APRIL 1983 $2.35* NZ $2.75

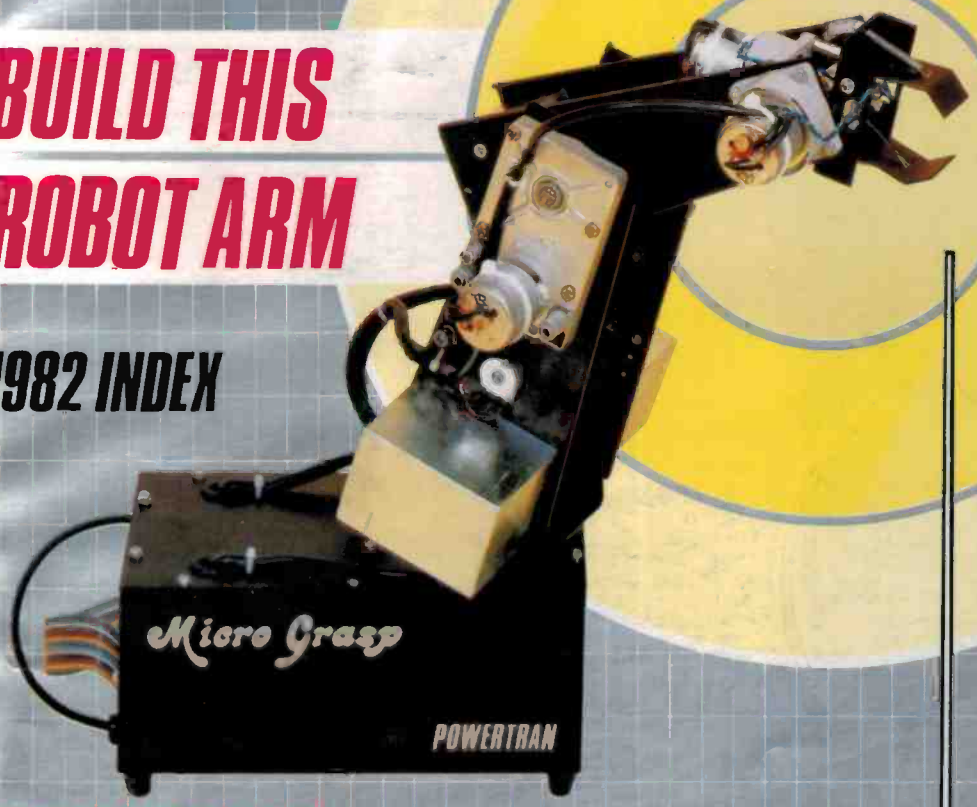
DICK SMITH CATALOGUE — CHECK INSIDE

HI-FI SEVEN LIGHTWEIGHT HEADPHONES REVIEWED

eti

ELECTRONICS TODAY INTERNATIONAL

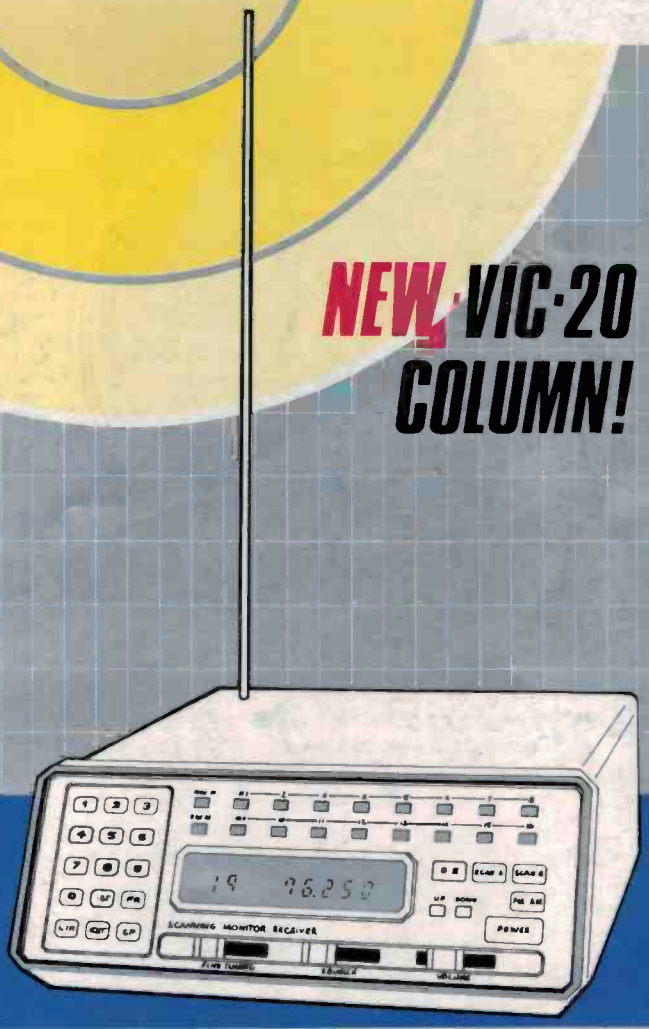
BUILD THIS ROBOT ARM



1982 INDEX

NEW VIC-20 COLUMN!

SCANNING
The World Beyond Shortwave



