2 separate inputs for added versatility
- Front panel sensitivity control

Cat Q-1300 **$225.00**

SAVE AROUND $10 ON COMPARABLE UNITS

the exclusive Dick Smith

Solder station

Cat T-2000

If you're serious about good soldering, there is only one way to do it - with a temperature controlled soldering iron. Until now, temperature controlled irons have been expensive. But Dick Smith Electronics has solved the problem! The Dick Smith Auto Temp offers you the best quality at an unbelievably low price. Compare our soldering station with others: Ours features fully variable temperature control (from around 200 degrees to over 500 degrees Celsius) with a temperature meter to show you what's happening. The station comes complete with lightweight iron, iron holder and cleaning sponge, with a comprehensive instruction manual with full servicing information included - just in case you need it. And the price of this superb unit?

VALUE AT ONLY $69.00

ELECTRICITY AUTHORITY APPROVED TRANSFORMERS

Dick Smith Power Transformers are tested and approved to the stringent Australian standard AS3126 and the materials used in them to AS3100. Don't take chances with non-approved transformers: your life could depend on it!

DSE-0144
Now for the big guns! Over 100VA rating with 28V per side @ 2A. Great for amplifiers.
Cat M-0144
$29.95

DSE-0150
And the really big guns: 300VA with 2 x 47V @ 3A windings, 2 x 15V @ 0.5A – for high power amplifiers AND you get the preamp voltages too!
Cat M-0150
$49.95 VALUE

DSE-2155
The handiest transformer for the hobbyist. With 6 taps between 6.3 and 15V an incredible 21 different voltages are available – including two centre tapped! As used in countless magazine projects. max sec current 1A.
6.3, 7.5, 8.5, 9.5, 12, & 15V @ 1A.
Cat M-2155
$5.90 VALUE

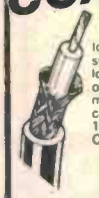
DSE-6672
The second handiest! Slightly higher voltages, with 6 taps between 15V & 30V @ 1A.
15, 17.5V, 20, 24, 27.5, & 30V.
20 different voltage combinations
Cat M-6672
$7.60 VALUE

TOP QUALITY MULTICORE SOLDER

1.25mm (18g) 200 grams Cat N-1619 **$5.50**
0.71mm (22g) 200 grams Cat N-1623 **$5.50**

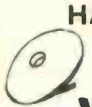
LOW LOSS HEAVY DUTY COAX

50 ohm
UR67
RG8U



Ideal for long run feeder systems due to its very low loss. Ensures maximum operating range of transmitters. Insulation is coloured black and has a 10mm diameter.
Cat W-2095
$1.75

HAVE YOU TRIED DICK WICK?



Known to one and all as the 'Dick Wick', this is a specially treated copper braid that is used to remove solder from the PC board by capillary action.
Cat N-1682
ONLY $2.45

DICKS ENERGY+ PLUS WHY PAY MORE?

GREAT VALUE PANEL METERS

A high quality range of moving coil meters with a full scale accuracy better than 2%. Pre-calibrated and easily adapted to suit virtually any requirement with shunts and body matte black. All meters have a fine needle for optimum accuracy in reading, and all have mechanical zero adjustment. Mounting is by four bolts (mounted on meter body with nuts and washers supplied).

0-20V (100 ohms)
Cat Q-2040
ONLY $9.95

FULLY APPROVED 9V DC Power Supply

Extra high power – ideal for 9 volt equipment which needs more than the low power-plug packs can provide. (such as cassette recorders etc.)
Cat M-9560
$15.25

Alkaline Long Life

Dick's own long life quality made in Japan and guaranteed fresh as a daisy! Come in blister packs of two batteries and look at our bargain price!
Cat S-3281
$1.50 PACK TWO

OR SHOP FROM THE COMFORT OF YOUR ARMCHAIR

WITH OUR LIGHTNING FAST, FULLY COMPUTERISED, NEW MAIL ORDER SYSTEM.

JUST CALL
(02) 888 2105

Just quote your Bankcard No. & tell us your requirements, we will do the rest!

DICK SMITH Electronics

INCORPORATED IN NSW

Also in Auckland, New Zealand. Re-Sellers across Australia & N.Z.

Check with local store for store hours.

Any terms offered are to approved, personal applicants through HFC Finance. Terms not available by Mail Order

bankcard welcome here

1000's of enthusiasts rely on the

DICK SMITH Variable Power Supply

A very popular power supply that features a variable voltage range from 5V to 15V DC. The current ratings are 2 amps continuous, 3 amps short term or 4 amps peak pulse. Also included is a current limit protection switch with two positions: over two amps with the switch on, and just over 4 amps with the switch off.
Cat M-9546

$67.50

SAVE ON BATTERIES

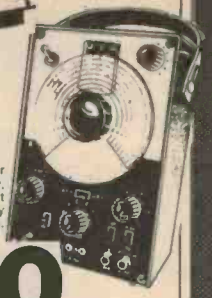
9V DC Power Supply

For all equipment requiring 9V DC transistor type battery. Eliminator module simply plugs into a 240V AC power point.
Cat M-9514

$6.30

TWO INSTRUMENTS IN ONE!

AF/RF Signal Generator



Two instruments in one! This new wideband signal generator is ideal for the service technician, developmental laboratory, the amateur and hobbyist. Solid state compact and lightweight it gives you a selectable sinewave or squarewave at any frequency from 18Hz to 200MHz. Supplied with coax cable.

Frequency	18Hz to 220MHz
AF section	18Hz to 220kHz, sine or square.
Output	Sine 10V P-P, Square 4V P-P
RF section	100kHz to 50MHz
Range	On 6 fundamental bands, 50MHz to 200MHz on harmonics

Cat Q-1305

$160

WHAT A PERFORMANCE

PIEZO TWEETER

We don't have to tell you the advantages of piezo tweeters. But you'd expect to pay $10 or more for a good un. Here's a beauty: $$$ less than normal! The supplier need the money – so we bought them for a song. Figaro. Figaro.
Cat C-2006

$6.95

HURRY! SOME STOCKS LIMITED!

Large UB1 - (50 x 90 x 150mm) Cat H-2751 **$2.80**

Giant UB2 - (60 x 113 x 196mm) Cat H-2752 **$3.99**

DICK'S ZIPPIES ORIGINAL & BEST!

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 from Dick Smith!

STOCK UP & SAVE

BNC LINE PLUG

Want to make up a cable for your VCR? A lot of them use BNC plugs for sure connection! This line plug is easy to connect, suits both 50 & 75 ohm systems.

$2.75 Cat P-2210

'D' Type Plug and Socket

25 pin plug and socket for RS232C port and Sorcerer parallel port.
PLUG - Cat P-2690 **$3.95**
SOCKET - Cat P-2691 **$4.75**

SCOPE PRO-QUALITY

Superspeed Iron

This iron has a huge 150watt capacity with features only found on the more expensive irons. Supplies heat in an amazing 6 seconds. Stainless steel non corrosive barrel. Comes complete with spare tip and element, great for any serviceman or hobbyist!
Cat T-1605

$29.95

SCOPE

MINI SCOPE

Great for servicing PC boards etc. Has all the advantages of bigger irons and its small size makes it easier to handle. Finger tip control of wattage and tip temperature. Complete with spare tip element.
Cat T-1660
VALUE AT ONLY **$34.50**

SOLDER SUCKER

A rugged all metal construction solder sucker complete with Teflon tip and a nozzle sweeper as well. A top quality import from Dick Smith.
Cat T-2580
TOP QUALITY IMPORT

WAS $13.50
NOW **$9.95**

URGENT PRODUCT SAFETY NOTICE

RE: High Resolution Green Screen Monitors Cat X-1200 'BMC' Brand, units marked with code BM12ES only (marking on identification plate on rear of monitor).

We have been advised that wiring in a small number of these monitors could develop a fault which, in conjunction with incorrect mains power point wiring could make them potentially dangerous.

If you have purchased a monitor as described above please return it to the point of purchase where a free safety examination will be made and, if necessary, arrangements will be made for modification. ONLY monitors with code BM12ES on the rear panel are affected.

CANNON 3 PIN PLUGS & SOCKETS

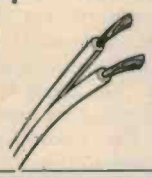
Mains Rated! Don't take chances with mains! If you haven't got room for normal 3 pin plugs/sockets, these genuine Cannon brand fittings are the ONLY safe way to go!
LINE PLUG Cat P-1627 **$6.95**
PANEL SOCKET Cat P-1630 **$5.95**

SAVE A FORTUNE

Rainbow Cable

12 colour coded strands of insulated conductor bonded together in a flat cable. Ideal for wiring looms or intercoms etc. Can be laid under carpets. Can be split and the individual wires used.
Cat W-2045

ONLY **90¢**



Speaker Cable

Ideal cable for use with Hi Fi systems for speaker connections or with intercoms. Twin plastic insulated conductors, insulation marked with a trace to keep speakers correctly polarised.
Cat W-2010

NOW **18¢**

YOU REAP THE BENEFIT!

FM HANDHELD WIRELESS MIC

Elegant styling and powerfull performance make this mic excellent value. Telescopic antenna supplied.
Cat C-1070
ONLY **$24.50**

TOP VALUE METAL FILM PACK

Our new 1% metal film types in a new computer selected pack. Great value!!!
Cat R-7015
WAS $21.00
$9.95

HEAD OFFICE AND MAIL ORDER CENTRE: P. O. Box 321 NORTH RYDE 2113. TEL (02) 888 3200. TELEX AA20036. CABLES 'DISKMIT' SYDNEY.

NSW	Parramatta Rd & Melton St	AUBURN	648 0558
	155 Terrace Level	BANKST. SQ.	707 4888
	613 Princes Hwy	BLAKEHURST	546 7744
	Oxford & Adelaide Sts	BONDI JUNCT.	387 1444
	818 George St	BROADWAY	211 3777
	531 Pittwater Rd	BROOKVALE	93 0441
	147 Hume Hwy	CHULLORA	642 8922
	162 Pacific Hwy	GORE HILL	439 5311
	315 Mann St	GOSFORD	25 0235
	Elizabeth Dr & Bathurst St	LIVERPOOL	600 9888
	Lane Cove & Waterloo Rds	NORTH RYDE	88 3855
	George & Smith Sts "The Gateway" Shop 1c	PARRAMATTA	689 2188
	4 Florence St	HORNSBY	477 6516
NSW	Cnr High & Henry Sts	PENRITH	32 3400
	6 Bridge St	SYDNEY	27 5051
	125 York St	SYDNEY	267 9111
	Tamworth Arc & Kable Ave	TAMWORTH	66 1961
	173 Maitland Rd	TIGHES HILL	61 1896
	263 Kiera St	WOLLONGONG	28 3800
ACT	96 Gladstone St	FYSHWICK	80 4944
VIC	260 Sydney Rd	COBURG	383 4455
	Nepean Hwy & Ross Smith Ave	FRANKSTON	783 9144
VIC	205 Melbourne Rd	GEELONG	78 6766
	399 Lonsdale St	MELBOURNE	67 9834
	Bridge Rd & The Boulevarde	RICHMOND	428 1614
	Springvale & Dandenong Rds	SPRINGVALE	547 0522
QLD	293 Adelaide St	BRISBANE	229 9377
	166 Logan Rd	BURANDA	391 6233
	Gympie & Hamilton Rds	CHERMSIDE	359 6255
	Bowen & Ruthven Sts	TOOWOOMBA	38 4300
	Ingham Rd & Cowley St West End	TOWNSVILLE	72 5722
SA	Wright & Market Sts	ADELAIDE	212 1962
	Main South & Flagstaff Rds	DARLINGTON	298 8977
	Main North Rd & Darlington St	ENFIELD	260 6088
WA	Wharf St & Albany Hwy	CANNINGTON	451 8666
	William St & Robinson Ave	PERTH	328 6944
	Centreway Arc. Hay St	PERTH	321 4357
TAS	25 Barrack St	HOBART	31 0800

Project 736

Print weather maps with your Microbee using our "picture plucker" facsimile decoder

Be the first on your block to have your own weather maps! This project allows you to decode the signals of shortwave stations transmitting 'radio facsimile' weather maps and satellite pictures and then reproduce them on your dot-matrix printer.

Tom Moffat VK7TM
39 Pillinger Drive, Fern Tree, Tasmania 7101

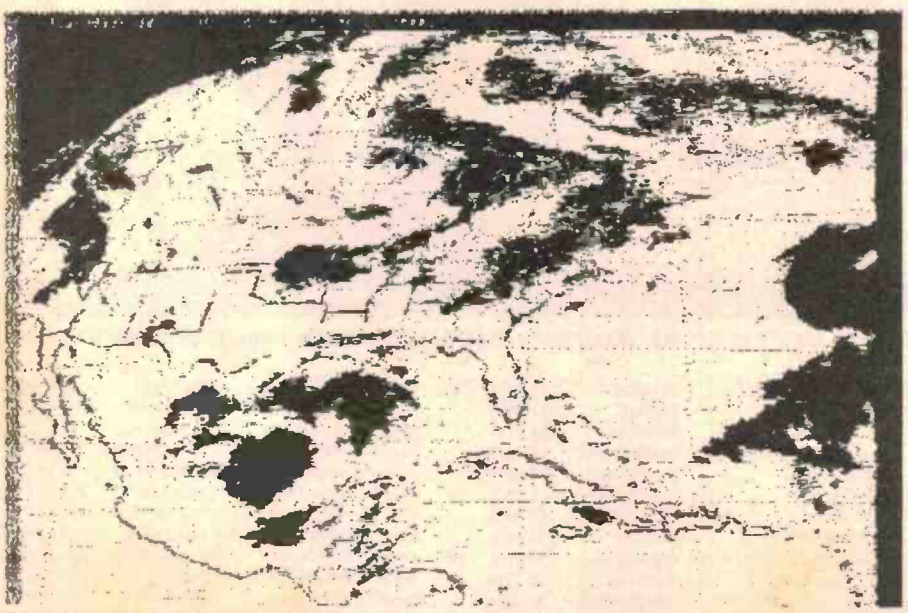
MAY 29, 1983, was the day the drought well and truly broke in Tasmania. The rain poured down from dawn till dusk. The roof leaked and the lawns became mudholes. The farmers rejoiced and everyone else grizzled about their ruined weekend. If they'd had some weather charts they could have grizzled with more authority ... the charts told the whole story in graphic detail!

The accompanying series of charts was received on an ordinary home-style shortwave receiver, a Drake SSR-1 to be exact. The audio was processed by a phase-locked loop decoder and a Microbee computer into graphics print data which was fed to a C-ITOH 8510 printer.

The transmission process is called 'fascimile', which we'll call 'fax' for short. Now I've spelled *that* once, I won't do it any more times. Let's call it *fax*, like the cogniscenti do.

As far as I know this is the first time the world of fax has been opened to the electronics-computing enthusiast. The secret, of course, is the computer.

Traditional fax methods are mostly mechanical, and to home-brew a decent fax machine would require access to a lathe and a lot of time and trouble. They appear to be non-existent on the disposals market. The mechanical fax systems now in use are so well made they seem to last forever. Maybe, when more electronic systems appear ... but we're getting ahead of ourselves. Before we go much further we'd better get down to the bare fax.



Believe it or not. Believe it or not, satellite pictures too! (See later.)

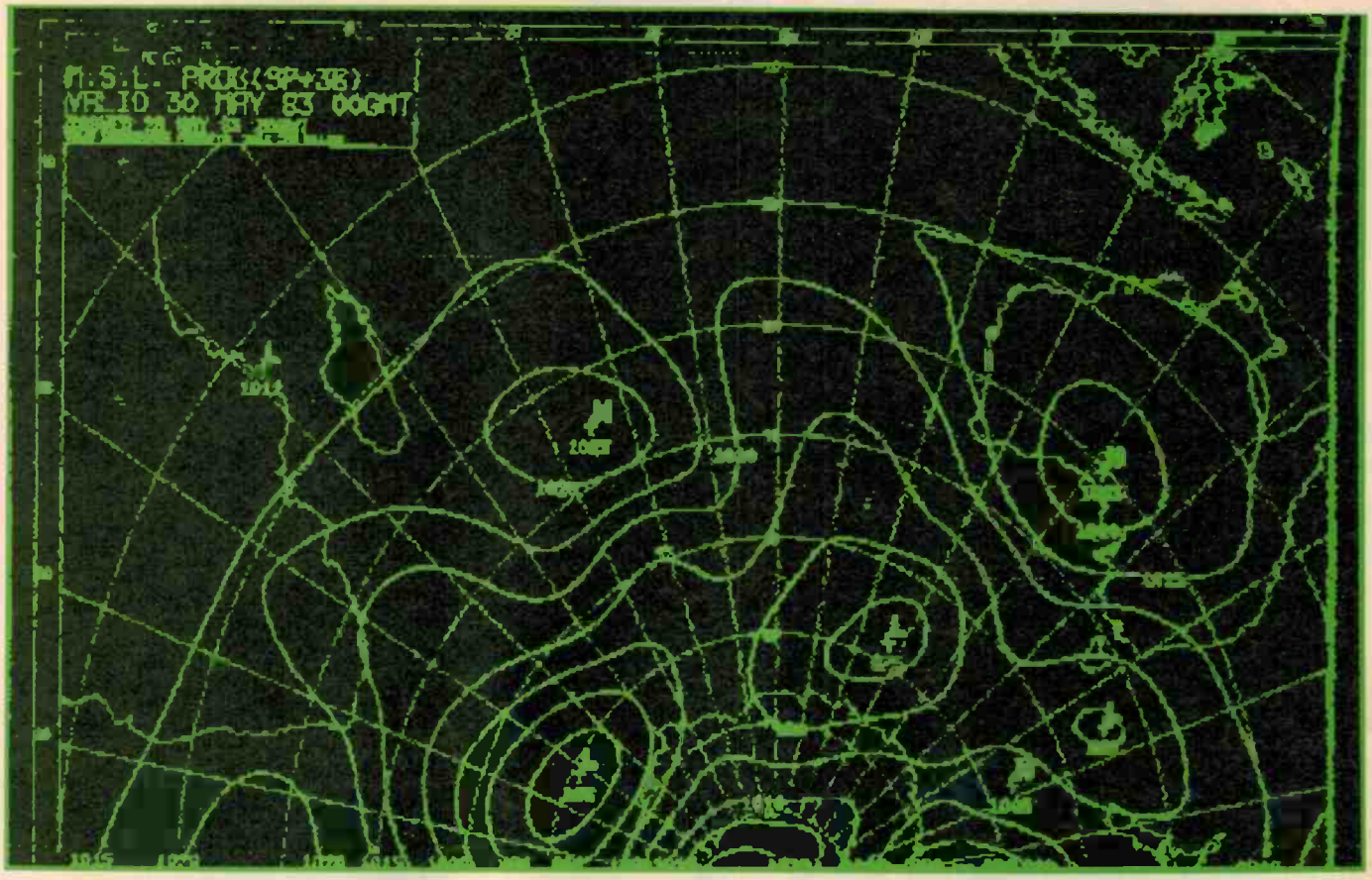
Facsimile explained

The object is to send pictures over a distance. Written data can be transmitted by teletype, but for pictures, or written data in one's own handwriting (such as signatures), fax is the only way to go. Fax is really *veeerry slooowww* television. If the data rate is slow enough you can squeeze an extremely sharp and detailed picture through the restricted bandwidth of a telephone line, or a radio transmitter. Television delivers a complete picture in 1/25th of a second. Fax can take more than 20 minutes for one picture.

Both television and fax work on a system of scanning lines; only the speed of the scanning and the density of the lines is different. Television, with its wide bandwith of 5 MHz or so, is restricted to the line-of-sight coverage of VHF. But since narrowband fax can be transmitted on HF, the range is world-wide, and it makes for some interesting viewing.

The traditional method of fax transmission is shown in a much simplified form in Figure 1. The system consists of two metal drums, one at the transmitter and the other at the receiving end. The two drums are rotating at (hopefully) the same speed. Near the top of the transmitting drum is a lamp illuminating the whole surface.

Above the drum is a 'telescope', a system of lenses, feeding into a light dependent resistor (LDR). The light falling on the LDR is only that from the image of the tiniest pinprick portion of the drum, directly at the focal point of the telescope. The whole telescope is connected to a leadscrew arrangement that moves it slowly along the length of the drum.



The breaking of the drought. Wide-angle view of the southern hemisphere, Africa and Madagascar to the left, Australia to the right. The low that broke the drought has just passed east of Tasmania. Printout shown actual size.

The receiver has a similar telescope over its drum, although there is a lamp in place of the LDR. The receiver lamp is connected via a pair of wires to the transmitter LDR, via a battery to power the lamp.

To the transmitter drum we will attach a piece of paper with some wavy lines drawn on it which is held in place with a piece of black electrician's tape. To the receiver drum we will attach a sheet of photographic printing paper (first turning out the light).

Now we can start the drums rotating in unison. As the telescope at the sending end 'sees' the white paper, the LDR will pass maximum current from the battery via the pair of wires to the lamp at the receiving end. The lamp, through its lenses, will expose at any instant a tiny portion of the photographic paper.

When the first of the wavy lines appears under the sending telescope, its black colour will cause less light to fall on the LDR, less current will pass, less light will fall on the photographic paper, and the image will be reproduced.

As the process continues, lines of whiteness or blackness will begin to build up on the paper, a new line for each rotation of the drum. If the drum turns 1000 times, there will be 1000 lines, quite a high resolution picture, which is better than the television's 625 lines. (Purists will note that since photographic paper is negative-working, the resulting picture will have its blacks and whites reversed. But it illustrates how the system works.) Also note that the image of the black electrical tape will be reproduced. This is important, as we'll see shortly.

Now that we are instant experts on the basic fax system, we can see the problems it generates. If the drums aren't running at exactly the same speed, the picture will slant one way or the other, like on a TV set with misadjusted horizontal hold control.

If the drums don't start rotating from exactly the same angular position, the left of the picture will be on the right and the right will be on the left and the edge will be in the middle. What a muddle!

If the transmitter sends 1000 lines and your receiver needs 1500 lines to cover the paper, your image will be squashed into the upper 2/3 and the lower 1/3 will remain unexposed.

Let's tackle the problems one by one, beginning with the matter of getting the transmitter and receiver to start together. Most fax systems transmit what are called *phasing pulses*; bursts of white against a black background, before the actual picture begins.

One pulse is sent for each line, and the *end* of the pulse, the white to black transition, says, 'the next line starts here!'. At the receiving end the machine adjusts its motor speed faster or slower until the edge of its paper coincides with the finish of each phasing pulse. Normally about 30 seconds of phasing pulses are provided, and if the receiver doesn't 'lock up' in that time the picture is going to be a mess. ▶

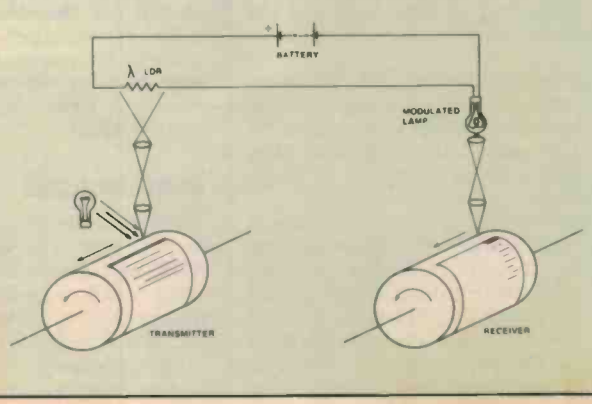
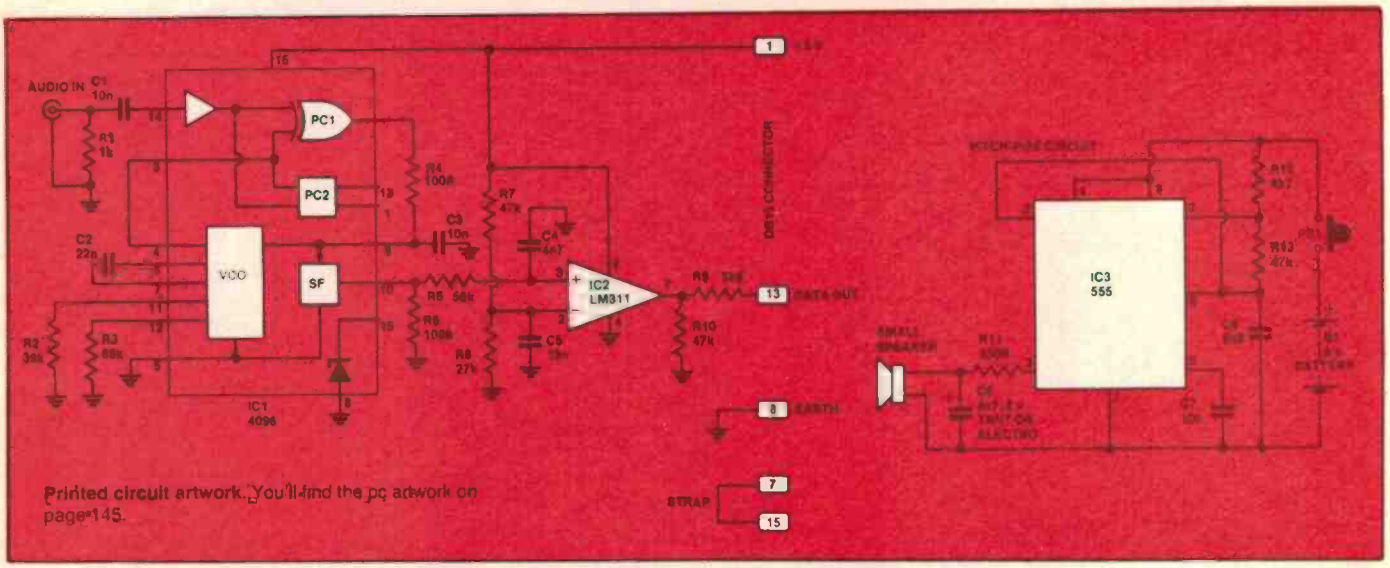


Figure 1. The basic facsimile picture transmission and reception system.



Printed circuit artwork. You'll find the pc artwork on page 145.

Now to the problem of keeping both drums going at the same speed, once phasing has been achieved. There are several ways of going about this, and they're all currently in use.

The simplest method of 'sync' is to use synchronous motors at each end. This method is common in simpler fax machines for use on 'phone lines. It assumes that both transmitter and receiver are running from the same power grid, so their mains supplies are synchronised.

A more elegant way of going about it involves driving both the transmit and receive motors from power supplies derived from crystal oscillators. If the oscillators are stable to within 0.001% good fax pictures will result, and there's no dependence on mains frequencies. So reception is possible aboard a ship, for instance. This is currently the most common sync method.

A third and slightly older system involves the transmission of sync pulses at the start of each line, just like in television. The receiving motor is set to run slightly fast and when it reaches the end of a scan line it slows or stops until told to go ahead by a sync pulse. Sync pulses show up as a black line down the left hand side of a picture (or the right side if it's been sent upside down).

The faithful reproduction of shape is determined by the system's *index of co-operation*. This is the product of the length of a line measured in some unit and the number of lines per the same unit. Confusing? Yup.

Let's try again. Assume that our transmitter drum can take a picture 38.4 cm wide. Assume that it sends 15 scan lines for each vertical centimetre of picture. The system's 'index of co-operation' is $15 \times 38.4 = 576$.

Now assume that our receiving system is only 18 cm wide (which just happens to be the width of our computer graphics printout). If we still went for 15 lines per cm the resulting picture would be very tall and narrow. To stay with the transmitter's index of co-operation of 476, our line density must be 576/18 or 32 lines per cm. If this is so, a circle from the transmitter will look like a circle on the receiver. For various reasons the computer receiver index of co-operation isn't exactly 576, and the resulting circles are slightly 'tall'.

One fact that emerged from researching this article is that there is no single standard for fax transmission. Scan speeds can range from 68 lines per minute (one a second) to 360 lpm. Scan densities can be just about anything.

Radio fax can be sent as AM where the amplitude of the carrier varies with the picture, or as FM where the frequency varies. A picture may run for seven or 10 or 20 minutes and it seems some stations transmit non-stop strips of picture and never any phasing pulses. Pictures may be black and white only (binary), or they may contain many shades of grey (analogue).

From observations on the shortwave bands, certain systems seem popular. Every one I've got printable pictures from seems to use an index of co-operation of 576, which certainly makes life easier. About 80% scan at 120 lpm, about 18% use 60 lpm and the remaining 2% use some weirdo system. All seem to use FM with *white* as the *higher* frequency, and most seem to shift their carriers about 800 Hz between white and black.

So, the computer system described here is set up for the most likely signals: I.O.C. of 576 (or thereabouts), 120 lpm, 'sync pulse' synchronisation, FM with shift in the 800 Hz region, and a picture time of nine minutes which is plenty of time to receive a 'right-way-around' picture from station AXM.

Station AXM

AXM was the inspiration for this whole project. You've possibly heard mention of AXM regarding radio-teletype (ETI, April 1983) which it generally transmits during the first half of every hour. For the rest of the time it sends fax.

I first encountered AXM fax during a trip to the Antartic last summer aboard the Nella Dan. In the ship's chart-room is a large Japanese-made fax machine that uses a flat bed recorder instead of a rotating drum. Two or three times a day an officer would press a few buttons and the machine

HOW IT WORKS — ETI 736

There are two basic parts to the project: the decoder itself, and the pitchpipe tuning aid. A shortwave receiver, set to receive the upper sideband mode, is tuned to a station transmitting radio facsimile (see main text). The pitchpipe is used to tune the receiver so that the 'high' tone is around 2300 Hz. The receiver output is then recorded on tape. The tape is played back and the decoder inserted between the tape recorder's output and the Microbee's 8-bit port. The computer does the rest.

The decoder is built around a 4046 CMOS phase-locked loop IC. The incoming audio consists of two tones 800 Hz apart. These tones are around 2300 Hz (high) and 1500 Hz (low). They are applied to the PC1 phase comparator input of IC1. The output goes via a low pass filter to the voltage-controlled oscillator (VCO) control input (pin 9). The VCO output goes to the other PC1 input so that the incoming frequency and the VCO frequency are compared. The 'lock' range is determined by R2 and R3. The VCO's free-running frequency is 'pulled' according to the incoming high and low tones.

The 'error' signal generated at the output of PC1 is buffered (after conditioning by the low-pass filter R4-C3) and appears at pin 10. The buffer output at pin 10 is passed to a voltage comparator, IC2, which generates high and low pulses for the input port at pin 13 of the DB15 connector (DATA OUT). Resistors R7-R8 set the non-inverting input of the comparator, IC2, to about 1.8 V. C4-C5 are bypasses.

Supply for the decoder is derived from the Microbee's 8-bit port. Note that the ARDY and ASTB signals are tied at the connector (pins 7 and 15).

The pitchpipe circuit consists of a 555 connected as an astable multivibrator. The oscillation frequency of IC3 is determined by R12-R13 and C8. R11-C6 form a low-pass filter so that a relatively 'pure' tone is issued from the loudspeaker. The output level is low, but then you don't need watts of power to do the job.

would emit from its top a large weather map which was then posted on the wall. As well as serving in more traditional roles, these weather maps would allow the ship's company to estimate how seasick they were going to be the next day.

The fax decoder

To be the first in your block to have 'fax-in-the-home' you're going to need a few items of equipment:

1. A singlesideband shortwave receiver.
2. A good quality cassette recorder.
3. An ETI-736 Fax Decoder and Pitchpipe circuit.
4. A 32K Microbee computer.
5. A C-ITOH 8510 printer (or Epson MX-80).
6. Lots of patience.

I won't launch into a long technical description of the Fax Decoder here. It's a good old phase-locked loop, very similar to the ETI-733 Radio Teletype to Computer Decoder (April '83). This new circuit has been optimised for fax data rates and frequency shifts (both very large) and it is working its poor little guts out just to stay in lock.

Considering what is being asked of it, the decoder works very well and it can recover lockable pictures even in the presence of noise or multipath distortion. With the comparator circuit, the decoder will even decode analogue pictures and turn them into binary along the way; just right for feeding to the Microbee.

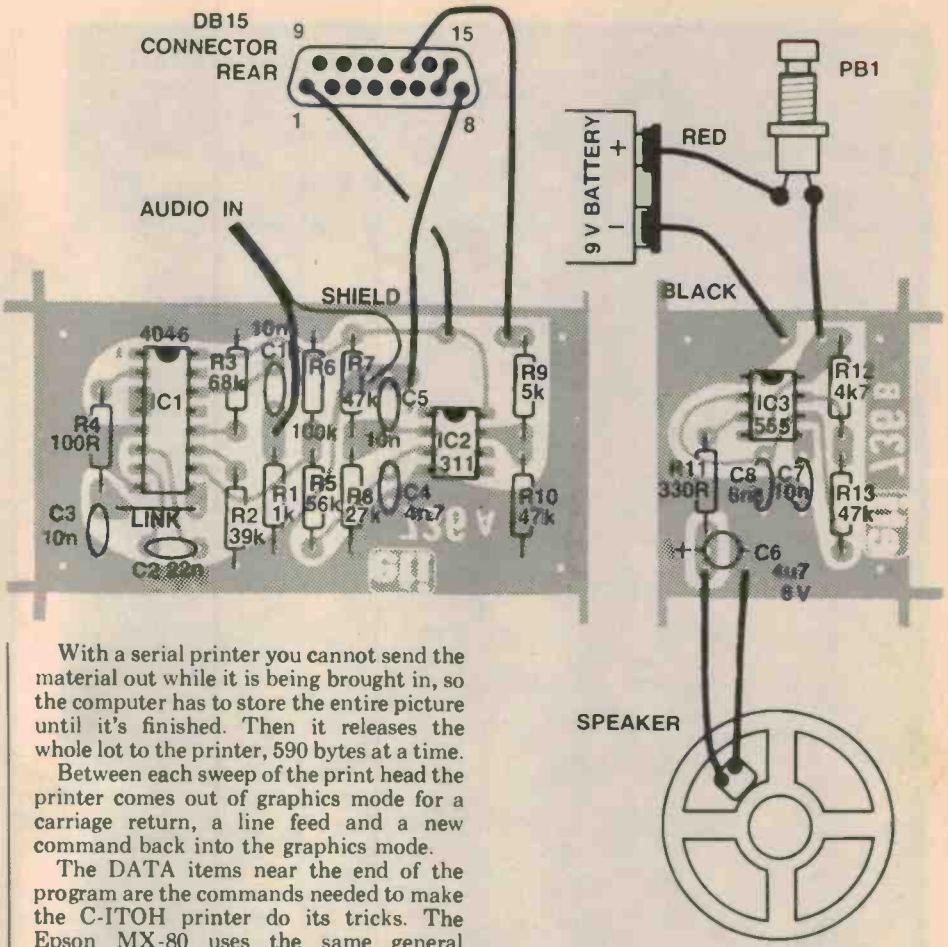
The ETI-736 Fax Decoder is made up of two independent circuits, the Fax Decoder and the Pitchpipe tuning aid. If your receiver is in one room and the computer set-up in another, you can separate the two circuits with a hacksaw so the Pitchpipe stays with the receiver.

The software for the Microbee is one of those big bit-shuffling programs that's a natural for machine code. It provides for the collection and storage of precisely 637 200 bits of fax information. That is 1080 lines with 590 dots per line. Actually we compress three adjacent fax lines into one, with each vertical group of three dots logically ORed together.

So, after compression 212 400 bits are stored in 26 550 bytes. They make up 360 lines for the printer. Before a picture starts the program locks onto any one phasing pulse and shows the remainder as a continuous black bar. So it's best to wait till they're nearly finished before running the program. During the run, the program waits for a black sync pulse before it inputs the next fax line.

The printer, running in the graphics mode, uses its eight dot-matrix print wires to 'paint' eight lines of fax (24 before compression) onto the paper in one sweep of the print head. A smaller than normal line feed is given so each sweep just touches the one above it. In a byte sent to the printer under the graphics mode, each bit controls the action of one of the print wires.

With 590 dots per line, the software must first do 590 bit zeroes, then 590 bit ones, etc, until all eight bits in each byte are set high or low as required.



With a serial printer you cannot send the material out while it is being brought in, so the computer has to store the entire picture until it's finished. Then it releases the whole lot to the printer, 590 bytes at a time.

Between each sweep of the print head the printer comes out of graphics mode for a carriage return, a line feed and a new command back into the graphics mode.

The DATA items near the end of the program are the commands needed to make the C-ITOH printer do its tricks. The Epson MX-80 uses the same general principle in its graphics mode, so substituting its control codes in the DATA area should make it work the same as the C-ITOH.

If you'd like a ready-to-run cassette of the software (set up for the ITOH printer), send the usual $12 to the author for a speedy post-paid return. If there's a demand I might even be able to cook up an Epson version.

Construction

This project is very simple to assemble. First thing to do, no matter whether you've made your own pc board(s) or bought a kit, is to check the board(s) to see that there are no broken tracks, copper bridges (especially between IC pins) and that all holes are correctly drilled. Separate the Pitchpipe board from the Decoder board before assembling the components.

Start construction by installing the resistors and capacitors on the Decoder board. Then install the link at the end of the 4046. Last of all, install the two ICs, making sure you get them the right way round. Now wire the DB15 plug to the board, not forgetting to link pins 7 and 15.

Now tackle the Pitchpipe board. Solder the resistors and capacitors in place first, making sure you put the electrolytic in the correct way. Then solder the 555 in place, taking care to orientate it correctly, also. Finish by wiring in the pushbutton, speaker and battery clip. ▶

PARTS LIST — ETI 736

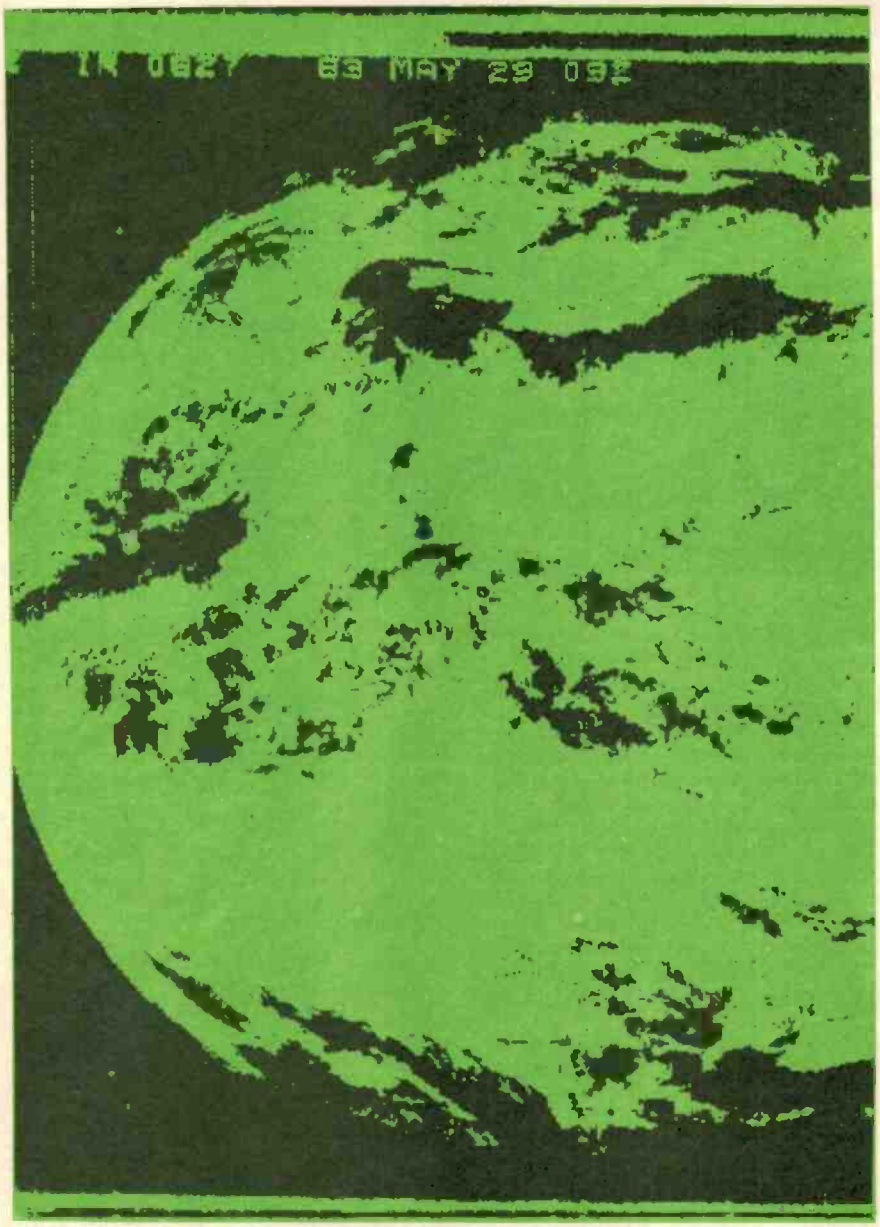
Resistors ..... all ¼W, 5% unless noted
- R1 ..... 1k
- R2 ..... 39k
- R3 ..... 68k
- R4 ..... 100R
- R5 ..... 56k
- R6 ..... 100k
- R7,10,13 ..... 47k
- R8 ..... 27k
- R9 ..... 5k6
- R11 ..... 330R
- R12 ..... 4k7

Capacitors
- C1,3,5,7 ..... 10n greencap
- C2 ..... 22n greencap
- C4 ..... 4n7 greencap
- C6 ..... 4u7/10 V single-ended electro.
- C8 ..... 6n8

Semiconductors
- IC1 ..... 4046B
- IC2 ..... LM311, uA311
- IC3 ..... uA555, LM555, NE555

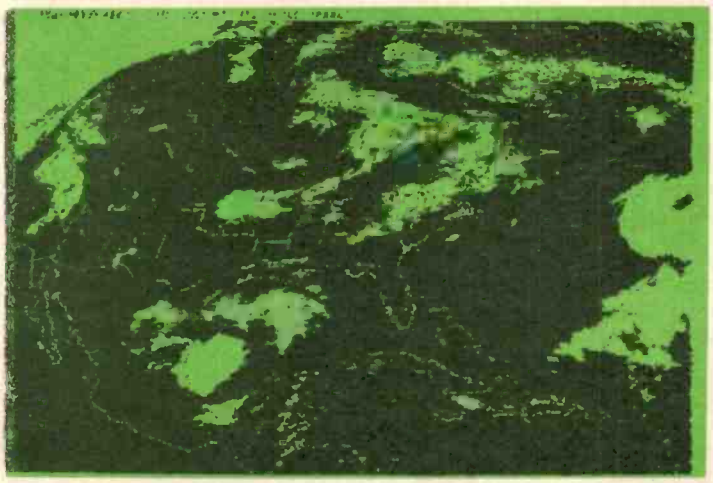
Miscellaneous
PB1 min..... momentary-action pushbutton. ETI-736 a and b pc boards; DB15 plug; 50 mm 8 ohm speaker; No. 216 9V battery; jiffy boxes to suit; audio connectors to suit; wire, shielded cable, nuts, bolts etc.

Estimated cost: $25-$30



Picture 3. Satellite picture from AXM, actual size, rotated 90 degrees.

Picture 5. Doctored US satellite picture, transmitted from New York.



If you've got a frequency counter — you only need an audio frequency counter accurate to a few Hertz — then check that the Pitchpipe output is close to 2300 Hz. If you haven't got an audio frequency counter, then turn your Microbee into one! Details were given in the Microbee Column on page 56 of the July '83 issue.

Get the picture

Now here's how to collect your pictures: Connect a speaker, nine-volt battery and a press button switch to the pitchpipe circuit. It should beep at 2300 Hz when you hit the button.

With pitchpipe and cassette recorder at hand, tune the receiver until you hear that chorus of crickets called fax; 11 030 kHz is a good place to start. Switch to 'upper sideband'. If a picture is already running, wait for the next one.

The start of a new picture is signalled by a loud *blurt*, actually five seconds of carrier modulated by 300 Hz. Start the recorder. Next, you'll hear the lower tone, punctuated by some 'pip ... pip ... pips' from the higher tone. Push the button on the pitchpipe circuit and tune the receiver until the pips sound the same pitch. This might sound like a rough and ready method of tuning but it's really quite accurate.

Some 30 seconds or so after the pips begin the picture itself should start, with the high tone becoming more dominant. Hold down the pitchpipe button and check the tuning pitch again. Now let the recording continue, checking the tuning from time to time. When the picture is finished the receiver will blurt again; switch off the recorder and take it to the computer.

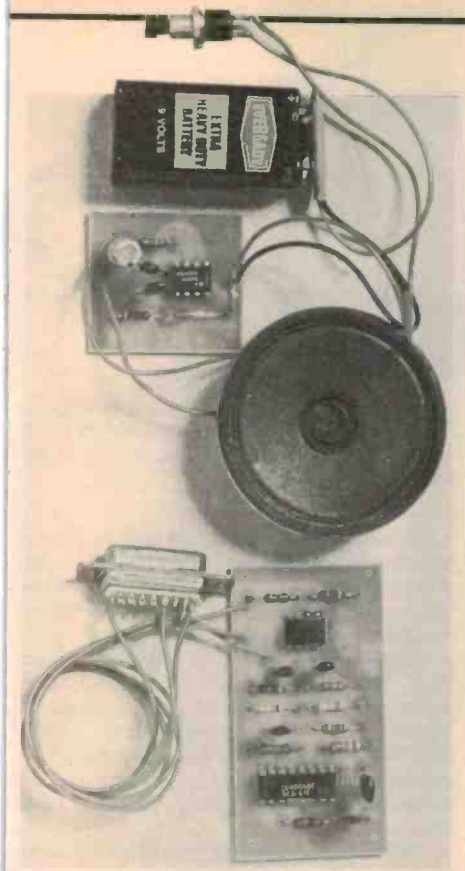
Now rewind the tape and cue it up so it is sitting just a few pips (phasing pulses) in front of the picture. Set the recorder's volume near where you would to load a tape into the Microbee. With the decoder plugged into the computer's parallel port and the audio line plugged into the cassette 'earphone' jack, roll the tape and then run the program. Turn the printer on and wait. Nine minutes later the computer will beep and your picture will begin painting onto the printer. Two minutes after that you'll be hooked on fax.

About the pictures

All the Australian pictures were received from the Bureau of Meterology's broadcast station, AXM. The 'studios' are located in the Weather Bureau's Melbourne office, although the actual transmitters are in Canberra, operated by the Navy. There's a sister station, AXI, in Darwin.

AXM transmits continuously on four frequencies: 5100, 11 030, 13 920, and 19 690 kHz. Its index of co-operation is 576, scan speed is 120 lpm, frequency shift is 800 Hz and transmission is binary, black and white only, with no shades of grey.

AXM depends on the 'crystal lock' method of sync. It doesn't transmit 'official' sync pulses. But there is something similar to the black electrical tape mentioned earlier ... a black line that always appears on the left hand edge (or the right, if the



Set to go. The completed decoder and pitchpipe, before housing in jiffy boxes.

picture is sent upside down). As far as the Microbee is concerned, it's a sync pulse, and it locks up with ease.

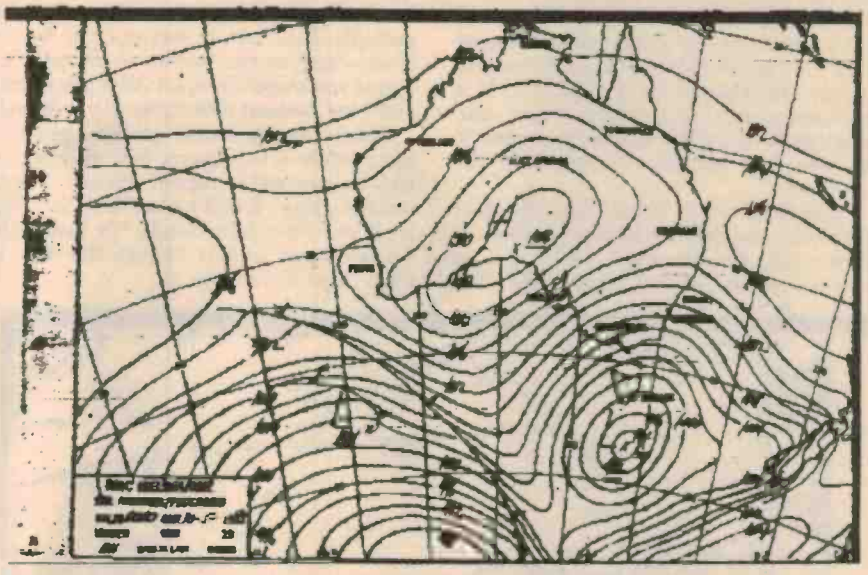
Picture 1 is a standard weather chart just like you see on television every night. Note the big nasty low just south of Tasmania. There's also a cold front sweeping in from the southwest.

Picture 2 is much the same thing, only showing the isobars at 20 000 feet instead of sea level. The low is still much in evidence.

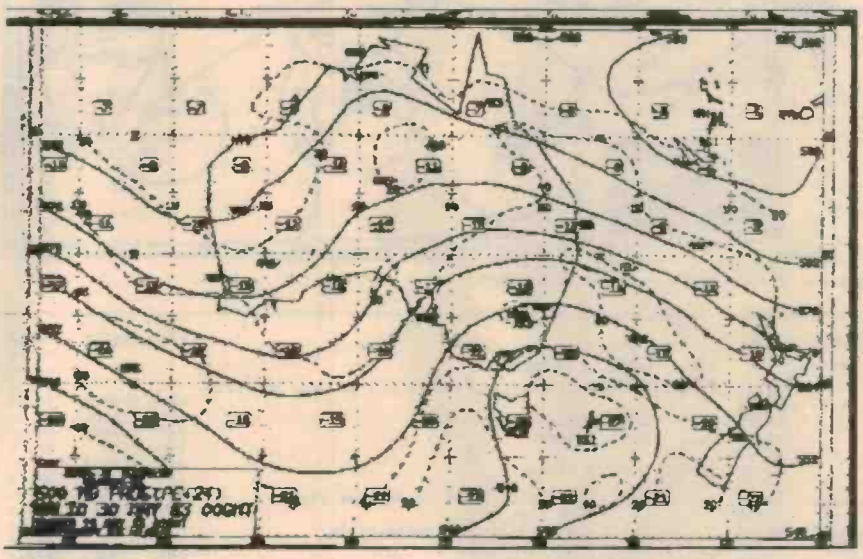
Picture 3 is not a weather map, it's a proper satellite picture transmitted from AXM. Since it's a binary fax system the shades of grey are lost but it's still a pretty smashing view of mother earth, or at least part of it. The picture was too big for all of it to fit in the computer. Rotate it 90 degrees to get the writing the right way up and you'll see the picture in the proper perspective. According to AXM it's the 'southern half of the earth disc as seen from the Japanese satellite GMS'. (That means 'Geostationary Meteorological Satellite.')

Picture 4 is a 'Nephanalysis' . . . a study of the cloud situation in the southern hemisphere. The raw data is a satellite picture which is interpeted and re-drawn by meteorologists, with special symbols indicating the cloud types. Again, that big low blots out Tasmania. Obviously this type of chart would not have been possible before the days of satellites.

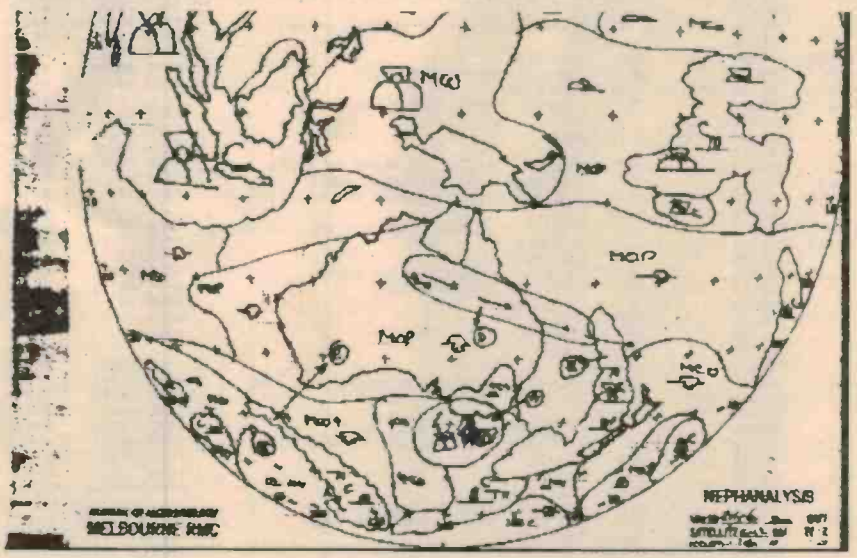
Now to **Picture 5**. You can say you're amazed and astounded now, or later. This one originated from one of America's NOAA satellites and was transmitted from space to the USA where it was souped up



Picture 1. A standard weather chart, from station AXM, 11:30 am, 29 May '83.



Picture 2. Similar to Picture 1, but isobars at 20 000 ft; 2.30 pm same date.

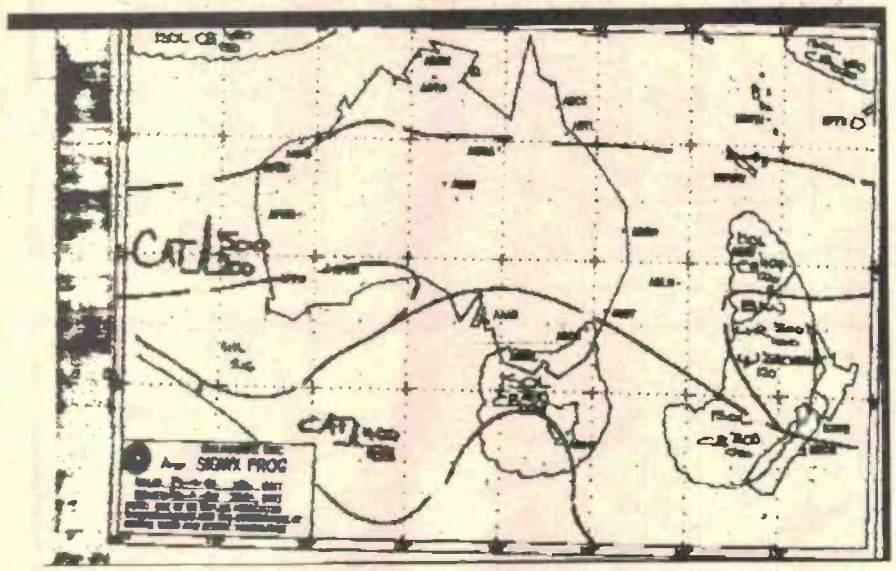


Picture 4. Nephanalysis, 11.45 am 29 May '83, AXM 11 030 kHz.

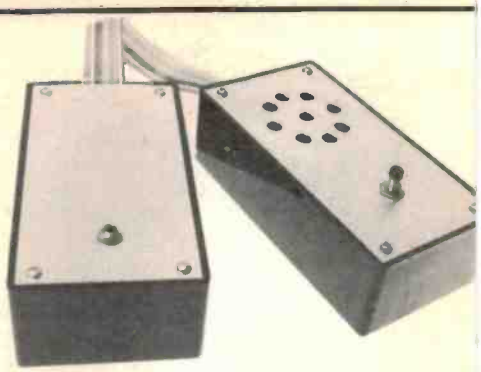
The rest of Australia is gloriously clear! with state borders and the like. Then it was sent back out on HF radio many thousand more kilometres into my humble cassette recorder. In other words it's 'fax DX'. It is an analogue picture that was forced into binary state by the decoder's comparator. It has also had its video inverted in the computer.

Picture 6 is a 'Significant Weather Prognosis', designed especially for pilots. It shows high altitude wind trends and jet streams, and significant cloud areas. The word 'CAT' means 'clear air turbulance' to be avoided if at all possible. This particular example looks like it was put out by the Queensland tourist bureau. It shows Tasmania smothered in cloud (that low again), and New Zealand is about to cop it as well.

Those 'mostly black' satellite pictures, like Picture 3, play merry hell with printer ribbons, so we've turned Picture 8 into 'mostly white'. It still looks OK, huh? That is, if you like black clouds. To invert the video on any picture change the data at 0426 (hex) from 38 to 30.



Picture 6. One for the pilots, another AXM picture.



Housing. Two small jiffy boxes served admirably to house the decoder (left) and pitchpipe (right). The ribbon cable goes to the DB15 plug which plugs into the Microbee user port.

So now you know all about fax, as do thousands of other enthusiasts throughout Australia. Perhaps home fax will join home video and compact disc and all the latest electronic pastimes.

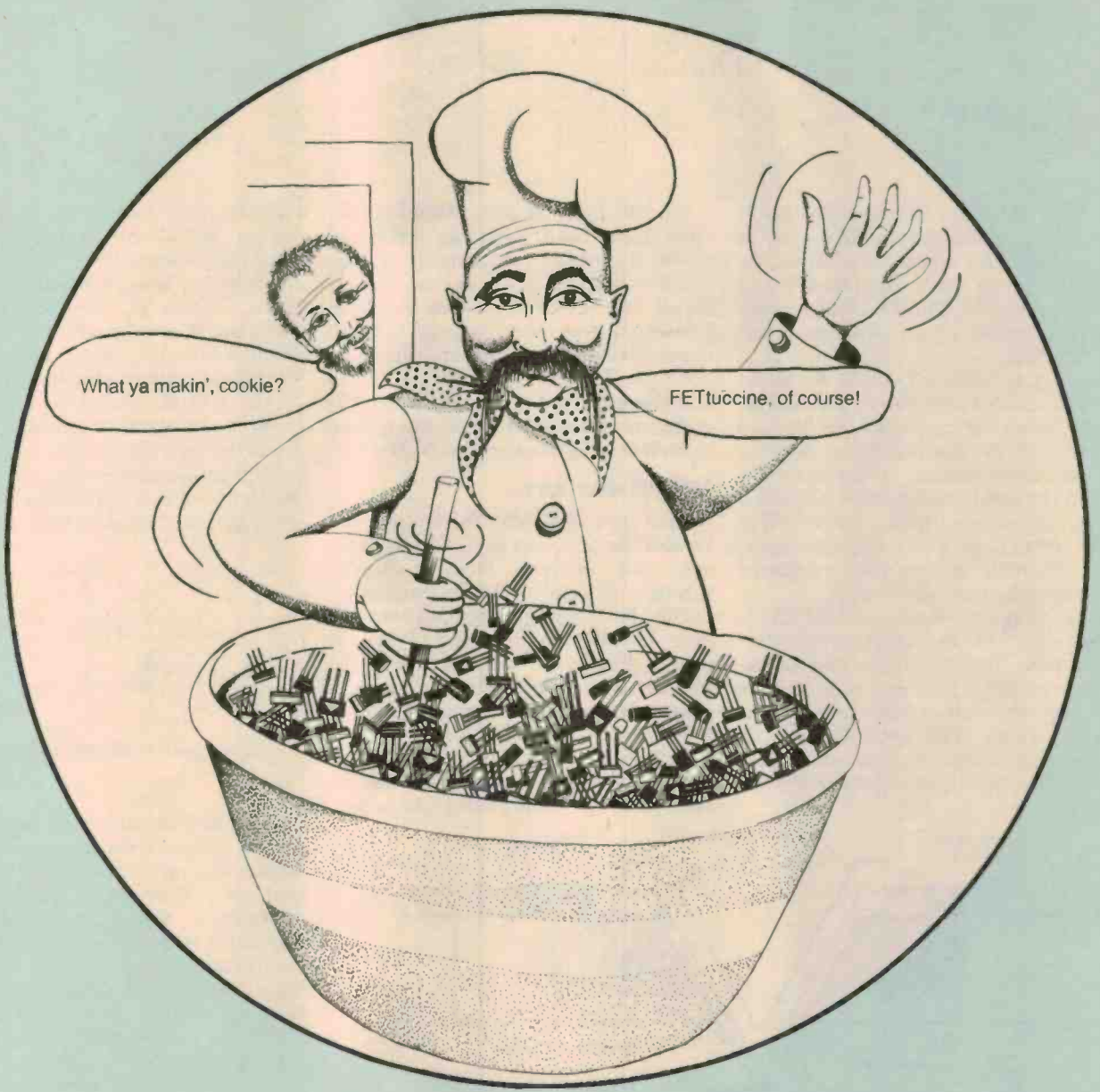
Maybe AXM will even join the ratings race, "Hey folks! You're on AXM! 5000 watts of picture power! And tonight a request from Melbourne listener Randy Oldfellow! Randy asks us to *drop* tonight's *nephanalysis* and play a picture of Bo Derek instead. OK, Randy, this one's for *you!*"

Seriously, though, fax can be useful, and it's certainly a lot of fun. Faxinating. I'd like to thank all those people at the Bureau of Meteorology who suffered my silly questions and helped with the preparation of this article. ●

PROGRAM LISTING

```
ADDR   CODE     LINE   LABEL  MNEM    OPERAND

                00100 ;Facsimile Receiver Program by Tom Moffat: May 20, 1983
                00110
0400            00120          DEFR    16
0400            00130          DRG     0400
                00140
                00150 ;Clear the data store:
                00160
0400 210810     00170          LD      HL,1000 ;START OF PICTURE STORE
0403 110110     00180          LD      DE,1001
0406 01B667     00190          LD      BC,67B6 ;CLEAR 26550 BYTES
0409 3600       00200          LD      (HL),0
040B E5         00210          PUSH    HL
040C EDB0       00220          LDIR
                00230
                00240 ;Synchronize the computer with a phasing pulse:
                00250
040E CD7504     00260 LP1      CALL    SAMPLE
0411 30FB       00270          JR      NC,LP1  ;WAIT FOR WHITE
0413 CD7504     00280 LP2      CALL    SAMPLE
0416 38FB       00290          JR      C,LP2   ;WAIT FOR BLACK
                00300
                00310 ;Start of picture:
                00320
0418 E1         00330          POP     HL      ;POINT TO START OF STORE
0419 114E02     00340          LD      DE,24EH ;590 DOTS PER LINE
041C 01012D     00350          LD      BC,2D01 ;LINE COUNTER AND ROTATING BIT
041F C5         00360 LP4      PUSH    BC
0420 0603       00370          LD      B,3     ;3 FAX LINES = 1 PRINTER LINE
0422 CD7504     00380 LP3      CALL    SAMPLE
0425 7E         00390          LD      A,(HL)
0426 3001       00400          JR      C,$+3   ;SKIP NEXT IF WHITE
0428 B1         00410          OR      C       ;PRINT A DOT
0429 77         00420          LD      (HL),A
042A 23         00430          INC     HL
042B 1B         00440          DEC     DE
042C 7A         00450          LD      A,D
042D B3         00460          OR      E
042E 20F2       00470          JR      NZ,LP3  ;FOR ONE COMPLETE FAX LINE
0430 DB00       00480 SYNC     IN      A,(0)
0432 0F         00490          RRCA
0433 38FB       00500          JR      C,SYNC  ;WAIT FOR BLACK
0435 114E02     00510          LD      DE,24EH ;FOR 590 HORIZONTAL DOTS
0438 ED52       00520          SBC     HL,DE
043A 10E6       00530          DJNZ    LP3
043C C1         00540          POP     BC
043D CB01       00550          RLC     C       ;ROTATE THE BIT
043F 30DE       00560          JR      NC,LP4  ;GO TO START OF LINE
0441 19         00570          ADD     HL,DE
0442 10DB       00580          DJNZ    LP4
0444 0607       00590          LD      B,7
0446 CD0C00     00600          CALL    000CH   ;BEEP WHEN FINISHED
                00610
                00620 ;Send out the picture to the printer:
                00630
0449 218904     00640          LD      HL,DATA1
044C 110600     00650          LD      DE,6
044F CD7E04     00660          CALL    PRINT   ;SET LINE FEED PITCH
0452 062D       00670          LD      B,2DH   ;45 GROUPS OF 8 LINES
0454 210810     00680          LD      HL,1000 ;START OF DATA STORE
0457 E5         00690 LP5      PUSH    HL
0458 218F04     00700          LD      HL,DATA2
045B 1E08       00710          LD      E,8
045D CD7E04     00720          CALL    PRINT   ;CR/LF AND GRAPHICS INIT.
0460 E1         00730          POP     HL
0461 114E02     00740          LD      DE,24EH ;590 DOTS PER LINE
0464 CD7E04     00750          CALL    PRINT   ;8 LINES OF PICTURE
0467 10EE       00760          DJNZ    LP5     ;IF NOT 45 GROUPS
0469 218F04     00770          LD      HL,DATA2
046C 1E02       00780          LD      E,2
046E CD7E04     00790          CALL    PRINT   ;CRLF
0471 2AA200     00800          LD      HL,(0A2);PICTURE FINISHED,
0474 E9         00810          JP      (HL)    ;JUMP TO MONITOR
                00820
0475 3E63       00830 SAMPLE   LD      A,63    ;SET DELAY TIME BETWEEN DOTS
0477 3D         00840          DEC     A       ;847 uS PER DOT
0478 20FD       00850          JR      NZ,$-1
047A DB00       00860          IN      A,(0)   ;GET A PIXEL
047C 0F         00870          RRCA            ;SHIFT IT TO CARRY
047D C9         00880          RET
                00890
047E 7E         00900 PRINT    LD      A,(HL)
047F CD7FA8     00910          CALL    0A87FH  ;1200 bd SERIAL PRINT ROUTINE
0482 23         00920          INC     HL      ;GET NEXT BYTE
0483 1B         00930          DEC     DE      ;BYTE COUNTER
0484 7A         00940          LD      A,D
0485 B3         00950          OR      E
0486 20F6       00960          JR      NZ,PRINT
0488 C9         00970          RET
                00980
0489 1B54       00990 DATA1    DEFW    541BH   ;ESC T
048B 3136       01000          DEFW    3631    ;1 6    ;LINE FEED PITCH
048D 1B5B       01010          DEFW    5B1BH   ;ESC [  ;INCREMENTAL MODE
048F 0D0A       01020 DATA2    DEFW    0A0DH   ;CR LF
0491 1B53       01030          DEFW    531BH   ;ESC S
0493 3035       01040          DEFW    3530    ;0 5
0495 3930       01050          DEFW    3039    ;9 0
0000            01060          END
00000 Total errors

DATA2   048F    LP5     0457    PRINT   047E    DATA1   0489
SYNC    0430    LP3     0422    LP4     041F    LP2     0413
SAMPLE  0475    LP1     040E
```

THE UNFETTERED FET FIDDLER'S FANTASTIC COOKBOOK!



THE RECIPE

Power MOSFETS — the technology, the techniques

Brian Dance

IN 1976 Siliconix startled the semiconductor world with a new type of power MOSFET device. Recently other manufacturers have produced many other types of MOSFET products which are challenging power transistors and Darlingtons.

The name MOSFET stands for Metal Oxide Silicon Field Effect Transistor. Field effect transistors (FETs) are essentially voltage controlled devices, unlike conventional transistors in which the small base current controls a larger collector output current. FETs have very high input impedances so that very little input current is required to control their output current.

The input impedance of MOSFETs is especially high because they have an insulating film of silicon dioxide between the input gate electrode and the channel through which the output current flows. The gate electrode is therefore essentially completely insulated and virtually no input current can flow.

Various types of small MOSFET devices have been available for many years. Internally they contain a very small silicon chip on the surface of which the MOSFET device has been fabricated. Any current passes through these devices in a horizontal direction through the very thin surface layers and therefore the maximum current is quite low; maximum power dissipation in such devices is not normally over 1W.

VMOS devices

In the so-called VMOS devices, developed by Siliconix about eight years ago, the current flows vertically through the semiconductor material — hence the name VMOS. This name is also associated with the V-shaped groove formed in the surface of the semiconductor material of such devices. Figure 1 shows a cross-section of a VMOS transistor.

If the gate electrode is connected to the source and the drain contact at the bottom of Figure 1 is made positive relative to the source, no appreciable current will flow from drain to source, since the internal diode formed between the p and n type materials will be reverse biased. If, however, the gate electrode is made positive with respect to the source, the electric field produced by the gate potential creates a channel in the position shown in Figure 1. A current can now flow upwards from the drain through the channel to the source. As the gate becomes more positive, the width of the channel increases and the current from drain to source increases.

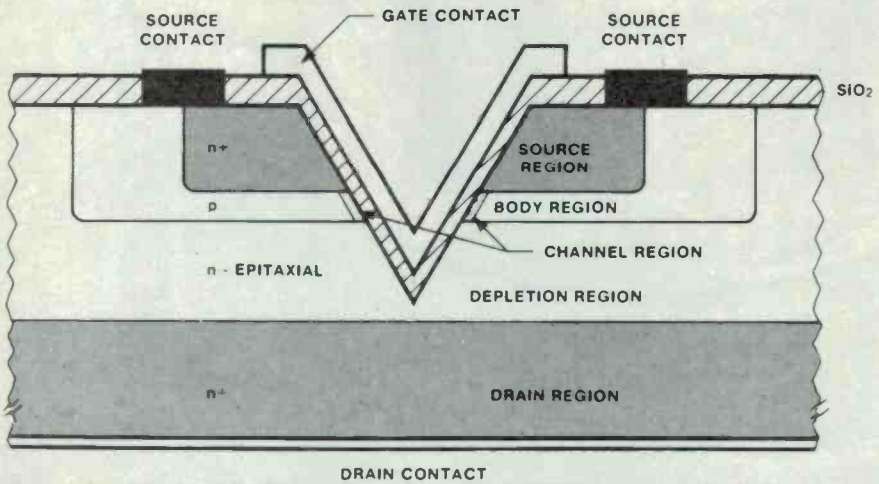


Figure 1. Structure of the VMOS device developed by Siliconix. With the gate biased positive with respect to the source, current flows from the drain region to the source via the channel region indicated. As the gate is biased more positive, the channel region increases, increasing the drain-source current. VMOS FETs are majority-carrier devices and can switch current in less than 10 ns. Bipolar transistors cannot compete as they suffer from minority carrier storage in the base region.

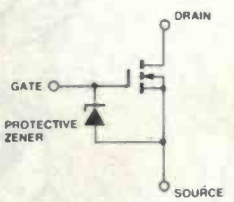


Figure 2. Zener protection of the gate.

If small changes in the gate voltage are to produce the required channel depth, the insulating layer must be extremely thin, which results in an appreciable gate input capacitance (typically some 50 pf). The thin layer also imposes a limit to the maximum voltage which can safely be applied to the gate without the risk of breaking down this thin layer and thus destroying the device. As the gate input resistance is so high (often of the order of a million megohms), it is very easy for small stray electrostatic charges to be picked up on the gate and produce voltages which can puncture the insulating film.

In some devices a small zener diode is connected between the gate and the source, as shown in Figure 2. If the gate to source voltage exceeds the zener voltage, the zener conducts and shorts out the voltage, protecting the MOSFET.

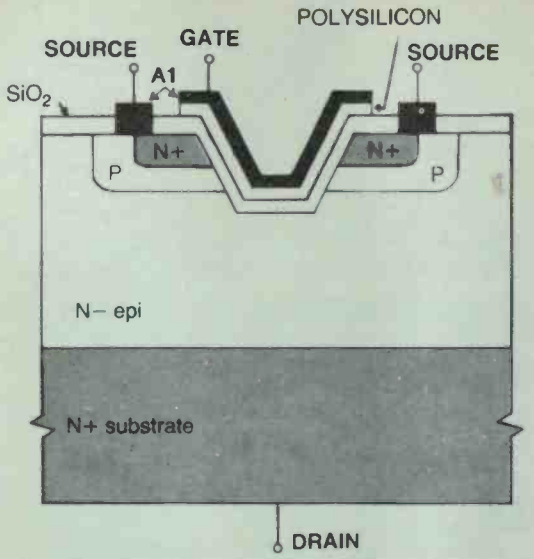


Figure 3. The U-groove device, introduced by Intersil, reduces problems associated with the intense electric field at the edge of the V-notch in VMOS devices. The polysilicon layer prevents migration of sodium impurity ions through the gate oxide layer, a source of chip failure in VMOS.

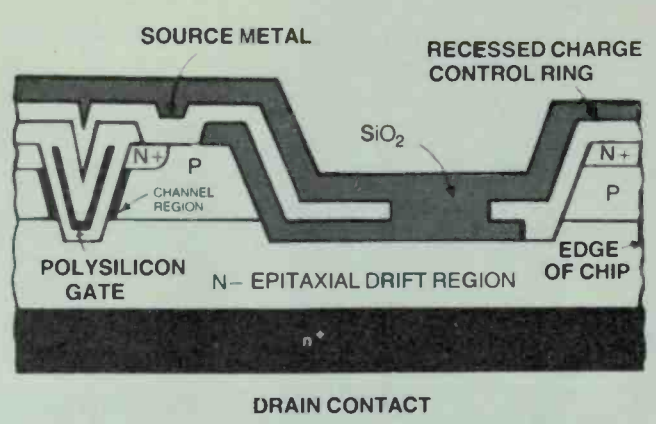


Figure 4. Having introduced power MOSFET technology, Siliconix have gone on to improve the devices. The tri-planar construction shown here allows much higher packing densities on the chip, the smaller size resulting in lower on state resistance. Polysilicon gates are buried in the oxide layers allowing source metallisation to cover a greater fraction of the chip area.

However, the maximum zener current is quite small, so the zener can easily be damaged. The maximum input voltage 'in circuit' should not exceed the zener voltage so that the zener is used to provide protection against electrostatic charges only.

If the gate becomes more than a fraction of a volt negative with respect to the source, the zener will conduct in its forward direction. If one wishes to operate a MOSFET with the gate voltage negative with respect to the source at any part of the duty cycle, a device not containing a zener should be selected, but then one must take precautions to avoid electrostatic charge pick up.

The first VMOS devices marketed were n-channel devices, with an n-type channel formed in the p-type material shown in Figure 1.

Comparison with bipolars

As the early VMOS devices could not handle so much current or so much applied voltage as conventional transistors, yet were more expensive than the latter, they obviously had some advantages or their manufacture would not have been a viable proposition.

Ordinary bipolar transistors suffer from the disadvantage of minority carrier storage in the base region. VMOS products are majority carrier devices and can therefore switch a current in less than 10 nanoseconds and operate up to several hundred mega-Hertz. For example, the 2N6657 can switch 1 A on or off in less than 4 ns, this being 10 to 200 times faster than a comparable bipolar device.

'Secondary breakdown' is another problem with bipolar transistors. If the current density increases at one point, the temperature rises in this region, leading to a still greater current density — a positive feedback effect which can lead to the rapid destruction of the device. In VMOS devices, an increase in the current density in the channel produces an increased temperature which results in a *lower* current density in that region, so that the current density automatically equalises itself throughout the chip without the formation of hot spots.

It follows that it is possible to connect two or more VMOS devices in parallel (often without any additional components), since the total current is automatically shared equally between the devices. Any device passing more current than the mean will become hotter and this will reduce the current somewhat in that device.

Apart from their higher cost, one of the disadvantages of VMOS devices is that their saturation voltage (typically 2V, maximum 4V for some devices when passing 1A) is much greater than for bipolar transistors. Although the V-shaped groove utilises the silicon area quite efficiently, the relatively sharp bottom of the groove is a disadvantage, since a strong electric field can be developed at this point between the gate and the drain where the insulating layer tends to be thinner than elsewhere. This results in a limited operating voltage capability owing to the possibility of gate to channel breakdown.

A perfect switching device would have an infinite resistance in the off state, but the drain current of many VMOS devices is in the nA region when in the off state with gate and source voltages equal. The resistance in the conducting state is normally a few ohms instead of the zero resistance of the perfect switch. This on-resistance is greater for devices with higher voltage ratings.

U-groove devices

The problem of the relatively intense electric field at the edge of the V-shaped notch of VMOS devices has already been mentioned. Intersil, followed by some other manufacturers, reduced this problem by producing devices with the structure shown in Figure 3, where the bottom of the groove is flat. Note that there is an additional layer of phosphorus-doped polycrystalline silicon between the gate and the insulating layer of silicon dioxide. This overcomes another problem of the early VMOS devices, namely the migration of sodium impurity ions through the gate oxide layer, which can cause reliability problems.

Other VMOS products

In 1980 Siliconix announced an improved triplanar VMOS process with the device structure shown in Figure 4. The source, the gate and the drain are each fabricated in a different plane. It is stated that this type of structure allows much higher packing densities on the chip and the smaller size will enable lower on state resistances to be obtained. Polysilicon gates are buried under the oxide layers so that the source metallisation can cover a greater fraction of the chip area.

Another major improvement from the triplanar structure arises from the use

of thin low-resistivity doped layers and from a re-arrangement of the V grooves for optimum use of the epitaxial layers.

Vertical DMOS

Although the modified VMOS processes are very good for devices rated up to about 150 V, they are not ideal for higher voltages. The vertical DMOS structure shown in Figure 5 has been found very suitable for high voltage devices. The current flows upwards from the drain into the n-epitaxial layer, but then flows horizontally for a short distance through a channel to the source.

Supertex of California originally used this technique to make devices with ratings of up to about 500 V, but somewhat higher voltage devices of this type have since become available. Figure 5 shows how the main junction region is surrounded by a concentric second junction which is in turn surrounded by a third junction. Apart from high voltage capability, this process can produce devices with a very low on-resistance (down to 0.05 ohm). In addition the devices are very fast, owing to the low gate capacitance. For example, a 1 A device can operate at about 2 GHz and a 10 A device at about 500 MHz.

The Ferranti Company of Oldham, England has co-operated with Supertex to develop vertical DMOS devices, both n-channel and p-channel, with ratings up to 650 V and drain currents up to 16 A continuous.

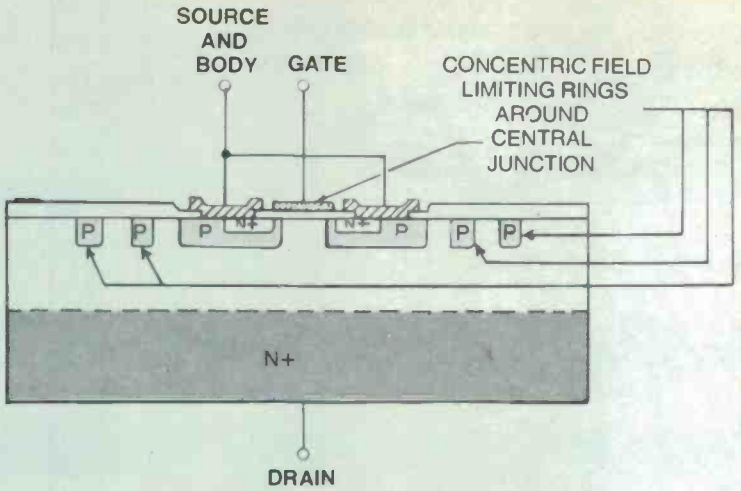


Figure 5. In the vertical DMOS device, current flows from the drain (N+) into the n-epitaxial layer (N−) then flows horizontally through a channel into the source. The concentric rings of p-type material around the main junction help improve the current capability and reduce the on-resistance. This form of construction achieves significantly higher voltage and current ratings compared to prior power MOSFETs.

Hitachi devices

Hitachi has developed a MOSFET device with the structure shown in Figure 6. The gate oxide layer is designed to handle only 20 to 30 V, so a field plate is provided to prevent high electric fields from forming near the gate. This type of device is most suitable for audio frequencies and for operation at up to a maximum of a few MHz. Both p-channel and n-channel types are available with ratings of up to 200 V and 8 A.

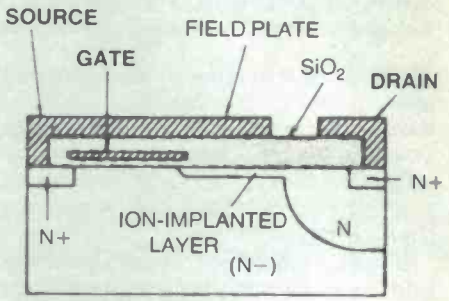


Figure 6. Hitachi MOSFET construction.

HEXFET devices

In mid-1980 International Rectifier introduced a range of devices named HEXFET after the hexagonal structure of the source cells which are connected by a common silicon gate (see Figure 7). The density of these source cells is over half a million per square inch.

HEXFET devices are available in both p-channel and n-channel polarities and can handle high power levels. They have voltage ratings of up to 500 V and continuous current ratings of up to 25 A. Values of channel resistance as low as 0.05 ohm can be obtained in the on state.

Some of the main applications for HEXFETS include servo motor control, RF induction heating, welding control equipment, audio amplification and other uses where the control of high power is required.

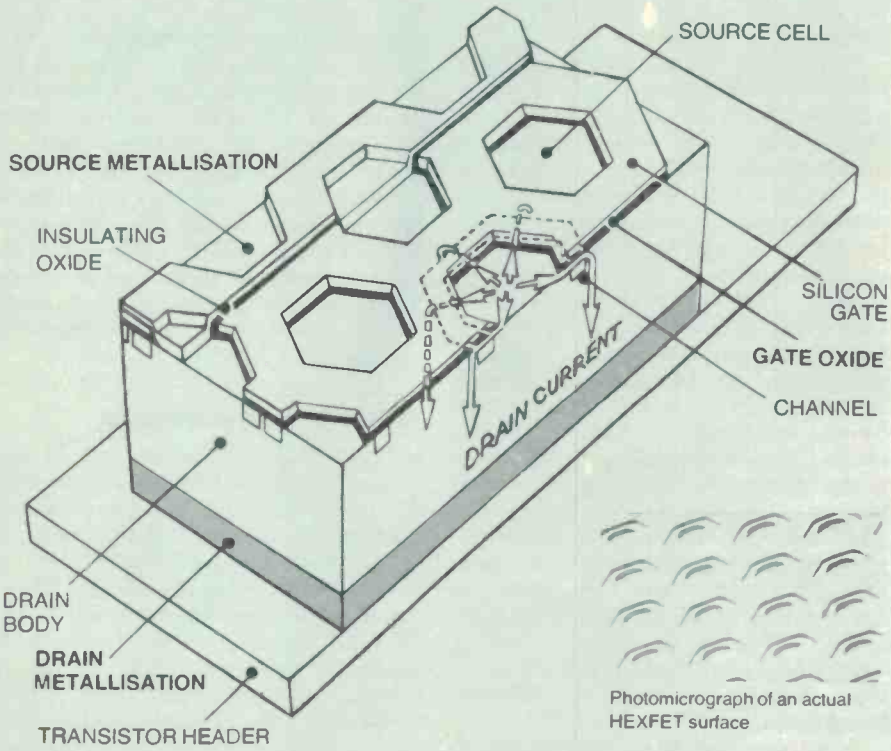
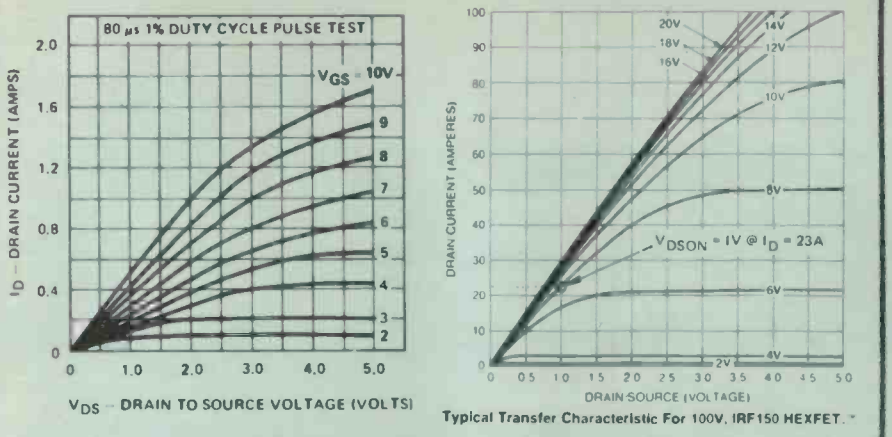


Figure 7. Construction of the HEXFET device introduced by the International Rectifier company in mid-1980. The hexagonal source cells (hence the name) are connected by a common silicon gate. Claimed advantages include high voltage and current ratings plus very low on-resistance.

SIPMOS

The latest technology to emerge in the power MOSFET field is SIPMOS from Siemens of West Germany, which is an extension of the vertical DMOS technique. Siemens has used this technique to fabricate the first 1000 V MOSFET device, the BUZ 54, which can handle 5 A. It has found wide uses in switching



Typical Transfer Characteristic For 100V, IRF150 HEXFET.

The saturation characteristics of a VMOS device (left) and a HEXFET (right)

mode power supplies.

Other SIPMOS devices have ratings in the range of 50 V to 500 V, all being n-channel types. SIPMOS transistors can switch loads of up to 5 kW using inputs to the gate of less than 1 mA at 5 V. Maximum drain currents of up to 30 A can be handled, while on-resistance values can be as low as 0.03 ohm.

Applications

Power MOSFET devices can be used as alternatives to power transistors and power Darlington devices in many applications, but they are generally more expensive than the latter and the circuit designer must decide which types of device are most suitable for his own application.

The use of power MOSFET products is particularly attractive when one can take advantage of their high switching speed or their high frequency capability. Although they may be somewhat more expensive than other transistors, the use of these new devices may simplify circuitry and reduce the overall costs. For example, a conventional power transistor requires a considerable current at its input and one or more driver stages may be required to provide this current, whereas the high input impedance of the power MOSFET enables the latter to operate with such small input currents that power driver stages can usually be eliminated.

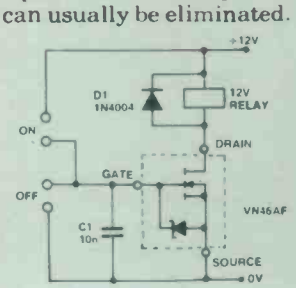


Figure 8. Simple touch switch.

Simple touch switch

The circuit of Figure 8 shows how the very high input impedance of a VMOS power MOSFET can be employed in a simple touch switch. When the circuit is first switched on, the capacitor C1 is normally fully discharged, so the VN46AF VMOS device passes negligible drain current.

When the upper pair of contacts is touched, current flows from the +12 V line ,through the person's skin and charges C1. The VN46AF device is thus biased to conduction and the relay closes. If a finger is now placed across the lower touch contacts, C1 discharges and the VN46AF is turned off, opening the relay. The diode D1 is used to bypass the transient voltages formed when the current ceases to flow through the relay coil — such voltages can destroy MOSFETs.

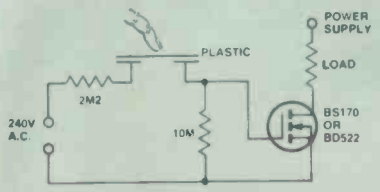


Figure 9. Capacitive touch switch.

Capacitive touch switch

The gate circuit impedance of VMOS devices is so high that circuits can be designed as touch switches in which no part of the circuit is actually touched. In Figure 9 (designed by ITT Semiconductors), the presence of a finger just above the plastic material at the point of separation of the electrodes under the plastic is sufficient to cause current to flow in the load.

The capacitance between each of the electrodes and the finger allows a small alternating current to flow through the 2M2 safety resistor to the gate circuit of the small BS170 or the larger BD522 n-channel device.

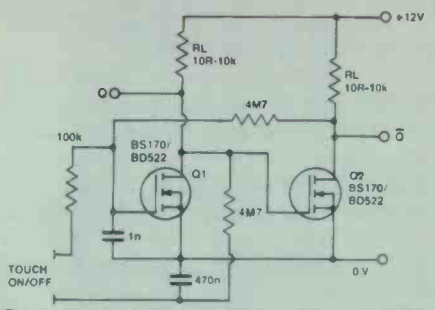


Figure 10. Capacitive touch switch will cycle on and off if finger is held on the sensor.

Figure 10 shows another touch switch designed by ITT Semiconductors, only a single touch point being used for on/off operation. When power is first switched on, T1 will conduct and T2 is kept non-conducting. Touching the sensor contacts will cause T2 to conduct and feedback from the drain of this device through the 4M7 resistor to the gate of T1 will keep the latter device in the non-conducting state. The 470n capacitor now becomes charged.

If the sensor is touched again, the positive potential from this capacitor is transferred to the gate of T1 and the latter device is switched to conduction, whilst T2 is turned off. If the sensor is touched for longer than about one second, the circuit will operate as a relaxation oscillator which changes its state about once per second. The load impedances employed in this circuit need not be identical, any values from about 10 ohm to 10k being suitable.

CMOS interfacing

The 4000 series of CMOS logic devices can provide only small output currents, but sometimes one wishes to use the output from such a device to control a relay or other load which requires a relatively large current. A VMOS device can conveniently be employed to match the high output impedance of a CMOS device to a relatively low load

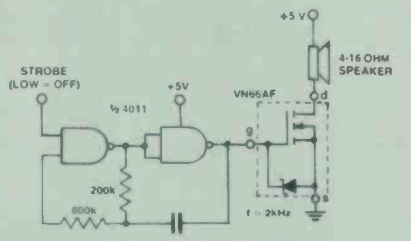


Figure 11. Audio alarm.

impedance such as a tungsten filament lamp.

An example is the audio alarm circuit of Figure 11. Two of the four logic gates of a CD4011 device are connected as a standard 2 kHz oscillator. Any appreciable current taken from the output of this oscillator affects the operation of the circuit, but the VN66AF requires negligible current and forms an ideal

interface device between the CMOS oscillator and the loudspeaker.

When the upper input of the left hand CMOS gate is connected to the +5 V line, oscillation takes place, but when this input is connected to ground, oscillation ceases. Thus a high impedance logic output can be used to switch the oscillator on and off through the use of this input to the left hand gate.

Figure 12 is an interesting variation of the circuit of Figure 11 in which the four gates of a 4011 device are used to form two oscillators. The two left hand gates form a sub-audio frequency oscillator which modulates the audio oscillator formed by the two right hand gates of Figure 12. Thus one obtains a much more impressive two-tone alarm sound than with the simpler constant-note circuit of Figure 11.

The timer circuit of Figure 13 is another example of VMOS interfacing between a CMOS device and a relay. In the quiescent state, the upper input to the left hand gate will be low and the output from this gate high. Thus the output from the right hand gate will be low and the relay will remain open.

If the start switch is momentarily closed, the high input applied to one input of the left hand gate will cause the output from this gate to go low, while the output from the right hand gate goes high and switches the VN46AF to conduction. Thus the relay closes.

The capacitor between the two gates charges slowly through the fixed and variable resistor from the positive supply line. When the inputs to the right hand gate become sufficiently high in potential, the output of this gate goes low and by feedback to the left hand gate the circuit switches back rapidly to its quiescent state in which

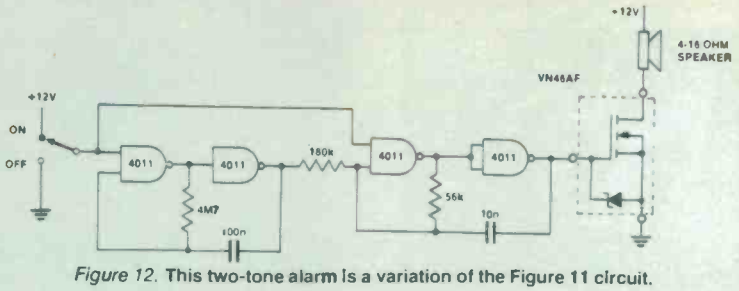


Figure 12. This two-tone alarm is a variation of the Figure 11 circuit.

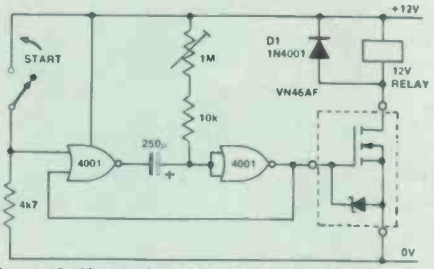


Figure 13. Simple timer has a variable range from a few seconds to a few minutes. The 1M pot sets the time the relay holds in.

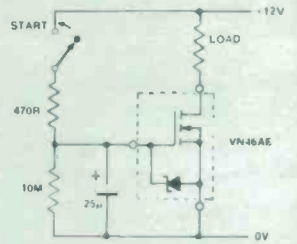


Figure 14. Simple delay timer. The load could be a lamp, relay or whatever.

negligible current passes through the relay. The length of time for which the relay remains closed can be set by the 1M pot or by altering the value of the capacitor connected between the two gates. When the values shown are used, times obtained range from a few seconds to a few minutes as the variable resistor is moved.

Delay switch

A simple VMOS delay switch is shown in Figure 14. When the switch is closed for a moment, the capacitor becomes fully charged and the VN46AF passes current through the load. The capacitor slowly discharges through the 10M resistor, so the gate voltage of the VN46AF will eventually fall to a value where very little current can pass through the load.

Auto devices

The fast switching ability of MOSFET devices renders them very suitable for use in vehicle electronic ignition systems. Timing pulses from a magnetic or other contactless pickup may be fed to an IC which provides a voltage output for the control of a MOSFET device. The latter switches the current through an ignition coil to provide the required high voltage.

An automobile circuit using a SIPMOS transistor as a power switch is shown in Figure 15. As in so many applications of MOSFET devices, the high input impedance of the SIPMOS device is utilised here, since it can be voltage driven by a suitable IC. This circuit is for an automobile alternator voltage regulator and has been designed for a SIPMOS device rated at

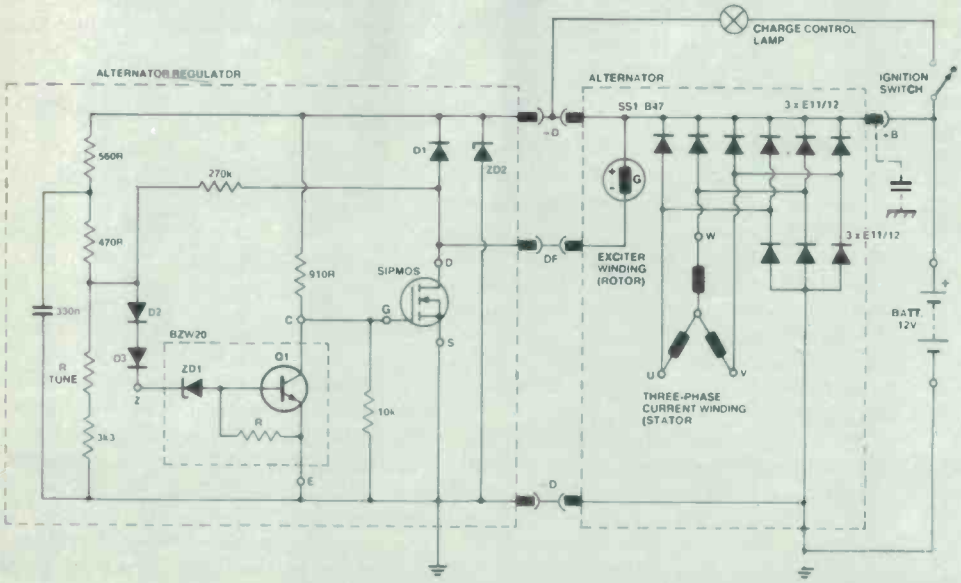


Figure 15. The latest power MOSFET development, SIPMOS, has already found application in automotive electronics. This circuit is an alternator regulator and employs a SIPMOS device rated at 500 V/8 A and an on-resistance not greater than 0.2 ohm.

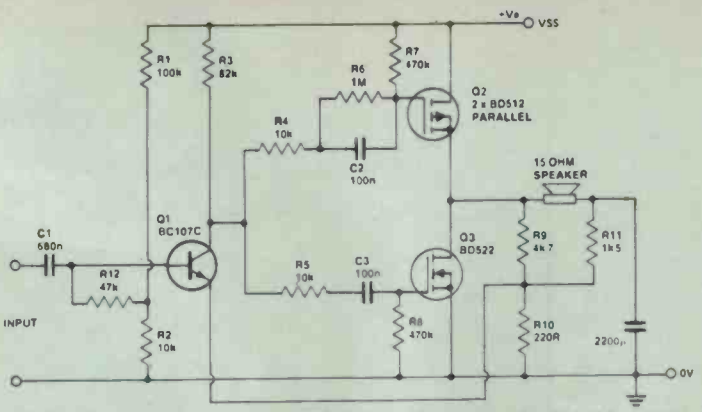


Figure 17. **Class ABC amplifier circuit from ITT Semiconductors is simple but has 3½% distortion at 1.75 W and is only suited to general applications.**

about 500 V maximum drain-to-source voltage, 8 A current and an on-resistance of not more than 0.2 ohm.

Simple audio applications

The excellent linearity of VMOS devices has attracted considerable interest in their possible use in the audio field but the relatively high price of these devices and their previously limited power handling capability retarded their adoption until recently. They may be used in simple, low-power circuits, but moderately high power ultra-low distortion circuits have also been designed using VMOS devices. The very fast switching ability of VMOS devices also makes them very suitable for Class D pulse width modulation circuits.

To operate a VMOS device as a simple class A amplifier, it is only necessary to provide a bias network so that the device operates in its linear region without cutoff. The gate is connected to a tap on a resistive potential divider across the power supply lines and the input signal is capacitively coupled to the gate. The gain will be approximately equal to the mutual conductance of the device multiplied by the load resistance; gain values of over 30 dB are obtainable, and this gain extends well into the MHz region.

A circuit of this general type is shown in Figure 16. The bias level of the VMOS device is stabilised by means of negative voltage feedback from the drain to the gate circuit.

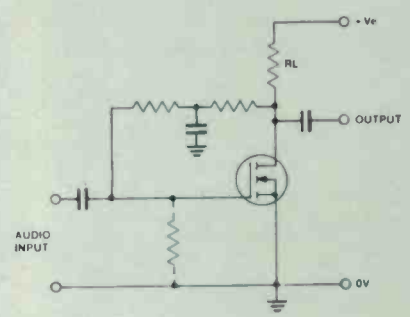


Figure 16. **General circuit of a simple class-A audio amplifier using a power MOSFET.**

Figure 17 shows a particularly interesting circuit from ITT Semiconductors which they call a class ABC amplifier, since it is basically a Class B amplifier, but one of the transistors is more in Class A, while the other is definitely in Class C. It is a simple circuit not designed for particularly low distortion.

The output stage is unusual in that it comprises two BD512 p-channel VMOS devices in one part and a complementary BD522 single device in the other part. This is because hole mobility in the p-channel BD512 is only half that of the electron mobility in the n-channel BD522s so two p-channel devices are required to obtain about the same mutual conductance as that provided by the single n-channel device. As explained earlier, MOSFETs can be connected in parallel without extra circuitry because they automatically share the current.

As the drain electrodes of the VMOS devices in Figure 17 are connected to the device tabs, all of the tabs can be bolted to the same heatsink without the need for insulating washers. The negative feedback circuit compensates for any variations in the biasing requirements of the particular VMOS devices employed. Both ac and dc feedback are employed, but there is heavier dc feedback through R11 and R10 to stabilise the quiescent dc output voltage at half the supply potential so as to ensure a maximum available output voltage swing.

This circuit provides a voltage gain of 30 and a bandwidth extending from 35 Hz to 125 kHz at the −6 dB points. Distortion increases at ultrasonic frequencies above about 25 kHz (as with most audio amplifiers). When a 25 V supply is used, the distortion is a minimum of about 0.4% at about 0.5 W, rising to about 0.8% at 1 W, 2% at 1.5 W and 3½% at 1.75 W.

High fidelity

In 1976 Siliconix published a circuit for a high quality 40 W amplifier using VMOS devices, but each half of the output stage required three VMP12 (now designated 2N6658), 90 V TO-3 devices in parallel. Thus, twelve of the devices were required in a stereo amplifier providing 40 W per channel. Rather cumbersome — and costly. However, distortion at the mid-frequency range was only about 0.04% at the 40 W level and about 0.025% at the 1 W level. Only 22 dB of feedback was needed to obtain a response flat to 4 MHz and the slew rate was 100V/μs!

One of the advantages claimed for VMOS amplifiers is the lack of transient intermodulation (TIM), because the power bandwidth exceeds the small signal bandwidth. For any frequency below 500 kHz, the amplifier simply overloads before TIM appears.

Taking things a step further, the circuit in Figure 18 is a simple power amplifier first published in the Hitachi MOSFET application notes. The 2SK133 and 2SJ48 have an on-resistance of roughly two ohms, so that at 7 A peak output current you can expect a voltage drop of about 14 V across each device. With the power supply voltages shown the circuit is capable of around 50 W.

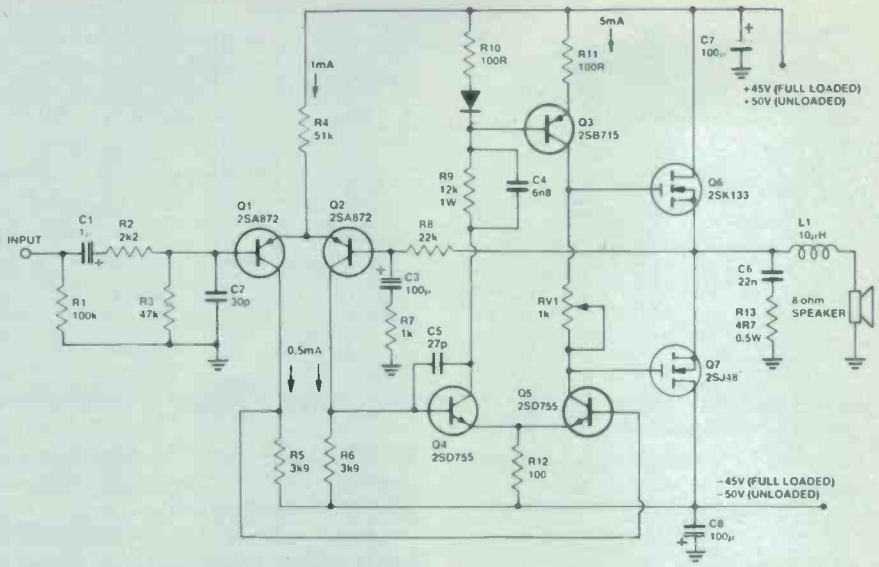


Figure 18. **Circuit of a 50 W hi-fi amplifier from the Hitachi MOSFET application notes. Performance is quite good but dependent on the driver transistors.**

The transistors forming the driver stage, Q3 and Q5, have been specially designed by Hitachi to drive MOSFETs. They're superb devices, having a V_{ceo} of 100 V and a typical gain (h_{FE}) of around 500. With these transistors the distortion characteristics shown in Figure 19 can be expected. Unfortunately, these transistors are not available in Australia at the present time and substituting alternative available transistors degrades performance considerably. A BD139/BD140 complementary pair for instance, with typical h_{FE} of around 50, is not capable of providing the necessary open-loop gain, especially at high frequencies. An experimental circuit we built with BC177s and BD139/BD140s gave less than 0.02% at 1 kHz at full power, rising to as much as 0.1% or more at 20 kHz. So, MOSFETs with all of their advantages have disadvantages too — mainly due to the fact that the forward transconductance is only a fraction of that of a good bipolar transistor.

In order to design an extremely high quality amplifier employing MOSFETs, we are really faced with a new set of problems to solve, but with the promise of performance that makes it worthwhile. (This section on Figure 18 inserted by David Tilbrook . . . Ed.).

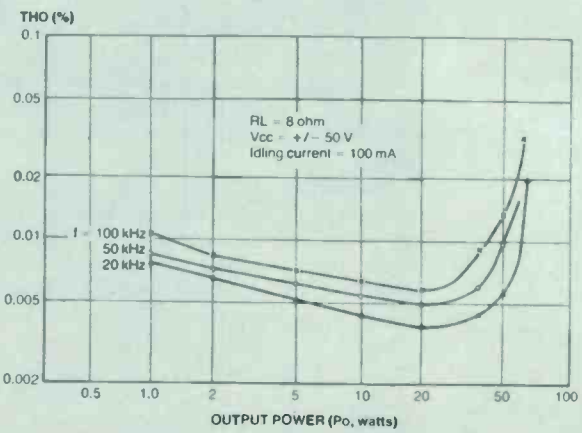


Figure 19. **Distortion characteristics of the circuit in Figure 18.**

VFETS for everyone — Part I

Wally Parsons looks back to valves to explain VFETs.

Wally Parsons

A DIODE VALVE emits electrons from a heated cathode and these are then attracted by an electric field to the positive anode. Since only the cathode is heated, current can flow in only one direction. The diode will thus act as a rectifier, conducting only on alternate half-cycles of an AC voltage (see Fig. 1).

If a grid structure is placed between these electrodes, it can be used to control current flow. A negative potential will repel electrons, opposing their flow to the anode, and by placing the grid close to the cathode, a small change in grid potential will have the same effect on anode current as a much larger change in anode potential. Therefore, the device will amplify. Since the anode current is controlled by the electric field in and around the grid, the triode is, in a sense, a field effect device.

The action is direct, and electron flow responds rapidly to changes in control potential. Moreover, in switching applications it can switch an inductive load rapidly, because the back EMF sees an extremely high impedance and no reverse current flows.

Figure 2 shows the relationship of anode voltage, grid volts, and anode current for a triode. It can be seen that anode current can be controlled by both anode volts and grid volts. If a load is inserted in the anode circuit, current changes will cause voltage changes across the load. These can be plotted in the form of a load line as shown, and also as a transfer curve for the specific load.

The amplification is quite linear, but gain and output are limited – as shown by the semi-vertical slope of the curves.

Inserting a second grid between the control grid and anode and applying a fixed positive voltage somewhat lower than on the anode further accelerates

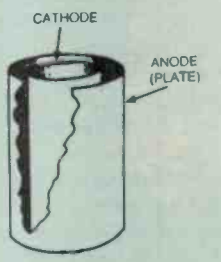
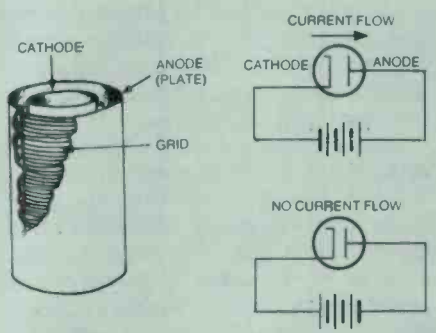


Fig 1. Basic diode tube construction and operation.



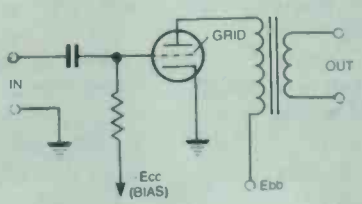
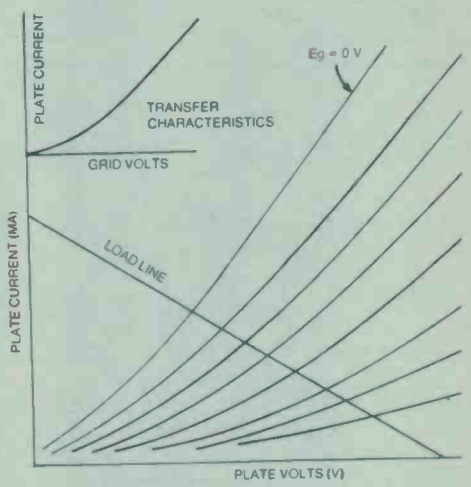


Fig 2. Triode construction, circuit and characteristics.

electrons, but because of the grid's open structure, most of them continue on to the anode. Note the screen voltage takes precedence over the anode in controlling current. And we can swing the anode voltage further for more output, and get higher gain too.

The addition of the second grid with a fixed high potential results in a current flow essentially independent of anode voltage, but still subject to the action of the control grid. (Figure 3). Trouble occurs, however, when we try



to produce an anode voltage swing lower than the screen voltage. Electrons are moving so fast that when they strike the anode they dislodge other electrons, which are attracted to the higher potential screen grid, thus reducing current through the load.

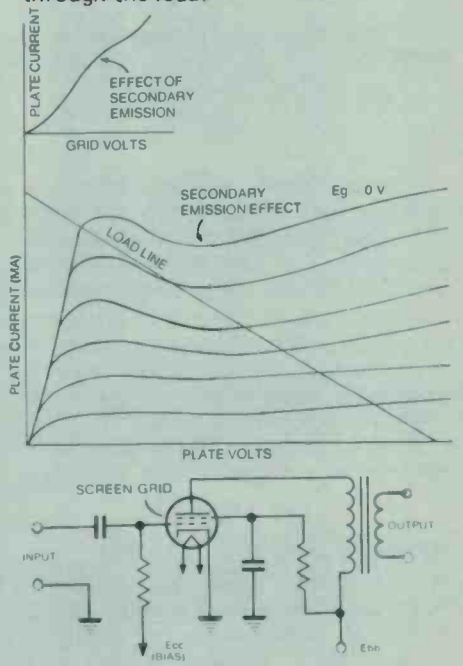
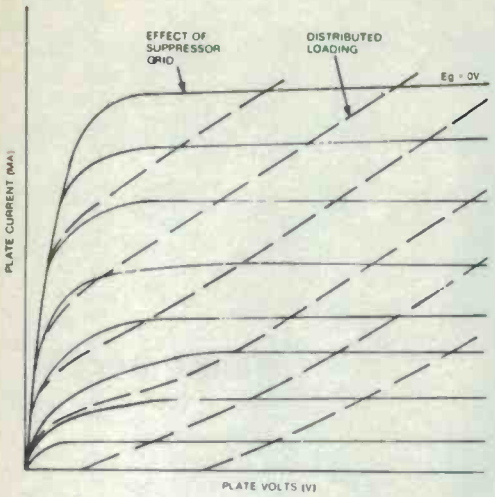
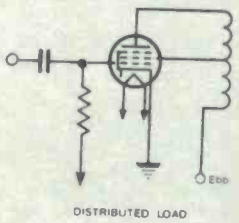


Fig 3. Series output arrangement.





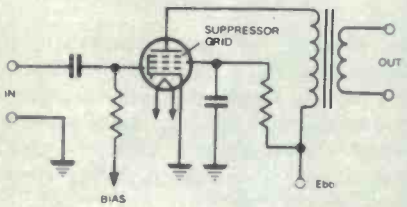


Fig 4. Single ended output with current source.

This problem was overcome by adding a third grid between the screen and plate and tied to the cathode. Because it is at cathode potential the grid pushes the secondarily emitted electrons back to the anode, resulting in a family of curves as in Figure 4.

Distributed loading is also possible by dividing the load between screen and anode, and results in Figure 4a. This kind of flexibility makes it possible to design circuits of exceptional linearity.

Problems

So far so good – except for a few problems. To begin with, the valve, like a light bulb, converts more electricity to heat than to useful work. It's very inefficient – for example the author (who is associated with the Canadian version of ETI) uses two 75 watt output class AB valve amplifiers to keep his studio at 25° C. without any additional heating in a Canadian mid-winter!

Also like a light bulb, a valve's performance deteriorates from the moment power is applied. Thus, direct coupled circuits can give real headaches in maintaining correct operating characteristics.

And then there's the output transformer. In order to match the thousands of ohms impedance to a low impedance load such as a loudspeaker, a transformer is virtually a necessity. With the inefficiencies already involved we can't afford the resultant impedance mismatches if we try to eliminate transformers. And we can't use gobs of feedback to reduce the resulting distortion. It's bad enough that, if we don't opt for a delicately balanced direct coupled circuit we have a low frequency roll-off and 90° phase shift at every R-C coupling point, but we have in any case the additional phase shift and internal resonances of the transformer. In practice, we are limited to between 20 and 26 dB of overall feedback. Obviously, a high level of open loop linearity must be designed into such an amplifier.

A great deal of engineering energy was spent designing output transformerless amplifiers, but few were successful, and those that were often created more problems than they solved.

Some legendary amplifiers *were* built using tubes. The Williamson, (I have one in daily use and it still sounds great), Quad, Leak Point One, MacIntosh Unity Coupled. The Quad, for example, delivered all of 15 watts – and was rock stable driving an electrostatic (Quad, of course) at live performance levels. Mac's drove a lot of disc cutters (at 60 watts) to produce discs which still sound spectacular.

But many were anxious to do something with the new-fangled transistors, and we did.

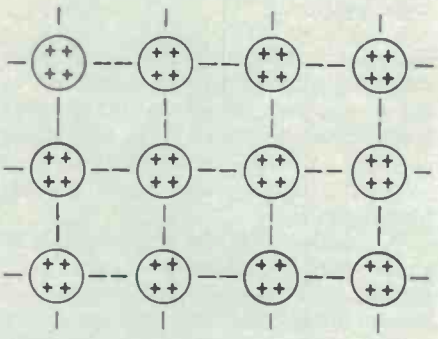


Fig 5a. Basic lattice structure

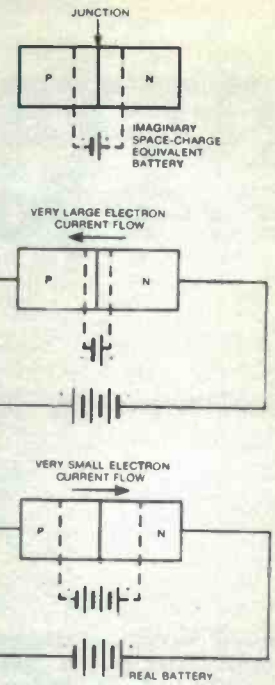


Fig 6. Drain to source resistance against temperature (Siliconix).

Transistors

The bi-polar transistor is composed of three materials, either a p-type semiconductor between two n-types, or an n-type between two p-types, (Figure 7a). A semiconductor such as silicon or germanium has a crystalline structure in the form of a diamond lattice with each atom having four adjacent neigh-

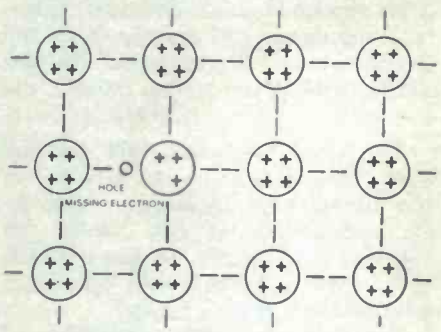


Fig 5b. P-type lattice structure.

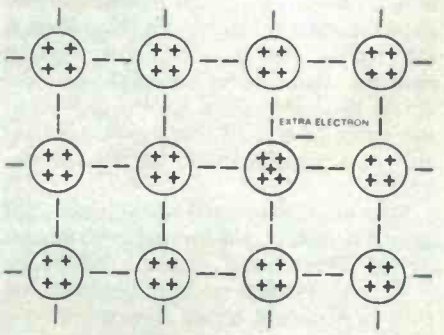


Fig 5c. N-type lattice structure.

bours, held together by co-valent bonds, each bond involving a shared pair of electrons. These electrons are not available for conducting current, so conduction is very semi. Indeed, resistance being around 100 million times that of copper.

However, if we introduce an impurity such as phosphorus or arsenic which has five valency electrons four of which form bonds while the fifth is only lightly held and is available for conduction. This is an n-type material (negative as it has an excess of electrons). If we add an impurity such as aluminium, only three valence electrons are available. Therefore, one of the valence bonds is not completed, resulting in a vacancy or hole in the lattice structure (Fig. 5). An electron from an adjacent electron pair bond may absorb enough energy to break its bond and fill the hold. This is a p-type material. This doesn't look like much of a big deal, but the result is quite dramatic.

Note that the atomic structure is in equilibrium – there is no net charge. However, if a free electron breaks its bond, it leaves behind a positive net charge; if it completes a bond by entering a hole, a negative net charge results. Current flow is produced by bringing about this carrier mobility. What was originally a very high resistance is now, under the right conditions, able to conduct substantial current, just as a small impurity (e.g. sulphuric acid) added to non-conductive pure water, makes electrolytic conduction possible.

When p and n-type materials are joined together, a p-n junction is formed (Fig. 6). Some of the free electrons from the n-type material diffuse across the junction and recombine with holes of the p-type material. The opposite process takes place with holes from the p-type material, producing a space charge or depletion region on either side of the junction, giving the p-type material a slight negative charge, and the n-type a slight positive charge. This process is finally limited by the resulting potential gradient.

If a battery is connected, as shown in Figure 6a, free electrons from the n-type material are attracted to the positive terminal, while holes from the p-type material are attracted to the negative terminal, widening the space charge region and increasing the potential gradient until it approaches that of the external battery. There is now little or no voltage difference across each region and little or no current flow. The junction is reverse biased.

If we reverse these polarities (Fig. 6b) electrons in the p-type material break their bond and enter the battery

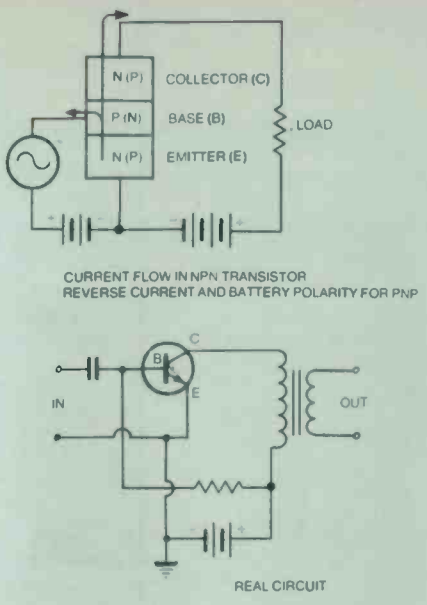


Fig 7a. Current flow in a semiconductor and circuit diagram.

creating new holes, while electrons from the battery negative terminal enter the n-type material and diffuse toward the junction. The space charge region narrows and the energy barrier becomes insignificant, so that excess electrons from the n-type material can penetrate the junction and move via the p-type holes to the positive battery terminal, for as long as voltage is applied. The junction is now forward biased.

Work!

In the device shown in Figure 7, the forward-biased emitter-junction injects electrons into the base region. The impurity or doping levels chosen are such that almost all the emitter current is composed of these electrons, and very few holes are injected into the emitter. The base region is very thin so that nearly all injected electrons diffuse to the edge of the depletion region of the reverse-biased base-collector junction where the field sweeps them across the collector bulk. Since for an equal current more power is developed across a high resistance than a low resistance, amplification occurs as a result of current being transferred from the low-resistance emitter-base junction to the high resistance collector junction.

The curves show that, as with the pentode tube, current is controlled mostly by the control electrode (base), but in this case the controlling parameter is current, not voltage. We have an inherently low-impedance device, and since it requires current into its input impedance, its signal source must be capable of delivering power. An ideal transistor requires input current, unlike an ideal vacuum tube. This reduces efficiency but we don't have to heat up a cathode to shake a few electrons loose, so our overall efficiency is vastly greater.

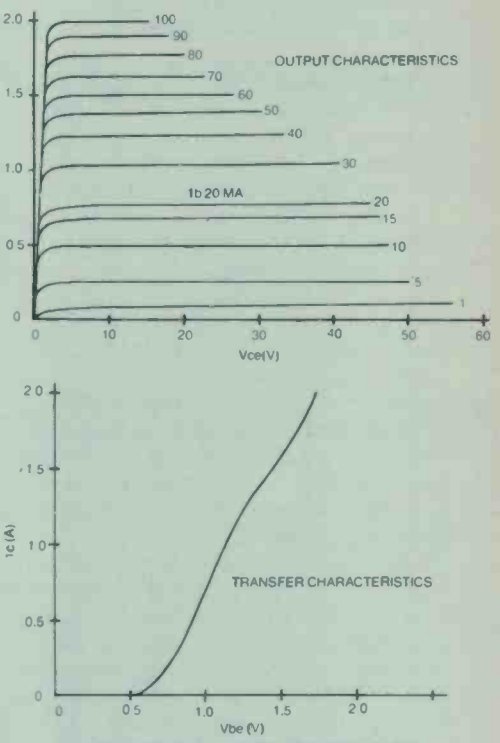


Fig 7b. Output and transfer characteristics of the 2N3054.

Disadvantage

The major disadvantage of this type of device lies in the nature of the depletion layers at the junctions, particularly the emitter-base. When current flows in a transistor, excess charge is stored in the base region. If the base-emitter junction is changed from a forward to reverse bias state, as in the negative swing of a class B or AB stage, or when a class A stage is overdriven, the junction cannot immediately switch to the reverse blocking state due to the presence of these excess charge carriers. They have the effect of allowing current to flow in reverse as if forward biased, until these charge carriers are removed.

In addition, there is capacitance effect associated with the barriers of a reverse-discharge time. The result is a switching transient during part of a cycle, sometimes erroneously referred to as crossover distortion (the latter occurs in any device in push-pull and is due to a discontinuity in the transfer function, usually caused by incorrect bias). This can be reduced by reducing the junction area but this reduces the dissipation capability. In fact, a transistor design favouring one characteristic usually does so at the expense of others.

Also, as temperature rises in the

device (due to current flow, for example) carrier mobility at the junctions increases, causing further increase in current. The current increase further raises temperature, which raises current – which further raises temperature – and so on. The resulting thermal runaway can quickly destroy the device. In milliseconds!

In large area transistors, current tends to become nonuniform in distribution. The temperature rise in the high current region leads to localized thermal runaway until equilibrium is reached by a sharp drop in collector voltage, (called secondary breakdown) frequently destroying the device. This is more true at high voltage and low current than the reverse, and frequently means that rated dissipation cannot be reached. This leads to overdesign, unnecessarily high voltage and dissipation ratings (and remember, a design which favours one characteristic often does so at the expense of others) plus elaborate protective circuits.

High levels of feedback are generally used to control distortion, and this in conjunction with the excess charge condition in the base, leads directly to transient overload, and resultant transient intermodulation. Output is delayed during this charge/discharge, which delays application of feedback. It simply isn't available. The input signal is not immediately reduced by feedback, and passes through at high initial level.

The millenium has not quite arrived after all!

The FET

Since a semi-conductor is precisely that, a battery connected across the ends of a p-type or an n-type bar will cause current to flow through the material, just as it does through a vacuum tube. We discussed earlier the characteristics of a pn junction. If, for example, a p-type material is joined to the surface of an n-type bar, located between the battery terminals, a pn junction is formed, and if this junction is reverse biased, a space charge or field is produced of opposite polarity which will inhibit current flow, just as the control grid inhibits current flow in a vacuum tube. Changing this reverse voltage causes a large current change, and amplification results.

A simple junction FET is shown in Figure 8. With a given drain-source voltage, maximum current flows at zero gate voltage, and at some reverse voltage, determined by device geometry and doping levels, no current will flow. Also, as in the vacuum tube, load characteristics are not reflected to the input circuit, because current is not controlled by carrier injection as in bipolars, but by voltage levels.

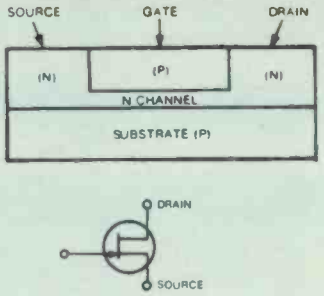


Fig 8. N-channel JFET construction and symbol.

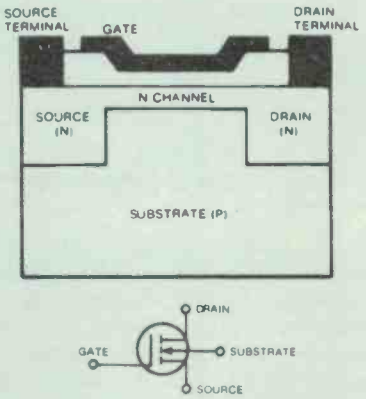


Fig 9a. N-channel depletion horizontal MOSFET construction and symbol.

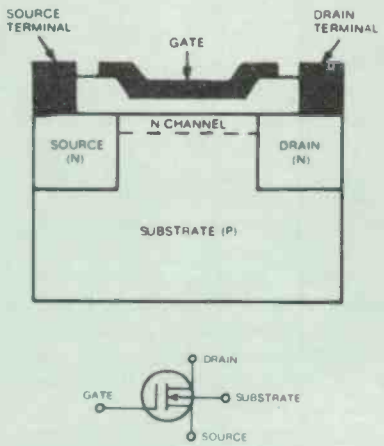


Fig 9B. N-channel enhancement horizontal MOSFET construction and symbol.

A variation is the Metal Oxide Semiconductor Field Effect Transistor. (MOSFET) (Fig. 9) a far more versatile device whose technology is virtually the cornerstone of modern computer technology, although it has had less use to date in linear applications such as audio amplification.

MOSFETS come in two basic types. In both the gate consists of a metal electrode separated from the channel by a thin oxide layer. In the depletion type current flow is controlled by the electrostatic field of the gate when biased. When a depletion MOSFET is so biased the device may be driven on both sides of the zero volts point as with vacuum tubes. Unlike vacuum tubes, under these conditions, the gate draws no current, therefore does not require the driver to deliver power.

The enhancement type MOSFET shown in Figure 9b, is more widely used. The source and drain are separated by a substrate of opposite material, and under zero gate volts no current flows. However, when sufficient forward bias is applied to the gate the region under the gate changes to its opposite type (e.g. p-type becomes n-type) and provides a conductive channel between drain and source. Carrier level, and conduction is controlled by the magnitude of gate voltage.

Although MOSFETS are handy devices they are not capable of handling high power levels. The channel depth available for conduction is limited by the practical limits on gate voltage. The lower current density has been the primary limitation due to the horizontal current flow.

VFETS

Recent years have seen the introduction and commercial use of Vertical Channel J-FETS, notably by Sony and Yamaha (Fig. 10). The vertical channel permits a very high width-length ratio, permitting a decreased inherent channel resistance and high current density. Unfortunately it suffers the same disadvantages as the small signal J-FET, plus, in currently available devices, a very high input capacitance, ranging from 700 pF to around 3000 pF, limiting high frequency response. In addition, since they must be biased into the off condition, bias must be applied before supply voltage and removed after the supply if it is to be operated anywhere near its maximum ratings. This problem doesn't exist with vacuum tubes because of heater warm-up time, although some

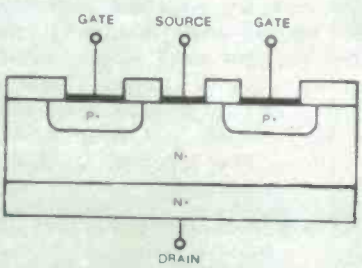


Fig 10. Vertical junction FET construction.

"instant-on" circuits impose heavy turn-on surges.

This necessitates a complex power supply, and Yamaha, for example, uses more devices in the supply than it does in its amplifier circuits. However, the construction does make possible the design of complementary types and both Nippon Electric and Sony have high power devices available.

However, the Vertical MOSFETS by Siliconix are readily available, at reasonable prices, and the manufacturer most generous in providing data. The following information is extracted from their application note AN76-3, Design Aid DA 76-1, plus device data sheets.

The device

Notice in Figure 11, that the substrate and body are opposite type materials separated by an epi layer (similar to high speed bi-polars). The purpose of this structure is to absorb the depletion region from the drain-body junction thus increasing the drain-source breakdown voltage. An alternative would have involved an unacceptable trade-off between increasing the substrate-body depth to increase breakdown voltage (but increasing current path resistance)

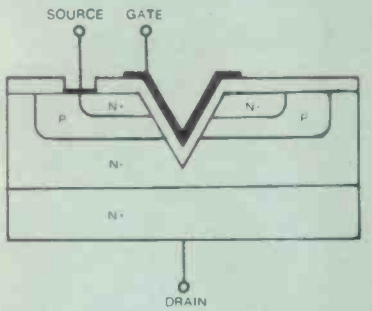


Fig 11. Vertical MOSFET construction (Siliconix).

and lengthening the channel. In addition, feedback capacitance is reduced by having the gate overlap n-epi material instead of n+.

In manufacture, the substrate-drain and epi layer are grown, then the p-body and n+ source diffused into the epi layer, in a simiar manner as the base and emitter of a diffusion type transistor. A V groove is etched through the device and into the epi layer, an oxide layer grown, then etched away to provide for the source contact and an aluminium gate deposited. This type of device allows current flow in one direction only; this is not always so with a similar type of horizontal FET, where source and drain may be identical in structure and of the same material. Therefore, no reverse current flows (we hope) when used in switching applications, as was also the case with vacuum tubes.

In-circuit operation is refreshingly simple: Supply voltage is applied between source and drain, with the drain positive with respect to the source, under which conditions no current flows, and the device is off. This is an enhancement type device, and is turned on by taking the gate positive with respect to the source and body. The electric field induces an n channel on both surfaces of the body facing the gate, and allows electrons to flow from the negative source through the induced channel and epi and through the substrate-drain. The magnitude of current flow is controlled almost entirely by the gate voltage, as seen in the family of curves (Fig. 12) with no change resulting from supply voltage changes above 10 V.

Advantages

The vertical structure results in several advantages over horizontal MOSFETS.
1) Since diffusion depths are controllable to close tolerances, channel length, which is determined by diffusion depth, is precisely controlled. Thus, width/length ratio of the channel, which determines current density, can be made quite large. For example, the VMP1 channel length of about 1.5 μ, as against a minimum of 5 μ in horizontal MOSFETS, due to the lower degree of control of the shadow masking and etching techniques used in such devices.
2) In effect, two parallel devices are formed, with a channel on either side of the V groove, thus doubling current density.
3) Drain metal runs are not required when the substrate forms the drain contact, resulting in reduced chip area, and thus reduced saturation resistance.
4) High current density results in low chip capacitance. Also, unlike horizontal MOSFETS, there is no need to provide extra drain gate overlap to allow for shadow mask inaccuracies, so feedback capacitance is minimized.

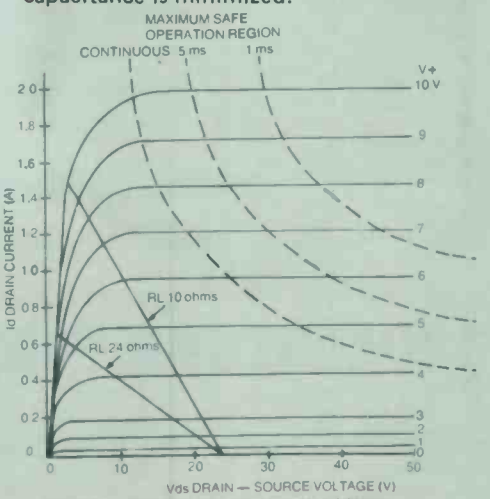


Fig 12a. Output characteristics VMP1.

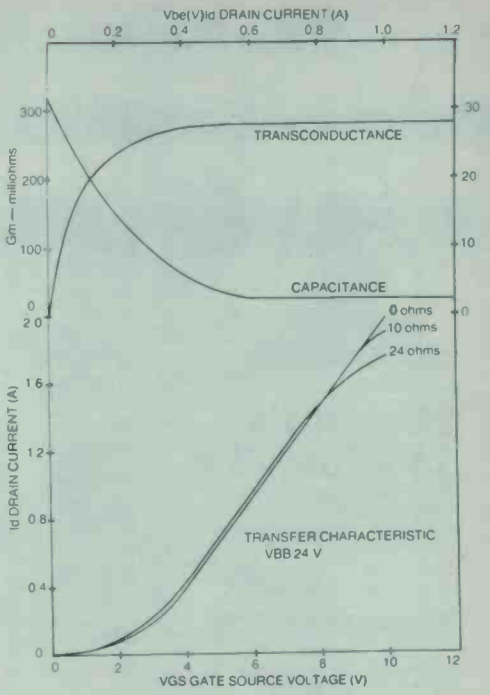


Fig 12b. Other VMP1 characteristics.

In comparison with bi-polars, especially power devices, the advantages are even more impressive.
1) Input impedance is very high, comparable to vacuum tubes, since it is a voltage controlled device, with no base circuit drawing current from the driver stage. A 7 V swing at the gate, at virtually 0A, represents almost 0W of power, but can produce a swing of 1.8 A in output current. This represents considerable power gain and will interface directly with high impedance voltage drivers.
2) There is no minority carrier storage time, no injection, extraction, recombination of carriers, resulting in very fast switching and no switching transient in class B and AB amplifiers. Switching time for a VMP1 is 4 ns for 1 A, easily 10-200 times faster than bi-polars, and rivalling many vacuum tubes.
3) No secondary breakdown, and no thermal runaway. VMOS devices exhibit a negative temperature coefficient with respect to current, since there is no carrier recombination activity to be speeded up with temperature. Thus, as current increases so does temperature, but the temperature rise reduces current flow. It is still possible to destroy the device by exceeding its maximum ratings, but a brief near-overload does not result in an uncontrollable runaway condition. Usually, simple fusing and/or thermistor protection is sufficient for maximum safety, and even this may be unnecessary with conservative design. Absence of secondary breakdown means that full dissipation can be realized even at higher supply voltages. In this respect they resemble vacuum tubes.

HIGH VOLTAGE SPECIALS!!

Rheostats 150ohm/25W

Massive savings on these ceramic body ¼" shaft rheostats. Normally $12.00 each. What a giveaway!!

normally $12.00 **$1.00 each**

Knobs to suit 20¢

Scoop purchase!! Hitachi 2114AP2

Fantastic price on brand new Hitachi 2114AP2. These are low power 200nS devices going for a song!! But stocks are limited so you'll have to be quick.

$1.50 each.

$1.30 10up

★★★★★★★★★★★★★

IC Clearout!!

4001A	10 for $1.00 100 for $9.00
4013B	40¢ each 10 for $3.50 100 for $30.00
4020A	10 for $2.50 100 for $22.00
7473	25¢ each 10 for $2.00 100 for $18.00
74121	25¢ each 10 for $2.00 100 for $18.00

SUPER SPECIAL Supergiveaway!! MOSTEK Z80 PIO and Z80 CTC. Both 2.5MHz. Were $6.75. Look at the savings **now only $3.00 each!!**

6116-P3 RAMs

Fantastic deals on these hard to get CMOS static RAMs. Order now to avoid disappointment!!

$7.00

10 for $63.00

Lamp Switch Bargain

We have a limited stock of these top quality Clipsal lamp holder, cord, plug and switch sets. These super handy sets normally sell for over $5.00, but we want to clear them out, so they're going at silly prices!!

$1.50 each, 10 for $13.00

★★★★★★★★★★★★★★★★★★★★★★

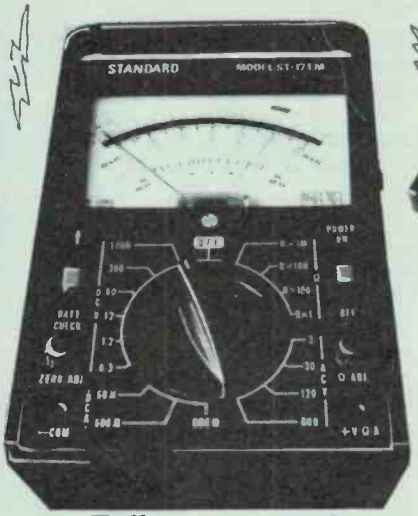
Monolithic Caps Sellout!!

These tiny 50V caps are ideal for computer and all bypass applications. We've slashed the prices. What a deal!!

.001uF .... 10¢ each, 8¢ 10up
.01uf ..... 15¢ each, 13¢ 10up
.1uF ..... 20¢ each, 15¢ 10up
1uF ..... 40¢ each, 35¢ 10 up

TOO GOOD TO RESIST!!

SCOOP PURCHASE



Fully guaranteed

Superb FET Meter

This highly accurate instrument is ideal for the hobbyist needing an instrument with a constant high input impedance on the voltage ranges and with extended resistance ranges. A balanced FET amplifier ensures high stability. Both movement and input section are diode protected.

NB The AC voltage frequency response is -3dB/30Hz to 100kHz on 3 and 30 volt ranges, this is far superior to all but very expensive digital meters. If you need to make audio frequency measurements, a FET meter is virtually essential.

only $38.00
reduced from $74.00

Brief Specifications:
Input Resistance: 12 megohms on all DC ranges (except 0.3V, 1.2 megohms)
DC Voltage : 0.3 1.2, 12, 60, 300, 1200V
AC Voltage: 3, 30, 120, 300
DC Current: 60uA, 600uA, 600mA.
Resistance Ranges: RX1, RX100, RX10K, RX1M
Accuracy: Within 3%
Decibel Scale: -20 to 63dB

Don't go ohm without one!!

Fully guaranteed

ST-100 100,000ohms/volt Multimeter

These meter features ultra high 100,000ohms/volt sensitivity and a superb 3¾" 10uA movement. A mirrored scale ensures reading accuracy and OF position protects the movement during transit.

only $26.00
normally $52.00

Brief Specifications
Ranges: 28 in total
DC Voltage: 0-0.5 -5 -50 -100 -250 -500 -1000V
AC Voltage: 0-5 -10 -50 -200 -500 -1000V
DC Current: 0-10uA -2.5mA -5mA -500mA
Resistance: 0-10K -1M -10M -100M
Decibels: -20 to 63dB in 6 ranges
Accuracy: within 4%
Size: 6" x 4¼" x 2"

Fully guaranteed

12-Digit LED Display

Sheridan does it again with a fantastic deal on these common cathode LED numeric arrays. Each digit is a 7 segment readout with a right hand decimal point. Eight inputs are provided for selection of segments and 12 inputs for digits (cathodes). The anodes are internally connected for multiplexing. Easy to interface with TTL, DTL or CMOS operation.

only $1.50

SHERIDAN ELECTRONICS

164-166 Redfern St., Redfern NSW 2016. Phone (02) 699 6912, (02) 699 5922. Mail Orders to Dept ETL, PO Box 229 Redfern NSW 2016

Trading Hours:-
Mon-Fri 9am-5.30pm
Thursday 9am-7pm
Saturday ... 9am-12noon

All prices include sales tax

Mail Charges:

$5.00-$9.00	$3.50
$10.00-$24.99	$4.00
$25.00-$49.99	$6.00
$50.00-$99.99	$7.00
$100 or over	$8.00

Note: We regret we cannot give quantity prices on credit card purchases.
Credit Cards: We accept both Bankcard and American Express.

Minimum mail order $6.00

Am Express 923 1499

VFETS for everyone — Part II

In the first part of this article we examined the structure and features of a new type of semiconductor, the vertical channel power metal oxide semiconductor, Vertical MOSFET, or V-MOS, introduced by Siliconix. The second part of the article covers the actual use of V-MOS.

Wally Parsons

V-MOS POWER FETS like signal MOSFETS, may be used to perform many different functions. However, no matter what the circuit, certain conditions, common to all applications, must be provided. These are supply power, loading, drive signal, and establishment of appropriate operating points.

The electrical characteristics of the VMP1, VMP11, and VMP12, are shown in Fig. 1, and Fig. 2 shows them in graphic form. Since these are unidirectional devices, the source and drain are not interchangeable, and as they are n-channel devices conduction can occur only if the drain is positive with respect to the source, and high enough to ensure operation in the linear region — as with a vacuum tube, bi-polar transistor, or signal FET.

Like the vacuum tube, the absence of secondary breakdown allows full dissipation at any voltage supply up to maximum voltage and current ratings. Thus, where two different designs require the same dissipation but different voltage/load current, no derating is required. This is shown in the "safe operating area" curves. The only bi-polar transistor possessing this characteristic is the single-diffused type, which is also the least suitable for any application requiring wide bandwidth and/or high speed.

This characteristic also simplifies the establishment of suitable load-lines allowing greater safety margin in driving reactive loads where the load-line may be elliptical to the point of leaving the safe-operating area. Designers accustomed to using high voltage high dissipation devices to assure adequate safety margins at relatively low power levels need not therefore be too disconcerted at the 25 watt rating of these devices.

A 10 watt class A amplifier suitable for driving a tweeter in a bi-amped speaker system, for example, need not suffer excessive dissipation except perhaps with an electrostatic unit where such a power level would be inadequate anyway, unless it were operating at a very high cross-over frequency.

Output

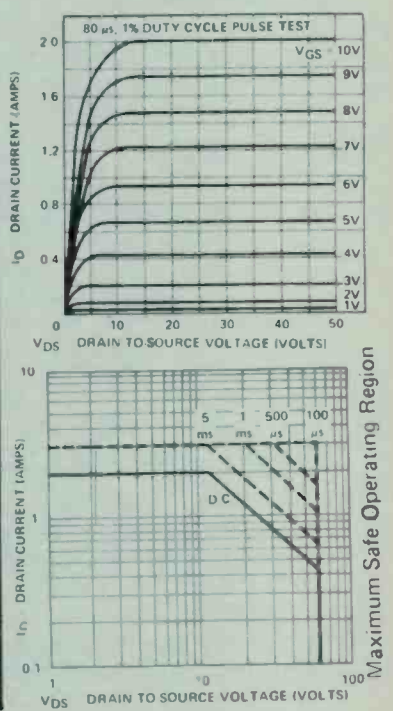
These devices may use any of the types of output circuits in general use with tubes and bi-polars, including transformer coupled (Fig. 12) where the benefits of the absence of charge carrier storage become apparent in the absence of severe ringing at the cross-over point, conventional series output such as in Fig. 3, which is a straightforward transformation from a bi-polar

Fig. 2 Typical VMP1 performance curves (Siliconix).

Fig. 1 Electrical characteristics of the VMP devices (Siliconix).

		Characteristics		VMP 11			VMP 1			VMP 12			Unit	Test Conditions
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
1	STATIC	BV_{DSS}	Drain-Source Breakdown	35			60			90			V	V_{GS} = 0; I_D = 100 μA
2	STATIC	$V_{GS(th)}$	Gate Threshold Voltage	0.8		2.0	0.8		2.0	0.8		2.0	V	V_{GS} = V_{DS}; I_D = 1 mA
3	STATIC	I_{GSS}	Gate-Body Leakage			0.5			0.5			0.5	μA	V_{GS} = 15 V; V_{DS} = 0
4	STATIC	$I_{D(off)}$	Drain Cutoff Current			0.5			0.5			0.5	μA	V_{GS} = 0; V_{DS} = 24 V
5	STATIC	$I_{D(on)}$	Drain ON Current*	1	2.0		1	2.0		1	2.0		A	V_{DS} = 24 V; V_{GS} = 10 V
6	STATIC	$I_{D(on)}$	Drain ON Current*	0.5			0.5			0.3			A	V_{DS} = 24 V; V_{GS} = 5 V
7	SWITCH	$r_{DS(on)}$	Drain-Source ON Resistance*		2.0	2.5		3.0	3.5		3.7	4.5	Ω	V_{GS} = 5 V; I_D = 0.1 A
8	SWITCH	$r_{DS(on)}$	Drain-Source ON Resistance*		2.4	3.0		3.3	4.0		4.6	5.5	Ω	V_{GS} = 5 V; I_D = 0.3 A
9	SWITCH	$r_{DS(on)}$	Drain-Source ON Resistance*		1.2	1.5		1.9	2.5		2.6	3.2	Ω	V_{GS} = 10 V; I_D = 0.5 A
10	SWITCH	$r_{DS(on)}$	Drain-Source ON Resistance*		1.4	1.8		2.2	3.0		3.4	4.0	Ω	V_{GS} = 10 V; I_D = 1 A
11	DYNAMIC	g_m	Forward Transconductance*	200	270		200	270		170			mΩ	V_{DS} = 24 V; I_D = 0.5 A
12	DYNAMIC	C_{iss}	Input Capacitance		48			48			48		pF	V_{GS} = 0; V_{DS} = 24 V f = 1 MHz
13	DYNAMIC	C_{rss}	Reverse Transfer Capacitance		7			7			7		pF	V_{GS} = 0; V_{DS} = 24 V f = 1 MHz
14	DYNAMIC	C_{oss}	Common Source Output Capacitance		33			33			33		pF	V_{GS} = 0; V_{DS} = 24 V f = 1 MHz
15	DYNAMIC	t_{ON}	Turn ON Time**		4	10		4	10		4	10	ns	See Switching Time Test Circuit
16	DYNAMIC	t_{OFF}	Turn OFF Time**		4	10		4	10		4	10	ns	See Switching Time Test Circuit
														VMC

*Pulse Test **Sample Test
Pulse Test Pulse Width = 80 μsec, Duty Cycle = 1%



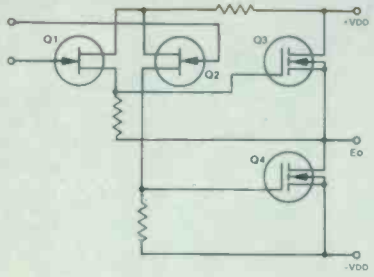


Fig. 3 Series output arrangement

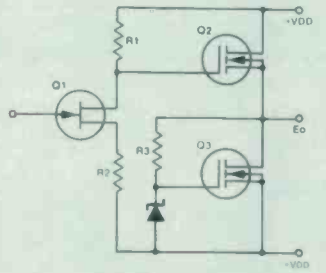


Fig. 4 Single ended output with current source.

circuit (1), and single-ended output with current source, also transposed from an excellent bi-polar circuit (2) (Fig. 4).

Bias and drive

These series of devices are n-channel, enhancement type MOSFETS, and may be biased and driven using methods appropriate to signal types and bi-polars. The drain is made positive with respect to the source and the gate enables conduction by being forward biased with respect to the source, that is to say it is biased in a positive direction. Unlike bi-polars, however, they are voltage, rather than current controlled, and circuit values are selected to provide the required voltage. Any current drawn is by the bias network itself.

Three bias methods are shown in Fig. 5. Figure 5a shows bias supplied from a fixed bias supply. It is the simplest possible method, allows extremely high input impedances since Rg may be almost any very high value desired, and its stability is limited only by the stability of the bias supply.

The design shown in Fig. 5b has the advantage of requiring no extra supply voltage since it is taken from Vdd. Disadvantages are low impedance and stability. Input impedance consists of the parallel combination of R1 and R2 (disregarding input capacitance of the MOSFET and the very low input leakage.) There are practical limits as to how high this combination can become; if for example, we have a 60 volt supply and require 6 volts bias, we might have some difficulty obtaining higher values than 9 megohms and one megohm for R1 and R2.

Higher values become more difficult to obtain, stability becomes less reliable, internal inductance and distributed capacitance become problems, and overcoming these difficulties usually costs money. In addition, if Vdd is subject to variation, then bias varies. In a class AB amplifier this could be quite serious, since Vdd varies considerably with output level; at high levels, Vdd can be expected to drop, causing a reduction in bias.

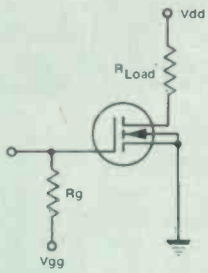


Fig. 5a. Hi-Z separate bias supply.

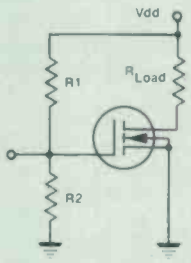


Fig. 5b. Moderate impedance supply.

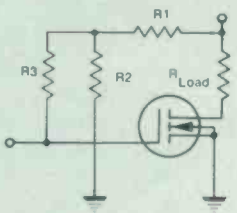


Fig. 5c. Hi-Z common supply.

While this may reduce the danger of over-driving the device, it will be forced to operate in its non-linear region which may result in unacceptable performance characteristics unless taken into consideration in the overall circuit design (e.g. choice of feedback values). It does provide some degree of overload protection, and with correct choice of values can provide for class AB operation at low levels, shifting to class B at high levels. With these considerations in mind, and/or where moderate impedances are required, it offers a low cost, simple, and reasonably reliable method of establishing the operating point.

The method used in Fig. 5c is similar except that with the addition of R3 higher input impedances are possible. Its configuration is similar to a noiseless biasing system frequently used in low-level bi-polar amplifiers and integrated circuits (e.g. National LM381A) but its function is somewhat different. Resistors R1 and R2 form a voltage divider as in Fig. 5b, but their junction now forms a fixed bias source as in Fig. 5a. Resistor R3 can be quite high since no current flows. Meanwhile, since the parallel combination of R1 and R2 are effectively in series with R3 they can be reduced to more manageable values. Alternatively R2 can be replaced by Zener diode for stability comparable to Fig. 5a.

Input protection

Unlike most signal MOSFETS, the gate of each of these devices, with the exception of the VMP4, is protected with an internal 15 volt, 10 mA zener diode. Most signal MOSFETS, as well as the VMP 4, are unprotected, or where extremely high impedances are not required, are protected by back to back zeners. I have no information as to why this different technique is used.

This different technique is used, but it is obvious that a negative signal swing on the gate will result in forward current through the zener. If the device is to be driven beyond cutoff, the driver must be capable of delivering current during its negative swing. Alternatively, a constant current source can be used, a series limiting resistor or a driver biased to the same class of operation as the V-MOS FET.

A constant current source (we'll examine an example of its use a little later) will limit current drive to the value of the constant current diode used; a series resistance will drop the drive voltage as the diode draws current. In both cases, diode current must be limited to 10 ma maximum. Higher currents will damage the protective zener diode.

In amplifier applications, a class A driver is commonly used. However, if a class B output is used, conduction only occurs during positive half-cycles. Therefore drive signal is not required during negative half-cycles. If a source or

emitter follower driver stage is biased so as to pass no negative drive, the problem does not occur. However, great care must be exercised in the design of such a stage to ensure that drive does not disappear before the output device is cut off.

This is not too difficult with a class B or near class B stage; If the output device is operated at zero bias, then a small amount of bias on the driver will ensure conduction during slightly more than 180 degrees. Class AB operation is a little more tricky. If conduction is to occur for 270 degrees, for example, the driver should conduct for slightly more than this period.

Two types of drive circuits familiar to designers of bi-polar circuits are the Darlington and super beta, commonly used together to provide a quasi-complementary circuit. Both circuits are current amplifiers designed to provide a compound device with very high hfe and provide base current to the output device. However, similar circuits can be used with these devices to provide phase inversion in a series output stage.

Thermal considerations

As described earlier (Part 1) these devices exhibit a negative temperature coefficient with respect to current, so that as temperature rises, current is reduced, thus providing a self-inhibiting action which provides some protection against overload. However, this is not an unconditional effect Fig. 6 shows the relationship between RDS(on) and temperature (3), based on a worst case temperature coefficient of 0.7 per cent per degree C.

Suppose that the device when 'on' passes a current of 1 amp which causes it to heat up. The 'on' resistance increases (which is why current drops), increasing the voltage drop across the device and the device dissipation. Now, if adequate heat sinking is used there is no real problem but if it isn't, the 'on' resistance and junction temperature will rise to the point where extra charge carriers are generated, thus stabilizing

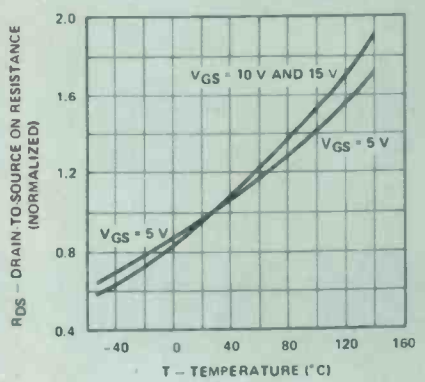


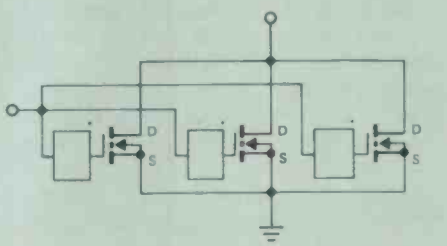
Fig. 6 Drain to source resistance against temperature (Siliconix).

RDS(on). That's great, except for the fact that this doesn't occur until the maximum safe junction temperature of 150 degrees has been exceeded.

You'll remember that we said earlier that the device was free of thermal runaway problems because of its negative temperature coefficient, but it isn't free of thermal destruction problems, and in any case, excessive temperatures will reduce output conductance. Heat-sinking requirements are, therefore, similar to those of bi-polars. The calculations of thermal operating conditions are beyond the scope of this article, but interested readers are referred to the Siliconix literature listed in the references, (4).

Extending the ratings

The current handling and therefore total dissipation capability may be increased by simply connecting several devices in parallel (Fig. 7). No ballast resistors are needed to ensure proper current sharing since if one device draws more current than another it simply gets a little warmer which causes it to draw less (assuming adequate heat sinking, of



*TO PREVENT SPURIOUS OSCILLATIONS, A 500 Ω 1K Ω RESISTOR OR FERRITE BEAD (FOR HIGHER SPEED) SHOULD BE CONNECTED IN SERIES WITH EACH GATE

Fig. 7 Basic circuit for parallel operation (Siliconix).

course). The only major precaution needed is to keep lead inductance in the gate and source connections to a minimum to prevent parasitic oscillations, unless the devices are driven from a low impedance source.

It may be advisable to insert what the British call "stoppers" – small resistors (100 to 1000 ohms) in series with each gate, wired directly to the socket, or ferrite beads mounted on the leads close to the socket terminals. An additional plus when paralleling several devices is that the gm is multiplied by the number of devices used. Mutual conductance gm is specified as the ratio of a large change in current to a small change in control voltage. If, for example, a change of 0.4 volts on the gate produces a change of 0.1 amp through one device, connecting two devices in parallel will give us an output swing of 0.2 amps, but it will still require only the original 0.4

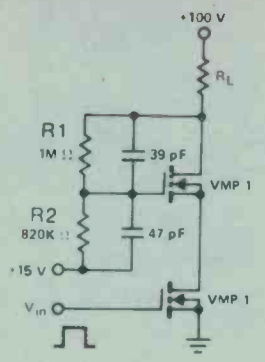


Fig. 8 Diagram for series operation (Siliconix).

volts gate swing. Since voltage gain A=gm x RL, if gm is increased, A is increased.

In real use, of course, the internal resistance of two devices in parallel is less than of one, the optimum load is less, so in amplifier applications, the net amplification A is the same. But notice that the drive requirements have not changed. With bi-polars current would have to be supplied to each base, thus increasing the output requirements of the drivers. Indeed, with many high-power amplifiers using multiple output devices the drivers are also power devices.

We can also extend the voltage ratings by series operation of two or more devices Fig. 8 shows the technique. Resistors R1 and R2 bias Q2 'on', while C1 and C2 ensure fast switching. The input control signal is inserted between gate and source of Q1. Ordinarily the bottom of the divider chain is at ground potential for signal frequencies, so that circuit is really a cascade.

Maximum current and gm are the same for one device.

Practical applications

An efficient light dimmer circuit as proposed by Siliconix is shown in Fig. 9. The 4011 acts as a pulse width modulated oscillator whose duty cycle is determined by the ratio of R1 to R2, with R2 adjusted to control the brightness of the W-90 bulb. Of special interest here is the fact that with its fast switching time, the VMP1 is especially suited to pulse width modulation at power levels and suggests it as being suitable for use in switching, or class D linear amplifiers.

A DC to DC converter is outlined in Fig. 10. The VMP1s form an oscillator with positive feedback provided by the additional coil in the gate circuits. In operation the upper V-MOSFET is biased 'on', and the lower V-MOSFET

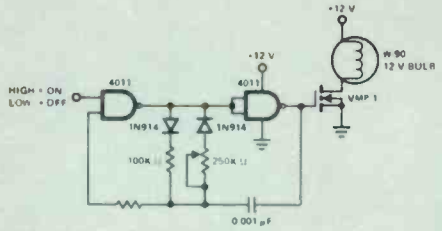


Fig. 9 Circuit of a high efficiency light dimmer (Siliconix).

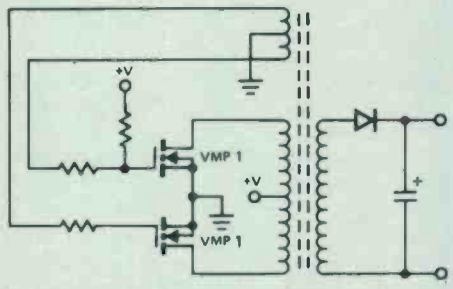


Fig. 10 A d.c. to d.c. converter (Siliconix).

is 'off'. When power is applied the upper device conducts causing current to flow from Vdd through the upper half of the transformer primary and the upper V-MOSFET to ground. The induced current flow through the feedback coil develops a voltage such as to shift the bias in the upper device 'off' (if the winding is connected with the correct polarity) and the lower device 'on'. This causes current flow from Vdd through the lower half of the transformer primary and the lower V-MOSFET to ground.

The secondary circuit consists of a single rectifier and filter. The resistor in the upper gate prevents shorting out gate bias, and the one in the lower gate keeps both sides balanced. In addition, each resistor limits current through the protective diodes. These are expensive devices for such an application, but the high reliability, the reduced rf radiation (due to reduced switching transients) and the circuit simplicity easily make up for the cost. The very high circuit impedance enables running frequency to be set by the self-resonance of the transformer.

Single-ended push-pull transformer coupled audio amplifiers are shown in Figs. 11 and 12. Both utilize the biasing system described in Fig. 5b. A load-line drawn on the output characteristic will show the optimum load to be 24 ohms. In Fig. 11 gate drive is supplied by a single junction FET, and voltage feedback is taken from the output transformer secondary and series fed to the source of the input device. Distortion is under 2% at full output (try to get that with a single ended tube or bi-polar) and could probably be reduced even further by adopting a source follower output stage.

A push-pull version of Fig. 11 is shown in Fig. 12 using a differential input to provide phase splitting, drive, and a feedback point. Although the transformer winding ratio implies the use of a low impedance loudspeaker, a step-up ratio could be used for direct coupling to an electrostatic speaker, a balanced transmission line (both with some modification of the feedback circuit) an unbalanced transmission line, or a 70 volt speaker distribution line.

Notice in both circuits, and in the biasing circuits of Fig. 5, that no source resistors have been used, either for local feedback or for bias setting. In tube and bi-polar circuits it's a useful technique, and with bi-polars can be used to stabilize bias and control thermal runaway by using the increased current flow to increase the voltage drop, thus reducing base-emitter voltage. However, if used with these devices, it will actually impair the self-limiting action of its negative temperature co-efficient. If temperature rises due to high current, current flow is reduced. This would reduce the voltage drop across a source resistor, lowering the source voltage and increasing the gate-to-source voltage, causing an increase in current flow. The circuit would work great while it lasted – which wouldn't be for long.

Record amp

Figure 13 shows a magnetic recording amplifier derived from a tube circuit. Its biggest advantage lies in its ability to provide equalization for head losses by incorporating the head within the feedback loop. Additional equalization is then required only for gap losses and tape self-demagnetization. Q1 acts as a driver for Q2, the output stage, which, with series resistor R9, provides a high impedance current source for the record head, as well as providing a mixing pad between audio and bias currents.

The record head's return path to ground is through R11. The inductance of the record head results in an impedance characteristic which rises with frequency. At frequencies at which the impedance of the head is low in comparison with R9 and R10 in series, load current is essentially constant. As frequency rises, however, head impedance becomes appreciable. With appropriate selection of R9 and R11, depending on head characteristics, the voltage across R11 decreases as the head impedance becomes significant. If feedback is taken across R11 it will decrease with rising frequency, causing an increase in gain, at a rate of 6dB/octave.

Feedback is applied across R3 via R10 and C8 (which supplies bass boost below 80 Hz) C5 and C6 provide additional high frequency boost for a total ultimate slope of 12 dB/octave. This circuit is so effective that no additional boost is needed at 15 ips, and only a small amount at 7.5 ips with high coercivity tape.

The biasing method used is that of Fig. 5c. The large amount of local current feedback provided by R2 and R3 results in a high output impedance

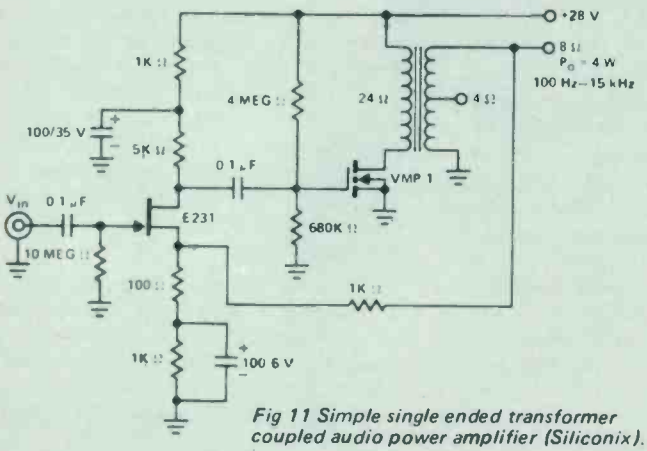


Fig 11 Simple single ended transformer coupled audio power amplifier (Siliconix).

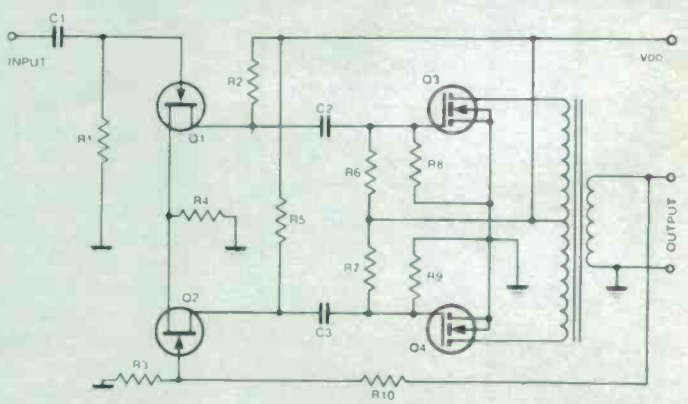


Fig. 12 Transformer coupled output.

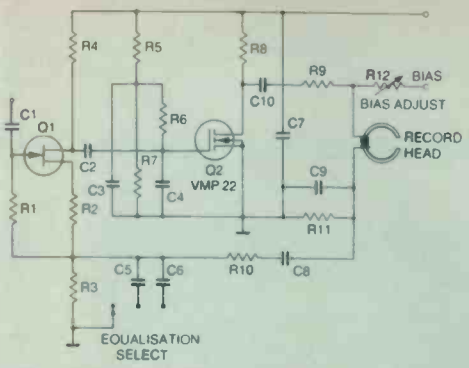


Fig. 13 Tape recording amplifier.

for Q1, so the biasing network is selected to provide high impedance with reasonable values. Capacitors C3, C4, C7 and C9 bypass bias signal to avoid overloading Q2, and to prevent attenuation of bias current.

Power amp

Figure 14 shows a high quality power amplifier designed by Siliconix Inc. (5) and described in their application notes. Output current capability is increased by using three VMP12's in parallel, providing for 6 amp current 75 watt dissipation and load optimized at 8 ohms. Q11-13 operate as a source follower, while Q8-10 form a quasi-source follower. This is accomplished by applying local feedback from drain to gate via R14, R15, and driving the gate by a modified current source. This consists of a cascade circuit with a constant current diode as the load.

For the benefit of those not familiar with these devices, a constant current diode is really a FET connected internally as shown in Fig. 15. Since current in a FET is controlled essentially by the gate-to-source voltage, changes in load or in applied drain-to-source voltage have negligible effect since gate-to-source voltage is held constant. This is a current analogue to the zener diode and is described in detail in Siliconix literature (6).

The design is push-pull from input to output, thanks to differential circuitry throughout, prior to the drivers. Open loop distortion is low, bandwidth wide, allowing satisfactory performance with only 22 dB of feedback. Lead compensation only is used (via C4), along with the liberal use of local feedback (R4, R5, R11, R12,). The result is very low transient IM and a slew rate of over 100 V/microsecond. THD is quite respectable even though the numbers might not impress the average audiophile accustomed to amplifiers with great specs and poor sound.

Incidentally, D8 and D9 illustrate an excellent method of providing output current limiting. In this case, 9.1 volt zener diodes limit drain current to slightly less than 2 amps. At first one might be tempted to depend on the built-in protection diodes to accomplish this, but it should be remembered that these devices are for protection against static discharge. Their zener voltage of 15 volts at 10 mA cannot possibly be used since the absolute maximum permissable drain current occurs at a gate-to-source voltage of 10 volts.

Commercial amps

A simplified version of Yamaha's B1 amplifier is shown in Fig. 16, (8). In this circuit a cascade drive system is used, but in a differential form with the constant current source in the

Fig. 14 A high quality 40W amplifier (Siliconix).

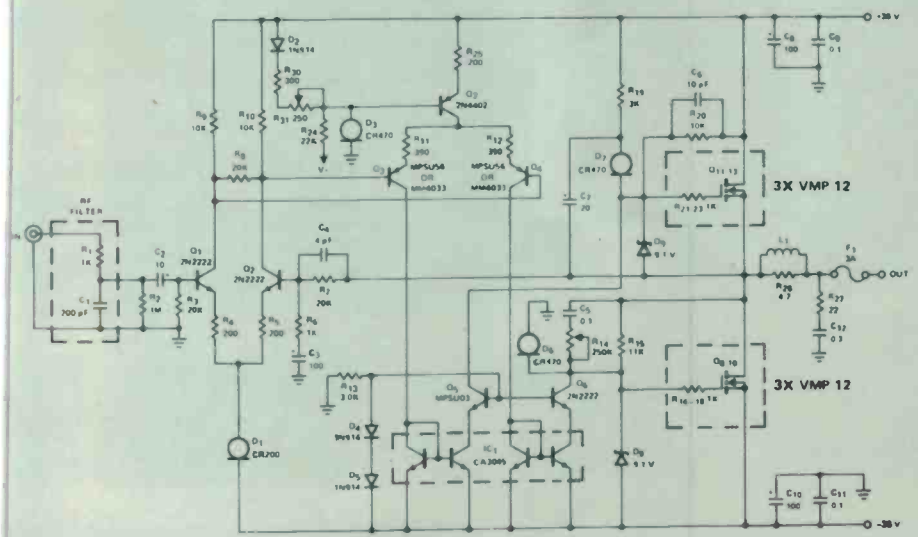


Fig. 15 A FET as a constant current diode.

common source circuit. This is an example of all FET design of excellent performance and received rave reviews in several publications including ETI. It's also inexpensive!

The VHF linear amplifier in Fig. 17 will deliver 5 watts peak envelope with second and third order intermodulation at -30 dB from 144-146 MHz. It will also prove useful as a receiver pre-amp with a noise figure of 2.4 dB. V-MOSFETS show considerable promise in rf applications because of their linear transfer characteristic, the high gain capabilities even with Ft somewhat above 600 MHz, low noise and (in receiver front ends) very wide dynamic range. Although this article has dwelt on the VMP 1 family, there is also the VMP 4, designed specifically for rf applications and which is now available.

Finally, how about something elegant for its simplicity, such as the tapered current voltage limiting battery charger shown in Fig. 18. This is especially useful with Ni-Cad batteries which are intended for stand-by use and are permanently on charge, such as electronic clocks. Overnight shut-downs of a few hours are occasionally but irregularly experienced. You know what this can do to clocks. Especially alarm clocks which are supposed to make noises, turn on radios, start the coffee at a pre-set time in the morning so you can go to work. Battery operation is not too satisfactory if the readout is on continuously, and Ni-Cads should not be on permanent floating charge.

With this little device current is supplied to the battery via the VMP-1. Gate voltage is set at a value equal to the desired end-of-charge voltage. As the battery charges, its voltage increases, reducing gate-to-source voltage, thus reducing charging current. When the battery reaches full charge its voltage, and that of the source, equals gate voltage, and charge is terminated. If a load is placed across the battery it will draw current, and as the battery voltage drops slightly below gate voltage, charging at a trickle rate occurs – automatically.

Experimentation

The various applications shown are intended as suggestions for further experimentation. They are mainly designed to illustrate various characteristics of the device under consideration, and are not necessarily representative of commercial practice or of finished designs. In some cases this may be just as well! But we would be delighted to hear of any readers' experience with any of these or other circuits.

The author's feeling is that V-MOS constitutes a genuine breakthrough in semi-conductor technology, as important as the silicon transistor and the FET itself. We'll be seeing more of these devices, with higher ratings (a 10 amp 200 volt unit is already under development) and specialized characteristics. They are said already to be in use commercially as magnetic core drivers.

Digital enthusiasts may be somewhat impatient with the strong emphasis on audio applications in this piece but other literature has placed great emphasis on digital applications, with little attention paid to linear techniques beyond the 40 watt amplifier described here. The serious reader in all areas is referred to the references at the end.

Have fun.

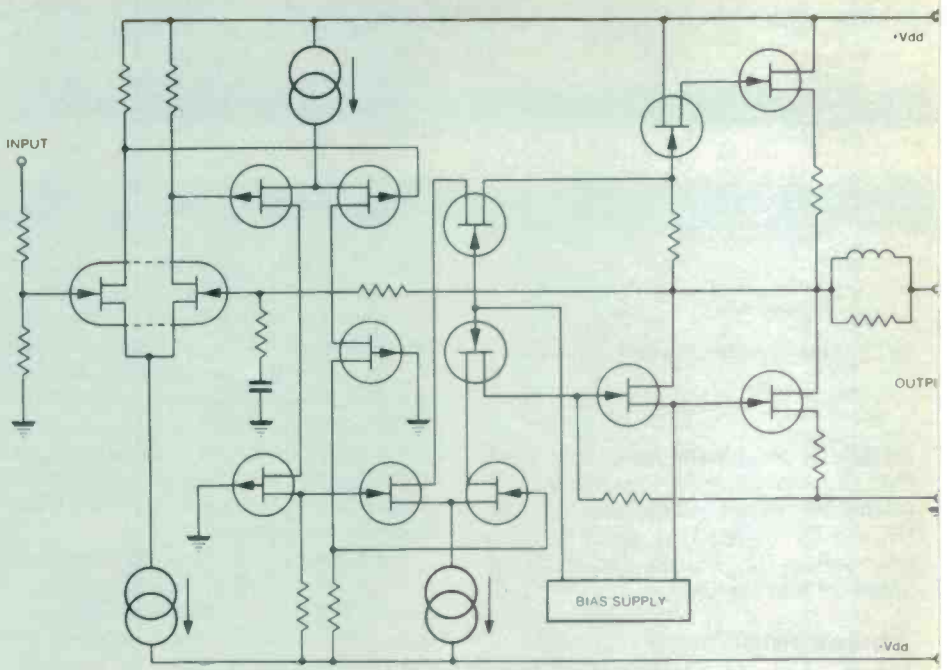


Fig. 16 Simplified Yamaha VFET amplifier diagram.

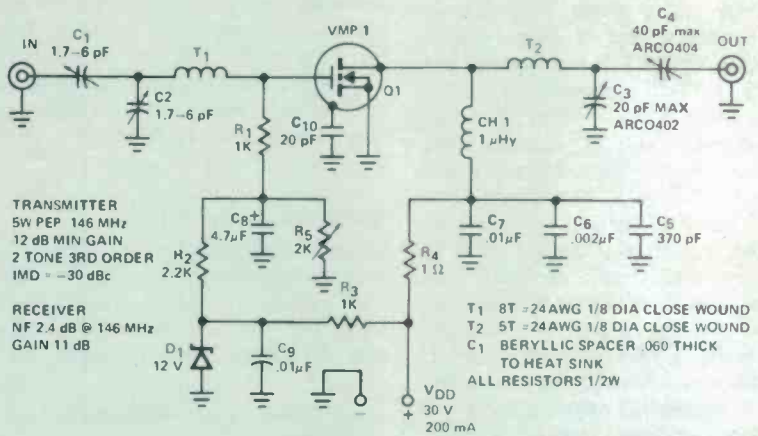


Fig. 17 144-146 MHz linear amplifier (Siliconix).

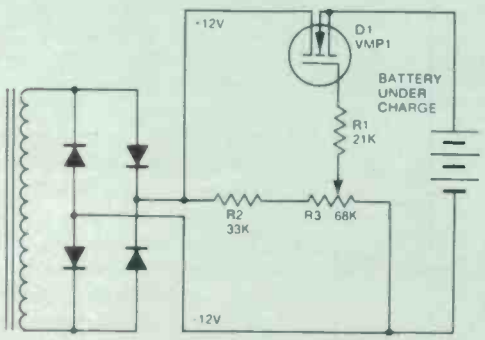


Fig. 18 Tapered current voltage limited battery charger.

REFERENCES

1. W. Marshall Leach: "Construct a Wide Bandwidth Preamplifier" Audio, Feb. 1977, p.39.
2. Nelson Pas: "Build a Class A Amplifier" Audio, Feb. 1977, p. 29.
3,4 Lee Shaeffer: "VMOS-A Breakthrough in Power MOSFET Technology" Application Note AN76-3, May 1976, Siliconix Inc.
5. Lee Shaeffer: "The MOSPOWER-FET Audio Amplifier" Design Aid DA76-1, May 1976, Siliconix Inc.
6. "The FET Constant Current Source" Design Idea D171-1, January 1976. Siliconix Inc. Also Siliconix Field Effect Transistors Data Book.
7. Ref. 5.
8. Bascom H. King: "Power FETs" Audio, Feb. 1975, p. 42.
10. Ed Oxner. "A New Technology: Application of MOSPOWER FETs For High Frequency Communications" Technical Article TA76-2, Nov. 1976, Siliconix Inc.

The junction FET — its haunts and habits

The first in a whole family of field effect transistors, the junction FET is found in many and varied applications. If you're new to electronics, or unfamiliar with the device, this article should introduce you to the haunts and habits of the JFET.

Brian Dance

THE JUNCTION Field Effect Transistor or JFET is a small electronic device much like a transistor in appearance which normally has three connections, although a fourth connection is attached to the metal case of some types for high frequency screening. Junction field effect transistors are one of the two main types of field effect transistor, the other type being known as the MOSFET (Metal Oxide Semiconductor Field Effect Transistor) or as the IGFET (Insulated Gate Field Effect Transistor).

Field effect transistors can be used as amplifiers and oscillators as well as for other applications for which an ordinary or bipolar transistor could be employed, but have particular advantages for certain applications. Field effect transistors are also used in the internal circuitry of integrated circuits.

Connections

As in the case of npn and pnp bipolar transistors, junction field effect transistors can be obtained in two polarities, these being known as n-channel and p-channel types. A far wider variety of n-channel types is manufactured than p-channel devices, since they tend to have a better performance, but devices of both polarities are readily obtainable.

The electrodes and circuit symbols for the two types are shown in Figure 1. The current flowing in a channel between the drain and the source is controlled by a voltage applied to the gate electrode. The gate is therefore the input electrode

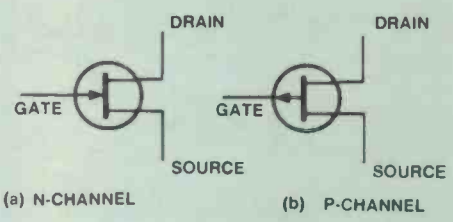


Figure 1. Symbols for n-channel (a) and p-channel (b) junction FETs.

and may be compared with the base of a conventional transistor. Similarly the drain and source may be compared with the collector and the emitter respectively.

One of the main differences between field effect transistors and bipolar transistors is that field effect transistors are essentially voltage amplifiers whereas bipolar transistors are basically current amplifiers. Thus the field effect transistor behaves more like the old thermionic valve in its circuits.

Field effect transistors tend to be more expensive than most of the common bipolar types — probably because the bipolar types are sold in much larger numbers. The economical 2N3819 n-channel field effect transistor is probably the most commonly used type and is very suitable for the readers who wish to carry out their first experiments with field effect transistors. This device is encapsulated in a black plastic or epoxy body and has the connections shown in Figure 2. The 2N3820 is a similar economical p-channel device.

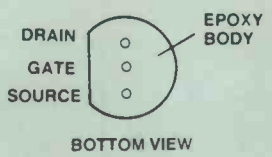


Figure 2. Connections for the common 2N3819 plastic-encapsulated n-channel JFET.

High input impedance

One of the main advantages of a field effect transistor is that it has a very high input resistance and therefore takes very little current from the circuit which feeds it — typically far less than a microamp. This means that it has very little effect on the circuit which feeds it, even if this circuit has such a high output impedance that it can deliver only a very minute current.

In order that an n-channel device shall operate correctly and have a high input impedance at its gate, it must be suitably biased with its gate negative with respect to the other electrodes. Similarly the gate of a p-channel device has a high impedance when it is positively biased.

APPLICATIONS

Pierce oscillator

In the circuit of Figure 3 the field effect transistor is employed in a Pierce type of oscillator whose frequency is controlled by the quartz crystal shown. The advantage of using a field effect transistor in this type of circuit is that the gate imposes only a very small load from the crystal and therefore the quality factor or Q factor of the crystal is not appreciably affected, so excellent frequency stability can be obtained.

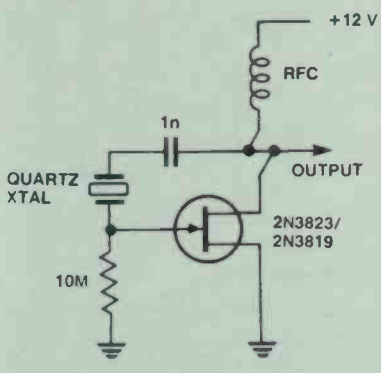


Figure 3. A Pierce crystal oscillator (National Semiconductor).

National Semiconductor recommend their 2N3823 n-channel device for use in this circuit, but the more economical 2N3819, which is made by the same type of process, is also suitable. The supply voltage is not at all critical, but the radio frequency chokes used in the supply lead should have a high impedance at the frequency of oscillation.

An advantage of this circuit is that one can change the crystal over quite a wide range of frequencies without making any other changes to the circuit and still obtain a satisfactory performance. The exact frequency range over

which the circuit will operate depends very much on the choke used and to some extent on the circuit layout.

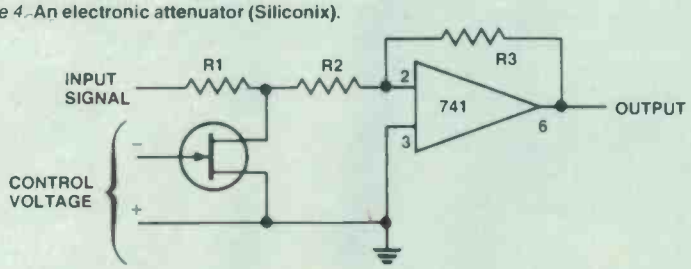
This type of circuit is suitable for use in a crystal calibrator for a receiver. If a 1 MHz crystal is employed, the output may be fed to a radio receiver to produce a signal at 1 MHz and at each multiple of 1 MHz up through the shortwave bands to provide calibration points.

Electronic attenuator

A junction field effect transistor can be used as a variable resistor, the value of which is controlled by the voltage applied to the gate electrode. As the applied bias becomes smaller, the resistance between the drain and source electrodes falls.

This property is used in the circuit of Figure 4 to design an electronic attenuator for audio signals. When the negative control voltage applied to the gate electrode is relatively large, little drain current passes through the device and the circuit behaves as if the field effect transistor were not present. However, as the control voltage falls at the gate electrode, the drain draws current from the junction of R1 and R2 so that the output signal amplitude is attenuated progressively.

Figure 4. An electronic attenuator (Siliconix).



Tone control

The circuit of Figure 5 is a tone control circuit with bass and treble boost and cut facilities. In this circuit the 2N3684 field effect transistor is used to enable the circuit to have a very high input impedance. It is used as a source follower circuit (analagous to an emitter follower) which provides a low output impedance signal coupled by a 1u capacitor to the tone control network. This network is in the feedback circuit of the LM301A operational amplifier circuit. The 2N3684 enables a good low-noise performance to be obtained.

Lambda oscillator

A very simple sinewave oscillator is shown in Figure 6; it is essential that one n-channel and one p-channel field effect transistor are used in this circuit. The two source electrodes are connected together and the gate of each device is connected to the drain electrode of the other device. This type of connection produces a negative resistance region in the current/voltage graph for the circuit with a peak in the graph like a Greek lambda (λ) — hence the name given to this type of circuit.

It is only necessary to connect the dual device circuit in series with a parallel tuned circuit, as shown in Figure 6, to produce oscillations at the resonant frequency of the tuned circuit used. It will oscillate at any frequency from the low audio region up to some tens of MHz, but the gate capacities of the devices used prevent operation in the regions above 100 MHz.

It is interesting to note that two separate parallel tuned circuits may be connected in series with the lambda circuit instead of the single tuned circuit shown in Figure 6. If one of these tuned circuits resonates at an audio frequency and the other at a radio frequency, the output will consist of an amplitude modulated radio frequency oscillation. This is perhaps one of the simplest possible modulated signal generators!

The output voltage from the circuit of Figure 6 is equal to twice the steady

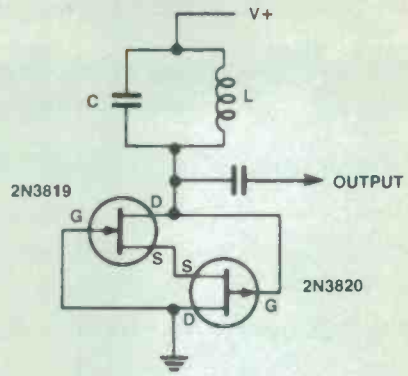


Figure 6. Sinewave oscillator using a 'Lambda' circuit.

power supply voltage applied to the circuit. Therefore this type of circuit can be very useful when one requires an output oscillation whose amplitude is accurately related to a steady applied voltage.

Complementary pairs of field effect transistors used in lambda circuits have other applications apart from simple oscillator uses.

High-impedance buffer stage

The circuit of Figure 7a shows a buffer or isolating amplifier which has a very high input impedance and low input capacitance. National Semiconductor recommend a 2N4416 field effect transistor for this circuit because it has a low input capacitance, but this is further reduced by the circuit feedback. The device is used as a source follower, so the voltage gain is about unity.

Although a 2N5139 pnp transistor is specified for this circuit, the 2N3906 plastic encapsulated type is much more readily available and is fabricated by the same process, so it can be used in this application.

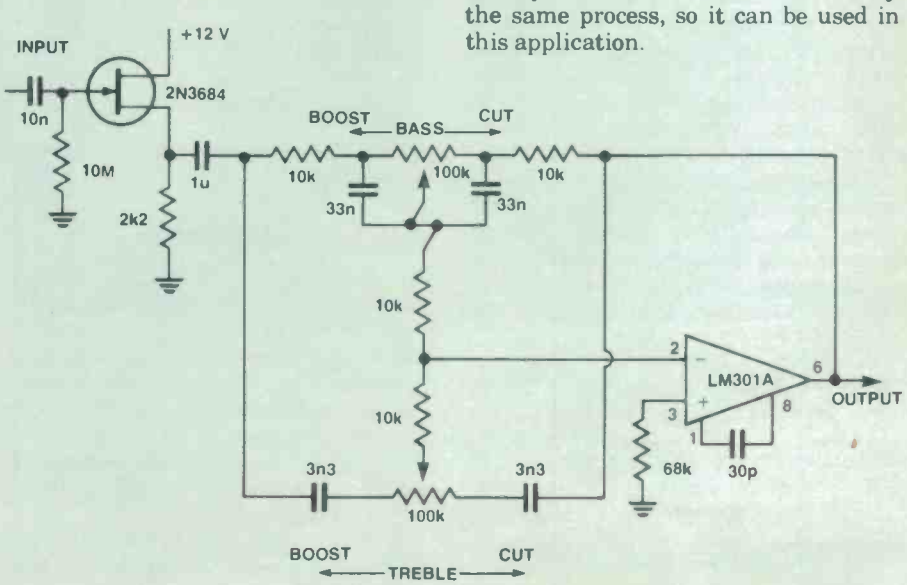


Figure 5. High input impedance tone control circuit (National Semiconductor).

High-impedance amplifier

The circuit of Figure 7b is very similar to that of Figure 7a except that the feedback circuit has been modified so that a voltage gain can be obtained. The circuit provides a gain of R2/R1 or 10 with the component values shown. Both the circuits of Figure 7 and of Figure 8 can be operated at high frequencies into the tens of MHz region.

RF amplifiers

Junction field effect transistors are much used in the radio frequency stages of HF, VHF and UHF receivers, since they offer a noise performance equivalent to that of bipolar transistors with improved crossmodulation and intermodulation performance. Crossmodulation is the transfer of the modulation of one carrier onto the carrier of another signal. Intermodulation occurs when two or more signals outside the passband combine in the circuit to form a signal within the passband which causes interference with the wanted signal.

The better linearity of field effect transistors over bipolar transistors is responsible for this improvement. Mullard have quoted a 12 dB improvement in crossmodulation in a narrow-band FM receiver and a 20 dB improvement in a VHF broadcast receiver as having been achieved by the replacement of a bipolar mixer circuit with a junction field effect transistor circuit.

Figure 8 shows a high-performance amplifier using two JFETs connected in 'cascode' (series) with automatic gain control (AGC) applied to the gate of the upper device. The supply is applied to the 'cold' or 'ground' end of L2 via a feedthrough capacitor. Only the L-C values need be changed to operate this stage on other frequencies to the limits of the JFETs.

Simple voltmeter

The high input impedance of a junction field effect transistor is used in the circuit of Figure 9 to produce a voltmeter with an input resistance of over 10M; in some measurements this high input impedance is necessary to prevent the current taken by a conventional voltmeter from dragging down the voltage being measured.

The input voltage being measured is divided by R1 and R2 so that a voltage of +0.2 V is present at the gate electrode when the full scale input voltage is applied for the range in question. In practice R1 should consist of a fixed resistor of a value somewhat less than that shown in the table, in series with a preset potentiometer so that the sensitivity of the range can be adjusted. If desired, R1 may be switched to provide a number of ranges.

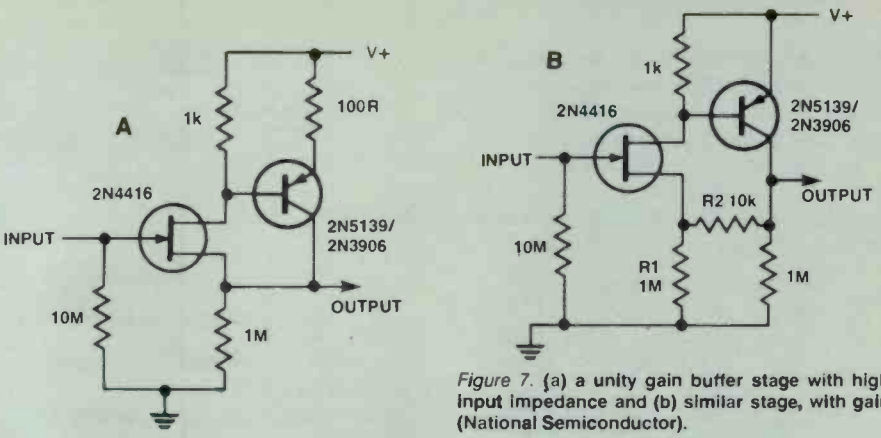


Figure 7. (a) a unity gain buffer stage with high input impedance and (b) similar stage, with gain (National Semiconductor).

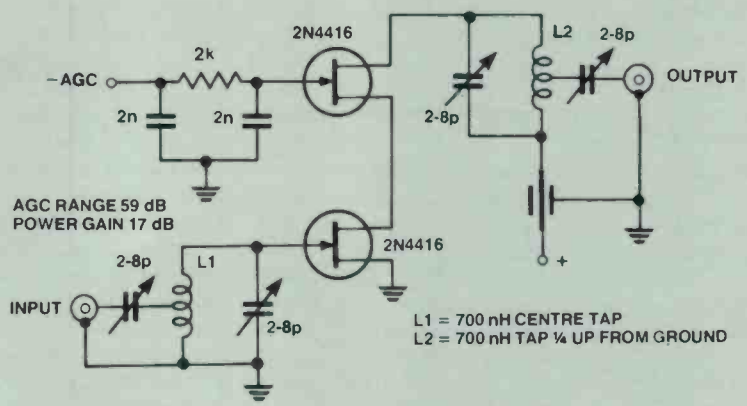


Figure 8. Typical high-performance amplifier stage employing two FETs in 'cascode'. Values given for 200 MHz. A wide variety of RF FETs may be substituted (National Semiconductor).

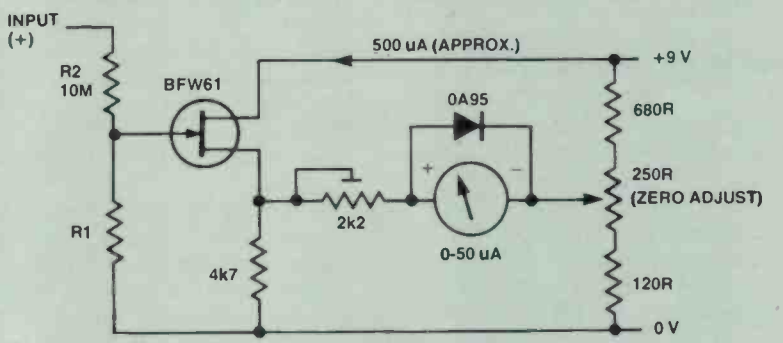


Figure 9. High input impedance voltmeter. Note that a BFW10 could substitute for the BFW61 (Mullard).

Table showing the value of R1 to be used in Figure 9 for various ranges.

Meter range	R1
250 mV	40M
500 mV	6M67
1 V	2M5
10 V	204k
50 V	40k
100 V	20k
250 V	8k
500 V	4k

the 2k2 resistor in series with the meter enables the full-scale meter current to be adjusted to allow for the characteristics of the particular device used. The diode protects the meter from overloading.

PhotoFET

Photosensitive field effect transistors (photoFETs) can be made which have a window or a lens, so that any light falling on this window affects the junc-

tion and hence the drain current of the device in much the same way that light affects a phototransistor. However, photoFETs are not very common devices.

An application of a Teledyne Crystallonics photoFET as a light-controlled variable attenuator is shown in Figure 10. The drain-to-source resistance of the

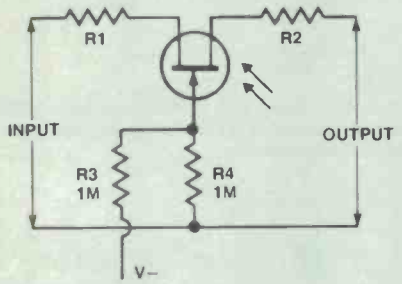


Figure 10. Example of a light-controlled attenuator (Teledyne Crystallonics).

photoFET is a function of the intensity of the illumination, so as more light shines on the device, the output rises. The negative voltage to which the resistor R3 is returned determines the range in which the drain-to-source resistance falls. Like other silicon photosensitive devices, the photoFET is sensitive to the red and near infrared regions of the spectrum, such as the radiation from an incandescent filament bulb.

HOW DO THEY WORK?

An n-channel field effect transistor consists of a channel of n-type semiconductor material between the drain and the source surrounded by p-type material of the gate electrode. Almost all of the devices are made of silicon, but a few special devices are produced in other semiconductor materials. As shown in Figure 11, the gate normally receives a

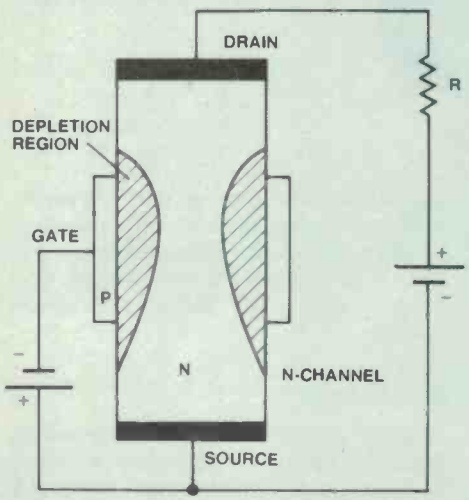


Figure 11. Control of channel width in an n-channel device.

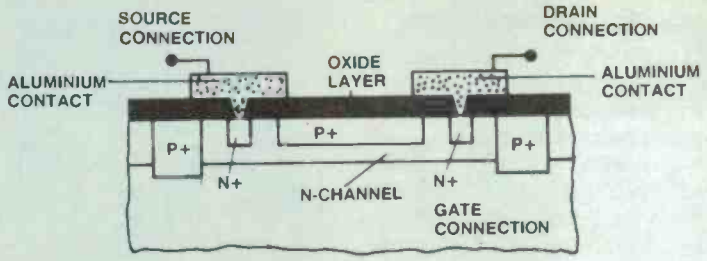


Figure 12. Structure of a silicon planar device (Mullard).

negative bias relative to the source and the drain a positive bias.

As the p-type gate material receives a negative bias, the junction formed between this material and the n-type channel is reverse biased. In any reverse-biased junction, a region which is depleted of charge carriers (electrons and holes) is formed. As this depletion region contains very few mobile charges, it acts almost as an insulator and has a very high resistance.

The gate is normally much more heavily doped than the channel material, since this results in the depletion region spreading fairly deeply into the channel and not very far into the material of the gate. As the drain is normally made positive with respect to the source electrode, the voltage between the drain and the negative gate is larger than that between the source and the gate. The electric field is therefore greater on the drain side of the gate electrode and this results in the depletion region becoming deeper on the drain side and thus producing a narrower channel on this side, as shown in Figure 11.

If the voltage applied to the gate becomes more negative, the depletion region goes deeper into the n-channel material until eventually the channel becomes completely cut off on the drain side of the gate. Very little drain current can then flow through the device. As the gate voltage becomes less negative, the channel opens again and becomes wider as the gate voltage approaches that of the source; the widening of the channel under the control of the gate voltage results in the channel current from the drain to source increasing.

As the gate-to-channel capacitance comprises a reverse-biased pn junction, the gate has a very high input resistance and passes only a very minute current (often in the pA region). However, the gate capacitance is appreciable and therefore an appreciable alternating current may flow to this electrode at high frequencies. Even when the gate and source potentials become equal, there is still a small depletion region and the gate input resistance is high. However, if the gate of an n-channel device receives a positive bias of more than about 0.65 V, current can flow in the gate circuit and this current may damage the device.

Structure

The design of a modern field effect transistor is not implemented in the form of Figure 11, which has been used for explanatory purposes, but silicon planar technology is usually employed to produce a structure such as that of the Mullard/Philips BFW11 shown in Figure 12. This has a surface or planar structure which is covered with a protective layer of silicon dioxide at all points except where electrode connections are attached. This oxide layer prevents impurities from contaminating the surface of the material and thus producing unwanted currents.

The aluminium contacts at the source and drain electrodes allow current to flow from them into the heavily doped small n+ regions, which make good contact with the n-channel region. In some devices a number of n-type channels are connected in parallel to enable a larger current to flow at the expense of an increased gate capacitance.

P-channel types

P-channel field effect transistors have the same type of structure as shown in Figures 11 and 12, but the p and n type materials are interchanged. The gate is made of n-type material and must therefore be biased positively, as shown in Figure 13. The drain is normally biased negatively.

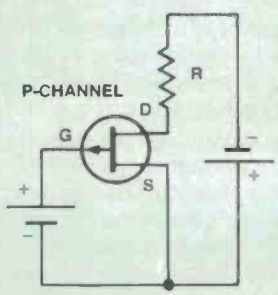


Figure 13. A p-channel device requires supplies of the opposite polarity to those used with n-channel devices.

Limiting voltages

If the bias applied to the gate is taken far beyond that required for normal operation, a point will eventually be reached at which reverse breakdown occurs. Similarly there is a limit to the voltage which should be applied between the drain and the source electrodes. However, junction devices cannot be damaged by the ordinary electrostatic charges which can accumulate on people and clothing and which can damage MOSFET devices.

Testing JFETS

It is relatively easy to check that a junction field effect transistor is able to function correctly. The circuit of Figure 14 may be used for an n-channel device and that of Figure 15 for a p-channel device.

If the gate is initially connected directly to the source (and not as shown), it will be found that the meter provides a reading of a few mA. This current is limited by the 1k resistor in the drain circuit to a safe value.

If the gate electrode is now connected to the 10M resistor as shown, the gate to channel junction is reverse biased. Thus the channel width decreases and with most devices the drain current will fall to zero in the circuits shown. As the gate circuit has a very high resistance, the voltage can be applied to it through a high-value resistor; indeed, it is interesting to note that the human body can be used in place of the 10M resistor shown when testing junction field effect devices.

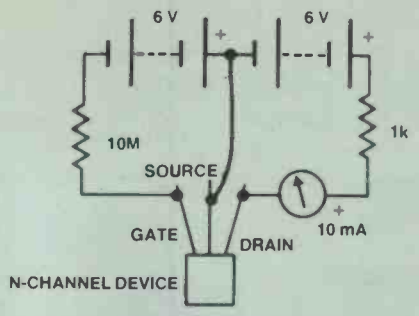


Figure 14. Testing an n-channel device.

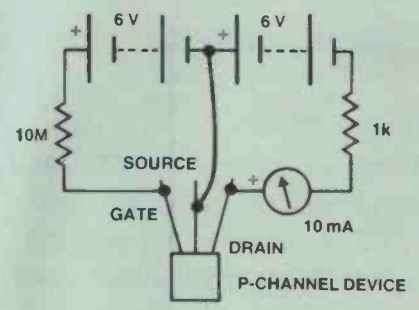


Figure 15. Testing a p-channel device.

If one wishes to test a device and does not know the connections, one can first find two connections in which a small current will pass in either direction. These are the source and drain connections.

A current should pass from the third electrode, the gate, only in one direction to either of the other two electrodes. If conduction takes place when the gate is positive, one has an n-channel device, whereas if conduction takes place when the gate is negative, the device is of the p-channel polarity.

One cannot easily determine which electrode is the drain and which is the source, but these electrodes are to some extent electrically interchangeable. ●

USEFUL BOOKS

Two very useful books, though difficult to obtain, are: 'FET Databook' from National Semiconductor and 'Field Effect Transistors' from Philips.

Lab Notes

Using BiFET and BiMOS op-amps

The availability of BiFET and BiMOS op-amps has revolutionised circuit design since they appeared on the scene six years ago. While we've used devices like the CA3140 op-amp in projects we've not got around to describing practical applications circuitry. This 'Lab Notes' fills that gap.

Brian Dance

THE AVAILABILITY of BiFET and BiMOS devices in various packages with one to four operational amplifiers per package has revolutionised the operational amplifier market. Apart from the relatively expensive hybrid FET input devices, other FET input operational amplifiers had been available for some considerable time, so why should BiFET and BiMOS devices be so important?

The first point to note is that amplifiers with FET input stages can offer far higher input impedances than devices with ordinary bipolar transistors in their input stages. For example, the well-known 741 has an input impedance of the order of 1M and a maximum input bias current of 500 nA. The use of bipolar transistors to obtain a high input impedance has been pushed to the limit in devices such as the LM108, using supergain input devices to provide a typical input impedance of 70M and an input bias current of just under 1 nA. These values may be compared with those of some of the economical BiFET and BiMOS devices, where typical input impedances are of the order of 1 Terraohm (one million Megohms!) and input currents are some tens of picoamps (pA) at room temperature.

Thus if one connects the input of one of these BiFET or BiMOS amplifiers to almost any circuit, it will impose a very small load on that circuit. This can be a vital consideration when one is designing such high-impedance circuits as those used in pH meters or in ionisation chamber smoke detector circuits, whose output current is inadequate to drive devices such as the 741.

If one considers the very early types of monolithic FET input operational amplifiers (such as the Fairchild μA740), they do have the desired high input impedance, but their disadvantage is that their input offset voltage and its temperature coefficient are so high that they do not approach the high standard of performance required by the modern

INTRODUCTION TO THE BIMOS AND BIFET OP-AMP

The first BiFET products were announced by National Semiconductor in 1975 (the LF155, LF156 and LF157 series, where LF signifies Linear FET device). The main advantages of these products is that the junction FET devices used in their input stages are fabricated on the same silicon chip as the remainder of the operational amplifier. Although hybrid operational amplifiers with FET input stages had been available for some considerable time previously, all of these hybrid devices contained the junction FET devices fabricated on a separate silicon chip from the remainder of the operational amplifier. Such hybrid devices can be made to have a very good performance if adequate trouble is taken in their design, but the extra labour costs involved in the testing of the separate chips for appropriate matching characteristics and in connecting the two chips in a single hybrid package inevitably resulted in a price tag far above that of modern BiFET devices. The general type of construction of a BiFET device is shown in Figure 1, the channel between the source and the drain electrodes of the FET input devices being fabricated by ion implantation.

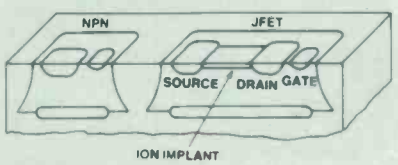


Figure 1. Construction of a BIFET device.

Although National Semiconductor produced the first BiFET products, it was not long before other manufacturers entered the BiFET market, and such products are now available from Advanced Micro Devices, Analog Devices, Fairchild, Harris Semiconductor, Motorola, Intersil, Precision Monolithics, Raytheon and Texas Instruments, although National Semiconductor still offer the widest range of BiFET products, details of which can be found in their Linear Databook.

Very soon after National Semiconductor had announced the first BiFET products, RCA introduced their first BiMOS product, the economical CA3130 operational amplifier. This has some similarities to the BiFET amplifiers, but employs MOSFET transistors in the input stage rather than junction FET devices. RCA soon introduced further BiMOS devices, one of the best known type being the CA3140, which can be used as a pin-for-pin replacement for the 741 when a higher performance is required. More recently the CA080 series has been introduced as pin-for-pin replacements for the Texas Instruments series of TLO80 BiFET types.

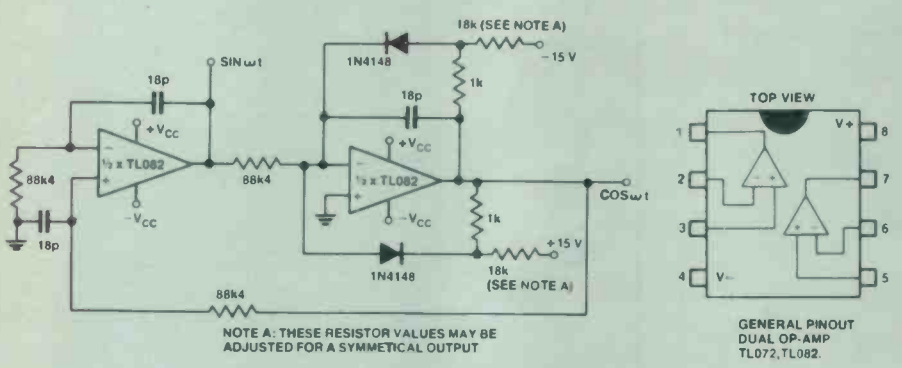


Figure 3. Quadrature oscillator producing two outputs 90° out of phase, using a TL082 dual op-amp — pinout at right.

professional engineer. Modern BiFET and BiMOS devices provide a very high input impedance with relatively good stability and temperature performance — although the input impedance of any of these devices at 25°C is much greater than over the full temperature range.

In general BiFET and BiMOS economical devices offer a comparable performance. If anything, BiMOS devices tend to offer the lower input bias currents and BiFET products the lower noise levels. However, premium devices of both types are available with performances far above the average for the type of device concerned.

Half-Hertz oscillator

Figure 2 shows the use of the economical TL081 device in a simple 0.5 Hz square wave oscillator. The TL081 is a single operational amplifier in a dual-in-line package with the connections shown in Figure 2; the pin connections are the same as those of the well-known 741 devices, internal frequency compensation being employed so that no external compensating capacitor is required. External offset adjustment can be made when required by means of an external variable resistor. The TL071 is a similar low-noise device with the same connections, and is quite suitable for use in this circuit, but its low-noise characteristics are not needed. The TL061 is a low-power device with the same connections.

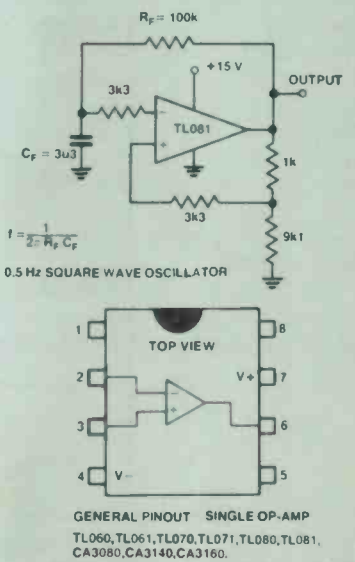


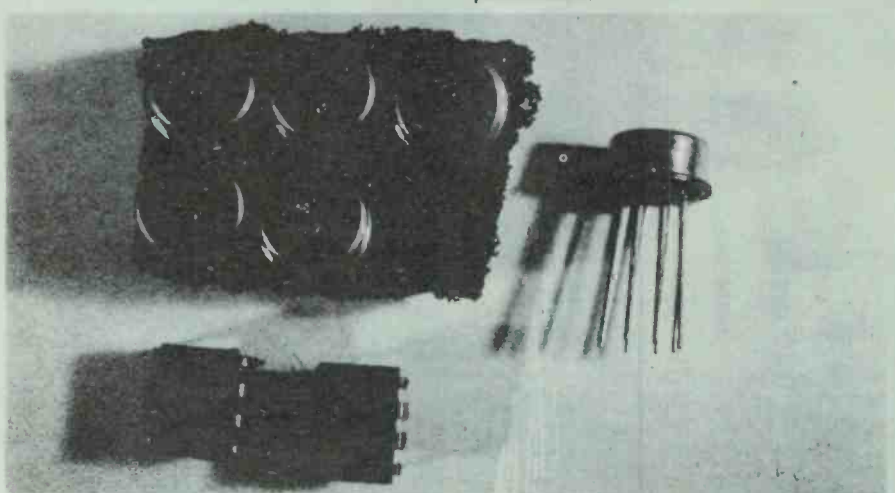
Figure 2. Half-Hertz oscillator using a TL081 — pinout below.

The frequency of oscillation of the Figure 2 circuit is given by $f = 1/(2\pi R_F C_F)$, or about 0.5 Hz with the values shown. The high input impedance of the circuit enables a relatively high value of feedback resistor, R_F, to be employed, so the value of C_F can be reasonably small for a given frequency of operation. About nine-tenths of the output voltage is fed back to the non-inverting input to provide positive feedback to maintain oscillation. The capacitor C_F charges and discharges through R_F according to whether the state of the output voltage is 'high' or 'low' at the time concerned.

The circuit of Figure 2 generates square waves which are approximately symmetrical. However, if a circuit which generates waves with an unequal mark-to-space ratio is required, it is only necessary to connect a resistor of perhaps 10k to 50k in series with a diode across R_F. The direction in which the diode is connected determines whether the output spends the greater part of its time in the 'high' or in the 'low' state.

100 kHz oscillator

Figure 3 shows the circuit of a 100 kHz oscillator providing two outputs which are 90° out of phase with each other. Although the TL081 is perfectly satisfactory for use in this circuit, it is more convenient to use the dual TL082 device so that this one device is all that is needed. The connections of the 8-pin dual-in-line TL082 device are shown in Figure 3; it employs internal frequency compensation, but has no external offset adjustment facilities.



Modern BiMOS and BiFET op-amps come in both can and DIL packages.

Lab Notes

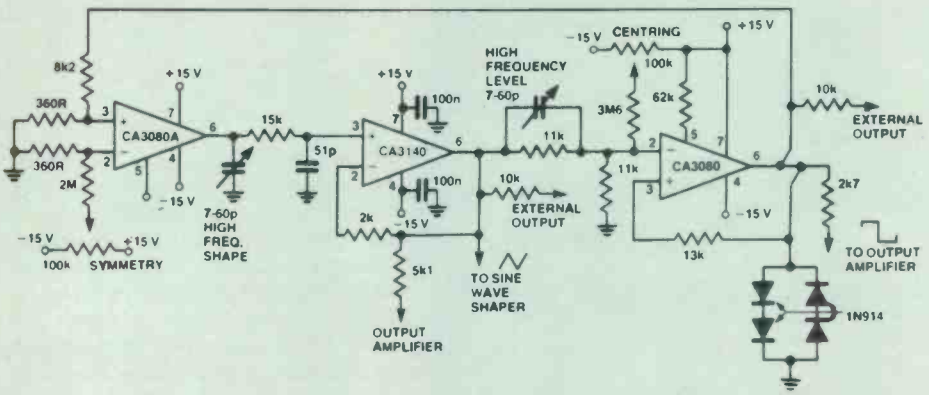


Figure 4. Function generator circuit. Sourcing or sinking current from pin 5 of the left hand CA3080 will vary the frequency.

BiMOS generator

A function generator which produces square and triangular waveforms is shown in Figure 4. It employs a CA3140 BiMOS device together with a CA3080A and CA3080. A particular feature of this circuit is that a frequency range of one million to one can be obtained by the use of a single variable resistor, or alternatively by the use of an auxiliary sweeping signal.

A CA3130 device may be employed instead of the CA3140 shown, but in this case a frequency compensating capacitor (about 56p) must be connected between pins 1 and 8, since the CA3130 is not internally compensated. The CA3160, which does not require any external frequency compensation, is also suitable for use in this circuit.

The high frequency linearity of the ramp is adjusted by the 7-60p variable capacitor connected between the output of the CA3140 and the output CA3080 device. The triangular wave output level is determined by the four 1N914 level-limiting diodes in the output circuit and the network connected to pin 2 of the CA3080.

It is important to minimise lead length and parasitic coupling capacitance in this circuit by careful layout.

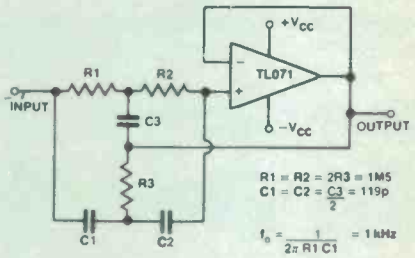


Figure 5. Notch filter using a 'Twin-T' filter section on the input of a TL071 op-amp.

Notch filter

The circuit of Figure 5 shows the use of a TL071 low-noise amplifier in a notch filter circuit. This is the normal 'twin-T' filter in the input circuit, in which one of the 'T' sections consists of R1, R2 and C3 and the other part of C1, C2 and R3. It is designed to reject signals of one particular frequency (the notch frequency), whilst passing signals of any other frequency virtually unattenuated.

For optimum performance, when a sharp notch in the frequency response is required, the components should have matched values (to within 1% or 2%). When the values shown are employed, the notch frequency occurs at approximately 1 kHz. An advantage of using a high input impedance device such as the TL071 is that relatively large values may be employed for R1, R2 and R3 and,

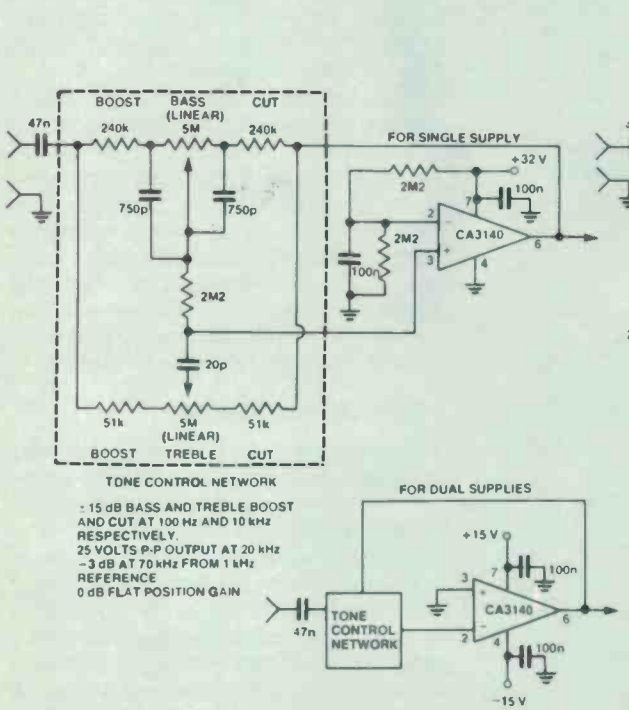


Figure 6. Baxandall type tone control circuitry, with unity gain (flat position).

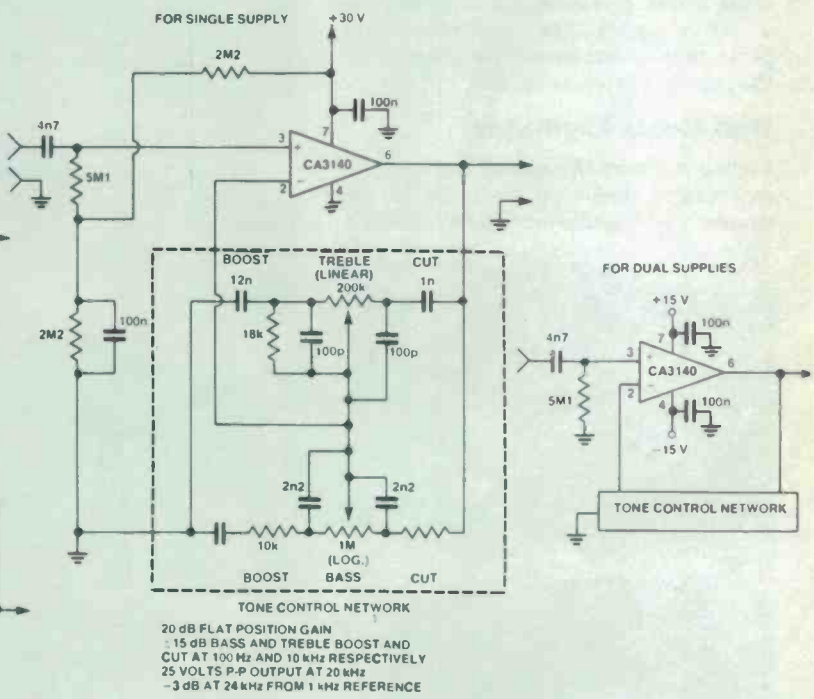


Figure 7. Tone control circuit with 20 dB of gain, flat position.

therefore, for any given frequency, C1, C2 and C3 can have a relatively low value. Large value, close tolerance capacitors are expensive, so the ability to employ devices of low value is important.

Tone controls

Two tone control circuits using the CA3140 are shown in Figures 6 and 7. Figure 6 is of the Baxandall type, which provides a gain of unity at the mid-frequencies and uses standard linear potentiometers. The high input impedance of the CA3140 enables low-value (and therefore cheap) capacitors to be employed in a circuit which has an impedance great enough to avoid excessive loading of the stage feeding this circuit.

Bass/treble boost or cut are about ±15 dB at 100 Hz and 10 kHz respectively. Full peak-to-peak audio output is available up to at least 20 kHz, since the CA3140 has a relatively high slew rate (about 7 V/us). The gain falls by about 3 dB at a frequency of around 70 kHz.

The circuit of Figure 7 provides similar boost and cut facilities, but the gain of this circuit is about eleven. The input impedance is basically equal to the resistor from pin 3 to ground.

off between bandwidth and power consumption which is required). Figure 9 shows the response of the Figure 8 circuit.

Mic preamp

A moving-coil microphone preamplifier with tone control is shown in Figure 10. A TL061 low-power device which is internally compensated is employed in this circuit.

Distribution amp

The Texas Instruments series of BiFET devices is also available with four separate amplifiers in a single 14-pin dual-in-line package. Figure 11 shows the connections of the TL064 low-power BiFET quad amplifier, together with a

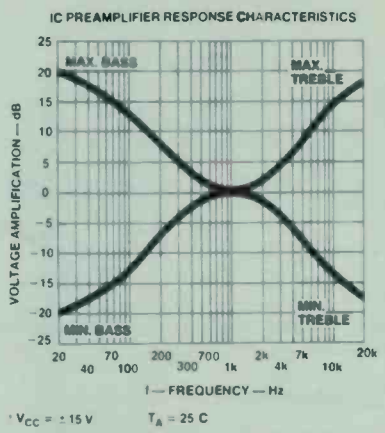


Figure 9. **Response characteristics of the Figure 8 circuit.**

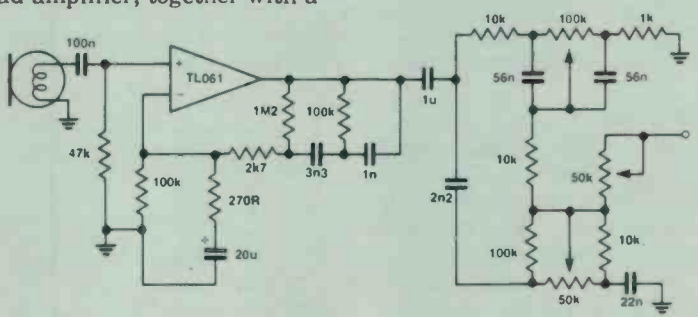


Figure 10. **Moving-coil mic preamp with tone controls, using an internally compensated TL061 device (same pinout as TL071).**

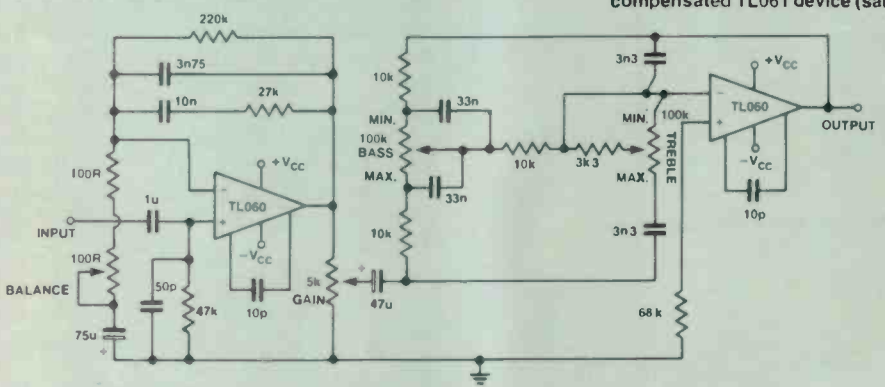


Figure 8. **A two-stage tone control circuit using TL060 devices. (Same pinout as TL070).**

A tone control circuit using the TL060 low-noise BiFET devices is shown in Figure 8. The TL060 is not internally compensated and therefore requires the 10p external frequency compensation capacitor shown connected in the circuit of each device. Similar circuits can, of course, be made using the TL080 devices at the expense of a higher power level. A further alternative is the use of TL066 programmable BiFET device without any compensating capacitors, but with a suitable value of the programming resistor between pin 8 and the negative line (about 1k, depending on the trade-

circuit for an audio distribution amplifier using one of these quad devices. The input stage acts as an input buffer and the other three stages act as output buffers, so that no signal from output A finds its way into any of the other outputs.

The TL084 and the low-noise TL074 have the same pin connections (which are the same as those of the LM324 type of device), whereas the TL085 and the low-noise TL075 devices are quad types with connections similar to the RC4136. There is no TL065 at present.

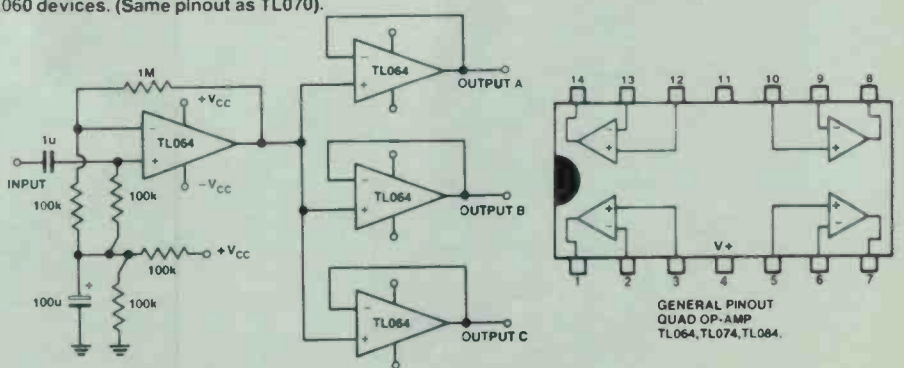


Figure 11. **An audio 'distribution' amplifier for 'slaving' several pieces of equipment from a single source. Pinout for the quad op-amp is shown at right.**

Lab Notes

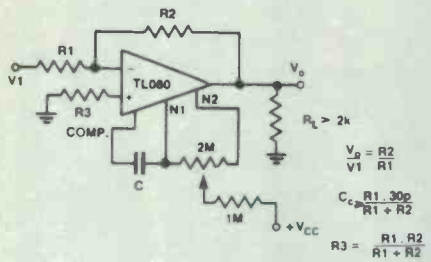


Figure 12. Simple voltage-variable gain amp using the TL080.

Variable gain

The simple circuit of Figure 12 is an amplifier which provides a variable gain set by the potentiometer. A TL080 device is employed, so the compensating capacitor C_c is required, since this device is not internally compensated.

Ice warning

The circuit of Figure 13 employs three of the four amplifiers of the TL084 device in an ice warning detector. It is especially suitable for use in vehicles to warn the driver when the temperature of the thermistor (placed outside the vehicle) falls below 0°C.

When the temperature of the thermistor falls, its resistance rises and the current flowing through the thermistor decreases. Thus the inverting input of the TL084 connected to this thermistor receives less current from the positive supply line and its output voltage tends to rise. This output voltage is fed to the TL084 output amplifier and produces a voltage across the LED, which lights, providing the required warning.

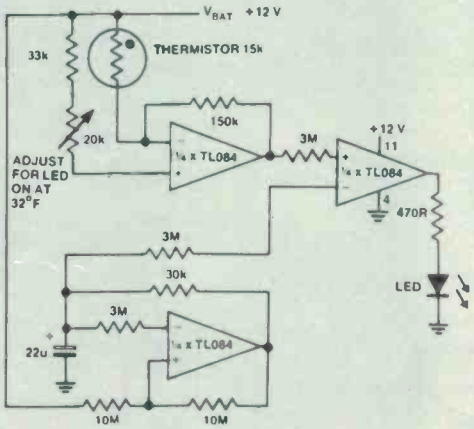


Figure 13. An ice warning indicator.

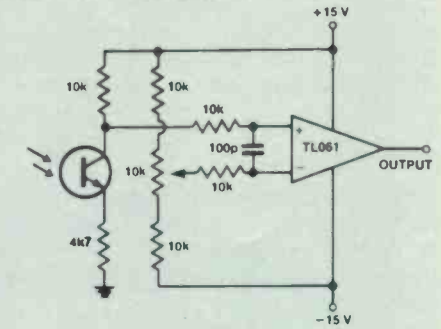


Figure 14. Low-level light detector using FPT100 or similar phototransistor.

Light detector

The circuit of Figure 14 is a low-level light detector preamplifier using the low-power TL061 device with a TIL601 or similar phototransistor. The variable resistor can be used to balance the output at any particular value of light level.

Sine shaper

The circuit shown in Figure 15 uses a CA3140 as a voltage follower device in combination with diodes from the CA3019 array to convert the triangular signal from a function generator into a sinewave output, which has typically less than 2% harmonic distortion.

The circuit is best adjusted using a distortion analyser, but a fairly good adjustment can be made by comparing its output signal on an oscilloscope with that from a good sinewave signal generator. The initial slope is adjustd by R1, followed by an adjustment of R2. The final slope is established by adjusting R3, thereby adding additional segments that are contributed by these diodes. Repetition of the adjustments may be necessary, since there is some interaction between the adjusting potentiometers.

Wien bridge

A CA3140 BiMOS amplifier is used in the circuit of Figure 16, together with a CA3019 diode array, to form a Wien bridge oscillator. The zener diode shunts the 75k feedback resistor and, as the output signal amplitude increases, the zener diode impedance rapidly decreases so as to produce more feedback, with a consequent reduction in gain. This action stabilises the output signal amplitude. This combination of a monolithic zener diode and the bridge rectifier tends to provide a zero temperature coefficient for this regulating system.

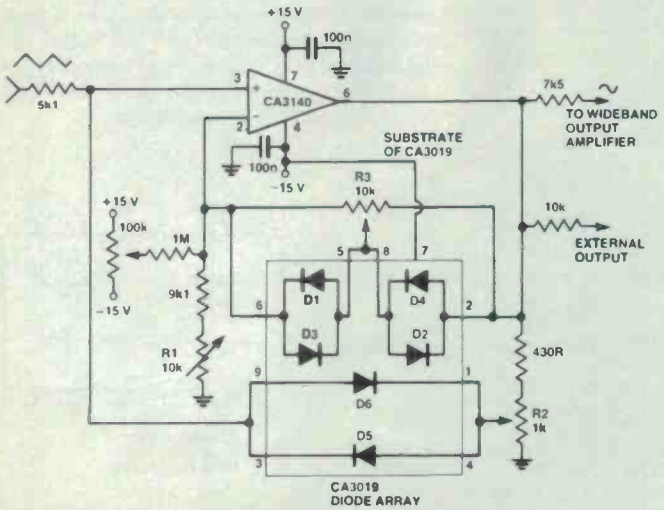


Figure 15. A triangle-to-sine waveshaping circuit employing a CA3140 op-amp and a CA3019 diode array.

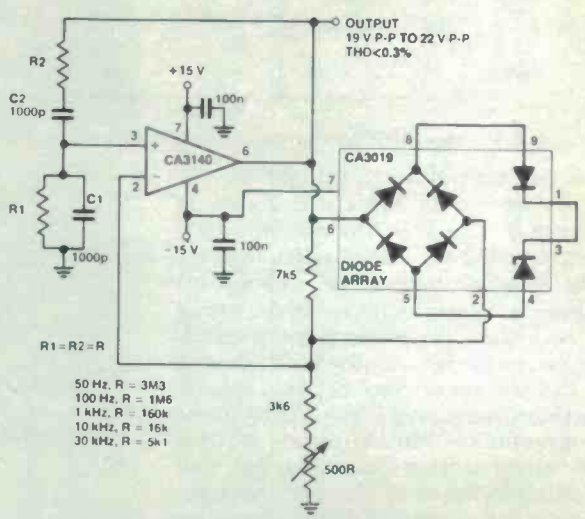


Figure 16. A Wien bridge oscillator featuring amplitude stabilisation via the zener action from the CA3019 diode array.

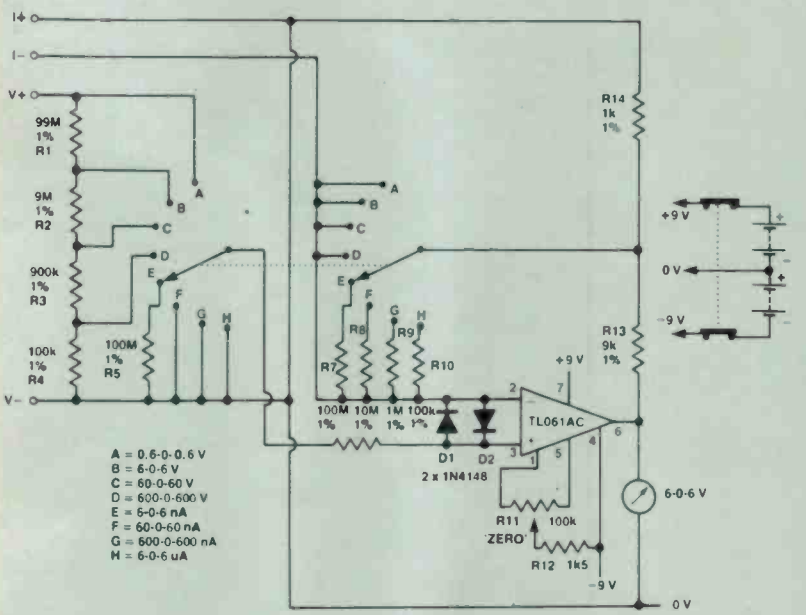


Figure 17. **A multi-range voltmeter with high impedance input plus multi-range low-current meter.**

As the output circuit contains no RC time constant, there is no lower frequency limit for operation. If C1 = C2 = 1u (polycarbonate) and R1 = R2 = 22M, the operating frequency can be about 0.007 Hz. At high frequencies, as the frequency is increased the amplitude of the signal must be reduced to prevent slew rate limiting from taking place. An output frequency of about 180 kHz will reach a slew rate of about 9 V/us when the output voltage amplitude is about 16 V peak-to-peak.

Meter

The high input impedance of BiFET and BiMOS devices has led to their use in many voltmeters of high input resistance and also in meters to measure very small currents.

The circuit of Figure 17 was designed by Texas Instruments for the measurement of voltages in the range ±0.6 V to ±600 V, where the source resistance may be quite high, and to measure currents from 6 nA to 6 uA. The instrument was required to accept inputs of either polarity and be inexpensive, robust and reliable. It also had to have a long battery life, so a TL061 low-power operational amplifier device was selected. An inexpensive centre zero meter is considerably cheaper than a liquid crystal display and would provide adequate accuracy for the purpose.

When the switch is in one of the positions A to D inclusive, the instrument is set for the measurement of voltages. The amplifier has a non-inverting gain of 10 and range selection is achieved by a simple potential divider network with a fixed input impedance of 1000 megohm. A panel-mounted 'centre zero' control is included in the circuit to facilitate corrections for the mechanical movement of the meter zero and for the change in the operational amplifier input voltage offset (for example, with temperature).

In the current measuring mode of switch positions E to H inclusive, the amplifier operates as a current-to-voltage converter. For the most sensitive range of 6 nA, a transimpedance of 1 Gigaohm is required to produce a full-scale deflection of the meter. Rather than use a resistor of such a high value, a resistance multiplier arrangement was devised with a 100M feedback resistor for the most sensitive range.

The two diodes across the input of the operational amplifier in conjunction with R6 provide protection against any gross overloading of the instrument. A suitable arrangement incorporating a fullwave rectifier into this circuit would allow alternating input signals to be measured, but arrangements would have to be made to allow for frequency roll-off of the response at high frequencies.

3 pA meter

A CA3160 and a CA3140 are used in the circuit of Figure 18 to construct a pico-ammeter with ±3 pA full scale deflection (one picoamp = 10^{-12} amps). Pins 2 and 4 of the CA3160 are connected to ground, so the input pin 3 between them is effectively 'guarded'. If slight leakage resistance is present between terminals 3 and 2 or 3 and 4, there would be zero voltage across this leakage resistance and this would reduce the leakage current by a large factor.

It is preferable to operate the CA3160 with its output pin 6 near the ground potential, so as to reduce the dissipation by reducing the device supply current. The CA3140 serves as a x100 gain stage to provide the required plus and minus output voltage swing for the meter and feedback network. A 100:1 voltage divider network consisting of a 9k9 resistor in series with a 100 ohm resistor sets the voltage at the 10 kMohm resistor to ±30 mV full-scale deflection. This 30 mV signal results from ±3 V appearing at the top of the voltage divider network, which also drives the meter circuitry.

It is possible to switch the 9k9 and 100 ohm network in the output circuit so that current ranges from 3 pA to 1 nA can be handled using the single 10kM resistor.

The writer has seen circuits using BiMOS devices published for use in measuring currents down to 100 femtoamps (0.1 pA), but obviously extreme care is required to ensure the insulation is adequate when such small currents are being measured.

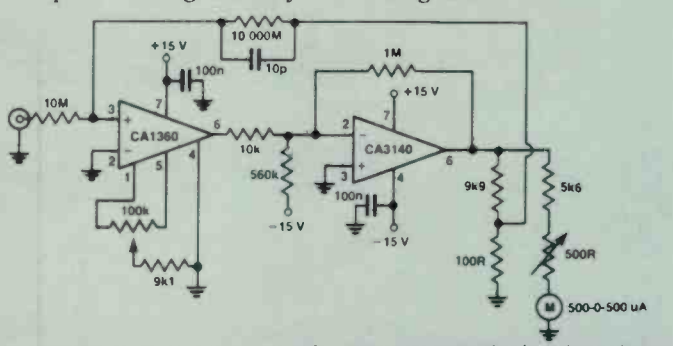
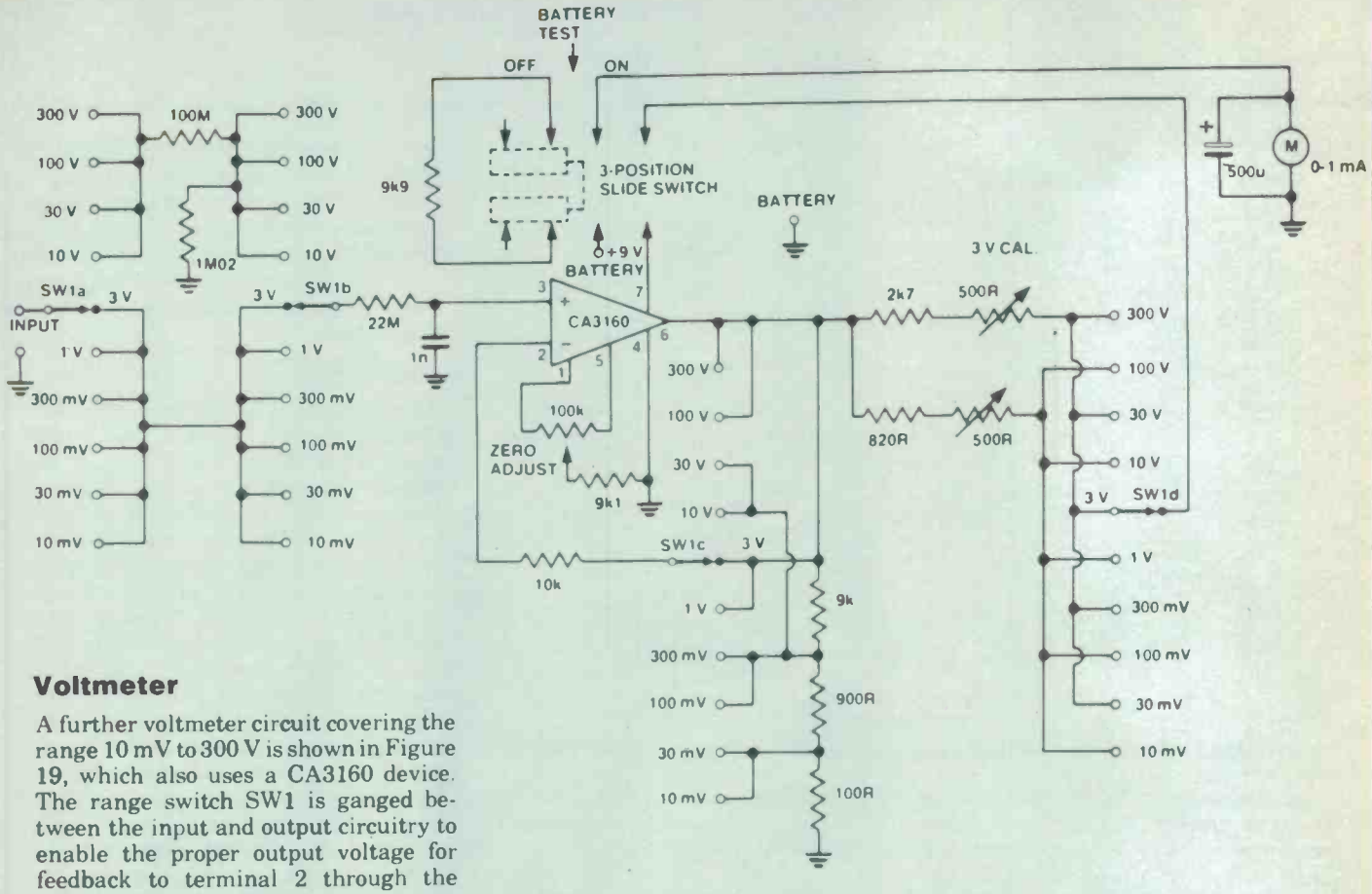


Figure 18. **This circuit will measure *very* low currents — full-scale deflection is ± three picoamps!**



Voltmeter

A further voltmeter circuit covering the range 10 mV to 300 V is shown in Figure 19, which also uses a CA3160 device. The range switch SW1 is ganged between the input and output circuitry to enable the proper output voltage for feedback to terminal 2 through the 10k resistor to be selected.

This circuit is powered by a single 8.4 V mercury battery, the power supply current being somewhat less than 500 uA plus the meter current required to indicate a given voltage. Thus the supply current rises to about 1.5 mA at full-scale deflection.

Any readers who experience problems in obtaining a CA3160 may use a CA3130 with a frequency compensation capacitor of about 56p between pins 1 and 8.

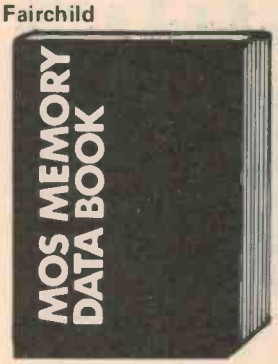
The aim of this article has not been to introduce readers to all the latest BiFET and BiMOS devices (of which there are large numbers), but rather to give an indication of the wide selection of circuits that can be made with just a few of the standard types of device which are readily available.

Figure 19. **Example of a multi-range voltmeter measuring from 10 mV to 300 V.**

ESCHEW TERMINOLOGICAL OBFUSCATION

If you can't understand the "Big Words" that are commonplace in Electronics these days, but you can't avoid them, perhaps you need a Jaycar Book! Or perhaps you just need some data. In any case, you can't go wrong with Jaycar — No.1 for Books!

MOS MEMORY DATA by Fairchild



This book measuring 230 x 175mm gives full data on popular RAM and EPROMs (2102, 2114 4116, 4164, 2708, 2732, 2764 etc) as well as many other lesser known types including shift registers etc. Due to industry standardisation, the data in this book will relate to other manufacturers of MOS memory with the standard part numbers.
Cat. BF-4710 $3.95

MOTOROLA CMOS DATA

862 pages crammed with up-to-the minute information on 4000, 4400, 4500 devices. A complete product index is included along with comprehensive data on every device (almost 200 described) As the part numbering system is standard, you can use this reference for other manufacturers products with the same generic numbers. This book normally sells for $14.50. But for September only $11.50 SAVE $3.00!
Cat. BM-4210 $11.50

SAVE $3.00

EXPERIMENTS IN ARTIFICIAL INTELLIGENCE FOR SMALL COMPUTERS

Conducts interesting and exciting experiments in artificial intelligence with this book, a small computer with extended BASIC, and some knowledge of the BASIC language. The author first introduces you to artificial intelligence — the capability of a device to perform functions normally associated with human intelligence, such as game playing, problem solving, reasoning, creativity, and verbal communications. Then game-playing programs, with a checkers-playing game as the main topic are explained. 112 pages, 5½ x 8½, soft.
Cat. BS0512 $12.95

ONLY $12.95

TRS-80 INTERFACING BOOK 1

Written for users who have a fairly good understanding of Level II BASIC. Author John Titus introduces you to the various I/O signals used by the TRS-80 and explains how these signals can be used in a number of interesting and practical circuits. Numerous hands-on experiments are included. 192 pages, 5½ x 8½, soft.
Cat. BS0572 $15.95

BOOK 1 $15.95

TRS-80 INTERFACING BOOK 2

Provides you with a number of practical and useful ways to utilize your knowledge from Book 1. Applications include how to generate voltage and current signals used in a variety of control applications, how to measure unknown voltages how to drive high current and high voltage loads, and many more. Complete software programs are included. 256 pages 5½ x 8½, soft.
Cat. BS0574 $16.95

BOOK 2 $16.95

PET INTERFACING

Demonstrates how you can build numerous interfacing devices for your PET hardware. BASIC language programs are used throughout the book, so you should be familiar with this powerful programming language. The Commodore PET microcomputer has several special purpose interface connectors that ease the job of interfacing the computer to "real-world" hardware. Also includes a discussion of the microprocessor's internal architecture and general software/hardware interfacing. 264 pages, 5½ x 8½, soft.
Cat. BS0576 $25.95

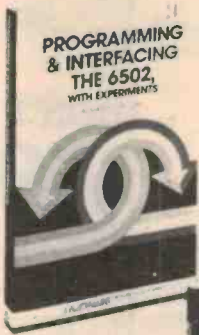
INTERFACE FOR $25.95

Z-80 MICROCOMPUTER HANDBOOK

Designed to acquaint you with the hardware of the Z-80 and to discuss the impressive software aspects of this "computer on a chip". A number of chapters are devoted to the use of machine and assembly language. Also included is a discussion of many different microcomputers built around the Z-80, including the popular TRS-80. 304 pages, 5½ x 8½, soft.
Cat. BS0594 $16.95
Also available: Z-80 MICROCOMPUTER DESIGN PROJECTS. 208 pages.
Cat. BS0596 $23.95

We have dozens of other books in stock -- call in and have a browse — magazines also!!

PROGRAMMING AND INTERFACING THE 6502 WITH EXPERIMENTS



Excellent starting point for 6502 based microcomputer novices and veterans alike who may not have much assembly language and programming or chip level interfacing experience. Includes experiments and examples of simple I/O techniques, instructions, and chip level interfacing that can be reinforced with a low cost KIM, SYM, or AIM system. Helps you understand all 6502 based computer systems 416 pages, 5½ x 8½, soft.
Cat. BS0580 $25.95
Also available: 6502 SOFTWARE DESIGN
Cat. BS0578 $17.95

16–BIT MICROPROCESSORS

Carefully steps you through the complex processes of programming and designing with the new and powerful 16-bit microprocessors. The major advantages and disadvantages of these state-of-the-art devices are discussed and numerous benchmarks are provided to help you in your comparison of the chips. The book begins with a simple, straightforward review of the basics of microprocessor design and construction, and then takes an in-depth look at each of the most popular 16-bit microprocessors on the market today, including the 68000, 8086, Z8001/2, 9900 and NS16000. 352 pages, 5½ x 8½, soft.
Cat. BS0588 $24.95

16–BITS FOR $24.95

USING THE 6800 MICROPROCESSOR

No special background in digital electronics is needed to use this book, which steps you through the conception, configuration, writing, and running of a variety of programs that demonstrate the practical application of the powerful 6800 microprocessor. The unit's straightforward internal architecture, efficient instruction set, and sophisticated support circuits are covered. 176 pages, 5½ x 8½, soft.
Cat. BS0584 $14.95

GREAT VALUE $14.95

8085A COOKBOOK

A design-it-yourself guide to developing a number of completely operational, low cost microcomputers around the 8085A microprocessor. Includes a discussion of all support hardware and 8085A family compatible chips. A tremendous amount of software is already available for use on these systems. Almost anyone can learn to design an 8085A based microcomputer with the 8085A Cookbook. 352 pages, 5½ x 8½, soft.
Cat. BS0592 $24.95

ONLY $24.95

MOTOROLA MASTER SELECTION GUIDE

THE catalogue of Motorola semiconductor's products. Over 330 pages of specs, drawings, data and other information on: * MOS devices including CMOS, Memory and CPU * Bipolar including Linear, Memory, Logic (SSI) etc * Power, including Rectifiers, SCR's, Triacs & power transistors * RF, small signal & Opto * Solar power systems. This valuable reference book also contains a comprehensive index at the back! Book measures 210 x 280 x 15mm
Cat. BM-4250 $3.95

ONLY $3.95

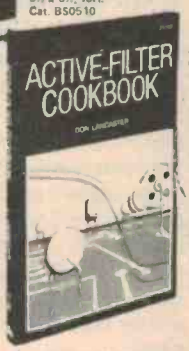
SON OF CHEAP VIDEO

This sequel to The Cheap Video Cookbook provides a complete video display system which you can build for as little as $7. Likewise, transparency display can be created for under $1 by using a video circuit called "The Snuffler" which is completely described in chapter 2. This book makes cheap video even cheaper. 224 pages, 5½ x 8½, soft
Cat. BS0604 $15.95

VALUE AT $15.95

THE CHEAP VIDEO COOKBOOK

Complete discussion of a new, low cost way to get words, pictures, and opcode out of your computer and onto any ordinary TV set. Don Lancaster outlines an easy to build seven IC circuit which you can build for less than $20. This circuit can be software-controlled to provide any alphanumeric or graphics format including high resolution (256 x 256) and a four colour mode. 256 pages, 5½ x 8½, soft.
Cat. BS0510 $11.95



A practical, easy-to-read discussion of the many types and uses of active filters. Learn how to construct filters of all types including high-pass, low-pass, and band-pass having Bessel, Chebyshev or Butterworth response characteristics. Easy to understand — no advanced math or obscure theory is used. Active Filter Cookbook can be used as an introduction to active filter circuits or as a reference book for analysis and synthesis techniques for active filter specialists. 240 pages, 5½ x 8½, soft.
Cat. BS0519 $21.00

MODERN RECORDING TECHNIQUES

ONLY $18.95

Explains the equipment, controls, and techniques found in the modern recording studio and how to use them creatively as well as properly to produce a desired result. Numerous photographs, diagrams and charts. 368 pages. 5½ x 8½, soft.
Cat. BS-0546 $18.95

REGULATED POWER SUPPLIES

(3rd Edition)

The newest, most comprehensive discussion of internal architecture and operation of the latest solid state regulators. Thoroughly explains when regulated supplies are needed and how to incorporate them into your design projects. Discusses modern, practical circuitry including linear and switching circuits and late ICs. A valuable asset for any technician or egineer involved in servicing or design 424 pages, 5½ x 8½, soft
Cat. BS0526 $27.95

GREAT VALUE $27.95

RF CIRCUIT DESIGN

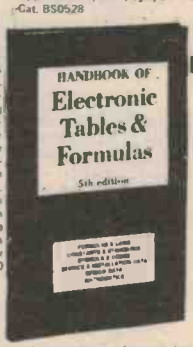
A user-oriented text with a practical approach to the design of RF amplifiers, impedance matching networks, and filters Can be used in cookbook fashion as a catalogue of useful circuits with component values. Utilizes a minimum of complex math. A valuable bridge between the classroom and "real world" application, and an excellent reference manual. 352 pages, 5½ x 8½, soft.
Cat. BS0530 $27.95

DESIGN OF PHASE-LOCKED LOOP CIRCUITS WITH EXPERIMENTS

An excellent introduction to the theory, design and implementation of phase-locked loop circuits using various TTL and CMOS devices. Useful self-study course for the experimenter and for inclusion in college courses on control systems or linear ICs. Includes manufacturers data sheets and describes the use of breadboarding aids in the wide range of laboratory type experiments. 256 pages 5½ x 8½, soft.
Cat. BS0534 $15.95

ELECTRONIC MUSIC CIRCUITS

Written for computer and electronics hobbyists with an interest in music, as well as musicians and studio engineers. The author describes how to build a custom electronic music synthesiser, outlines numerous other circuit designs and then shows you how to modify them to achieve particular responses. Many of the circuits can be used as special effects boxes for guitars and other musical instruments. Approximately 288 pages, 5½ x 8½, soft.
Cat. BS0528 $25.95



ELECTRONIC TABLES AND FORMULAS

A complete reference book that quickly puts at your fingertips the laws and formulas so important to all branches of electronics. Provides you with the hard-to-remember constants as well as standards that have been established by industry and government. Also covers symbols and codes, design data, and math tables and formulas. 288 pages, 5½ x 8½, hard.
Cat. BS 0550 $17.95

VALUE AT $17.95

TV ANTENNAS AND SIGNAL DISTRIBUTION SYSTEMS

An aid in selection and installation of TV antennas and signal distribution systems, and how to implement these systems for high quality TV reception. Includes valuable performance data based on actual measurements made by the author, M.J. Salvati. 256 pages, 5½ x 8½, soft.
Cat. BS 0542 $13.95

SEE PAGE 77 FOR THE JAYCAR ADDRESSES AND PHONE NUMBERS

Price/performance Breakthrough

DON'T PAY ~~$699~~

$499 including tax.

The unbeatable FAX-80

Australia's best value printer – now at an unbeatable Sheridan price!!

If you've been looking for a high quality printer at a down to earth price, the FAX-80 is right for you. It offers features equal to printers costing over $1,000. We have made a huge purchase of these superb printers and reduced the price by a staggering $200. We believe this is Australia's best value dot matrix printer. Look at the features and specs. We don't think there's another printer near the price that even comes close.

- **Accepts 4" to 10" paper**
- **High resolution 9x9 matrix (including graphics)**
- **Adjustable tractor and friction feed**
- **80 characters per second with bidirectional printing**
- **User detachable print head**

Serial RS232 Option

Need RS232 serial interface? Just buy the RS232 serial card and plug it into your FAX-80. Others charge up to $300 extra for the serial interface. Our price is a low: **$79.90**

Specifications

Printing Method	Serial Impact Dot Matrix
Printing Matrix	9x7 (8x8 Graphics)
Printhead	9 wires printhead
Print Rate	80 CPS
Line Spacing	1/6" x 1/8" Software selectable
Number of Columns	80, 142 (40, 71 Enlarged)
Printing	Bidirectional
Character Set	96 ASCII plus European
Switches	Power On/Off, Line Feed, Form Feed, On-Line
Indicators	Power On/Off, On-Line, Ready, Paper Out
Interface	Standard Centronics parallel (completely compatible with Epson MX-80).
Paper Width	4" to 10"
Printing Ribbon Type	Cassette with endless loop
Ribbon Life	6 x 10^6 characters
Print head life	30 million characters (replaceable).
Dimensions	390mm(W) x 320mm(D) x 115mm(H)

Sheridan Electronics

164-166 Redfern St., Redfern NSW 2016

Trading Hours
Mon-Fri 9am-5.30pm
Thursday 9am-7pm
Saturday ..... 9am-12 noon

All prices include sales tax.
Printer sent freight on.

AMERICAN EXPRESS

Phone: (02) 699 6912, 699 5922

Art Express 923 1499

Hand held 20 MHz digital frequency/period meter features liquid crystal display

This project features a 4½-digit liquid crystal display and is completely portable as it's battery powered. It counts to 20 MHz in four ranges (2 kHz, 20 kHz, 2 MHz, and 20 MHz) and measures period from 200 ms to 200 us (full scale).

Part 1
Geoff Nicholls

NO MATTER HOW you're involved with electronics, there's always a need to measure various quantities — voltage, current, resistance, frequency, etc. What you want to do is put a *number* to that quantity and the best way to do that is to employ a digital display.

Digital displays, based on neon-filled vacuum tubes called 'Dekatrons' first appeared in the late '50s-early '60s. With the advent of seven-segment LED displays, digital measuring instruments rapidly became commonplace. With the introduction of liquid crystal displays, which require virtually no power to operate, battery-operated portable measuring instruments burgeoned.

Portable instruments can be used almost anywhere — right where you want to make the measurement. It's not always possible or convenient to take the equipment to the workshop. The majority of multimeters are portable, handheld devices and we thought, "why shouldn't a frequency meter be the same?"

There are so many occasions in electronics today (... err, pardon the pun) where you need to measure frequency. In times past, it was almost the exclusive reserve of 'the RF man'. These days even those involved in audio and computing need to have frequency measuring facilities.

Just being able to measure frequency is great, but what sort of accuracy is generally required? I asked around and, for the great range of applications, it seems six-figure accuracy, while seemingly desirable, is not really necessary.

Take a computer modem for example. These use two audio tones to signal the 'high' and 'low' bits of the digital information transmitted through them. The accuracy required is a few Hertz in several thousand Hertz — about 0.1%.

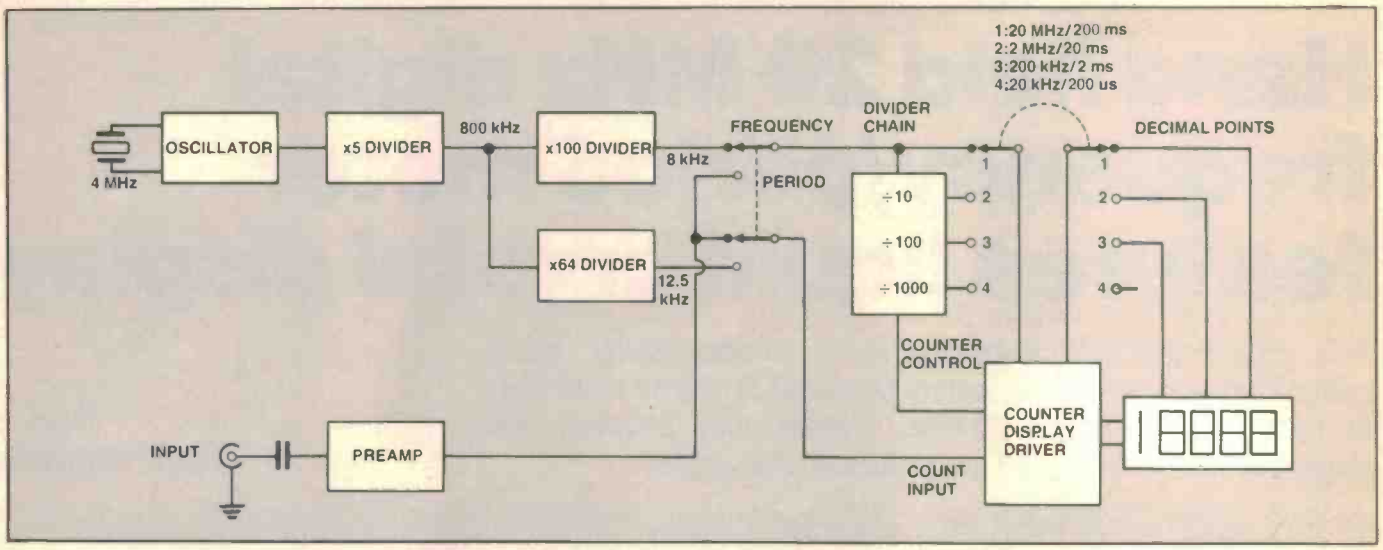
The accuracy and temperature stability of your 'off-the-shelf' quartz crystal is 100 parts per million (ppm) and 20 ppm/°C, respectively. Put another way — 100 Hz per megahertz accuracy, 200 Hz per megahertz for a 10°C temperature range.

All that adds up to this — a 4½-digit display has all the accuracy you need for the greater range of applications. (The leftmost digit on a 4½-digit display will only read '1', while the other four will read 1 to 9).

That's when I went searching for a 4½-digit counter-display driver as 4½-digit liquid crystal displays are readily available.

I turned up Intersil's ICM7224IPL, which is perfect for the job, and what's more, it's capable of counting to 20 MHz! A portable, battery-operated digital frequency meter was a distinct possibility, so I obtained several samples from R&D Electronics, the Intersil agents, through All Electronic Components in Melbourne.

Many months before we tackled this design, a representative from Mayer Krieg & Co had called in and left us a range of sample 'Unimes' cases, amongst which was a small handheld case just made for the application. It was palm-sized and featured a 'sculpted' front with a window just the right size for a liquid crystal display. It also had a battery compartment to take a ▶



standard No 216 9 V battery. It was all too easy!

The electronic design was a 'snack' but it was obvious that fitting the components on a pc board and into that case was going to require some pretty fancy juggling. Right here, Murphy stepped in. After considerable effort with the mechanical design, it was abandoned and another case sought. But Mayer Krieg came to our rescue with a somewhat larger handheld case with all the features we wanted. Known as the Unimes 2, it measures 180 mm long by 100 mm wide and from 35 to 44 mm deep. It has a battery compartment in the rear to take 4 x AA cells, plus a wire tilting bail so that the case can be either laid flat or stood up on a flat surface. There is a recessed window in the front, up top, for a display and a recessed, sloping section for a front panel label.

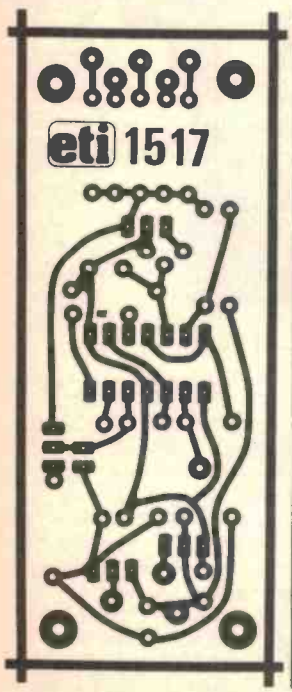
Design

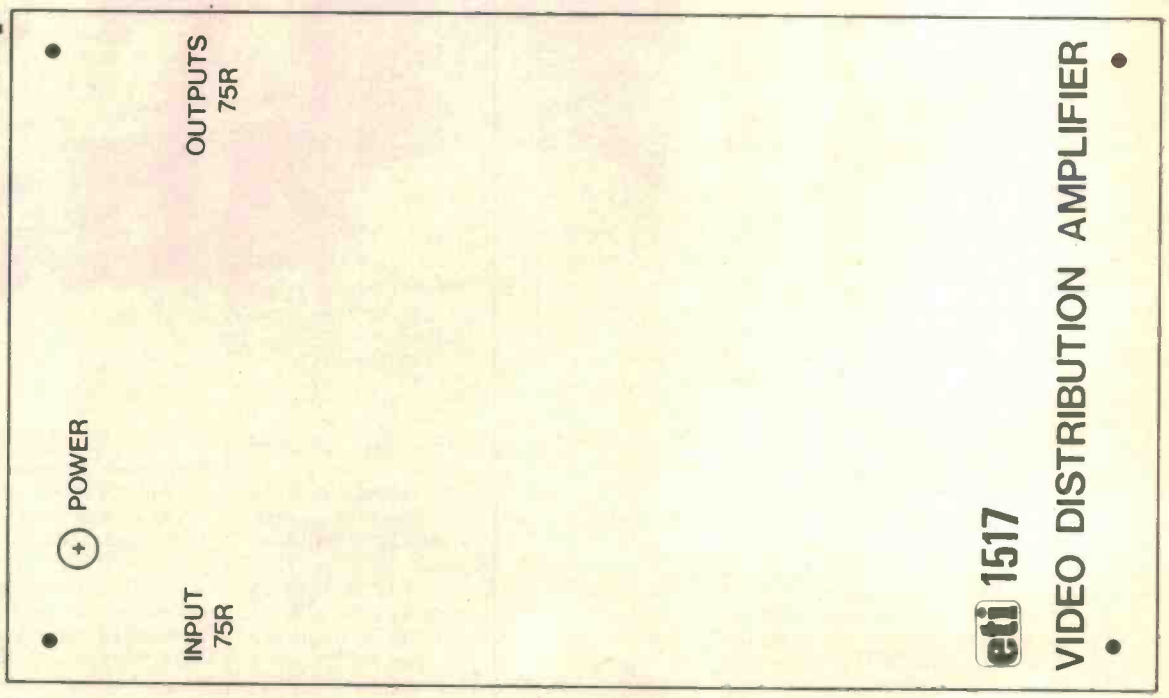
Frequency counter designs may be classified according to the type of range switching employed. In low-cost designs there are only two common types, the *switched gate period* type and the *input divider* type. The latter divides the input signal down by various ratios, according to the range selected, while keeping a fixed gate period, typically one second. This allows the actual counter to operate at a low frequency while counting a high input frequency but requires high speed dividers for one or two stages. I decided to take advantage of the excellent high frequency counting ability of the Intersil ICM7224IPL and use a switched gate period. The block diagram here shows the overall arrangement of the instrument.

The count input of the Intersil device has a Schmitt trigger first stage with a typical hysteresis of 0.5 V, centred on 2.0 V. When operating in the frequency mode, the preamplifier output is fed to the COUNT input while the 8 kHz reference is divided to select gate times of 1 ms, 10 ms, 100 ms or one second, corresponding to ranges of 20 MHz, 2 MHz, 200 kHz and 20 kHz. The actual gate time is eight cycles of the frequency sent to the divider chain.

In period mode, the count input of the ICM7224IPL is switched to a fixed 12.5 kHz reference, while the input signal from the preamplifier goes to the divider chain. Once again, the gate period is eight cycles, so the counter ends up counting at the rate of 12.5 kHz for eight input periods. This produces a 'true' decimal period readout in microseconds or milliseconds.

Next month I'll reveal the circuit and describe the construction.●





AVTEK (ELECTRONICS) Pty. Ltd.

Correspondence P.O. Box Q302, Queen Victoria Building, Sydney 2001
Showroom 119 York Street, Sydney 2000
Phone: (02) 267 8777

ROBOTICS MOTOR

DISTRESSED STOCK. . .

24 Volt but runs perfectly on 12 volts DC.
Output speed @ 12V approx. - 40 RPM.
Current drain @ 12V No Load approx. 100mA
Stalled current approx. 200mA
Size: Overall 55mm long by 35 mm wide. Shaft length 20mm and shaft diameter approx. 4mm.
MADE BY CANON OF JAPAN

SAVE ABOUT 30% OFF NORMAL PRICE. . .
ONLY $9.99 EACH
Buy 4 units for only $35.00

only $9.99

bankcard

ATTENTION TRS-80 OWNERS

Have you suffered problems with faulty connectors in the CPU to expansion box cable — halfway through writing a big program the ??? crashes and the disk de-boots.
We have the answer! It consists of 2 x 40 way transition connectors that you solder to your CPU and expansion box and a pre-made 6" cable with 40 pin SOCKETS FITTED — It will take about 20 minutes to install and will fix the problems forever!

DON'T PAY OVER $35.00
ONLY $27.50

NEW KITS IN STOCK

MicroBee Light Pen — New Low Price $19.50

ETI 163 Power Supply — We think we are the only people in Sydney with it.
ONLY $175.00

ATTENTION MICROBEE OWNERS

Have you ever wanted to do some experimenting with the Expansion Connector but have been unable to find a supplier of the 50 way transition connector.

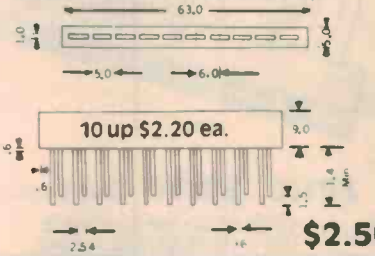
WE NOW HAVE IT IN STOCK
ONLY $8.95
IDC SOCKET TO SUIT
ONLY $8.95
IDC 50 WAY CABLE
ONLY $5.25/metre
We also have a 16 to 32K Expansion Kit available which includes all IC's and IC sockets.
ONLY $85.00
Takes about 30 minutes to fit.

EDGE CONNECTORS BRAND NEW QUALITY MANUFACTURERS SURPLUS!!

0.156" Pitch 86 way double side
ONLY $2.95
0.156" Pitch 24 way single side
ONLY $1.95
0.156" Pitch 80 way double
ONLY $2.50

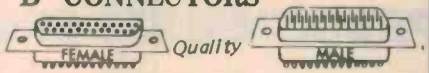
10 up less 10%

10 SEG. RED BAR GRAPH MODULE



$2.50

"D" CONNECTORS



	Solder	W/W	PC mnt	IDC
9 pin M	$2.50	—	$3.95	$7.95
9 pin F	$2.95	—	$4.50	$8.00
15 pin M	$2.95	—	$3.95	$8.95
15 pin F	$3.50	$4.95	—	$9.00
25 pin M	$4.50	$7.50	—	$12.50
25 pin F	$4.95	$7.95	—	$12.95

IDC CABLE NOW IN STOCK — all 28awg stranded

	Grey	Rainbow	
16 way	$1.75	$2.20	
25 way	$2.50	$3.95	all
34 way	$3.45	—	prices
50 way	$5.25	—	per/m

STOP PRESS: We now stock a range of T&B Ansley Insulation Displacement Connectors — phone for requirements.

SUPER SIMPLE LOGIC TESTER

1. Compatible with logic families covering supply voltage 4.5V to 18V, DTL, TTL and CMOS
2. Automatic adjustment of Light Emitting Level according to supply voltage
3. High input impedance: more than 100K ohms
4. Maximum input voltage: 0 to 18V DC
5. Supply current: 35mA at 18V DC
6. Min. detectable pulse width: 20m/s
7. Protection for input overload, for negative input and reverse polarity of supply voltage.

ONLY $9.50

NEW PRODUCT

UNIVERSAL VOLTAGE/-POLARITY CHECKER

Checks AC/DC 3.5V — 400V
A simple probe with 2 x LEDs that indicate whether the point being checked is positive, negative or AC voltage.
IDEAL FOR AUTOMOTIVE USE AND AROUND THE HOUSE — when you don't want to get out a multimeter.

ONLY $9.50

$2 POST AND PACKING

PLUS 5% OF ORDER VALUE — (Divide your order by 20 to get post and packing value then add $2); All Bankcard orders can only be sent to a normal address (not a PO Box). BC orders will be sent by registered mail (add $3 to P&P charges).

AVTEK No2

CALL IN TO OUR NEW SHOP AT 172 LIVERPOOL ROAD (HUME HIGHWAY) ENFIELD — BETWEEN BURWOOD AND CHULLORA AND SAY HELLO TO TONY ROSA AND HIS STAFF. THIS NEW AVTEK SHOP WILL BE STOCKING THE SAME GREAT RANGE AS YORK STREET AND WILL BE OPEN 7 DAYS A WEEK — PHONE TONY ON (02) 745 2122
SEND ALL MAIL ORDERS TO BOX Q302 AS IN MAIN AVTEK ADDRESS PANEL. . .

STOP PRESS :: STOP PRESS

BANKCARD HOLDERS PHONE YOUR ORDER TOLL FREE

008 999 007 FOR NEXT DAY DELIVERY*

*All Capital Cities and Suburbs — Country areas allow extra 24 hours. Offer applies to Altronics JET SERVICE.

INCREDIBLE VALUE BULK PACKS

ALL COMPUTER SELECTED

SUPER PRICE

$5 each

R3501.....25W Resistor Pack
Av. contents 300..... $12 Value

R3510.....Greencap Pack 100V
Av. contents 50..... $12 Value

R3515.....CERAMIC PACK 50V
Av. contents 100..... $14 Value

R3520. ELECTROLYTIC PK. PCB TYPE
Av. contents 40..... $14 Value

UK MADE, GOLD PLATED
D RANGE CONNECTORS
SAVE 25% ON BULK QUANTITIES!

		ea.	10 +	25 +
P 0880 DB9	Male 9 Pin	2.50	2.20	1.95
P 0881 DB9	Female 9 Pin	2.95	2.70	2.50
P 0885 DB9	Backshell	2.85	2.50	2.30
P 0890 DB15	Male 15 Pin	2.95	2.50	2.29
P 0891 DB15	Female 15 Pin	3.50	3.00	2.80
P 0895 DB15	Backshell	2.85	2.50	2.30
P 0900 DB25	Male 25 Pin	4.50	3.95	3.60
P 0901 DB25	Female 25 Pin	4.95	4.50	3.98
P 0905 DB25	Backshell	2.85	2.50	2.30

JUST ARRIVED

ATTN: FND 500 USERS

THE FND 560 IS HERE

This Brillaint High Intensity version of the ever popular FND 500 (pin for pin compatible) is now available from us **at the same low price.**

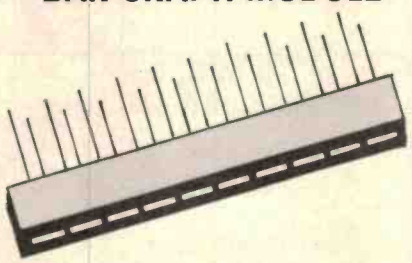
- ☆ Exclusive to Altronics.
- ☆ Quality Fairchild brand.
- ☆ TWICE THE BRIGHTNESS OF AN FND 500.

Normally $3.95

NOW ONLY... **$1.95 ea.**

NEW PRODUCT

10 SEG. RED BAR GRAPH MODULE



Z 0180 **$2.50** 10 up $2.20 ea.

LIMIT OF 20 PER CUSTOMER UNTIL MORE STOCKS ARRIVE

IMPORT SCOOP

PROFESSIONAL QUALITY

SOLDER SUCKERS

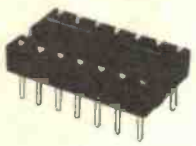
Not to be compared with inferior "Hobby types". Saves countless hours in fault finding and repair of complex PCB's.

- ☆ SINGLE HANDED OPERATION
- ☆ SELF CLEANING PLUNGER
- ☆ LONG LIFE TEFLON TIP
- ☆ DDUBLE DIAPHRAGM, DUAL O-RING SEAL
- ☆ 225mm x 20mm(d) 50mm STROKE POWERFUL SUCTION

And if you order this month ASK FOR A FREE REPLACEMENT TIP CAT. T1241 **YOU MUST ASK!!**

T1240.. only **$11.95**

T1241. Replac. tip. **$1.95**



IC SOCKETS DIL

LOW PROFILE

		ea.	10 +	25 +
P 0550	8 Pin	.25	.20	.18
P 0560	14 Pin	.30	.25	.20
P 0565	16 Pin	.30	.25	.20
P 0567	18 Pin	.40	.35	.30
P 0568	20 Pin	.50	.45	.40
P 0570	24 Pin	.60	.50	.45
P 0575	40 Pin	.80	.70	.65

TOP QUALITY MADE IN USA

☆ PROTOTYPE SOLDERLESS BREAD BOARDS ☆

MINI STRIP 100 HOLES

P 1000..... **$1.95**

640 HOLES

P 1005..... **$8.50**

640 + 100 HOLES

P 1007..... **$10.00**

640 + 200 HOLES

P 1009..... **$12.00**

NON-CORROSIVE NICKEL ALLOY CONTACTS RELIABLE FOR 50,000 INSERTIONS

There's a limit to just how many times you can resolder components while prototyping before you either destroy the component or lift a track from the vero.
These solderless breadboards enable circuits to be literally thrown together in an instant, yet all components remain reusable.
A necessity in all research laboratories to save on expensive development costs.

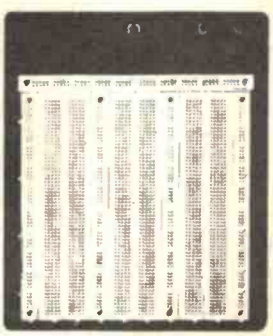
- ☆ Standard 0.1 inch spacings.
- ☆ Accepts all LSI'S, semis, transistors, diodes, leds and passives.
- ☆ 22-30 gauge solid hook up wire for interconnections.
- ☆ Boards are "Keyed" to enable easy expansion.

400 + 1280 HOLES

ACCEPTS UP TO 16 x 16 pin D.I.L. IC'S

SCREW TERMINALS FOR PS CONNECTIONS

P 1012..... **$26**



500 + 1920 HOLES

ACCEPTS UP TO 24 x 16 pin D.I.L. IC'S

METAL BACKING PLATE FOR SHIELDING OF SENSITIVE CIRCUITRY

P 1015..... **$38**

2 YEAR WARRANTY

NEW 20 WATT P A AMPLIFIER

UNCONDITIONALLY STABLE

The AS-20 is a **rugged, reliable general purpose public address amplifier.** Designed and manufactured in Australia this amp is suitable for use by **schools, sporting clubs, function centres** and in **professional installations** (paging systems, background music).

- Balanced Low Z mic input
- Unbalanced Low Z mic input
- Mic muting function (mutes program music with PA announcement)
- 4-16 OHM output • AUX Treble and Bass controls
- 100V Balanced line output
- Full 20 Watts RMS into 8 OHMS
- Short circuit load protection
- Less than 1% Distortion.

WHY PAY OVER $200.00 FOR AN INFERIOR UNIT?

A2000..... **$149.00**

TOP QUALITY PAGING MIC

STURDY ROBUST BASE

Has tapered low frequency response for articulate speech reproduction. Low impedance balance line. PTT switch with lock facility. Additional switch contacts for remote switching, muting etc. Gooseneck approx. 350mm.

C0166..... **$59.95**

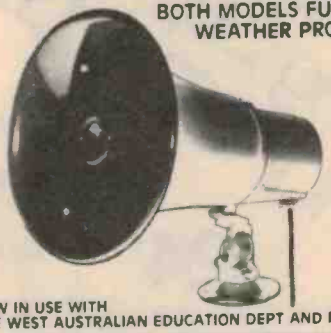
SUPER SPECIAL SPEAKER TWIN FLEX

2 x 19/.193

WO204 .... RED TRACE **35c/m**
WO205 BLACK TRACE **$34/200m**

PROFESSIONAL HORN SPEAKERS

BOTH MODELS FULLY WEATHER PROOF



NOW IN USE WITH THE WEST AUSTRALIAN EDUCATION DEPT AND PWD

30 WATT WITH LINE TRANSFORMER

Multitap inbuilt line transformer allows taps 330/30W, 660/15W, 1000/10W, 2000/5W. Universal swivel mounting bracket supplied.

C2033..... **$69.95**
4 or more..... **$67.80**

15 WATT WITH LINE TRANSFORMER

Multitap inbuilt line transformer allows 2 taps 660/15W, 1K/10W, 2K/5W, 4K/2.5W. Mounting bracket clears line † X allowing rear wall mounting.

C2030..... **$59.95**
4 or more..... **$56.00**

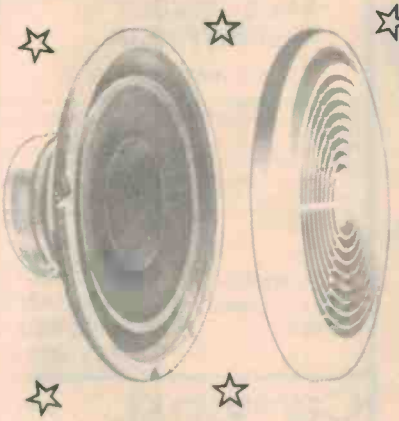
8 INCH WIDE RANGE DUAL CONE SPEAKER

200mm (8 in.). 10 Watts Max. power input. Public Address, Background Music. Ideal HI FI extension speaker. Includes transformer holes at 51mm. Over 30,000 sold in Australia!
Mounting holes 140 x 140mm.

C2000..... **$9.50 ea**
10 Up..... **$8.70**

8 INCH CEILING SPEAKER GRILL

C0800..... **$2.75**
10 Up..... **$2.00**



20W HIGH POWER SPEAKER TRANSFORMER

Primary Power Taps (100V Line) 1.25/2.5/5/10/15/20W (Halve these for 70V line)
Secondary Taps 4/8/16 OHMS.

M1120.... **$10.80**
10 or more **$9.90**

4W MULTI-PURPOSE SPEAKER TRANSFORMER

Primary: 2.5K, 5K OHMS
Secondary: 2, 4, 8, 16 OHMS
Frequency Response: 30 Hz - 12 KHz. Mounting hole centres 51mm. Ideal for high quality constant voltage PA systems.

M1105..... **$4.95**
10 Up each **$4.50**

GRAIN ORIENTED STEEL CORE

SAVE 25% THE SET OF TEN
B9995..... **$79.50**
PLUS $10 P&P

TOP SELLING MOTOROLA BOOKS

IF YOU MISSED OUT LAST TIME, ORDER NOW!
LATEST EDITIONS JUST ARRIVED

MOTOROLA CMOS DATA
B 1105..... **$11.50**

A comprehensive reference covering 40XX, 45XX CMOS family's along with specialty devices such as LCD drivers, telephone and general communication functions and industrial control.
862 pages essential in all spheres of electronics.

MOTOROLA MECL DATA
B 1100..... **$9.95**

Emmiter Collector Logic (ECL) is today's fastest form of digital logic providing the most direct way of improving system performance. This previously hard to get manual provides data on the 10KH, 10K and III families. MECL memory and PLL CHIPS.

MOTOROLA OPTO DATA
B 1118..... **$8.95**

Handy reference provides data and application notes on opto couplers, infra red LEDS, Photo transistors and a complete chapter on fibre Optics, a communications system which is fast gaining usage worldwide. VERY EDUCATIONAL.

MOTOROLA POWER DATA
B 1101..... **$12.95**

Motorola are the undisputed world leader in Power transistors. Renowned for their low cost and reliability. Book includes a 9 page selection guide, application notes and Data Sheets for over 700 Devices, 989 pages. Previously over $20.00.

MOTOROLA MASTER SELECTION GUIDE
B 1104..... **$7.95**

The most useful book ever printed. Covers MOS IC'S listed by function. LINEAR IC'S listed by function. INTERFACE IC'S listed by function. LSI, memory, TTL ECL power products, SCR'S, diodes, transistors listed by application and ratings. RF, small signal and opto devices listed by application and ratings. Essential Data given for all devices. TERRIFIC VALUE

MOTOROLA LINEAR IC'S
B 1114..... **$9.95**

Popular data manual. At last readily available. Approx. 800 pages, full Data Design proceedures and equivalent listings for 1000's of devices under headings OP AMPS, VOLTAGE REGULATORS, CONSUMER CIRCUITS (eg TV AUTOMOTIVE, POWER), HIGH FREQUENCY CIRCUITS and SPECIAL-PURPOSE CIRCUITS.

MOTOROLA LINEAR INTERFACE IC'S
B 1115..... **$11.50**

Complements the Linear IC Manual. Gives data, design proceedures and equivalent listings for MEMORY MICROPROCESSOR SUPPORT, LINE DRIVERS/RECEIVERS, TELEPHONY, COMPARATORS, VOLTAGE REFERENCE AND DATA CONVERSION DEVICES. Includes comprehensive selector guide.

MOTOROLA MICROPROCESSOR DATA
B 1120..... **$14.95**

Over 1200 pages covering all aspects of motorola's microprocessor, microcomputer and peripheral components. A clearly written Manual providing all the data necessary to design and build a working computer system from scratch.
100's of circuit examples, flow charts, Truth Tables and programme routines.

MOTOROLA MEMORY DATA
B 1113..... **$8.95**

An absolute must for the microprocessor Buff. This is the latest reprint of Motorola's famous Memory Data Manual and includes all the latest specifications and design application data on TTL RAM, TTL PROM, MECL MEMORY, MECL RAM, MECL PROM, MOS dynamic RAM, MOS static RAM, MOS EPROM, MOS EE PROM and MOS ROM worth many dollars more!

SCHOTTIKY TTL DATA
B 1109..... **$9.95**

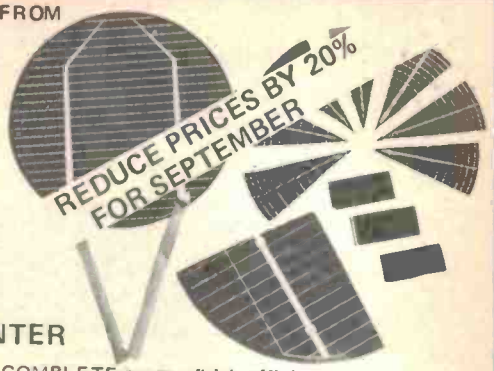
Essential reference for the enthusiast and engineer alike. Designing, building and servicing digital circuitry is an absorbing pastime. Data for the LS, ALS and FAST families along with design considerations and circuit characteristic are logically presented in this manual, making it quick and easy to use.

NEW STORE opening September HURSTVILLE

YOU CAN NOW PURCHASE ITEMS FROM JAYCAR THROUGH ALL REPAYMENTS INCLUDE INSURANCE

HFC

Customers must satisfy the requirements of HFC to purchase. All repayments are monthly



Breath Tester

$24.95

SAVE $5
Normally $29.95

Cat. KA1522

In all states and territories in Australia it is an offence to drive a vehicle with an alcohol/blood concentration above a certain limit. In most states it's 0.05 others 0.08. Either way it's only a relatively small number of alcoholic drinks.
Because it's only a small number of drinks, many people (quite wrongly) believe that they remain below the statutory limit.
The KA1522 Breath Tester can help here. A unit with the same circuit diagram was featured in May "Electronics Australia". It CANNOT give you an actual blood/alcohol content reading, however it can go close. And it can give you a relative reading between inebriated friends!!! Great at parties!!!
Grab the whole kit now for only $24.95. You never know, it may save your licence or your life!

SILICON SOLAR CELLS

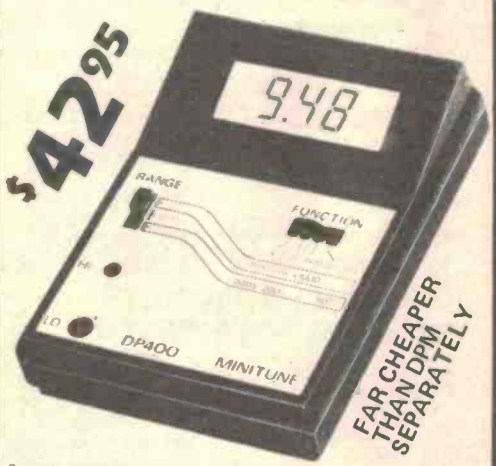
IDEAL FOR THE EXPERIMENTER

We now stock a COMPLETE range ofhigh efficiency SIlicon Solar Cells. All cells give 0.45V under rated load and they can be stacked in series or in parallel for higher current.

	1 – 9	10+
ZM9002 Rect. 10x20mm 45mA	$2.45	$1.95
ZM9003 3" diameter 1 amp	$26.50	$22.50
ZM9004 3" diameter x 30° segment 78mA	$3.25	$2.95
ZM9005 4" diameter x ¼ segment 450mA	$12.45	$11.95

minitune

$42.95



FAR CHEAPER THAN DPM SEPARATELY

Following the spectacular success of the DP2010 Digital Multimeter kit, we now have an ENGINE ANALYSER KIT! But the spectacular thing is the price! It is ACTUALLY CHEAPER than the DPM-05 Display and Case!! The Minitune will measure voltage, resistance (down to a very low range), RPM and Dwell Angle.
Cat. KJ-7012 $42.95

TEST LEADS TO SUIT ONLY $2.95

Specification

Function	F.S.D.	Resolution	Accuracy
Voltage (d.c.)	20v	10mV	0.5% ± 1 digit
	200v	100mV	0.5% ± 1 digit
Resistance	200Ω	100mΩ	0.5% ± 1 digit
	20kΩ	10Ω	0.5% ± 1 digit
R.P.M.	20,000r.p.m.	10r.p.m.	1% ± 3 digits
Dwell	90	0.1	2% ± 3 digits

Ref: EA June 1983

VIDEO SENSATION AT LAST

A Video Enhancer/ Distribution Amplifier designed EXCLUSIVELY for AUSTRALIA

VALUE $49.50

Cat. AV6501

Jaycar has had designed a high quality, high performance Video Enhancer which is specifically for the Australian 625 line 50 frame PAL-D system.
As far as we know it is the ONLY Australian designed, Australian built unit available!!
But, guess what? The Jaycar AV6501 Enhancer is CHEAPER than its inferior imported Asian counterparts!!
This unit is professionally designed and University tested! It works and it works well.

12 Volt AC Adaptor only $12.95

NOT A KIT BUILT, TESTED AND GUARANTEED KIT VERSION ONLY $39.50

SPECIFICATIONS
•1 Maximum enhancement, not less than +8.3dB @ 2MHz
•2 Enhance disabled (Bypass) response, DC to 6MHz, −0.8+1.0dB, 0.6dB, all settings.
•4 Amplifier group delay, less than 0.075uS
•5 Signal handling capability not less than 1.36 volts p-p. (Sync. is clipped first.
•6 Power 12V AC @ 100mA
•7 Controls, ON/OFF, ENHANCE, ENHANCE/BYPASS SWITCH, CORE/GAMMA CONTROL
•8 Input connector, RCA socket
•9 Output connector, RCA socket x 3

DESIGN FEATURES
•1 A unity gain notch at the colour subcarrier frequency, whose purpose is to prevent chrominance to luminance errors at high enhance levels.
•2 A closed loop configuration with lead tag compensation to achieve stable, well defined gain
•3 DC coupling, eliminating large capacitors in series with the video signal and achieving DC response for applications requiring it.
•4 Low output impedance prior to termination resistors, enabling up to three outputs to exist and be used or left unterminated.
•5 A level dependant closed loop response or Gamma control ('Core')
•6 Clip on negative going signals at −67 volts into 75 ohms to prevent sync errors owing to overshoot.

CannonXL connectors - great new range ★ ★ ★

5 PIN AND RIGHT ANGLE TYPES

NOW IN STOCK

PP2120 – 3pin male line	$3.50	PP2116 – 5pin male chassis	$5.95
PS4020 – 3pIn female line	$3.95	PS4016 – 5pin female chassis	$6.95
PP2112 – 3pin male chassis	$3.25	PS4010 – 240V mains line	$6.50
PS4012 – 3pin female chassis	$3.95	PP2110 – 240V mains chassis	$5.25
PP2117 – 5pin male line	$6.95	PP2113 – 3pin male r/angle	$4.95
PS4026 – 5pin female line	$7.95	PP4030 – 3pin female r/angle	$5.95

BBD EFFECTS BOX

Fantastic low-cost instrument using the versatile MN3001 Bucket-Brigade Delay Line to achieve brilliant sonic effects. Now you can emulate the commercial rock groups with Phasing, Flanging' Reverb and Echo. The Jaycar kit includes all components INCLUDING IC sockets and the TU-04 box. (Not cut down but this is easily done). Jaycar has a specially built cabinet for this kit with all holes pre-punched etc., at only $10 extra but only if you buy the original kit from us. Available as a separate item for $29.50. WHEN THE KIT IS PURCHASED WITH THE DE-LUXE CASE THE TU-04 CASE WILL NOT BE SUPPLIED.

COMPLETE KIT Cat. KE1522 $79.00

Special cabinet to suit $10.00 Cat. HB6445

TRANSISTOR ASSISTED IGNITION

Ref: EA Jan '83. Latest version of this popular kit. The Jaycar kit has a genuine die cast box - as used in the EA prototype. Beware of others that use flimsy sheet metal.
Cat. KA1506 $35

"Fluoro Starter"

Ref. EA Oct 1982
One of our most popular kits. Enables you to replace the electromechanical starter with an electronic one! The Fluoro starts up instantly without a flicker!
All electronic components supplied including high quality mains cap. (Fluoro starter case required)
NORMALLY $5.00

THIS MONTH $4 Cat. KA-1480
SAVE $1.00

Edge Connector No.1
This component has a 0.1" pitch 72 way (2 x 36) configuration. Each contact is heavily gold plated and bifurcated for lower contact resistance. The 0.025 square terminations will PC mount or take one level of wire-wrap. The body is moulded in high quality Diallyl Phalate with integrally moulded mounting feet on the ends. Outstanding quality for the price.
Cat. HE 8655
1 – 9 $2.95
10+ $2.45

Edge Connector No.2
This component has a 0.156" pitch 86 way (2 x 43) configuration. Once again each contact is heavily gold plated and bifurcated. The termination is of the solder-lug type. The body is identical in fashion to the HE-8655
Cat. HE-8656
1 – 9 $3.45
10 + $2.95

EDGE CONNECTORS EDGE CONNECTORS EDGE CONNECTORS CONNECTORS EDGE CONNECTORS EDGE CONNECTORS EDGE CONNECTORS EDGE CONNECTORS EDGE CONNECTORS CONNECTORS EDGE CONNECTORS EDGE

SEE PAGE 77 FOR JAYCAR ADDRESSES AND PHONE NUMBERS

Video Amplifier/-Buffer

Ref: EA Aug 1983

The answer to a maidens prayer!
This device can be made to fit inside a TV set (or in a separate box if necessary) It basically enables you to connect straight into the video drive of your TV, turning it into a colour monitor. This means that the video signal from your computer, VCR, TV game etc., does not need to be converted to RF and go through the TV IF strip. You will be amazed by the clearer, sharper signal that has less interference! Notes on how to fit to various TV sets are included
Cat. KA 1527 $14.95

Cat. KE4570

$49.50

- Fully protected
- Output variable from 0-30V DC
- Selectable current limit
- Both voltage and current metering
- After a multimeter & soldering iron an absolute must for the enthusiast.

You will never own a more useful piece of gear.

Ref: ETI December 1982

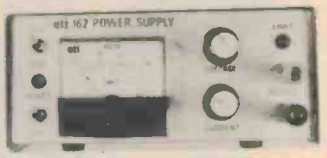
Touch Lamp Timer

Ref: EA Aug 1983

This project is very similar to the EA touch dimmer which has been very popular. Basically, you touch the wallplate and the light stays on for a predetermined amount of time. The same wallplate is used as the dimmer.
As usual the Jaycar kit contains quality components as originally specified, including a quality HPM wallplate.
Cat. KA 1525 $21.00

0-30V 1amp power supply

ETI 162



Cat. No.	DESCRIPTION OF KIT	Ref.	PRICE
KA1300	FUZZ BOX COMPLETE	EA 1/81	$ 19.50
KA1320	LE GONG	EA 3/81	$ 13.95
KA1346	PC BIRDIES SHORT FORM	EA 5/81	$ 14.95
KA1370	PHOTON TORPEDO	EA 9/81	$ 29.50
KA1400	METRONOME	EA 1/82	$ 16.95
KA1402	EPROM PROGRAMMER	EA 1/82	$ 59.00
KA1406	CUDLIPP CRICKET SHORT FORM	EA 2/82	$ 12.50
KA1408	DIGITAL STORAGE CRO ADAPTOR	EA 2/82	$110.00
KA1430	VOCAL CANCELLER	EA 4/82	$ 19.50
KA1432	VOX RELAY SHORT FORM	EA 4/82	$ 14.50
KA1450	GUITAR BOOSTER	EA 6/82	$ 14.50
KA1452	SUBWOOFER MOSFET AMP	EA 7/82	$ 79.00
KA1454	SUBWOOFER ENCLOSURE	EA 8/82	$ 79.00
KA1476	STEREO SYNTHESISER SHORT FORM	EA 9/82	$ 39.50
KA1478	STEREO SYNTHESISER COMPLETE	EA 9/82	$ 49.50
KA1482	POWER UP KIT COMPLETE	EA 11/82	$ 39.50
KA1484	SUPER SIREN SHORT FORM	EA 11/82	$ 5.00
KA1490	BOGGLE GOGGLES	EA 12/82	$ 9.50
KA1492	PH METER LCD	EA 12/82	$ 69.00
KA1494	PROBE FOR PH METER WITH BUFFER		$ 69.00
KA1498	AM WIDEBAND TUNER	EA 12/82	$249.00
KA1500	LED HEAD SHORT FORM	EA 1/83	$ 9.95
KA1510	STEREO SYNTHESISER SHORT FORM	EA 4/83	$ 11.95
KA1515	ALIGNMENT KIT AM TUNER	EA 3/83	$ 7.95
KE4050	50 WATT AMP MODULE	ETI 480	$ 23.00
KE4052	100 WATT AMP MODULE	ETI 480	$ 27.00
KE4064	PREAMPLIFIER MODULE	ETI 480	$ 30.00
KE4090	GENERAL PURPOSE PREAMPLIFIER	ETI 445	$ 7.99
KE4092	AUDIO LIMITER	ETI 446	$ 12.00
KE4094	BALANCED MICROPHONE PREAMPLIFIER	ETI 449	$ 5.50
KE4105	CAR ALARM	ETI 330	$ 29.50
KE4205	LED LEVEL METER	ETI 458	$ 59.00
KE4206	MC MOVING COIL PREAMPLIFIER	ETI 478	$ 26.50
KE4207	MM MOVING MAGNET PREAMPLIFIER	ETI 478	$ 19.50
KE4210	MOSFET AMPLIFIER	ETI 477	$ 59.00
KE4220	150 WATT MOSFET AMPLIFIER	ETI 499	$ 79.50
KE4222	150 WATT MOSFET PREAMPLIFIER	ETI 498	$ 39.50
KE4225	BRIDGING ADAPTOR	ETI 479	$ 9.95
KE4405	+/– 15 VOLT POWER SUPPLY	ETI 581	$ 17.50
KE4410	POWER SUPPLY 13.8 VOLT/10 AMP	ETI 160	$ 79.50
KE4505	SOUNDBENDER SHORT FORM	ETI 492	$ 24.50
KE4552	UHF CONVERTOR	ETI 735	$ 32.50
KE4554	VIDEO MODULATOR	ETI 760	$ 12.99
KE4560	LOW OHMS METER	ETI 158	$ 29.50
KE4570	POWER SUPPLY 0 - 30 VOLTS 1 AMP	ETI 162	$ 49.50
KE4600	MODEM SHORT FORM	ETI 644	$169.00
KE4602	MODEM COMPLETE	ETI 644	$189.00
KJ6502	SYNTOM DRUM SYNTHESISER KIT		$ 36.50
KJ6508	CHORUS GENERATOR KIT		$ 69.95
KJ6510	SHORT FORM IONISER KIT		$ 14.50
KJ6511	FULL IONISER KIT		$ 29.50

CD-424 14 BIT P.C.M. HIGH RESOLUTION DIGITAL DELAY

*** Pro quality with high signal to noise ratio and wider frequency response * Long delay time from 0 to 1,024mm/s * 8 step sub-delay preset from 5/- 764mm/s * superb combination effect with main and sub-delay * 2 inputs and 3 output levels * Low/High equalizer for sound variation**

NOT a kit

magnificent!

$795 Cat. AZ-5020

CX-230 ELECTRONIC CROSSOVER

NOT a kit

$257 Cat. AZ-5030

*** 2-way electronic crossover in stereo * 3-way electronic crossover in mono * 8 steps dividing points from 250Hz to 6KHz * Rack mountable compact dimensions (19") * Convenient 2-way input jacks of balanced (50K ohms) and unbalanced (25K ohms)**

Piezo Horns

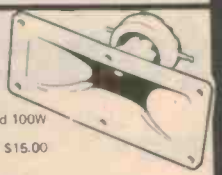
$9.95

Jaycar has broken the price barrier for Piezo Horn Speakers!!
We now DIRECT IMPORT a range of piezo horns at prices that will stagger you. Similar units are used everywhere in P.A., Disco and Hi Fi applications. Only Jaycar, however, can bring you these products at low Jaycar prices!!
We now stock the most popular piezo models at new low prices.

PH 1005A
3½" Square Super Horn for PA's, Disco's etc. Very efficient. Around 50Wrms equivalent capacity.
Cat. AS-3100 $9.95

PH 1038A
Hi Fi version of the PH 1005A. Slightly less sensitive but a smoother response.
Cat. AS-3102 $9.95

Amazing Value **$15**



PH 1025A
This design is one of the most popular for high power PA/Disco's around 100W rms equivalent power handling capacity! (6 x 2" rectangular)
Cat. AS-3106 $15.00

Quality Speakers

$9.95

FUEL SENSOR

almost 2/3 off!

GENUINE 'MORAY' FUEL SENSOR

This is the genuine unit as used in the EA Car Computer (Ref: EA August 1982). It is accurate to within 2% and will measure the flow of many other liquids besides petrol. It will give a TTL - compatible pulse for flows from 1-100 litres/hour. In September only we are letting these go for – $19.95! Under HALF our normal price.
Be early as this is a genuine limited offer.
Cat. XC-2020 NORMALLY $59.50 SEPTEMBER ONLY $19.95
SAVE ALMOST $40!!
Free data sheet and connection diagram with each unit.
THAT IS BELOW OUR COST!

FULL ROAD QUALITY 1/3 OCTAVE EQUALISER

ONLY **$225**

SPECIFICATIONS

Signal-to-Noise:	–102dB with respect to 1 Volt
Frequency 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 (DC): Approx 100mA @ : 15V
(Requires 30V AC CT)
Output short-circuit proof

Jaycar is renowned for their famous 2801 1/3 Octave Equaliser. Over 1000 of these units are giving reliable service in all parts of Australia and overseas. People recognise the value of this unit when they can get one for less than ⅓ the price of the cheapest ready built – with no deterioration in performance!! We are proud to announce a COMPLETELY BRAND NEW DESIGN based on the 5000 1/3 Octave unit. The specs on the totally new 2801 Mk 111 are UNKOWN in a 1/3 Octave graphic under $1000!!!
The 2801 Mk 111 comes with complete fused power supply for 240V AC operation. It is also fitted with standard Cannon Male/Female chassis connectors for ease of professional use. It is output short circuit proof and will drive very long unbalanced lines without degradation. Naturally it comes in a rugged 19" road quality rack cabinet. The 2801 Mk 111 looks almost the same as the 1/3 Octave 5000 except that it has brand new front panel livery. You can have a 2801 Mk 111 for only $225 in kit form.
Cat. KJ-6531 $225.00

JAYCAR

A laboratory standard function and pulse generator

Part 4

David Tilbrook

This instalment covers the preparation of the chassis and installation of the power supply and output amplifier modules. Do the chassis preparation carefully and you'll be assured of a 'professional' result, with no hassles during assembly. The front panel is particularly critical in this regard, the rear panel and chassis bottom, less so. A fully-dimensioned drawing for all the front panel holes has been prepared and is reproduced elsewhere in this article.

The case I have used is made by the Victorian firm, K&W. It is case No. C1066, the same as used in the ETI-163 Lab-standard Power Supply. In fact, I have designed that power supply and this generator to have a compatible appearance. The chassis of this case is of aluminium, while the lid is steel, having a number of ventilation slots and painted hammertone blue.

The place to start is the rear panel of the chassis. As layout here is generally non-critical, no dimensional drawing has been done. The power supply and the mains transformer are mounted on the rear panel and the mains cable enters at the lower right, when viewed from the front. A drawing of the general layout and wiring diagram of the power supply module and mains shows the details. Mark out the panel with a soft lead pencil, using the components as templates, where applicable. The power supply pc board artwork (reproduced in the last part) can be used as a template to mark the position of this module's mounting holes.

When you've marked all the hole centres, centre punch them before attempting to drill the panel. Drill a pilot hole first where large diameter holes have to be drilled (e.g: for the fuse and cable clamp). When the holes have been drilled, check that everything will fit without fouling anything or being cramped. Remove all burrs from the hole rims. Don't assemble anything yet.

Video Amplifier/-Buffer

Ref: EA Aug 1983

The answer to a maidens prayer!
This device can be made to fit inside a TV set (or in a separate box if necessary). It basically enables you to connect straight into the video drive of your TV, turning it into a colour monitor. This means that the video signal from your computer, VCR, TV game etc., does not need to be converted to RF and go through the TV IF strip. You will be amazed by the clearer, sharper signal that has less interference! Notes on how to fit to various TV sets are included.
Cat. KA 1527 $14.95

Cat. KE4570

$49.50

- Fully protected
- Output variable from 0-30V DC
- Selectable current limit
- Both voltage and current metering
- After a multimeter & soldering iron an absolute must for the enthusiast.

You will never own a more useful piece of gear.

Ref: ETI December 1982

Touch Lamp Timer

Ref: EA Aug 1983

This project is very similar to the EA touch dimmer which has been very popular. Basically, you touch the wallplate and the light stays on for a predetermined amount of time. The same wallplate is used as the dimmer.
As usual the Jaycar kit contains quality components as originally specified, including a quality HPM wallplate.
Cat. KA 1525 $21.00

0-30V 1amp power supply

ETI 162

Cat. No.	DESCRIPTION OF KIT	Ref.	PRICE
KA1300	FUZZ BOX COMPLETE	EA 1/81	$ 19.50
KA1320	LE GONG	EA 3/81	$ 13.95
KA1346	PC BIRDIES SHORT FORM	EA 5/81	$ 14.95
KA1370	PHOTON TORPEDO	EA 9/81	$ 29.50
KA1400	METRONOME	EA 1/82	$ 16.95
KA1402	EPROM PROGRAMMER	EA 1/82	$ 59.00
KA1406	CUDLIPP CRICKET SHORT FORM	EA 2/82	$ 12.50
KA1408	DIGITAL STORAGE CRO ADAPTOR	EA 2/82	$110.00
KA1430	VOCAL CANCELLER	EA 4/82	$ 19.50
KA1432	VOX RELAY SHORT FORM	EA 4/82	$ 14.50
KA1450	GUITAR BOOSTER	EA 6/82	$ 14.50
KA1452	SUBWOOFER MOSFET AMP	EA 7/82	$ 79.00
KA1454	SUBWOOFER ENCLOSURE	EA 8/82	$ 79.00
KA1476	STEREO SYNTHESISER SHORT FORM	EA 9/82	$ 39.50
KA1478	STEREO SYNTHESISER COMPLETE	EA 9/82	$ 49.50
KA1482	POWER UP KIT COMPLETE	EA 11/82	$ 39.50
KA1484	SUPER SIREN SHORT FORM	EA 11/82	$ 5.00
KA1490	BOGGLE GOGGLES	EA 12/82	$ 9.50
KA1492	PH METER LCD	EA 12/82	$ 69.00
KA1494	PROBE FOR PH METER WITH BUFFER		$ 69.00
KA1498	AM WIDEBAND TUNER	EA 12/82	$249.00
KA1500	LED HEAD SHORT FORM	EA 1/83	$ 9.95
KA1510	STEREO SYNTHESISER SHORT FORM	EA 4/83	$ 11.95
KA1515	ALIGNMENT KIT AM TUNER	EA 3/83	$ 7.95
KE4050	50 WATT AMP MODULE	ETI 480	$ 23.00
KE4052	100 WATT AMP MODULE	ETI 480	$ 27.00
KE4064	PREAMPLIFIER MODULE	ETI 480	$ 30.00
KE4090	GENERAL PURPOSE PREAMPLIFIER	ETI 445	$ 7.99
KE4092	AUDIO LIMITER	ETI 446	$ 12.00
KE4094	BALANCED MICROPHONE PREAMPLIFIER	ETI 449	$ 5.50
KE4105	CAR ALARM	ETI 330	$ 29.50
KE4205	LED LEVEL METER	ETI 458	$ 59.00
KE4206	MC MOVING COIL PREAMPLIFIER	ETI 478	$ 26.50
KE4207	MM MOVING MAGNET PREAMPLIFIER	ETI 478	$ 19.50
KE4210	MOSFET AMPLIFIER	ETI 477	$ 59.00
KE4220	150 WATT MOSFET AMPLIFIER	ETI 499	$ 79.50
KE4222	150 WATT MOSFET PREAMPLIFIER	ETI 498	$ 39.50
KE4225	BRIDGING ADAPTOR	ETI 479	$ 9.95
KE4405	+/– 15 VOLT POWER SUPPLY	ETI 581	$ 17.50
KE4410	POWER SUPPLY 13.8 VOLT/10 AMP	ETI 160	$ 79.50
KE4505	SOUNDBENDER SHORT FORM	ETI 492	$ 24.50
KE4552	UHF CONVERTOR	ETI 735	$ 32.50
KE4554	VIDEO MODULATOR	ETI 760	$ 12.99
KE4560	LOW OHMS METER	ETI 158	$ 29.50
KE4570	POWER SUPPLY 0 - 30 VOLTS 1 AMP	ETI 162	$ 49.50
KE4600	MODEM SHORT FORM	ETI 644	$169.00
KE4602	MODEM COMPLETE	ETI 644	$189.00
KJ6502	SYNTOM DRUM SYNTHESISER KIT		$ 36.50
KJ6508	CHORUS GENERATOR KIT		$ 69.95
KJ6510	SHORT FORM IONISER KIT		$ 14.50
KJ6511	FULL IONISER KIT		$ 29.50

CD-424 14 BIT P.C.M. HIGH RESOLUTION DIGITAL DELAY

* Pro quality with high signal to noise ratio and wider frequency response * Long delay time from 0 to 1,024mm/s * 8 step sub-delay preset from 5/- 764mm/s * superb combination effect with main and sub-delay * 2 inputs and 3 output levels * Low/High equalizer for sound variation

NOT a kit

magnificent!

CX-230 ELECTRONIC CROSSOVER

NOT a kit

$795 Cat. AZ-5020

$257 Cat. AZ-5030

* 2-way electronic crossover in stereo * 3-way electronic crossover in mono * 8 steps dividing points from 250Hz to 6KHz * Rack mountable compact dimensions (19") * Convenient 2-way input jacks of balanced (50K ohms) and unbalanced (25K ohms)

Piezo Horns

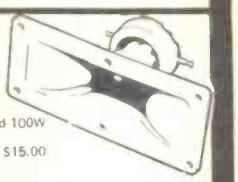
$9.95

Jaycar has broken the price barrier for Piezo Horn Speakers!!
We now DIRECT IMPORT a range of piezo horns at prices that will stagger you. Similar units are used everywhere in P.A., Disco and Hi Fi applications. Only Jaycar, however, can bring you these products at low Jaycar prices!!
We now stock the most popular piezo models at new low prices.

PH 1005A
3½" Square Super Horn for PA's, Disco's etc. Very efficient. Around 50Wrms equivalent capacity.
Cat. AS-3100 $9.95

PH 1038A
Hi Fi version of the PH 1005A. Slightly less sensitive but a smoother response.
Cat. AS-3102 $9.95

Amazing Value **$15**



PH 1025A
This design is one of the most popular for high power PA/Disco's around 100W rms equivalent power handling capacity! (6 x 2" rectangular)
Cat. AS-3106 $15.00

Quality Speakers

$9.95

FUEL SENSOR

almost 2/3 off!

GENUINE 'MORAY' FUEL SENSOR

This is the genuine unit as used in the EA Car Computer (Ref: EA August 1982). It is accurate to within 2% and will measure the flow of many other liquids besides petrol. It will give a TTL - compatible pulse for flows from 1-100 litres/hour. In September only we are letting these go for – $19.95! Under HALF our normal price.
Be early as this is a genuine limited offer.
Cat. XC-2020 NORMALLY $59.50 SEPTEMBER ONLY $19.95
SAVE ALMOST $40!!
Free data sheet and connection diagram with each unit.
THAT IS BELOW OUR COST!

FULL ROAD QUALITY 1/3 OCTAVE EQUALISER

ONLY **$225**

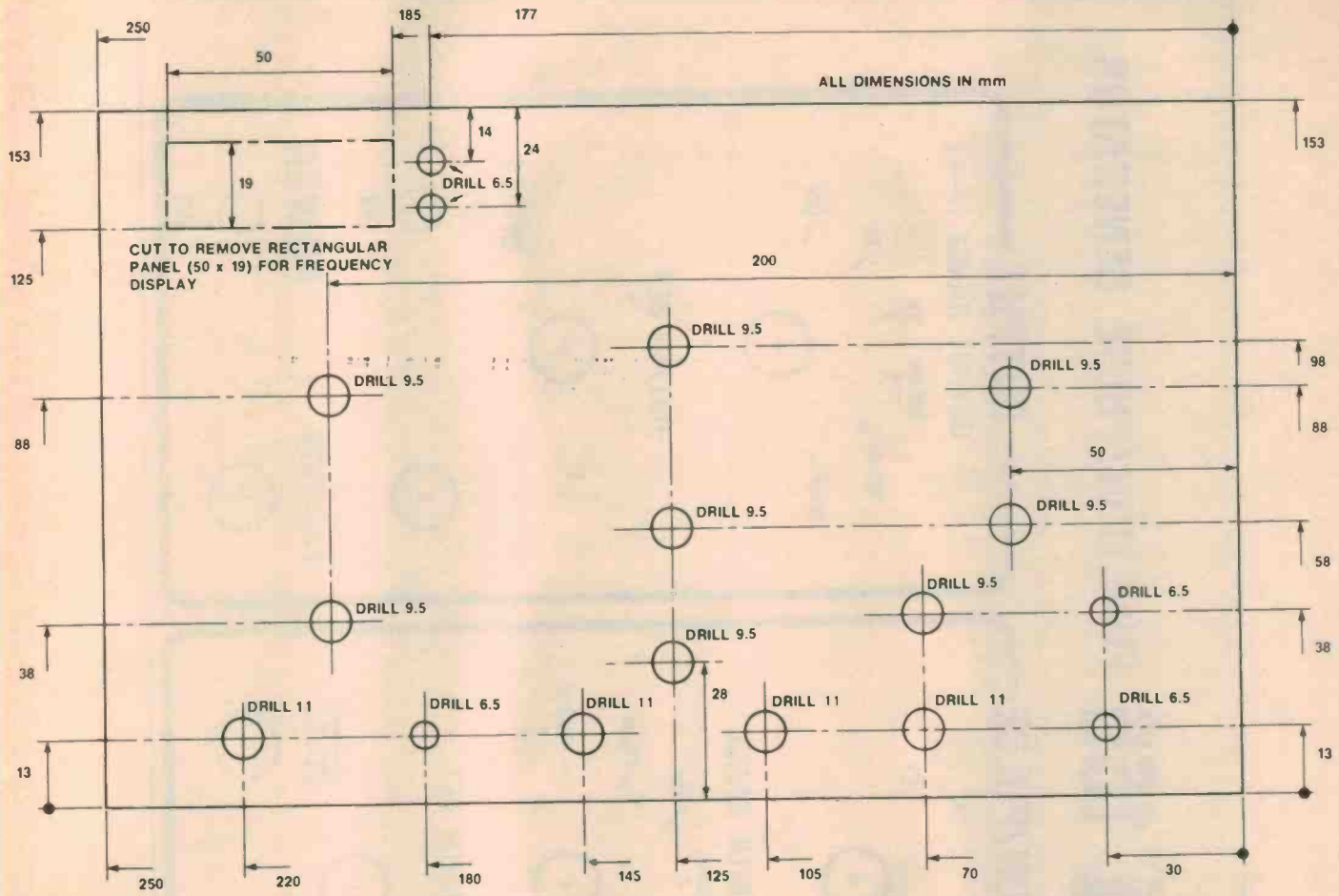
SPECIFICATIONS

Signal-to-Noise:	–102dB with respect to 1 Volt
Frequency 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 (DC): Approx 100mA @ ± 15V
(Requires 30V AC CT)
Output short-circuit proof

Jaycar is renowned for their famous 2801 1/3 Octave Equaliser. Over 1000 of these units are giving reliable service in all parts of Australia and overseas. People recognise the value of this unit when they can get one for less than ½ the price of the cheapest ready built – with no deterioration in performance!! We are proud to announce a COMPLETELY BRAND NEW DESIGN based on the 5000 1/3 Octave unit. The specs on the totally new 2801 Mk 111 are UNKOWN in a 1/3 Octave graphic under $1000!!!
The 2801 Mk 111 comes with complete fused power supply for 240V AC operation. It is also fitted with standard Cannon Male/Female chassis connectors for ease of professional use. It is output short circuit proof and will drive very long unbalanced lines without degradation. Naturally it comes in a rugged 19" road quality rack cabinet. The 2801 Mk 111 looks almost the same as the 1/3 Octave 5000 except that it has brand new front panel livery. You can have a 2801 Mk 111 for only $225 in kit form.
Cat. KJ-6531 $225.00

JAYCAR



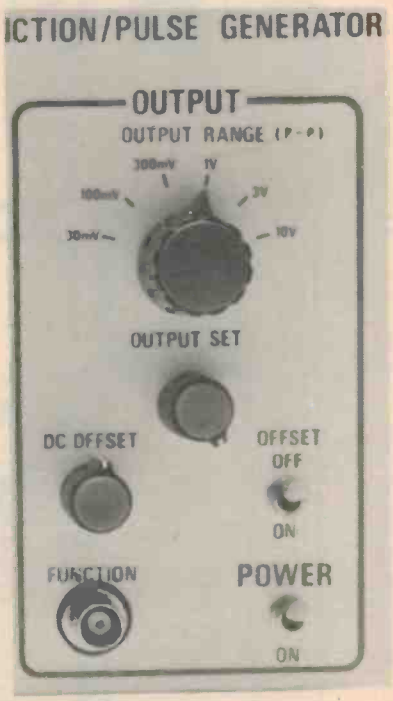
Now mark out the bottom of the case to take the mounting holes for the output amplifier module and the main generator pc board. The main artwork for the ETI-1520 module (reproduced in the article on the '1520) can be used to mark its mounting hole positions. The template drawing for the main generator pc board, reproduced here, can be used to mark out its mounting hole positions. Again, use a soft pencil to mark the hole positions and centre punch them before drilling. Check it after drilling and de-burr the holes.

Now for the front panel. I have to stress that this should be done with the *utmost care*. Follow the accompanying drawing carefully and you should have no difficulty. There is an option, though, that I should point out, with regard to the mounting of the 4-digit LED frequency display. This board, ETI-166c, is mounted with four long screws. The panel could be drilled and countersunk screws employed, but I found that, owing to the thinness of the chassis material, this was not going to be very satisfactory as the screw heads would not sit flush with the panel and thus would show beneath the Scotchcal front panel. Instead, I mounted the screws to the board so that the displays were held a millimetre or so back from the panel cutout and actually *glued* the screw heads to the front panel after carefully siting the display board. The choice I leave to you.

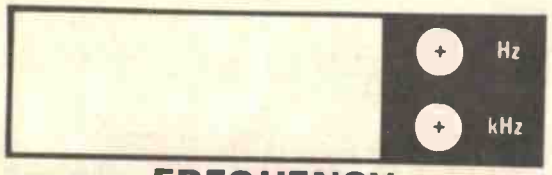
Mark out all the holes very carefully, measuring only from the bottom edge and the bottom right-hand corner, to ensure consistent accuracy. Centre punch all the holes before drilling. Drill a pilot hole first for all the holes, then the correct size drill. De-burr all the holes when you're finished. The LED display slot can be cut out in a number of ways. One way is to drill a series of holes around the inside edge of the hole, a millimetre or so from the marked edges. Break out the centre piece when you've completed the series and then file the edges smooth and straight. Alternatively, drill one large hole for a 'hole nibbler' and cut around the edge with that tool. Some filing will be necessary in this case too.

When you're satisfied the panel's finished, you can install the Scotchcal label. I used a plastic one - blue on a white background to match my ETI-163 Lab Supply - but an aluminium one can be used too. If you're using a plastic Scotchcal, paint the panel white first, as the Scotchcal is translucent. Let the paint dry thoroughly before proceeding.

Whether you've made your own or purchased one, the Scotchcal panel should be installed carefully. Start by cutting it carefully to size, then remove a 10 mm strip off the backing from the left-hand edge. Carefully line up the edge of the Scotchcal and the edge of the panel, ensuring that it will lay ▶



This bit. The assembly of this section and the power supply is covered in this instalment.



eti 166 FUNCTION/PULSE GENERATOR

FREQUENCY

FREQUENCY SET

FREQUENCY RANGE

x1 x10 x100 x1k x10k x100k

EXT SWEEP

MANUAL

SWEEP

FUNCTION/PULSE

PULSE WIDTH RANGE

x100ns x1us x10us x100us x1ms x10ms x100ms

PULSE WIDTH SET

PULSE

PULSE

OUTPUT

OUTPUT RANGE (P-P)

30mV 100mV 300mV 1V 3V 10V

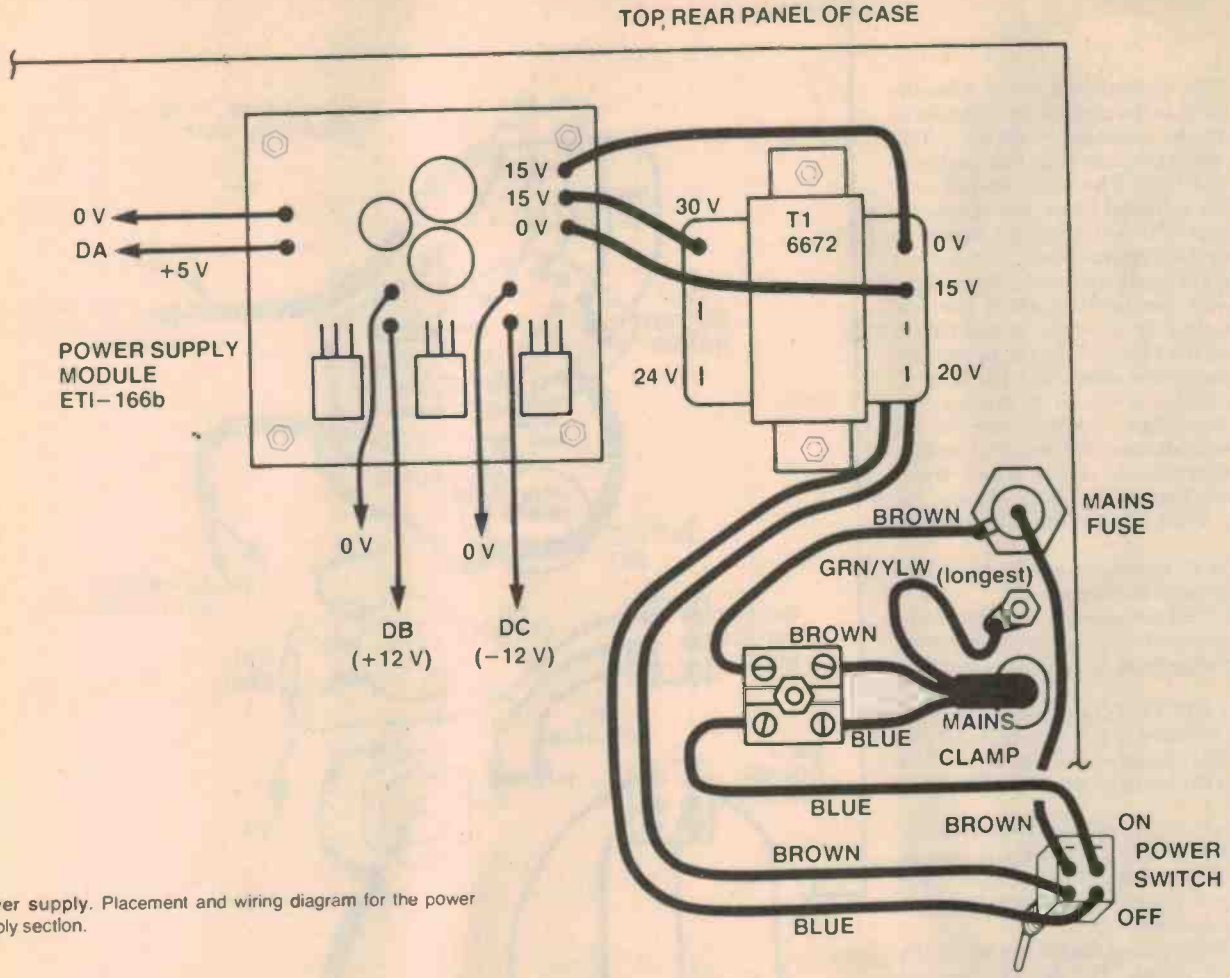
OUTPUT SET

DC OFFSET

OFFSET OFF ON

FUNCTION

POWER ON



Power supply. Placement and wiring diagram for the power supply section.

straight, and rub down firmly along the edge. Then, carefully peeling off the backing and rolling it under, rub the Scotchcal down, moving across the panel. This way, you should get no, or very few, bubbles under it. Any you may get can be rubbed away towards one edge as they occur.

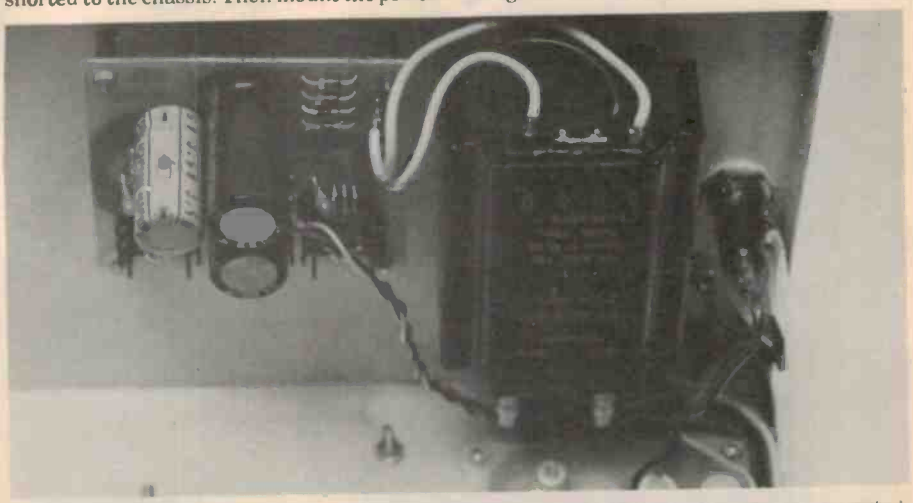
Using a sharp knife point or modeller's scalpel, cut the Scotchcal away from all the holes, being careful not to make any slips or you'll spoil your panel. Tsk, tsk.

Now you can mount the controls in the OUTPUT section of the front panel. There are two toggle switches, two pots and a rotary switch. Here's what you'll need:

1 x BNC socket, panel-mount, with earth lug.
1 x two-pole, 6-position rotary switch.
1 x 1k/A (lin.) pot.
1 x 10k/A (lin.) pot.
1 x SPDT miniature toggle switch.
1 x DPDT 240 Vac/1.5 A min. toggle switch.

Start with the BNC socket. This has to be installed from the front panel. What I did was to take a 6 mm i.d. rubber grommet and force (roll) it onto the socket's thread after removing the nut, washer and earth lug. This then slips neatly in the 11 mm mounting hole marked FUNCTION. Secure it by putting the washer on first, then the earth lug, followed by the nut. Check that it isn't shorted to the chassis. Then mount the power switch (DPDT), followed by the two pots and the rotary switch. Take care not to scratch the Scotchcal.

Now tackle the rear panel. Mount the terminal block and earth lug, then the mains cable. Strip the end of the mains cable so that the active (brown) and neutral (blue) leads are about 40 mm long and the earth lead (green with yellow stripe) is about 60-70 mm long. Terminate the leads as per the wiring ▶



Rear panel assembly. View of the rear panel showing placement of the various pieces of the power supply. I used a different transformer from the 6672 specified as I had one on hand but no 6672. Note the rear edge of the ETI-1520 output amplifier module.

diagram. The neutral lead (blue) from the terminal block to the mains switch should be attached to the terminal block next. This should be about 300 mm long, but don't wire it to the switch yet. The active lead (brown) between the terminal block and the mains fuse is about 200 mm long and should be attached to the terminal block next, but not to the fuse. The lead between the fuse and the mains switch can be attached to the fuse now, first slipping a length of heatshrink tubing over the two leads to the fuseholder. After the leads are soldered to the fuseholder, apply a blast of hot air to the sleeve so that the fuseholder terminals are not exposed. Now solder two 400 mm long leads to the mains terminals of the power transformer, one brown, one blue. Sleeve the terminals. Then mount the power transformer.

Note that all mains wiring should be done with mains-rated hookup wire.

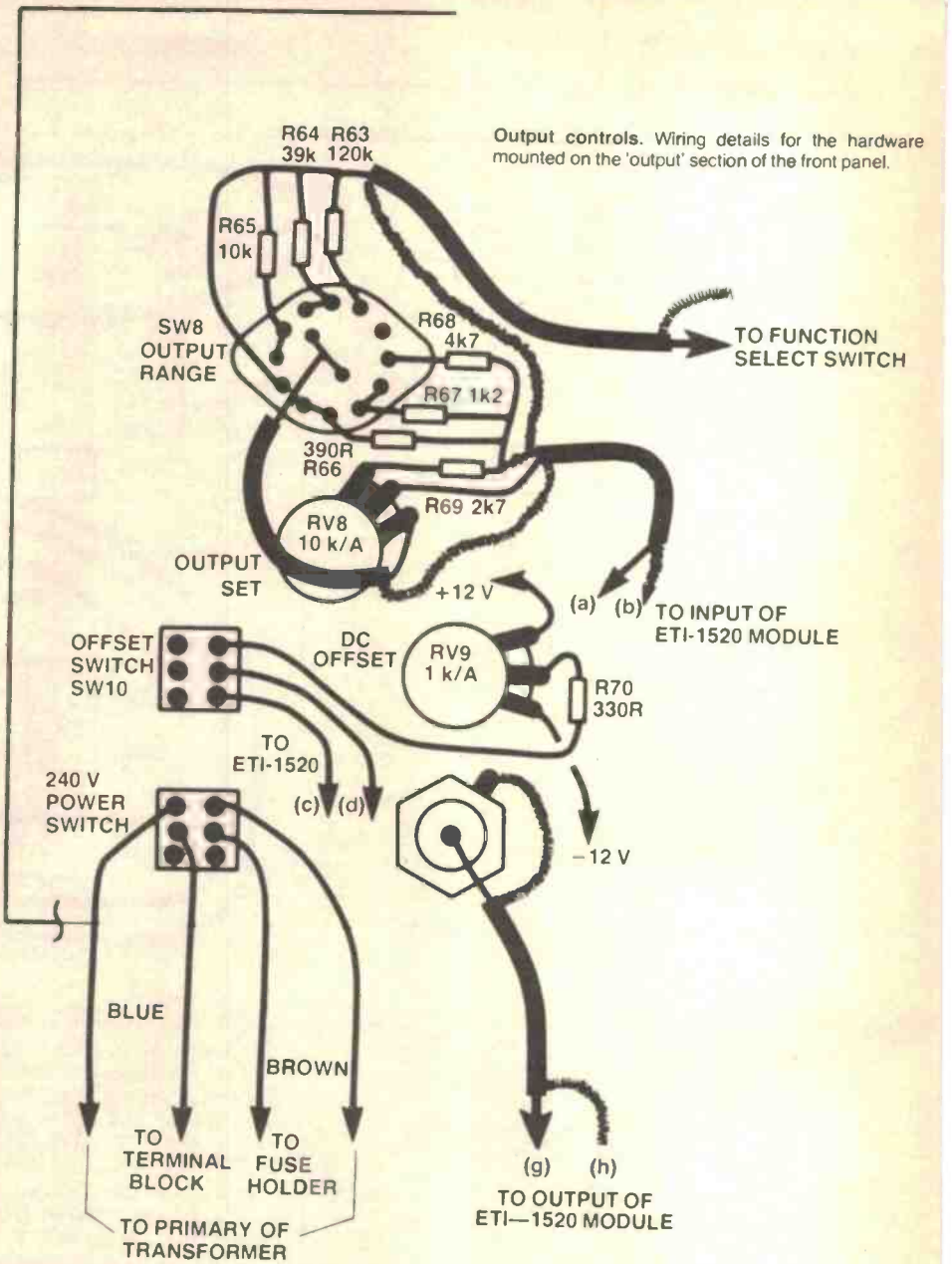
The ETI-166d power supply module can be mounted next and wired to the transformer. Use heavy duty hookup cable, at least 24 x 0.2 mm.

Now the ETI-1520 output amplifier module can be mounted in place. Note that the pc stakes or short lengths of tinned copper wire are used on the board for attaching the external wiring.

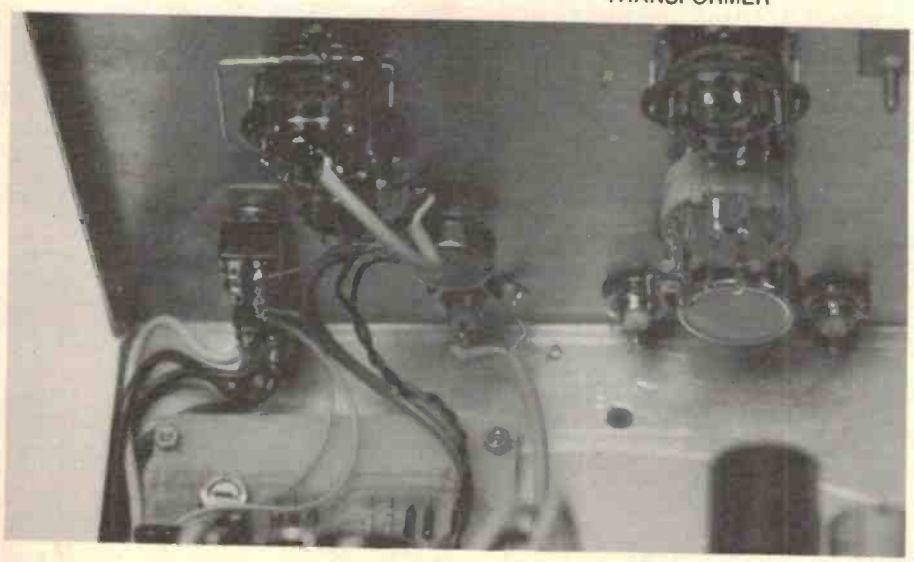
The power switch can now be wired up. Note that the neutral side wiring is nearest the edge of the chassis, for safety's sake. Don't forget to sleeve, or otherwise cover, all exposed mains connections.

With that completed, tackle the rest of the output stage wiring. The details are clear from the accompanying wiring diagram. The components you need are shown there. Don't worry about the numbering at the moment, all that will come together with the next instalment. The resistors are all ¼ W, 5% types. Note the use of shielded cable on the ETI-1520 input and output lines.

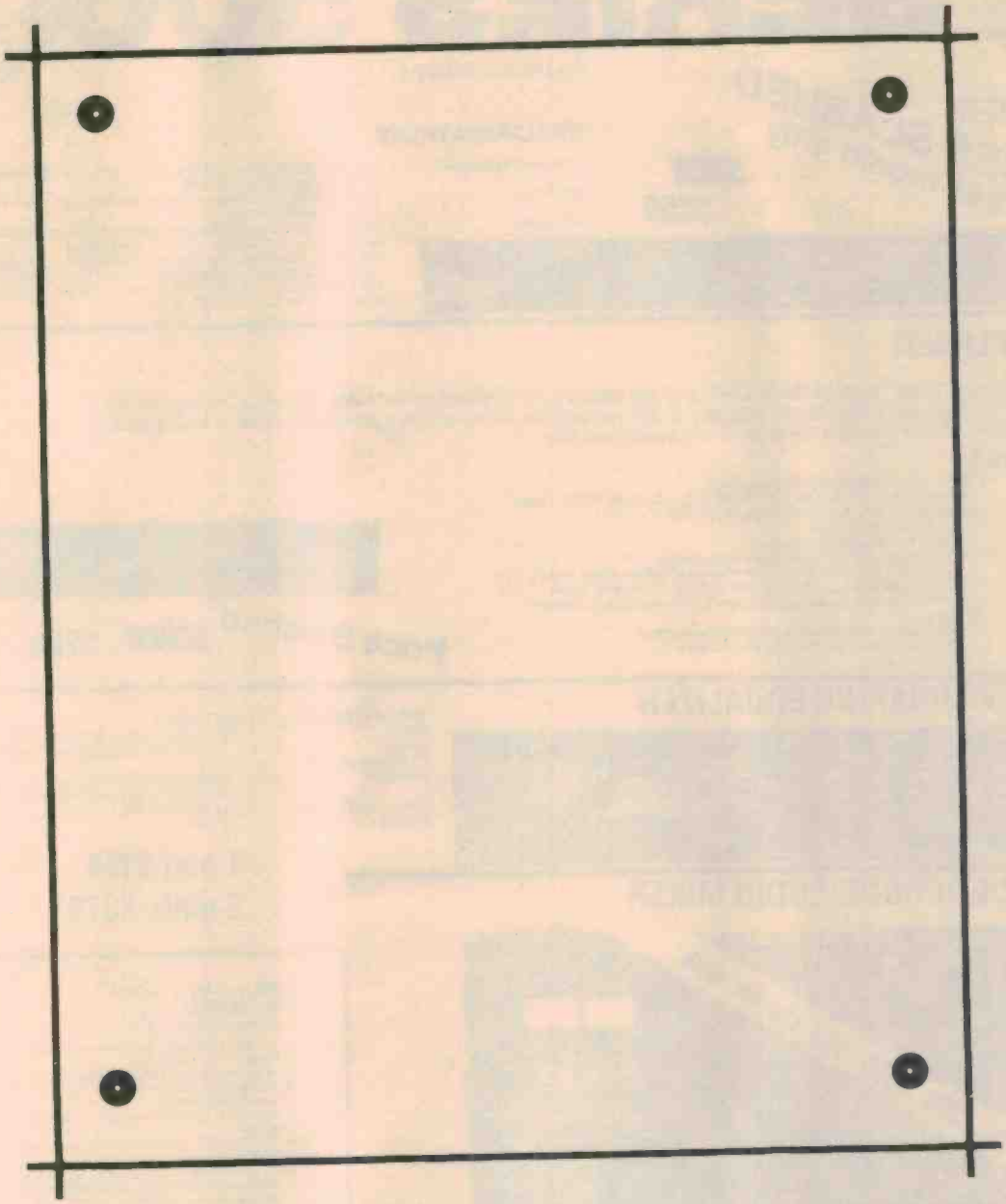
That's as far as you can go for the moment — but that lot should keep you occupied for some time. ●



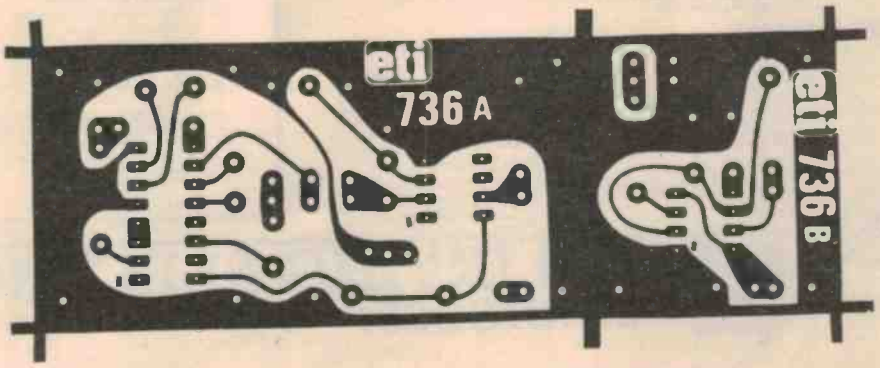
Output controls. Wiring details for the hardware mounted on the 'output' section of the front panel.



Behind the front. General view of the hardware mounted behind the front panel.



Template. This is a full-size template to enable you to locate the drilling positions for the main generator board mounting holes.



WE are a No.1 Kit Supplier

RIC SERIES 5000

PRICES SLASHED

As designed by ETI

PREAMPLIFIER

PRICES SLASHED this month only

~~$269~~ $259

SPECIFICATIONS

Frequency response: High-level input: 15Hz-130 kHz, +0, −1 db Low-level input — conforms to RIAA equalisation, ±0.2 dB

Distortion: 1kHz <0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).

S/N noise: High-level input, master full, with respect to 300 mV input signal at full output (1.2V): >92 dB flat >100 dB A-weighted.
MM input, master full, with respect to full output (1.2V) at 5 mV input, 50 ohm source resistance connected: >86 dB flat >92 dB A-weighted.
MC input, master full, with respect to full output (1.2V) and 200 μV input signal: >71 dB flat >75 dB A-weighted.

POWER AMPLIFIER

Please note that the "Superb Quality" Heatsink for the power amp was designed and developed by Rod Irving Electronics and is being supplied to other kit suppliers. This product cost $1,200 to develop so that your amplifier kit would have a professional finish as well as sound. We also have a new range of rack mounting boxes which will be released soon.

SPECIFICATIONS

Power output:	100W RMS into 8 ohms (±55 V supply).
Frequency response:	8 Hz to 20 kHz, +0−0.4 dB 2.8-Hz to 65 kHz, +0−3 dB. NOTE: These figures are determined solely by passive filters.
Input sensitivity:	1V RMS for 100W output.
Hum:	−100dB below full output (flat).
Noise:	−116 dB below full output (flat, 20 kHz bandwidth).
2nd harmonic distortion:	<0.001% at 1 kHz (0.0007% on prototypes) at 100 W output using a ±56 V supply rated at 4 A continuous. <0.003% at 10 kHz and 100 W.
3rd harmonic distortion:	<0.0003% for all frequencies less than 10 kHz and all powers below clipping.
Total harmonic distortion:	Determined by 2nd harmonic distortion (see above).
Intermodulation distortion:	<0.003% at 100 W. (50 Hz and 7 kHz mixed 4:1).
Stability:	Unconditional

Price Slashed ~~$299~~ $289

THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS E.T.I. Dec. 1982

Bands:	28 Bands from 31.5 Hz to 16 kHz
Noise: 20 kHz bandwidth	<0.008 mV, sliders at 0, gain at 0 (−102 dB).
Distortion:	0.007% at 300 mV signal, sliders at 0, gain at 0; max. 0.01%, sliders at minimum.
Frequency Response:	12 Hz-105 kHz, +0, −1 dB, all controls flat.
Boost & Cut:	14 dB

1 unit $199

2 units $379

MX-1200 MICROPHONE/AUDIO MIXER

This unit features: 12 microphone line inputs with pan, bass, treble, effect and foldback controls for each channel • LED peak indicators for each channel • 2 turntable inputs with cross-fade and individual output controls • master equaliser for bass, midrange and treble • variable headphone output etc. etc. • complete with carrying case.

~~$699~~

SPECIFICATIONS:

INPUTS
Level/Impedance Mic .46 db/1K
Line .22 db/16K x 12
Phono .32 db/50K STEREO x 2 (2mv) at 1KHz
Effect Return (Aux) .20 db/50K x 1

OUTPUTS
Level/Impedance L & R 0 db/2K
Effect Send 0 db/2K F/B Out 0 db/2K
Head phone Stereo +10 db/600 (100 .1K)

EQUALISATION
Channel
Bass ±15db
Treble ±15db
Master
Bass ±12db
Treble ±10db
Middle ±12db

FADER & CONTROLLERS
12 channel fader, Slide, 60m/m, LOG 25%
2 Master fader, Slide, 60m/m, LOG 15%
12 F/B Volume, 300, LIN
1 F/B Master level, 300, LIN
12 Effect Send, 300, LIN
1 Effect Return, 300, LOG 15%
2 Phono, 300, LOG 15%
1 Head Phone, 300, LOG 15%
S/N, 58DB
FREQUENCY RESPONSE: 20-20 KHz
TOTAL HARMONIC DISTORTION Less than 0.1%
METER 2 illuminated VU Meters 0db = 0.775V
PEAK INDICATOR 12 LED Peak Indicators
VOLTAGE: 240 VAL 50Hz
POWER CONSUMPTION 7.2 watts
DIMENSIONS: 820 (W) x 386 (D) x 108 (H) mm (supplied complete with carrying case)

EXTRA FEATURES OF OUR KITS

POWER AMPLIFIER

KIT PRICE $299 P&P $8.00

- 1% Metal Film Resistors are used where possible
- Prewound Coils are supplied
- Aluminium case as per the original article
- All components are top quality
- Over 200 Kits now sold
- We have built this unit and so know what needs to go into every kit
- SUPER FINISH Front panel supplied with every kit at no extra cost to you
- We are so confident of this kit that we can now offer it assembled and tested so that people who do not have the time can appreciate the sound that this applifier puts out. This is done on a per order basis delivery approx two weeks after placement.

only $425

*All parts available separately for both kits.

PREAMPLIFER

KIT PRICE $259 P&P $8.00

- 1% Metal Film Resistors are supplied
- 14 metres of Low Capacitance Shielded are supplied (a bit extra in case of mistakes)
- English "Lorlin" Switches are supplied no substitutes as others supply
- We have built and tested this unit and so know what needs to go into every kit
- Specially imported black anodised aluminium knobs
- Again as with the power amp we are offering this kit A & T at a price which we do not believe there is a commercial unit available that sounds as good. Same delivery as the P.A.

only $425

Errors and omissions excepted.

Bankcard mail orders welcome

ORDER FORM

Please Debit my Bankcard No.

Expiry Date

Name

Signature

ROD IRVING ELECTRONICS

2 BRANCHES:

425 High St. Northcote, Ph.: (03) 489 8131
48-50 A'Beckett St. Melb. Ph.: (03) 347 9251
Mail orders: P.O. Box 235 Northcote, Vic. 3070

Video distribution amplifier

This simple, low-cost project will allow you to drive, say, five video monitors from one source, such as a video cassette recorder or a computer.

John Power

PIPING VIDEO around has become quite common place: from a computer to a video display unit, from a video cassette recorder to a video monitor, etc. Occasions arise, however, when you need to 'drive' more than one display or whatever, from a single source. For example; when playing a video-taped lecture at a club meeting, it's more convenient for the audience to have several monitors placed at appropriate positions rather than everyone trying to strain to watch one small screen. Or, when doing a computer/computing demonstration, it's much handier to have several monitors hooked up rather than have the audience crowd around the one. Anyway, I expect many readers will have their own applications already in mind for this project.

Design

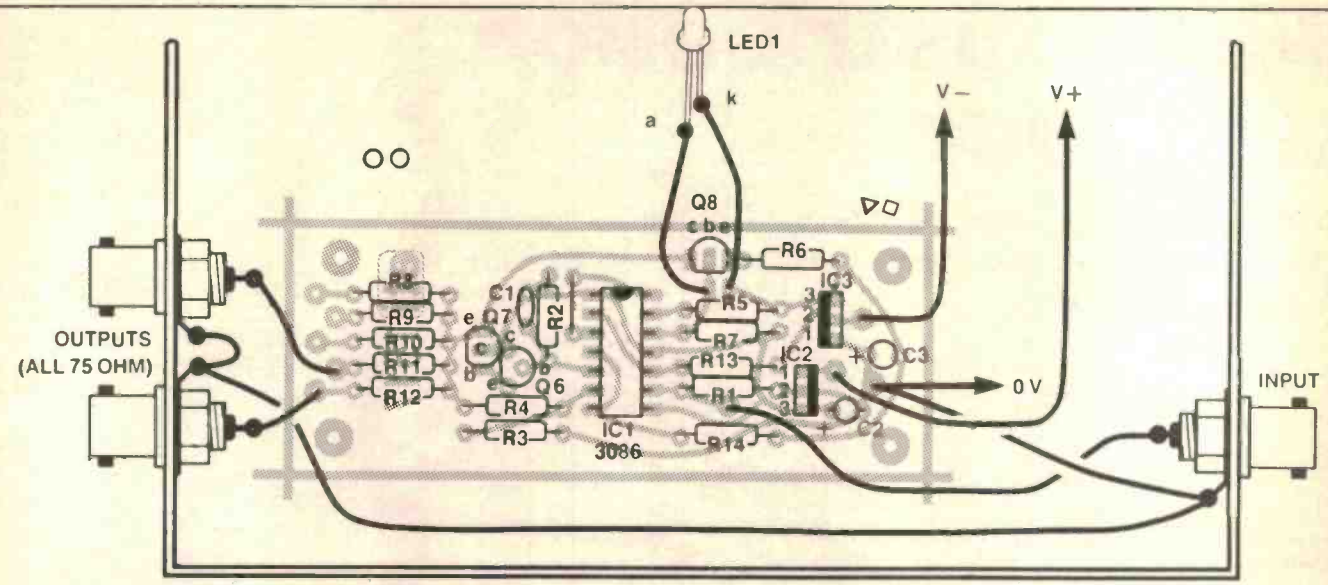
The requirements of a video distribution amplifier are quite straightforward. The unit must be able to take a single input and to drive the required number of outputs while retaining video fidelity. The bandwidth at full output level must be at least 5 MHz or more so as to retain video fidelity. The input and output impedances must be matched to standard 75 ohms widely used in video work and adding or subtracting units to or from the outputs should not affect any other device connected to an output. In essence, that's what this project does.

The heart of the unit is a transistor array IC — a CA3086. If you want to know more about this IC and its associated family, see Lab. Notes in the November 1980 issue. The transistors inside this package have been connected as a differential amplifier, the output of which drives a power output stage. Feedback provides a gain of one (i.e.: unity) and ensures a wide bandwidth. Regulated +/− 5 V supplies are used so that the whole amplifier can be direct-coupled, yet maintain the output point at dc earth potential. In practice, the 'dc offset' at the output is on the order of 100 mV or so (it could be positive or negative).

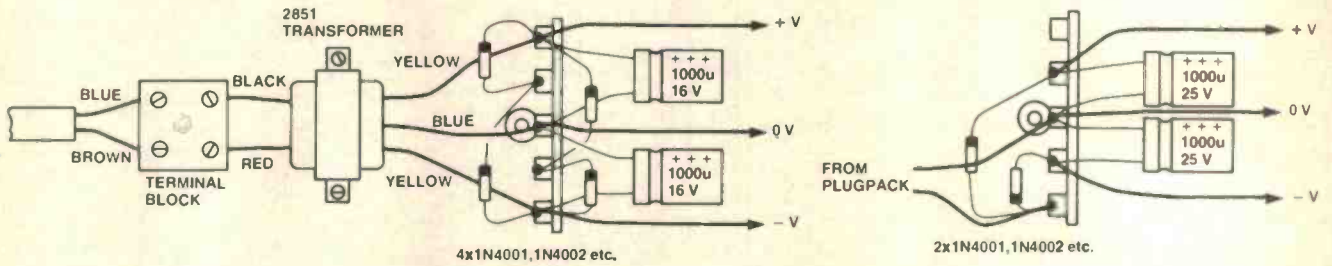
Construction

I built the video amplifier into a 50 x 95 x 158 mm jiffy box along with its own mains supply. This has the advantage of convenience, though it is possible to run the circuit off a 12 volt plugpack, which would make the whole a little cheaper if you already have the plugpack. Plugpacks are also safer for the constructor who is unfamiliar with mains wiring, though more ▶

Wrapped up, ready to go. The project and its power supply fit neatly in a large zippy box, leaving enough room to add a video enhancer later.



Overlay and wiring diagram. Showing how the pc board is assembled and wired up.



Power supplies. Wiring details for the two types of power supplies suggested.

expensive in the first place. Anyway, details are given for both situations.

In any case, the first stage is to select a box which will fit the parts comfortably. Ideally the project would be best in a tough metallic box, but the design is very stable and not liable to interference, so a cheaper plastic box such as the jiffy box I used is adequate, especially in a domestic situation.

Next, select the connectors you intend to use. Some video systems use RCA sockets and cables rather than the more robust BNC type. You may not require the full five outputs which the unit is capable of driving. Thus you may elect to economise and fit only two BNC sockets. (BNC sockets, if good ones, are not cheap). Or, you may fit two BNCs and an RCA type, in case. Note that solder lugs are needed for earthing.

Having selected the connectors you must decide on the power supply. I include the full mains transformer, rectifier, filter and so on, all of the components for which came to about half the cost of a plugpack, cord included! I recommend this approach as cost effective as well as convenient. (You cannot easily lose the parts you bolt in like you can lose a plugpack.)

Next, drill the box to allow the entry of the mains cable or the mounting of a plugpack connector as appropriate. Also, mounting holes for the connectors, the LED, printed circuit boards and power transformer, if applicable, will be needed.

It is convenient to use the pc board as a template for marking the position of its mounting holes, before you fit any components to the board. I placed the board right up one end of the box the power supply at the other end, leaving room for a video enhancer board in the middle (. . . it's coming — Ed.).

It should be possible to use one of the transformer mounting bolts for a cable clamp to hold the mains cable if one of those special hole clamps is not used at the entry to the box. The ribbed insides of jiffy boxes often prevent the use of the hole clamp brackets and, as the cable must be clamped for safety reasons, be sure to allow for a clamp strap if you are not using a hole clamp.

Once the drilling is finished fit the components to the pc board after checking that all holes are correctly drilled and that all the tracks are OK. Be sure to get the ICs, and the tantalum capacitors and transistors the correct way around. If you are using a BD139 rather than BD639 for Q7, you will find that it has a different package and thus does not match the overlay diagram — be very careful to get it in the right way around. Attatch short lengths of hookup wire to the pc board input, output and power connections. These can be trimmed and soldered to their respective destinations once the board is bolted in place.

Next fit the transformer, mains cable and connectors in their respective positions in the box. Clamp the mains cable carefully and connect it to the terminal block, along with the transformer wires.

Now wire up the tagstrip, following the diagram carefully. Solder onto it the transformer secondary wires and the wires leading to the pc board. Mount the tagstrip and the pc board. Run an earth lead to each of the connector ground lugs, as shown in the wiring diagram, and then the 0V point on the pc board. Finally, connect the input and output leads and the LED wires.

Test

To test it, apply power and check that the rectifier outputs are correct. If you're using the 2851 transformer, you should measure around 9 V across each of the 1000u filter capacitors. If you're using the plugpack supply, you should get around 16-17 V across the 1000u filter capacitors. If they're OK, check the outputs of the two regulators. These should each be 5 V. The LED should be lit.

If there are any faults to this stage, switch off and sort them out before continuing. A wiring error is the usual culprit.

If all's well, connect it up and try it out.

HOW IT WORKS — ETI 1517

The unit is basically a dc-coupled feedback amplifier. It comprises a differential input stage, a buffer stage and a power output stage which together form a small but fast and powerful operational amplifier. This is suitably configured to give an overall gain into 75 ohm matched loads of precisely one, and a bandwidth of better than five megahertz — the requirement for a video distribution amplifier.

The differential input stage is created from a CA3086 IC (IC1) which contains five discrete transistors. Four (Q1 to Q4) are used to provide a Darlington long-tailed pair, with the fifth transistor (Q5) acting as the current source for the stage. The use of this IC, rather than having five discrete transistors guarantees good thermal matching for low offset and good matching of the transistors for predictable balance and gain.

The use of a Darlington configuration produces high input impedance and permits the stage to deliver an output swing sufficient to comfortably achieve the ±2 V required to deliver colour video levels into a matching resistor and load. The fifth transistor is set to deliver around 2 mA into the Darlington pair, using a red LED as a voltage reference; this LED doubles as the power-on indicator.

This current would provide a transconductance of sufficient value to give a gain of 35 if it were not for the two 33k resistors, R13-R14. These boost the gain to more like 65, as well as ensuring that charge storage effects in the bases of the two central transistors (Q2, Q3) do not limit the slew rate of the circuit to an unacceptable level.

The open loop bandwidth of the circuit is defined by the capacitor C1 in conjunction with the 3k9 load resistor, R2, and other minor effects.

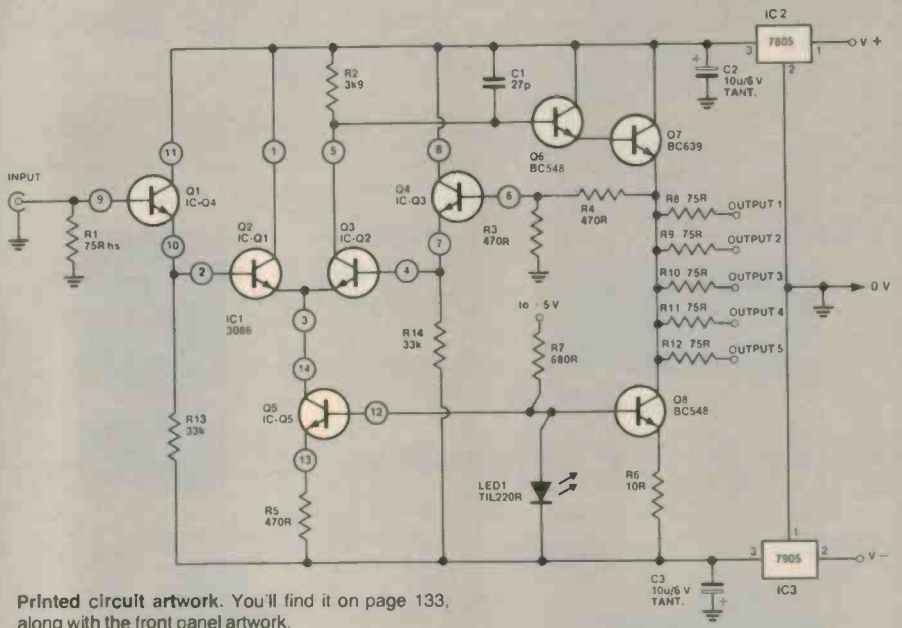
Transistor Q6 is a common collector circuit which buffers the differential pair output and provides a negative dc shift of about 0.6 volts. Q7 and Q8 form the output stage. Q8 is a current source setting the output quiescent current to about 100 mA, which is required (worst case) to drive five parallel output lines of 75 Ohms each. Q7 is a common collector stage which drives the output. Q8 also uses the LED as a voltage reference.

A BC548 or similar transistor has been specified for Q8, though a slightly more powerful one is required for Q7. In fact Q8 is just below the rated power level for a BC548 while Q7 may just exceed the maximum current rating. Neither transistor is very critical, owing to the feedback-type design employed, so some substitution is possible.

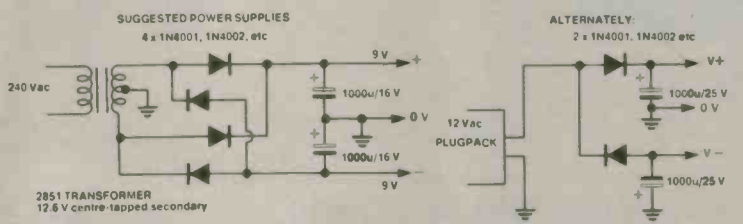
Resistors R3 and R4 form the feedback ratio defining resistors. High stability metal film types have been specified here. In practice, they define the gain of the whole amplifier and hence should be precise enough to ensure that the standard video levels are maintained. However, their value is not critical, only that they should be equal. It would be possible to use a pair of selected resistors of any value from 330 to 560 Ohms.

The input termination resistor and the output termination resistors are also specified as metal film types. This is in order to minimise mismatches with the cables used to connect to other video systems. It would be possible to use 47 or 51 Ohm metal film resistors if your system is 50 Ohm. In this case, the output stage could handle only four parallel loads.

The amplifier runs off + and −5 volts, provided by two three-terminal regulators. These are prevented from oscillating by the two tantalum capacitors, C2 and C3, which also provide supply rail bypassing over a wide bandwidth.



Printed circuit artwork. You'll find it on page 133, along with the front panel artwork.



PARTS LIST ETI-1517

Resistors ..... all ¼W, 5% unless noted
- R1, R8-12 ..... 75R, 1%
- R2 ..... 3k9
- R3, R4 ..... 470R, 1%
- R5 ..... 470R
- R6 ..... 10R
- R7 ..... 680R
- R13, R14 ..... 33k

Capacitors
- C1 ..... 27p
- C2, C3 ..... 10u/6 V tant.

Semiconductors
- IC1 ..... CA3086, LM3086
- IC2 ..... uA7805, LM7805, LM340/T5
- IC3 ..... uA7905, LM7905, LM345/T5.0
- Q6, Q8 ..... BC548
- Q7 ..... BC639
- LED1 ..... TIL220R red LED

Miscellaneous
ETI-1517 pc board; UB1 zippy box (50x90x150 mm); required number of BNC sockets; Scotchcal front panel; plugpack (12 Vac) or power supply components to suit — see text; wire, nuts, bolts, etc.

Price estimate: $35-$45

SPECIFICATIONS ETI-1517 VIDEO DISTRIBUTION AMPLIFIER

Number of outputs	up to five
Peak output	2 V peak-to-peak
Power bandwidth	8 MHz (-3 dB @ 1 Vp-p output)
Small signal bandwidth	26 MHz (- 3 dB @ 200 mVp-p output)
Input impedance	75 ohms
Output impedance	75 ohms (any port)

(performance measured on prototype)

ROD IRVING ELECTRONICS IS YOUR No. 1 KIT SUPPLIER

ROD IRVING ELECTRONICS IS YOUR No. 1 KIT SUPPLIER

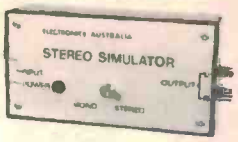
ROD IRVING ELECTRONICS IS YOUR No. 1 KIT SUPPLIER

STEREO SIMULATOR

EA APRIL 83

$12

for PCB version.



Self-contained version will cost approx. **$20** (does not include plugpack supply).

ETI-733 RADIOTELETYPE CONVERTER FOR THE MICROBEE

$20.00

ETI April 1983

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

OVER 300 NOW SOLD

EA INVERTER INCLUDING TRANSFORMER $195

300 WATTS

P & P $10.00 Anywhere in Australia

JUNE EA 1982

ETI-335 PUSHBUTTON-PROGRAMMABLE WIPER CONTROLLER

ETI March 1983 **$28.50**

No more fiddling with knobs and not getting the delay between wipes that you want — this windscreen wiper controller is simply programmed with two pushbuttons to provide the wiping delay you need

PHOTON TORPEDO GAME

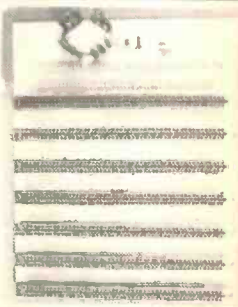
EA September 81

$24.50

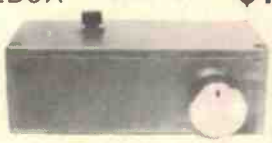
7-SLOT S100 MOTHER BOARD

ETI May 80

$90.00



FUZZBOX $19.90



Simple Fuzz Box for electric guitars. The no fuss, no nonsense Fuzz Box. Confused — So are we. Seriously though if you want a sound with a difference, build this project and you can distort the waveform. It produces a sound which is buzzy (like politicians at election time). EA February 81

150W MOSFET POWER AMP

$79.00

Plus Transformer $43.50

Plus Heatsink Drilled, Tapped and Black Anodised $42.50

A general purpose 150W Mosfet Power Amp Module. Here's a high power, general purpose Power Amplifier Module for guitar and PA applications employing rugged, reliable Mosfets in the output. ETI 499 March 82

CYLON VOICE EA December 80

$19.95

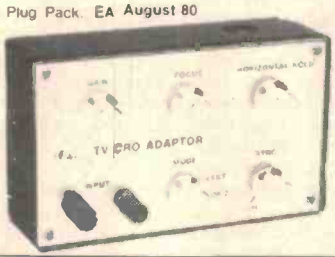
Sound like Darth Vader

SLIDE CROSS FADER $85.00

EA November 81

TV CRO ADAPTOR $38.50

Includes Plug Pack. EA August 80



VOICE CANCELLER

$22.50

Ever wondered how your voice substituted for your favourite vocalists would sound, well now its possible! You can cancel out the lead vocal on almost any stereo record and substitute your own voice or musical instrument. EA April 82

Oct 82 ETI

ETI'S BRILLIANT NEW DIRECT-CONNECT COMPUTER MODEM

Our Price $169.00

Employs unique 'Commutated Filter' design overcoming virtually all the problems involved with conventional modems.
Super flexible unit facilitates communications between computers over cables, the telephone network and radio links.
Unit connects to a standard RS 232 interface and is capable of both 1200/75 Baud and 300/300 Baud transmission and reception ★ Line switching; answer and dialing facilities on board.
EXCLUSIVES: ★ Plated through, double sided PCB ★ Complete set of IC sockets ★ Kit requires 85 IN914 Diodes for programming these are included ★ Ceralock resonator and matching balanced load capacitor used for long life and high accuracy ★ Telecom approved isolating transformer and Reed relays included.

LOUD SPEAKER PROTECTOR

ETI 455 March 80

$32.50

DIGITAL ENG. ANALYSER

$48.50

EA August 80

DIGITAL CAPACITANCE METER $47.50

Here is an inexpensive Digital Capacitance Meter which measures from 1pF to 99.99uF in just three ranges. It's simple to use and features a big bright four-digit display with automatic updating and decimal points. EA March 80

ELECTRONIC DUMMY LOAD

$99.00

With this unit you can test power supplies at currents up to 15 Amps and voltages up to 60 Volts. It can "sink" up to 200 Watts on a static test and you can modulate the load to perform dynamic tests. ETI 147 October 80

bankcard welcome here

ROD IRVING ELECTRONICS — YOUR MAIL ORDER SPECIALISTS

General Enquiries: (03) 489 8131 425 HIGH ST, NORTHCOTE, VICTORIA 3070 Mail Order Hot Line (03) 481 1436

SHOPAROUND

This page is to assist readers in the continual search for components, kits, printed circuit boards and other parts for ETI projects and circuits. If you are looking for a particular item or project and it is not mentioned here, check with our advertisers.

ETI-736 Fax decoder

Be your own weather forecaster - and with some authority, because you'll have all the weather maps and satellite pictures to hand! This project will be widely stocked as a kit and, as parts are all bog-standard items, constructors should have little difficulty getting it all together.

To date, the following firms have indicated they'll be stocking kits: **Altronics** in Perth, **Electronic Agencies** in Sydney, **Jaycar** in Sydney (now with three stores - 'Silicon Alley', Carlingford and Hurstville) and **Rod Irving** in Melbourne. You might also try **All Electronic Components** in Melbourne, **Avtek** in Sydney and **Tomorrow's Electronics** in Gosford.

Ready-made printed circuit boards should be available from the suppliers listed at the end of this column, or, if you're making your own, a positive or negative transparency can be obtained from us for $1.50 from ETI-Artwork, ETI Magazine, P.O. Box 21, Waterloo NSW 2017. Make cheques or money orders payable to 'ETI Artwork Sales', and ensure you ask for a positive or negative according to the type of photoresist you're using.

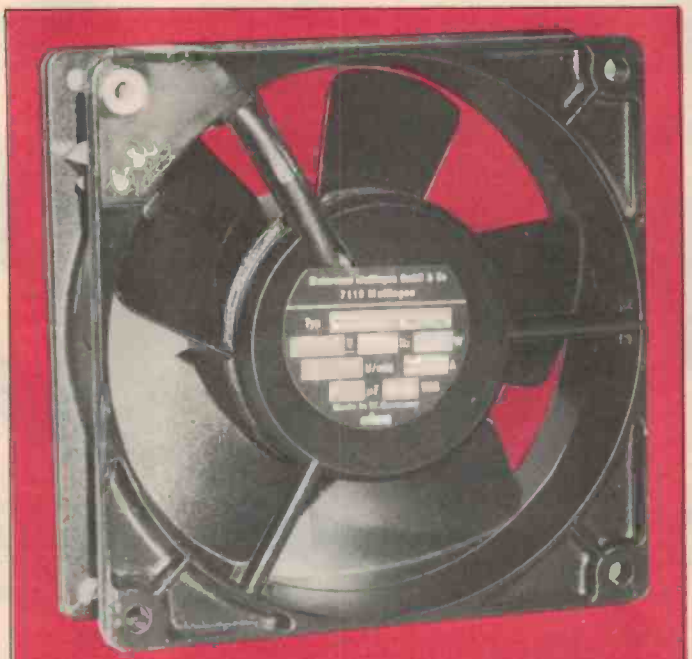
ETI-421 3-way speakers

Known as the Dick Smith 'Series 200' loudspeakers, these will be available in kit form, as well as built-up, from all Dick Smith stores. You get a pair in the kit for just $249.50 complete, or $299 the pair built-up.

ETI-1517 Video distribution amplifier

This project should be popular among the video buffs etal. It's cheap, easy to build and uses readily available bits. Not everyone stocks the CA3086, but they are widely available nonetheless.

Kits should be available from **Jaycar** in Sydney, **Rod Irving Electronics** in Melbourne, **All Electronic Components**, also in Melbourne and **Dick Smith** stores all over. **Altronics** may possibly stock this project as a kit,also.



No muffin for 'nuffin'. That's right folks, you can't get a Muffin-style rotary fan for nothing, but you can occasionally get a good price. This German-made 240-V, 150 mm diameter fan is currently available from Radio Despatch in Sydney at a price we can't disclose for fear of causing such a stampede that their premises would never recover. First in, best dressed. Keep your cool, stroll down to 869 George St., Broadway and shout your family/friends to lunch at McDonalds next door with your savings.

Printed circuit boards should be available from the suppliers listed at the end of this column. If you want to make your own, a positive or negative transparency is available from us for a piddling $1, post paid. Send your rustproof money to: ETI-1517 Artwork, ETI Magazine, P.O. Box 21, Waterloo NSW 2017. Make out cheques or money orders to 'ETI Artwork Sales', and make sure you ask for a positive or negative transparency, according to what you require.

ETI-166 Function/ pulse generator

The saga continues, once again. As this is an unusual project, requiring construction techniques that would not be familiar to most constructors, we're describing it in detail - and it's taking up a lot of room! But we like to ensure that any reader tackling such a project will be reasonably ensured of success. Be patient and you will be rewarded with a fine instrument.

More of the saga next month.

Gee, they look after you

In ever-increasing efforts to look after the whims and fancies of all you happy hobbyists out there, Altronics and Jaycar have just increased their services.

Altronics, manned by that Irishman-who-walks-on-water, Jack O'Donnell, and his happy band of leprechauns, has installed a 'toll free' telephone ordering service. For the cost of a local 'phone call (12 measly cents), bankcard holders may phone their order for any advertised Altronics products from anywhere in Australia. Just call **008-999007**.

Don't forget Altronics' overnight jetservice - 'phone in the afternoon, have your order delivered the next morning. Jack O'Donnell maintains that an order phoned through up to 6 pm eastern standard time will normally be delivered the next morning to any capital city or suburb east of Perth; the following day to country areas.

Jaycar has opened another store in Sydney. For southside constructors, from the first of September, you'll be able to get Jaycar kits, components and products from their new store located at 121 Forest Rd, Hurstville. The 'phone number is 570-7000. Call in for a browse, or to buy the latest copy of ETI.

Printed circuit board and panel suppliers

Almost every pc board ever published by ETI may be obtained from the following suppliers:

All Electronic Components
118 Lonsdale St
Melbourne Vic. 3000

RCS Radio
651 Forest Rd
Bexley NSW 2207

Panels, meter scales and dial faces for almost every ETI project published may also be obtained from the above two firms.

For pc boards produced over the last three to five years, the following suppliers generally keep stocks on hand:

Electronic Agencies
115-117 Parramatta Rd
Concord NSW 2137
and
117 York St
Sydney NSW 2000

Radio Despatch Service
869 George St
Sydney NSW 2000

Rod Irving Electronics
425 High St
Northcote Vic. 3070

James Phototronics
522 Grange Rd
Fulham Gardens SA 5024

Jemal Products
P.O. Box 168
Victoria Park WA 6100

Jaetronics
58 Appian Drive
St Albans Vic. 3021

Sunbury Printed Circuits
Lot 14, Factory 3
McDougall Rd
Sunbury Vic. 3429

Billco Electronics
Shop 2, 31 Pultney St
Dandenong Vic. 3175

Mini Tech
P.O. Box 9194
Auckland N.Z. ●

Kit Support For the Microbee

Altronics' unique combination as Australia's leading kit supplier and also as distributor for the sensational Microbee computer, allows us to present a range of unsurpassed quality kits suitable for use with the Microbee and other Z80 based microcomputers. Rather than just supply "a bag of bits", Altronics constructs the kits we sell and make improvements to ensure that you, the kit constructor have a professionally appearing, correcly functioning unit.

EPROM PROGRAMMER

(ETI JAN. '83)

K9668..... **$55.00**

Versatile, low cost and easy to build. Plugs straight into the microbee I/O port. Suitable for 2716, 2732, 2532, 2732A and 2764 Eproms. Burn your games programmes and eliminate cassette loading time.
KIT FEATURES ☆ Sockets for all other IC's ☆ 1 x 2716 supplied — get started straight away ☆ Front Panel and Mains (SEC approved) transformer ☆ 28 pin and 16 pin wire wrap sockets to flush mount personality plugs (2 included) and ZIF socket (included) ☆ DB 15 Plug ☆ Complete to last nut and bolt.

(See Review ETI AUGUST 1983)

RADIOTELETYPE DECODER

(ETI APRIL '83)

K9733..... **$19.50**

Display RTTY encoded messages on your Video Monitor. Receive up to date weather information, International News before the Papers, all sorts of coded military info. Simple circuit uses PLL techniques ☆ Single PCB Construction ☆ Kit includes DB15 Plug and backshell for connection to microbee ☆ Shielded pretinned PCB.

NEW MICROBEE LIGHT PEN

(ETI AUGUST '83)

PROVIDES DIRECT PERSONAL CONTACT WITH YOUR BEE!

K9649..... **$19.95**

AT LAST — a light pen for the Bee. This pen works in the low-resolution graphics mode and connects directly to the I/O port. ☆ Complete kit including DB15 and backshell, 2m CORD ☆ Fully documented with software examples.

GO ANYWHERE 12-240V POWER

These great Inverter kits enable you to power 240V appliances from a 12V DC power source. Tremendous for camping, fishing etc. Install into your Car, Boat or Caravan.

A fully regulated and overload protected design, featuring XTAL locked frequency. Use to power hi-fi, TV sets, even electric drills for short time periods.
MANY OF THESE KITS ARE NOW IN USE FOR EMERGENCY LIGHTING PURPOSES.
ALTRONICS' KIT features ☆ Gold plated edge connector and PCB buss ☆ Low age rate XTAL ☆ Sockets for all IC's ☆ High Efficiency Transformer.

K6750..... (EA JUNE '82) ... **$199.50**

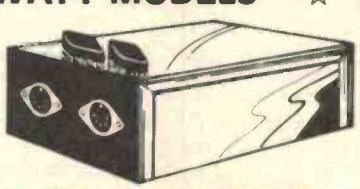
($10 DELIVERY AUSTRALIA WIDE)

☆ TWO GREAT 40 WATT MODELS ☆

GENERAL PURPOSE

Suits small appliances, ie. Turntables, Tape Decks, Shavers etc. Variable frequency adjustment enables speed control of turntables. Works as a trickle charger when mains power is available.
EASY CONSTRUCTION ☆ VALUE PLUS

K6700..... **$55.00**



FLUORESCENT LIGHTING

Operates above the audible frequency range and is capable of driving one 40 watt or two 20 watt fluorescent tubes to 150% of their normal 240V efficiency. Install permanently into caravans. **COMPLETE BOXED KIT, INCLUDING ALL WINDING WIRE.**

K6505..... **$37.50**

PRESTIGEOUS NEW TOUCH LAMP DIMMER

HALF THE COST OF COMMERCIAL UNITS

Great new kit from EA. (April '83). Based on new Seimens ICS576A Light Dimmer IC.
Instantly turn lamps on and off with just a light touch on a wall panel, or provide mood lighting by touching the panel for a few seconds.
The Altronics Kit is complete in every way, including satin silver touch plates for that touch of class.

K6320... (10UP$18.50)... **$19.50**

REMOTE CONTROL FOR K6320

This kit enables extra dimmer/switches to be installed in conjunction with the dimmer kit. Includes satin silver touch plate.

K6321..... **ONLY $9.00**

ELECTRONIC FLUORO STARTER

(SEE EA OCT. 1982)

Save a fortune on Fluoro Tubes.

- ★ Extends the life of your fluoro tubes by 1,000's of hours.
- ★ Instant "ON" — no more flickering at switch on.

K6300 (10UP$4.50) **$4.95**

IDEAS FOR EXPERIMENTERS

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.

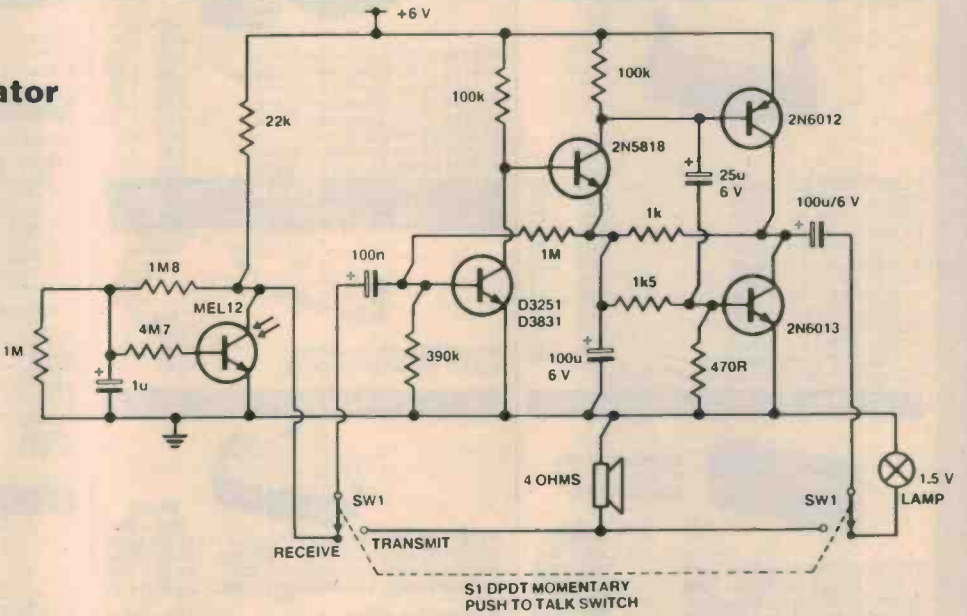
Flashlight communicator

This simple, portable, visually-aligned transceiver, designed by **Chris McRae of West Pymble NSW**, is quite effective and can be easily built into a flashlight.

The lamp current, modulated at an audio frequency, modulates the light beam. The light beam is detected by a photodarlington transistor and drives a small speaker for audio output.

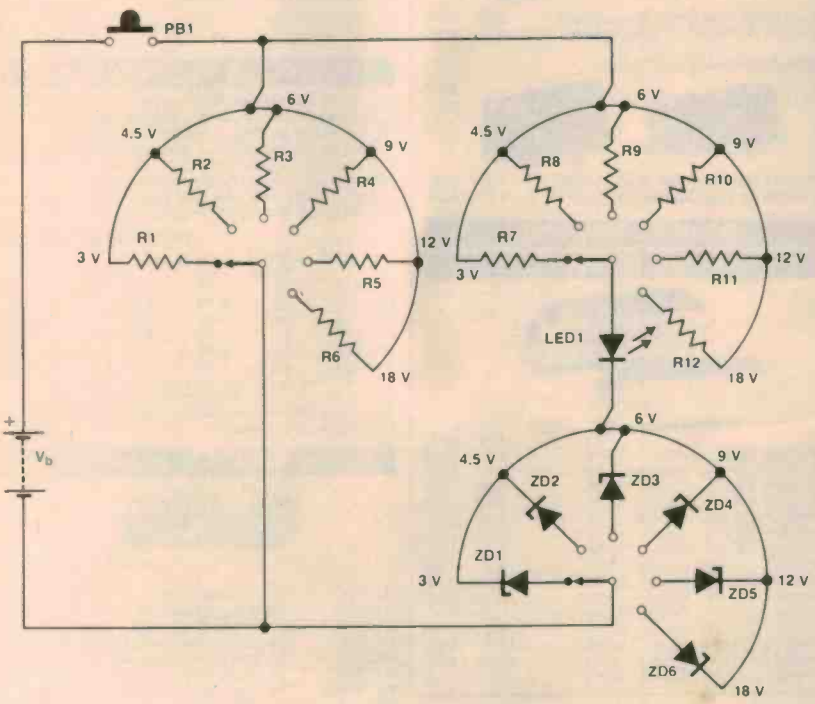
The lamp is driven by an ac signal which cuts the RMS voltage to about one-third of the six volts, which is why a 1.5 V bulb is used in a 6 V circuit.

The photodarlington can be mounted on the axis of the beam or you may get better sensitivity by placing it so that it faces the reflector of the flashlight just above the bulb (the bulb filament is at the focal point of the reflector).



Fidelity is not high due to the low pass characteristics of the bulb filament, but I have been able to have intelligible conversations at distances up to 30 metres.

Modification to battery condition indicator



Jerry Stamatelatos of St Kilda Victoria has come up with a modification for the battery condition indicator circuit which appeared in ETI Circuits No 4 on page 70.

The modification is based on the addition of three rotary switches which provide a selection of six voltages.

Resistors	all ¼ W, 5%
R1	270R
R2,R12	390R
R3	470R
R4	820R
R5	1k
R6	1k5
R7	68R
R8	100R
R9	120R
R10	180R
R11	220R
Semiconductors	
ZD1	0V7*
ZD2	2V1*
ZD3	3V3
ZD4	5V6
ZD5	8V2
ZD6	13 V

*For these low zener voltages, use one or more silicon diodes in series forward biased.

ROD IRVING ELECTRONICS

2 BRANCHES:

425 High St. Northcote, Ph.: (03) 489 8131
48-50 A'Beckett St. Melb. Ph.: (03) 347 9251

Errors and omissions excepted.

Mail orders: P.O. Box 235 Northcote, Vic. 3070 min p&p $3.00

INSULATION DISPLACEMENT CONNECTORS PC MOUNTING HEADERS

		PRICE 1–9	10+
P12010	10 Pin S.T Header	3.95	3.90
P12011	10 Pin R.A Header	3.95	3.50
P12020	20 Pin S.T Header	5.95	5.25
P12021	20 Pin R.A Header	5.95	5.25
P12026	26 Pin S.T Header	6.95	6.25
P12027	26 Pin R.A Header	6.95	6.25
P12034	34 Pin S.T Header	7.95	7.25
P12035	34 Pin R.A Header	7.95	7.25
P12040	40 Pin S.T Header	8.95	8.25
P12041	40 Pin R.A Header	8.95	8.25
P12050	50 Pin S.T Header	9.95	8.95
P12051	50 Pin R.A Header	9.95	8.95

Mounts on PCB and Mates with IDC Sockets.

CARD EDGE CONNECTORS

Edge Connectors to suit Disk Drives Etc.

		PRICE 1–9	10+
P12060	10 Way Card Edge Conn	7.95	7.10
P12062	20 Way Card Edge Conn	8.50	7.95
P12064	26 Way Card Edge Conn	8.95	8.10
P12066	34 Way Card Edge Conn	9.95	8.95
P12068	40 Way Card Edge Conn	11.50	10.50
P12070	50 Way Card Edge Conn	12.50	11.50

WIRE WRAP HEADERS

		PRICE 1–9	10+
P12080	10 Pin W.W Header	6.95	5.95
P12081	10 Pin W.W R.A Header	6.95	5.95
P12082	20 Pin W.W Header	7.95	5.95
P12083	20 Pin W.W R.A Header	7.95	5.95
P12084	26 Pin W.W Header	8.95	7.95
P12085	26 Pin W.W R.A Header	8.95	7.95
P12090	34 Pin W.W Header	9.95	8.95
P12091	34 Pin W.W R.A Header	9.95	8.95
P12092	40 Pin W.W Header	12.95	11.95
P12093	40 Pin W.W R.A Header	12.95	11.95
P12094	50 Pin W.W Header	13.95	12.95
P12095	50 Pin W.W R.A Header	13.95	12.95

IDC SOCKETS

		PRICE 1–9	10+
P12100	10 Pin Socket	4.95	3.95
P12102	20 Pin Socket	5.95	4.95
P12104	26 Pin Socket	6.95	5.95
P12106	34 Pin Socket	7.95	6.95
P12108	40 Pin Socket	8.95	7.95
P12110	50 Pin Socket	9.95	8.95

CABLE PLUGS

		PRICE 1–9	10+
P12114	14 way crimp	1.95	1.50
P12116	16 way crimp	2.25	1.95
P12124	24 way crimp	3.95	3.25
P12140	40 way crimp	6.50	5.95

COMPONENT CARRIERS

		PRICE 1–9	10+
P12148	8 Pin Component Carrier	1.75	1.50
P12152	14 Pin Component Carrier	1.95	1.70
P12154	16 Pin Component Carrier	2.25	1.95
P12156	18 Pin Component Carrier	2.75	2.50
P12158	20 Pin Component Carrier	3.50	3.10
P12160	24 Pin Component Carrier	3.95	3.50
P12162	28 Pin Component Carrier	4.95	4.50
P12164	40 Pin Component Carrier	5.95	5.40

25PIN "D" CONNECTORS 10C CRIMP

		PRICE 1–9	10+
P12170	25 Pin Plug Crimp	12.95	11.95
P12171	25 Pin Socket Crimp	13.95	12.95

CENTRONICS

		PRICE 1–9	10+
P12200	36 Way Centronics Plug IDC	12.50	11.50
P12201	36 Way Centronics SCKT IDC	13.50	12.50
P12203	50 Way Centronics Plug IDC	14.50	13.50
P12204	50 Way Centronics SCKT IDC	15.50	14.50
P12210	36 Way Solder Plug	15.95	14.50
P12211	36 Way Solder Line SCKT	15.95	14.50
P12213	36 Way Solder Chassis SCKT	15.95	14.50

STRIP HEADERS

30 Way Male .1" x .1" Matrix

		PRICE 1–9	10+
P12230	30 Way Single Strip Header	3.95	3.75
P12231	30 Way Oval Strip Header	4.95	4.75

30 Way Female .1" x .1" Matrix

		PRICE 1–9	10+
P12234	30 Way Single Plug Header	4.95	3.95
P12235	30 Way Dual Plug Header	5.95	4.95

SOLDER CONNECTORS

D RANGE CONNECTORS

				PRICE 1–9	10+
P10880	DE9P	Male	9 Pin	3.50	3.00
P10881	DE9S	Female	9 Pin	4.50	4.00
P10882	DE9C	Cover	9 Pin	2.50	2.20
P10890	DA15P	Male	15 Pin	3.90	3.50
P10891	DA15S	Female	15 Pin	4.90	4.50
P10892	DA15C	Cover	15 Pin	2.50	2.20
P10900	DB25P	Male	25 Pin	4.90	4.10
P10901	DB25S	Female	25 Pin	4.95	4.50
P10902	DB25C	Cover	25 Pin	2.50	2.20
P10910	DC37P	Male	37 Pin	8.90	8.20
P10911	DC37S	Female	37 Pin	10.90	9.90
P10912	DC37C	Cover	37 Pin	5.50	4.90
P10920	DD50P	Male	50 Pin	12.90	11.90
P10921	DD50S	Female	50 Pin	14.90	12.90
P10922	DD50C	Cover	50 Pin	6.50	5.50

100+, less 10% from 10+ price

LOGIC BOARD SOCKETS

			PRICE 1-9	10+
P10915	15/30	.156"S.T.	6.95	6.50
P10918	18/36	.156"S.T.	6.95	6.50
P10920	20/44	.156"S.T.	7.95	6.95

LOW PROFILE IC SOCKETS

		PRICE 1–9	10+
Economical Soldertail			
P10550	8 Pin	.25	.20
P10560	14 Pin	.35	.30
P10565	16 Pin	.40	.35
P10567	18 Pin	.50	.40
P10568	20 Pin	.50	.40
P10569	22 Pin	.50	.40
P10570	24 Pin	.50	.40
P10572	28 Pin	.60	.50
P10575	40 Pin	.70	.60

Precision Machined Gold Insert

		1-9	10-25
P10620	8 PIN	1.20	1.00
P10624	14 PIN	1.60	1.40
P10626	16 PIN	1.90	1.70
P10628	18 PIN	2.00	1.80
P10630	20 PIN	2.20	2.00
P10632	22 PIN	2.40	2.20
P10634	24 PIN	2.60	2.40
P10640	28 PIN	2.90	2.70
—	40 PIN	4.40	4.00

WIRE WRAP SOCKETS

		PRICE 1–9	10+
P10579	8 Pin	1.20	1.00
P10580	14 Pin	1.40	1.20
P10585	16 Pin	1.60	1.40
P10587	18 Pin	1.90	1.70
P10590	20 Pin	2.20	2.00
P10592	22 Pin	2.40	2.10
P10594	24 Pin	2.50	2.20
P10596	28 Pin	2.80	2.40
P10598	40 Pin	3.30	2.90

MOLEX PINS

Make your own IC Sockets.
Supplied on a Breakoff Header.

P10700	Pack 100 $2.25
P10701	Pack 1000 $16.00

IDC RIBBON CABLE

This is the only Ribbon Cable to use in I.D.S. or crimp style connectors. We use in our computer productions. As the exact spacing and quality is critical for ultra reliable long term computer operations. Do not try and use cheaper Ribbon Cables as you will find that the reliability doesn't justify the cheaper prices.
Colour is Grey with wire one being colour coded to match up with Pin one of I.D.C. Connectors.

	No. of Cond.	PRICE PER METRE 1-9	10-99	100+
W12616	16	1.90	1.70	1.40
W12624	24	2.90	2.60	2.10
W12634	34	3.90	3.50	3.10
W12640	40	4.90	4.40	3.90
W12650	50	5.90	5.20	4.60
W12660	60	6.90	5.90	4.90

WARNING

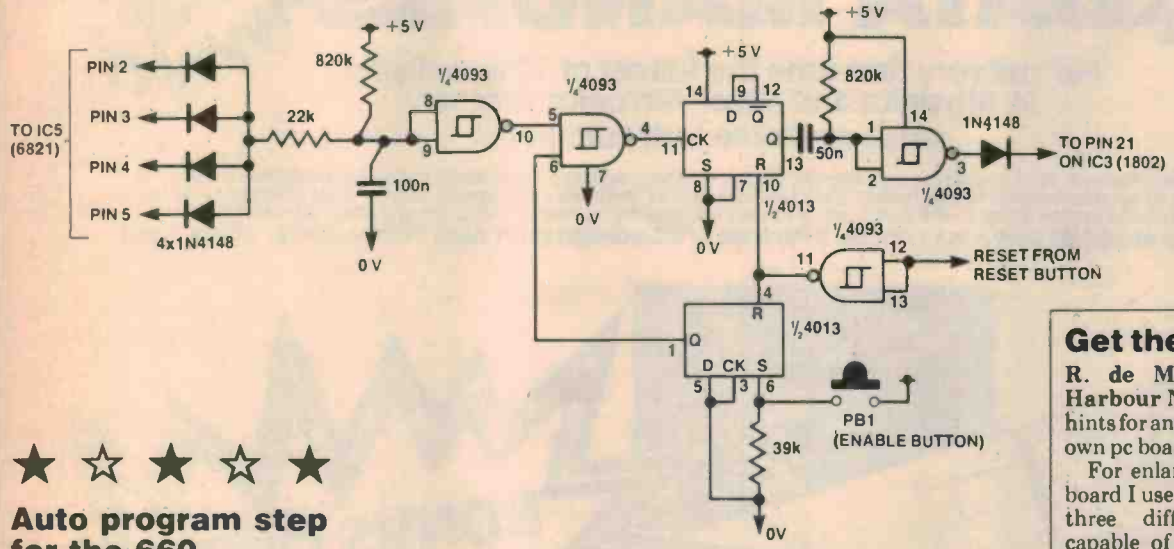
This is the only type of Cable to use for Insulation Displacement Connectors. I.D.C.

UNPROTECTED HEADERS

Dual In Line 2.54mm

		1-9	10+
P12240	10 Way Unprot. Header	1.95	1.75
P12246	16 Way Unprot. Header	2.95	2.50
P12250	20 Way Unprot. Header	3.25	2.95
P12256	26 Way Unprot. Header	3.75	3.25
P12260	30 Way Unprot. Header	3.95	3.50
P12264	34 Way Unprot. Header	4.95	4.45
P12270	40 Way Unprot. Header	5.95	5.25
P12275	50 Way Unprot. Header	6.95	6.25
P12280	60 Way Unprot. Header	8.95	7.95

IDEA OF THE MONTH



★ ☆ ★ ☆ ★

Auto program step for the 660

H. Greber, North Rockhampton Qld

This circuit eliminates the need to press the step key on the ETI-660 when you want to advance the address when you're programming it.

The annoying problem of contact bounce in the step key, which causes the computer to jump locations when programming, is also solved with this circuit.

The circuit is enabled by pressing SW1 which I set up as a spare key on my keyboard. With the circuit enabled you then type in the program as you would normally do, however, you don't have to press the step button after every second hex digit as this is done automatically.

When you have finished typing in the program press the reset button to disable the circuit. If a mistake is made the correction procedure is the same except the enable key must be pressed again, after correcting the mistake, to continue programming.

The step key operates normally when this circuit is enabled or disabled so you can still skip locations with it when programming.

When building up the circuit change the value of the capacitor across the reset button from 100n to 200n.

Get the drill on vice

R. de Mouilpied of Coffs Harbour NSW has some useful hints for anyone who makes their own pc boards.

For enlarging holes in the pc board I use a small pin vice with three different size collets capable of holding small drills from 0.8 mm to 3.5 mm. This is also very handy for inserting pc board stakes, instead of using a pc board insertion tool.

The problem of sharpening small drills has been overcome by using an old electric can opener. I removed the can cutter section and also the back plate covering the knife grinder. Then I put a switch on the side of the unit, connected the power and I had a small drill grinder.

I also use the pin vice for holding the drill while I am sharpening it, as I look through a head-type x10 magnifier.

'IDEA OF THE MONTH' CONTEST

PRIZE WORTH $90!

COUPON

Cut out and send to: **Scope/ETI 'Idea of the Month' Contest, ETI Magazine, 140 Joynton Ave, Waterloo NSW 2017.**

"I agree to the above terms and grant Electronics Today International all rights to publish my idea in ETI Magazine or other publications produced by them. I declare that the attached idea is my own original material, that it has not previously been published and that its publication does not violate any other copyright"*
* Breach of copyright is now a criminal offence.

Title of Idea .....

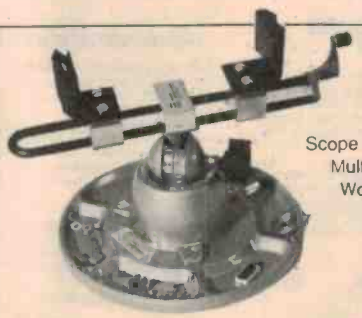
Signature .....

Name .....

Date .....

Address .....

..... Postcode .....



Scope Panavise Multi-purpose Work Centre.

Scope Laboratories, who manufacture and distribute soldering irons and accessory tools, have offered to sponsor a contest with a prize to be given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI. Each month we will be giving away a Scope Panavise Multi-purpose Work Centre, Model 376/300/312, comprising a self-centering head (376), standard base (300) and tray base mount (312), all worth about $90! Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, each winner will be paid $10 for the item published. You must submit original ideas of circuits which have not previously been published. You may send as many entries as you wish.

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Scope Laboratories, Federal Publishing Company Proprietry Limited, ESN, The Litho Centre and/or associated companies.

Closing date for each issue is the last day of the month. Entries received within seven days of that date will be accepted if postmarked prior to and including the date of the last day of the month.

The winning entry will be judged by the Editor of ETI, whose decision will be final. No correspondence can be entered into regarding the decision.

Winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries.

Entrants must sign the declaration on the coupon that they have read the above rules and agree to abide by their conditions.

A RARE OPPORTUNITY

NATIONAL SEMICONDUCTOR DATA MANUALS

EXCLUSIVE OFFER FROM ALTRONICS

For the very first time the full set of 10 is available at Altronics and Major Altronics Resellers (Also available individually)

Without doubt these National Semiconductors Data Manuals are the very best available in the world today, but until now they've been almost impossible to get (the National People forever giving excuses such as "Australia's allocation is only so many books per year etc"). So we've beaten our competitors to the punch and arranged a special Print Order for Altronics and Major Altronics Resellers.
But Once they are gone there may not be a further print edition until June 1984 — Order yours now!

BONUS OFFER
THE ENTIRE SET FOR JUST $89
PLUS $10 EXPRESS DELIVERY ANYWHERE IN AUSTRALIA.
ATTENTION: UNIVERSITIES, COLLEGES, SCHOOLS, DESIGNERS & ENTHUSIASTS.
An Outstanding chance to purchase the entire set of 10 books at a significant saving.
SAVE OVER $23
COMPLETE SET ORDER NO. B9996

LOGIC DATABOOK

National's new Logic Databook covers five of their logic families: TTL (54/74), Schottky (54S/74S), low power Schottky (54S/74LS), high speed (54H/74H), and low power (54L/74L).

The Logic Databook—especially organized for quick and easy referencing—offers two complete functional indices and selection guides, one for SSI and one for MSI devices. In addition, it includes over 100 connection diagrams and test waveforms to help speed the design-in cycle.

All in all, it's probably the most comprehensive collection of practical information ever assembled on such a broad line of practical components.

B1015.....(624 pages).....$9.95

HYBRID PRODUCTS DATABOOK

The Hybrid Products Databook is the only National Semiconductor publication that contains complete information on all of our hybrid semiconductor products. Included are precision thin film and thick film products which provide the user with standard functions from operational amplifiers to converters with capabilities beyond those of current monolithic technology.

Product selection guides and an application section are also included.

B1045.....(792 pages).....$11.50

AUDIO RADIO HANDBOOK

This handbook exists to acquaint those involved in audio systems design with National Semiconductor's broad selection of integrated circuits specifically designed to meet the stringent requirements of accurate audio reproduction.
Far from just a collection of data sheets, this manual contains detailed discussions, including complete design particulars. Thorough explanations and complete design examples, makes clear several audio areas never before available to the general public.

B1035.....(203 pages).....$9.95

VOLTAGE REGULATOR HANDBOOK

With the variety of fixed- and variable-regulator technology currently available, the 336-page Voltage Regulator Handbook becomes a must for the selection of three-terminal and dual tracking components that meet the system requirement while utilizing the most cost-effective approach.

Beginning with product selection procedure and a data sheet summary, the text continues with easily accessible information about booster circuitry, power transformer and filter specifications, test methods, manufacturers' cross reference, and extended use applications for National's regulators.

B1055.....(336 pages).....$9.95

LINEAR DATABOOK

The new 1983 edition of the National Semiconductor Linear Databook is the most comprehensive available. It presents approximately 2000 pages of specifications for high technology linear products within its two volumes. Applications, descriptions, features and diagrams in this databook include detailed sections for Voltage Regulators, Op Amps, Voltage Comparators, A to D, D to A Converters, Industrial Blocks and Audio, and TV Circuits.

The Databook also features advanced telecommunication devices and speech synthesis (DIGITALKER™), plus other non state of the art linear products offering performance, economy, quality and reliability.

B1010 (VOL I).....$12.50
B1011 (VOL II).....$12.50

THE INTERFACE DATABOOK

In National Semiconductor's Interface Databook, 702 pages of specifications describe one of the industry's broadest lines of interface products.

Over 300 data sheets have been compiled, covering transmission line drivers/receivers, bus transceivers, peripheral/power drivers, level translators/buffers, display drivers, MOS and magnetic memory interface circuits, microprocessor support circuits, applicable TTL and CMOS logic circuits.

An industry cross reference guide gives National Semiconductor's exact replacement for 7 other manufacturers. Product selection guides and a complete product applications section make it easy to find the correct part number for these specialized ICs.

B1005.....(702 pages).....$11.50

TRANSISTOR DATABOOK

National Semiconductor has added many new transistors and product families since publication of the last databook. Many have already been widely acclaimed by users.

In addition to small-signal, power-bipolar and field-effect transistors that have been the mainstay of our catalog, there is a section for multiple-field-effect transistors. More part numbers will be added as market needs expand.

To keep current on all new National transistors, please contact your National sales representative or franchised distributor and ask to be placed on the customer mailing list.

B1050.....(558 pages).....$11.50

CMOS DATA BOOK

This databook contains information on National Semiconductor's standard SSI/MSI CMOS products. This includes the popular 54C/74C series logic family, which is pin for pin, function for function equivalent to the 7400 family of TTL devices. All device outputs are LPTTL compatible, capable of sinking more than 360μA (≈ 1 LSTTL load). The AC parameters are specified with a 50pF capacitive load.

In addition, this book describes National Semiconductor's extensive line of CD40XXB and CD45XXB series devices. These parts meet the standard JEDEC "B-Series" specifications.

Special Function, LSI, A/D Converters and Memory device specifications contained herein offer the designer unique high-density low-power system solutions. All devices are compatible with 54C/74C series and CD4XXB series products.

B1030.....(842 pages).....$11.50

MEMORY DATABOOK

National Semiconductor has continued its reputation as a high-volume supplier of high-quality, cost-effective components by expanding into the design and processing of semiconductor memories.

While developing this state-of-the-art technology, National met the problems of industry standardization by proposing and utilizing new terminology and symbols to make all memory data sheets consistent. Hence, a cohesive, 464-page databook that includes selection guides, diagrams, and test characteristics for RAMs, EPROMs, MOS ROMs, and magnetic bubble memories.

B1025.....(464 pages).....$9.95

EXTRA KICK FOR OSCAR

The kick-motor firing of AMSAT Oscar 10, on July 12, injected the satellite into an intermediate orbit of 3900 km at perigee and 35 800 km at apogee, with an inclination of 26 degrees.

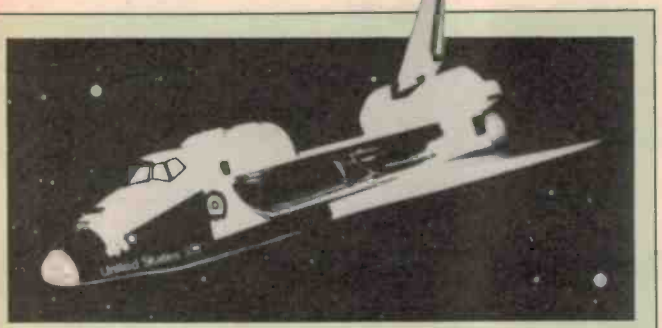
The motor burn lasted about 90 seconds longer than scheduled, causing the perigee to be higher than expected. This extra-length burn used more of the helium supply than it should have, making AMSAT unsure whether the next burn will be totally successful.

Even if the second kick-motor firing is not totally successful or is cancelled, AMSAT says the satellite will still produce some spectacular results from its present orbit.

The only serious ramification of a failure in the second motor burn would be to users in the Northern Hemisphere, who would not have as much access to the satellite over the next five years as they will if a successful firing occurs.

In its present orbit, Oscar 10 will be a Northern Hemisphere satellite for the next several years, but eventually the apogee will precess, changing it to a primarily southern latitude bird.

Oscar 10's initial problems after the orbital injection were probally caused by its being 'bumped' by the third stage of its Ariane L-6 booster.



A HAM IN SPACE!

Doctor Owen Garriott is set to become the first radio ham to operate a station from space. On September 30, when Dr Garriott (W5LFL) rides into Earth orbit as a crew member of the United States space shuttle Columbia, he will have with him a 5 W FM transceiver for operation on the two-metre band.

To contact W5LFL, who will be using a 'split-ring' antenna mounted in one of Columbia's windows, ground stations will need a rig with programmable offset, or separate receive-and-transmit VFOs. Alternatively, two different radios can be used, one for transmitting and the other for receiving.

Ground stations will transmit on frequencies between 144.91 and 145.49 MHz, with W5LFL acknowledging the callsigns he hears on a frequency between 145.51 and 145.77 MHz.

The maximum duration from time of acquisition to loss of signal, from any given geographic point, will be about eight minutes for a pass directly overhead. Access time will be shorter if Columbia passes closer to the horizon at the ground-station location.

Unless they are adept at satellite tracking, radio amateurs have been advised to avoid using highly directional antennas. The speed of the shuttle will be about 27 000 km/h, so unless the rotor system can operate under computer-tracking control, use of a highly directional antenna array will be more of a hindrance than a help.

Amateurs who are unfamiliar with the intricacies of satellite tracking should use omni-directional antennas, with the 'turnstile' crossed-dipole array deemed the best choice.

Dr Garriott has requested that high-power amplifiers be avoided. A 10 W output FM signal into a turnstile-type antenna will be more than adequate to reach W5LFL.

50-50.15 MHz OPEN FOR BUSINESS!

The lower 150 kHz of the 'international' sector of the six-metre band can now be used by Australian amateurs on a restricted basis, according to recent advice from the Federal Department of Communications

As from the last week in July this year, amateurs will be allowed to operate between 50 MHz and 50.150 MHz subject to the following restrictions:

- No interference is caused to reception of Channel 0 transmissions (i.e. operation is generally in accordance with the provisions of paragraphs 5.37 to 5.39 of the Amateur Operator's Handbook — DOC 1978).
- Operation is restricted to outside the hours of broadcast of Channel 0 stations.
- Operation in Western Australia, the Australian external territories and Antarctica is not time limited.

It's a pity this de-restriction long missed the peak of Cycle 21, but some intercontinental DX can still be had, undoubtedly. It should certainly 'open the window' to a lot of trans-Pacific DX.

If you're thinking of arranging skeds with west coast United States and Central American stations (via trans-equatorial propagation), you should start sked sessions around the equinoxial periods (around March 21 and September 21), commencing when the mid-path time is midday and running for some hours following. That's about 8-8.30am EST.

CHANGES TO VK2 BEACONS

The Sydney beacons, located at the WIA transmitting site at Dural, have changed callsign from VK2WI to VK2RSY and the new 70 cm band beacon is now operational.

The beacon frequencies are: 28.262, 52.420, 144.420 and 432.420 MHz.

The new 70 cm beacon runs 15 watts to a horizontally polarised omnidirectional antenna at a height of 20 metres above ground. Identification is by frequency shift keying, as with the VHF beacons.

The Dural two-metre and 70 cm repeaters now operate under the one licence, using the callsign VK2RWI. The 70 cm repeater previously had the callsign VK2RUS.

An information sheet detailing the operation of these repeaters may be obtained by writing to the **WIA NSW Division, P.O. Box 1066, Parramatta NSW 2150.**

MELBOURNE'S BIGGEST COMMUNICATIONS EXPO

Communications Expo '83, a combination hamfest and communications exhibition, is to be held in Melbourne on September 3.

The largest event of its kind held in Melbourne, the Expo is being staged at the Nunawading Civic Centre (Whitehorse Road, Nunawading) by the Eastern and Mountain District Radio Club, as part of World Communications Year.

The Expo will feature a working amateur radio station and a variety of communications technology, displayed by emergency services, electronics companies and the Army.

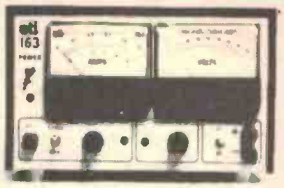
VK3WCY will be on HF and VHF from 9.30 am to 4.30 pm. on the day of the Expo.

For further information, contact **Jim Linton, Eastern and Mountain District Radio Club, P.O. Box 87, Mitcham Vic. 3132. (03)232-3534.**

ETI-163 LAB SUPPLY

$159.00

ETI May 1983



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

$47.50

ETI-688 BIPOLAR PROM PROGRAMMER

ETI June 1983

Every digital workshop should have one! Can be used to program the popular fusible-link PROMs like the 74S188/288, 82S23 and 82S123 etc.

$47.50

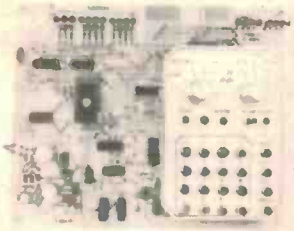
ETI-688 MICROBEE EPROM PROGRAMMER

Simple, low cost programmer for the MicroBee can program 2716s, 2516s, 2732s and 2764s.

P.O.A. **ETI Feb 1983**

EPROM PROGRAMMER

$43.00

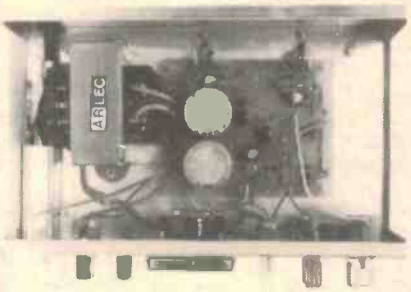


No need for a Micro with EA's great Eprom Programmer suitable for 2716/2758 Eproms.

With Textool Sockets $55.00

EA January 82

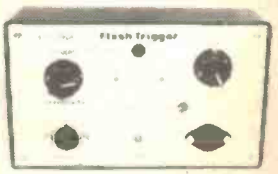
DUAL TRACKING POWER SUPPLY **$83.50**



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

SOUND TRIGGERED FLASH **$26.50**

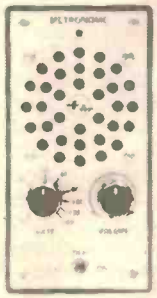
This easy to build sound or light operated flash trigger has many feature.



Catch those spectacular and humorous moments like that time your mother-in-law slipped on the moss covered patio and broke her neck. **ETI 568 October 80**

ELECTRONIC METRONOME

$16.90



Great new Metronome Circuit with low current drain (less than one milliamp) drives a Loudspeaker and a Led Indicator. **EA January 82**

"LE GONG"

$14.95

The "Le Gong" Doorbell with those unmistakable chimes generated by the LSI. A must for the man who has everything! **EA February 81**

VOICE OPERATED RELAY **$14.95**

EA's great new Voice Operated Relay can be used to control a tape recorder, as a VOX circuit for a transmitter, or to control a slide projector. **EA April 82**

3½ DIGIT LCD CAPACITANCE METER

Handy pocket size Digital Capacitance Meter, runs off a 9V battery and measure 1pF to 19.99uF in just three ranges. **EA March 82**

$79.00

LED LEVEL METER

$27.00

Build a Led level Meter with simultaneous peak and average display plus 60dB dynamic range. This kit is ideal for any application requiring a wide dynamic range level display. **ETI 458 June 81**

DIGITAL THERMOMETER: 3½ DIGIT LCD

$79.00

Measure temperatures from below freezing point to around boiling point. **EA February 82**

FUNCTION GENERATOR **$79.50**

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

LOTTO/POOL'S SELECTOR

$22.50

You have to be in it to win it ... Take the chance out of winning the Pools as well as Lotto, and build the great new Pools/Lotto Number Selector. **EA July 81**

LARGE SCREEN TV STORAGE CRO ADAPTER **$119.00**

For a low cost Storage CRO with Synchronised Display, Electronic Graticule, One-Shot Triggering and Optional Storage of up to four Screen Displays it can't be beaten. **EA February 82**

LOW OHMS METER

$34.50

How many times have you cursed your Multimeter when you had to measure a low-value resistance. Well alas, with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms. **ETI 158 November 81**

SOUNDBENDER

$29.00

Have great fun creating your own recording effects with music and voice. The Sound Bender can receive from Electric Guitar, Microphones, etc. **ETI February 82**

IMARK'S MOBILE SCANNER

The Tri-Star Compu-20D scanner is different from most in that it is specifically designed to be mounted in a vehicle for mobile use. Available from Imark, it operates on the vehicle's 12 Vdc supply and is compact enough to be conveniently mounted in almost any vehicle.

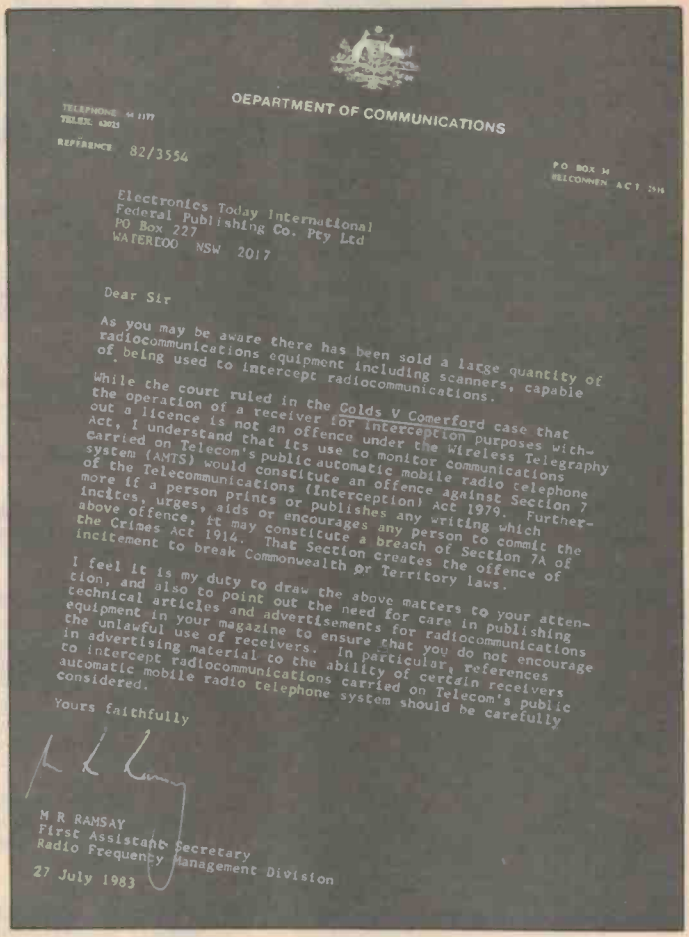
While a telescopic antenna is supplied, the receiver is fitted with a Motorola-type connector on the rear to accept the normal car-type antenna lead.

The unit features a programmable PLL-type double-conversion FM receiver which covers both the VHF high and low bands, from 70.010 MHz to 84.410 MHz and from 156.010 MHz to 170.410 MHz, in 15 kHz steps. Any 20 frequencies of the 1920 frequencies within these ranges can be programmed.

The receiver is solid state for low battery consumption and uses one crystal filter and two ceramic filters to ensure excellent sensitivity and selectivity. Back-up batteries are included to provide memory keep alive of the programmed frequencies even if the power is removed.

Manual channel change and automatic scanning function, as well as a channel bypass feature, are standard equipment. A green LED display is used for channel number indication. Other features include adjustable squelch control and scanning delay function.

Further details are available from **Imark, 167 Roden Street, West Melbourne Vic. 3003. (03)329-5433.**



DEPARTMENT OF COMMUNICATIONS

TELEPHONE 64 1177
TELEX 62023

REFERENCE 82/3554

P.O. BOX 34
BELCONNEN A.C.T. 2616

Electronics Today International
Federal Publishing Co. Pty Ltd
PO Box 227
WATERLOO NSW 2017

Dear Sir

As you may be aware there has been sold a large quantity of radiocommunications equipment including scanners, capable of being used to intercept radiocommunications.

While the court ruled in the Golds V Comerford case that the operation of a receiver for interception purposes without a licence is not an offence under the Wireless Telegraphy Act, I understand that its use to monitor communications carried on Telecom's public automatic mobile radio telephone system (AMTS) would constitute an offence against Section 7 of the Telecommunications (Interception) Act 1979. Furthermore if a person prints or publishes any writing which incites, urges, aids or encourages any person to commit the above offence, it may constitute a breach of Section 7A of the Crimes Act 1914. That Section creates the offence of incitement to break Commonwealth or Territory laws.

I feel it is my duty to draw the above matters to your attention, and also to point out the need for care in publishing technical articles and advertisements for radiocommunications equipment in your magazine to ensure that you do not encourage the unlawful use of receivers. In particular, references in advertising material to the ability of certain receivers to intercept radiocommunications carried on Telecom's public automatic mobile radio telephone system should be carefully considered.

Yours faithfully

M R RAMSAY
First Assistant Secretary
Radio Frequency Management Division

27 July 1983

BIG-MEMORY SCANNER

The Saiko SC7000 scanner allows you to store up to 70 channels in memory and provides coverage from 60-89 MHz, 108-138 MHz, 140-179 MHz and 380-519 MHz plus both AM and FM reception.

You can manually select any frequency or any of the memory channels, scan between preset limits within any of the four bands or scan the memory channels.

Operation of the rig is via a calculator-style keyboard. A 'priority' channel feature is included so that you can program your favourite channel or a particularly interesting frequency into memory channel 1.

The scanner holds on a busy channel for two seconds. In addition, certain channels may be 'locked out' of a scanning sequence by using the lockout.

The SC7000 can be operated from the mains (using a plugpack power supply) or from 12 Vdc. In our April scanning feature, we inadvertently attributed this receiver as being sold by Imark. In fact, it is sold through **Time Plus, 55 Sydney Road, Brunswick 3056 Vic. (03)380-4942.**

MINI-MART

Where readers can advertise — For Sale/Wanted/Swap/Join

• We'll publish up to 24 words (maximum) totally free of charge for you, your club or your association. Copy must be with us by the 1st of the month preceding the month of issue. Please — please — print or type adverts clearly, otherwise it may not turn out as you intended! Every effort will be made to publish all adverts received; however, no responsibility for so doing is accepted or implied. Private adverts only will be accepted. We reserve the right to refuse adverts considered unsuitable.

• Conditions: Name and address plus phone number (if required) must be included with the 24 words. Reasonable abbreviations, such as 25 W RMS or 240 Vac, count as one word. Adverts must relate to electronics, audio, communications, computing etc — general adverts cannot be accepted.

Send your advert to:

ETI Mini-Mart,
140 Joynton Ave, Waterloo NSW 2017.

AUDIO

FOR SALE: NAIM 42/110 MC Input $1100. Supex 900 Super $90, sell after Naim. Newcastle (049)51-4439.

SELL: SERIES 5000 preamp and amp (Blueprint), $780. Pair speakers, 80 WRMS, 12″ driver, piezo tweeters, $400. All $1100. Chris Tolley, P.O. Box 2, Renmark SA 5341. (085)85-1377.

FOR SALE: REALISTIC (Tandy) stereo bass enhancer/subsonic filter. No alterations made to unit, good condition, ten months old. New $75, will sell for $60 ono. T. Firman, P.O. Box 498, Cheltenham Vic. 3192.

AMPLIFIERS: SANSUI 2900 stereo integrated 25 WRMS/ch, $55. Monarch A-5000, 40 WRMS, $50, mint condition. (02)896-2975.

GOODMANS AUDIOM 15P, 15″ bass woofers. Still in original carton. New price $300,

AMCRON LABORATORY reference stereo power amplifier. Dc 300 A, 155 WRMS/ch, 0.01% THD. Mint condition, $730 ono. (02)896-2975.

COMMUNICATIONS

FOR SALE: AMATEUR transceiver, National RJX-1011, 10-160 m bands, AM-CW-SSB. 180 W max. output on SSB, in perfect order $400. Andrew (02)449-5870 ah.

FOR SALE: TRANSCEIVER Yaesu FT200 with ac power supply, excellent condition, $300. (02)887-2371 ah.

MISCELLANEOUS

FOR SALE: 30 cps THERMAL PRINTERS, various, includes RS232, acoustic and programmable from $200. Keyboards from $25. Dual tape decks from $150. Data cartridges TC150 $5. I/F cables $2. TI 733 spares (new) from $10. (02)605-4929 after 6pm.

FOR SALE: MAGAZINES. 124 EA, 1972-83. 77 ETI 1975-83. 30 others, $120 the lot ono. (03)434-3993.

FOR SALE: AWA radio equivalent to AR7 in rack, handbook, spare valves, ac power supply, complete set of coils, $25 ono. (02)427-2326 evenings.

FOR SALE: COLOUR TV game. Ten games, joystick controls, volume control, $20. (03)277-6987.

SELL: FRONT-WHEEL drive R/C car C/W radio, batteries, fast charger, spares, electronic speed controller. Very little use. VGC, $240. (03)857-7463 ah.

FOR SALE: WIRELESS WORLD back issues 1946 to August 1983. Almost complete, best offer. (03)589-1511 ah.

FOR SALE: HEATH oscilloscope, model no. 10-4105. Mint condition, $700. (08)250-4776 ah.

WANTED: ANY BOOKS containing circuit diagrams or information on radios made before 1949. (02)524-8082.

FREE: ONE model 15 teletype plus handbook. Good working order, just come and get it. R. Watters, 33 Captain Cook Drive, Willmot NSW 2770. (02)628-9187.

MANUALS WANTED: CBS710, B&K1503/1602, Taylor 45D, Haltronics 201B, Khan SP58-1A, AWA Voltohmyst, AWA 1A57321, MAGNATECH 34B, PULTEC EQP-1A/MEQ5. GMT 303. R. Hibberd, P.O. Box 318, Willoughby NSW 2068. (02)406-5782.

WANTED: CIRCUIT diagram for Fluke differential dc voltmeter model 801. (02)92-4025.

COMPUTERS

FOR SALE: 48K SYSTEM 80MKII, green screen, printer, one disc drive. Used six months, half price at $1100. (02)440-8428.

MICROBEE GAMES: Lunar Lander with inputs of time, thrust and angle, and Golf. Both feature hi-res graphic. $6 each. Both $10. Chris Dalitz, 12 Paperbard Close, Wyoming NSW 2250.

SELL: SINCLAIR SPECTRUM 16K, BASIC, manuals, power pack, printer, games tapes, $450 ono. Tony Andrews, International House, Uni of NSW, Kensington NSW 2033.

FOR SALE: ZX81 (two available), as new, $110. ZX81 16K RAM pack, $100. Tony, 14 Wulagi Cres, Wulagi NT 5793. (089)27-5539.

FOR SALE: S100 16K static memory board. Suits DGZ80 CPU, $70 ono. TI LCD programmer, $50. Jurgen Rochelmeyer (02)487-1816 ah.

APPLE II PLUS compatible computer: 48K RAM, all standard Apple features plus upper/lower case, RF modulator and handbook, $650. Disc drive and interface, $500. Will separate. Sth Melbourne (03)699-8844.

FOR SALE: TRS-80 Model 1 cassette test editor. Bank cheque $10 payable to Mr E. Hughes, 52 Lowry St, Cardiff NSW 2285.

FOR SALE: SORCERER 32K MK1, with monitor, cassette and many tapes. Excellent condition, $800 ono. K. Lakeman (02)74-9040.

FOR SALE: DREAM 6800. 4K RAM, 3K ROM, Dreamsoft expansion board, Soundex, joystick, ASCII keyboard and model 15 tty, cassette software. Price negotiable. Jim McCabe (062)88-2768 ah.

APPLE GAMES to swap, many good games in stock, over 30 available. Good titles such as Sneakers, Flight Simulator, Wizard, Alien Rain and Apple Panic etc. (02)412-2352.

FOR SALE: MICROACE computer. Leads, manual, power supply, inverse video switch, joystick, Super Invasion and Double Breakout tapes, 2K RAM, 4K ROM, $160 ono. (03)277-6987.

FOR SALE: 16K ZX81 with power supply, much software (tapes, books), excellent condition. Must sell, $150 ono. Ron (02)622-5825 ah.

FOR SALE: JOYSTICK for BBC computer, fully proportional. Supports BBC arcade games. Value at $37 inc. p & p. Write to James Freeman, 6 Greystanes Pl, Hobart Tas. 7005.

FOR SALE: FLOPPY discs. 10 brand new unopened Verbatim, single-sided, double-density, 40-track, 5¼″ mini-floppy discs for $25. (02)516-9528 bh.

FOR SALE: SORCERER computer, full 56K RAM, 8K BASIC ROM pac, $700. (02)633-4915 ah.

ACT BIMONTHLY VIC-20 newsletter. August issue $1.50. Subscriptions $8 per year. Write to Chris Groenhout, 25 Kerferd St, Watson ACT 2602.

FOR SALE: NEW AMERICAN video terminal with technical and operator's manuals, separate keyboard, $450 including delivery. J. Solomon, 16 Lennox St, Glenbrook NSW 2773.

SELL: Chip-8 editor for '660. Inserts, deletes, etc., GOTOs etc. Adjusted. Listing and instructions $8. Tim Parish, 10 Rodda Rd, Myrtle Bank, Adelaide SA 5064.

FOR SALE: PB-100 PERSONAL computer. Very compact and versatile. VGC. Bought for $99, sell for $75. Write to Chris Groenhout, 25 Kerferd St, Watson ACT 2602.

FOR SALE: HES Synthesound cartridge for VIC-20. Almost new. Rrp $61, sell for $40. Chris Groenhout, 25 Kerferd St, Watson ACT 2602.

No. 1 for Video accessories

Built and tested

Video Switching box

$47.50

Low loss R.F. switching—allows inputs for:- VCR, video disc, antenna, cable TV, home computer and video games.

WE HAVE A GREAT RANGE OF VIDEO CONNECTORS AND CABLES FOR VIDEO TO VIDEO DUBBING.

Cables

PA-25
5 pin 180 degree dubbing adaptor—Reverse pins for video use **$6.95**

VC-14
8 pin square plug to 8 pin square plug. Cable length 2 metres **$29.95**

VC-15
6 pin DIN plug to 6 pin DIN plug. Cable length 1.5m **$4.95**

VC-1
BNC plug to BNC plug. Impedance-75Ohm. Cable length 1.5m **$6.50**

VC-2
BNC plug to PL259 plug. Impedance-75Ohm. Cable length 1.5m **$6.75**

VC-3
PL 259 plug to PL 259 plug. Impedance-75Ohm. Cable length 1.5 **$4.95**

VC-4
PL 259 plug to RCA plug. Impedance-75Ohm. Cable length 1.5m **$4.95**

VC-5
RCA plug to RCA plug. Impedance-75Ohm. Cable length 1.5m **$5.95**

VC-6
BNC plug to RCA plug. Impedance-75Ohm. Cable length 1.5m **$5.95**

Video Connectors

VP-8
8 pin square video connector plug **$7.50**

VS-8
8 pin square video connector inline socket **$7.50**

VP-10
10 pin male video plug. Used in J.V.C., Panasonic, Sharp and other VHS machines **$11.50**

VS-10
10 pin female inline socket. Used in J.V.C., Panasonic, Sharp and other VHS machines **$11.50**

VP-14
14 pin male video plug. Used in Sony, Sanyo, Toshiba and other Beta machines **$16.50**

VS-14
14 pin female inline socket. Used in Sony, Sanyo, Toshiba and other Beta machines. **$16.50**

VIDEO HEAD CLEANERS

HC-1 V.H.S. Video head cleaner
HC-2 Beta Video head cleaner

A professional head cleaner—employs new "double sided" cleaning action—no need to "operate" on your machine. Just insert the cassette, play for 30 seconds and the job's done. Effective for 100 operations.

HC-1 $17.50 HC-2 $17.50

Built and tested

Video Enhancer

Detail Enhancer VP5030 is another important contribution to the world of video accessories. The lightweight Detail Enhancer has been particularly designed to rectify loss in detail derived from VCR tapes and picture impairments. With simple adjustments for more or moderate detailing, the detail enhancer can also overcome such picture impairments as loss of detail and disappearance of verticle lines.

Bargain Price $87.50

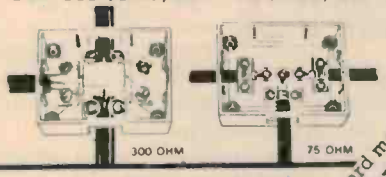
Specifications:
1. Power requirement: 12V DC 110mA
2. Input: 1 Video (RCA connector)
3. Outputs: 3 Videos (RCA connectors)
4. Output lever: Video outputs: 1.0Vp-p, 75 Ohm unbalanced below 1Vp-p out.
5. Enhance: Enhance 9dB (Referenced/1.0Vp-p)
6. Signal-to-noise ratio: Greater than 50dB below 1Vp-p out.

TDK E180 VHS VIDEOTAPES 10 for $148.00
Unbelievable Value!!

T.V. and F.M. Splitters

Model	F Range (MHz)	Impedence (Ohms) IN	Impedence (Ohms) OUT	Output	Band	Splitting loss	Isolation	VSWR
DDF-332 U/V	50-890	300	300	2	VHF	3.5	25	1.5
					UHF	4	20	1.7
DDF-772 U/V	50-890	75	75	2	VHF	3.5	25	1.5
					UHF	4	20	1.7
DDF-774 U/V	50-890	75	75	4	VHF	6.7	30	1.4
					UHV	7.6	22	1.8

DDF-332 $3.95, DDF-772 $4.95, DDF-774 $6.95



Errors and omissions excepted.

ROD IRVING ELECTRONICS

2 BRANCHES:

425 High St. Northcote, Ph.: (03) 489 8131
48-50 A'Beckett St. Melb. Ph.: (03) 347 9251

min p&p $3.00

Mail orders: P.O. Box 235 Northcote, Vic. 3070

Bankcard mail orders welcome
ORDER FORM
Please Debit my Bankcard
No.
Expiry Date
Name
Signature

BUGS

I'M SICK of hearing about that bug-eyed, skinny-necked extraterrestial. His bumbling shuffle as he blundered his way around this planet, rasping out a few words, seems to have captured the imagination of thoughts-less earthlings.

But I think he was a fake. He couldn't even ride a bicycle. You've probably heard that 'real men don't eat quiche' and now I'm told that 'real women don't pump gas'. Well, I know that real extraterrestials don't phone home. How they manage to get back home is beyond me.

And speaking of what real people do, which I wasn't, but just so we know who is really for real. 'Real programmers' can't even spell quiche, unless it's in hexspell.

Real programmers don't read 'Creative Computing'.

Real programmers read 'Byte'.

Real programmers don't jump out of FOR...NEXT loops.

Real programmers don't read the manuals – it takes too much time.

Real programmers solve 'adventure' games by disassembling the program.

Real programmers have messy desks.

Real programmers don't wear suits (except to interviews).

Real programmers patch object code rather than recompiling.

Real extraterrestials probably don't eat quiche either. And if they drink beer, they shouldn't.

Since this is for real, I'd like to know what is a 'real bug'. 'Real bugs' don't live happily at a temperature of 250° C. Or so I thought until I read about certain bacteria which have their home in the output of sulphurous, hydrothermal vents deep in the floor of the east Pacific Ocean.

At 250° C these bacteria will still grow, beating by a comfortable margin the record of 105° C set by another heat-loving strain.

So what can one do with a hot bug? Throw away your old hotwater bottle and take a hot bug to bed instead, to keep you warm on those cold, winter nights. 'Well, I'll be .....' could have a whole new meaning.

Instant hot drinks, just add a hot bug to your cold cup of tea or coffee. Save on your heating costs during winter, scatter a few hot bugs around your home or office.

Scuba divers wouldn't have to freeze in that cold current; warm diving could be guaranteed all year by slipping a few hot bugs down one's wetsuit and they (the bugs) should be happy in their natural environment. But hot bugs trapped between one's skin and the wetsuit could lead to a ticklish situation. Or even worse, hysterical bugs out of control.

Out-of-control hot bugs. 'Breeder reactor' could have an entirely new meaning if a few hot bugs took a fancy to each other. The fundamental laws of physics would have to be rewritten – energy can be created – all that is needed is the fusion of two hot bugs to create an increasing supply of energy.

Electronic eavesdropping devices would be outdated by big-eared bugs. These microscopic bugging devices would be invaluable in the foreign service, especially in cold countries like Russia. With a temperature of 250° C they could easily tunnel through the ice and snow.

I knew I'd find some association between bugs and electronics. As we all know, the biggest problem with a circuit is trying to get the bugs out of it so that it will work. And debugging a computer program is not everyone's idea of fun. But now the discovery of volcanic bugs has erupted in our lives we have a better idea of the size of the problem; small but too hot to handle. ●

SONY
THE ONE AND ONLY

The Sony CDP101
The magic of digital audio becomes a magnificent reality.

Digital Audio is a revolution. The greatest advance in home music reproduction since the gramophone record. As you'd expect, Sony is the leader of this revolution with its magnificent CDP-101 player that offers you original studio master quality at home.

For the technically minded, the specifications read more convincingly than any superlatives • flat frequency response over the entire audible range • dynamic range and signal to noise ratio over 90dB • perfect channel separation • immeasurable wow and flutter • negligible distortion.

Sony's CDP-101 uses an optical laser pick-up (incorporating three micro processors), it is easier to use than a conventional turntable and connects easily to your existing system.

Other features include • fully automatic linear skate front disc loading • automatic music sensor • dual function digital readout of playtime • audible fast forward and reverse • 10 function wireless remote control.

Compact Discs Last Forever

Just 12 cms in diameter, the Compact Disc plays up to 60 minutes of music. It's protected from scratches, dust and finger prints by a plastic coating; and because the pick-up is a laser beam, deterioration is non-existent. Reproduction remains perfect virtually forever.

Hundreds of titles will be available with many more to follow from major companies such as CBS.

CDP-101 Specifications

Frequency Range	5Hz-20kHz ± 0.5dB
Dynamic Range	more than 90dB
S/N	more than 90dB
Channel Separation	more than 90dB (at 1kHz)
Harmonic Distortion	less than 0.004% (at 1kHz)
Wow and Flutter	immeasurable

Contact Sony for the name of your nearest dealer.

Sydney (02) 266 0655, Adelaide and N.T. (08) 212 2877, Brisbane (07) 44 6554, Perth (09) 323 8686, Melbourne (03) 419 3133, Launceston (003) 44 3078, Wollongong (042) 71 5777.

AUD0378

How to invest in Yamaha, without living beyond your means.

Yamaha's new top-of-the-range Cassette decks, the K-1000 and K-2000, incorporate the most advanced, state-of-the-art studio component technology at prices $200 to $300 less than comparable equipment.

Indeed, they compare favourably in significant performance areas with any cassette decks at any price.

Both decks have been painstakingly designed and uncompromisingly engineered for optimum functionality and reproduction performance.

Each employs a specially designed two-motor, direct drive transport mechanism for smooth, silent precision, and three low-impedance heads which features a unique Sendust formulation to ensure superb, long lasting reproduction quality. Plus the heads have a lifetime warranty.

The two decks utilise Yamaha's unique Linear Electromagnetic Transduction system which extends linearity to the point where the signal is transferred from the head to the tape–a previously uncontrollable area in the recording chain.

High performance features on both decks also include dbx and Dolby-B* noise reduction, ORBiT (Optimum Record Bias Tuning), a microcomputer controlled Linear Counter, expanded range level meters and a number of auto memory functions.

For Yamaha the K-1000 and K-2000 cassette decks are a natural progression in 95 years of outstanding accomplishments in musical instruments and audio componentry.

For you they represent the finest natural sound recording and reproduction at a surprisingly affordable cost.

Your Yamaha dealer can show you the full range of Yamaha Cassette decks starting at around $200. If you'd like further information just complete and post the coupon below.

K-1000

K-2000

*Dolby is the registered trade mark of Dolby Laboratories

I'd like further technical information on the new K-1000 and K-2000 cassette decks.

Name_____

Address_____

_____

_____ Postcode_____

Send to: Yamaha Hi-Fi Division,
Rose Music Pty. Ltd.,
17-33 Market Street, South Melbourne,
Victoria 3205.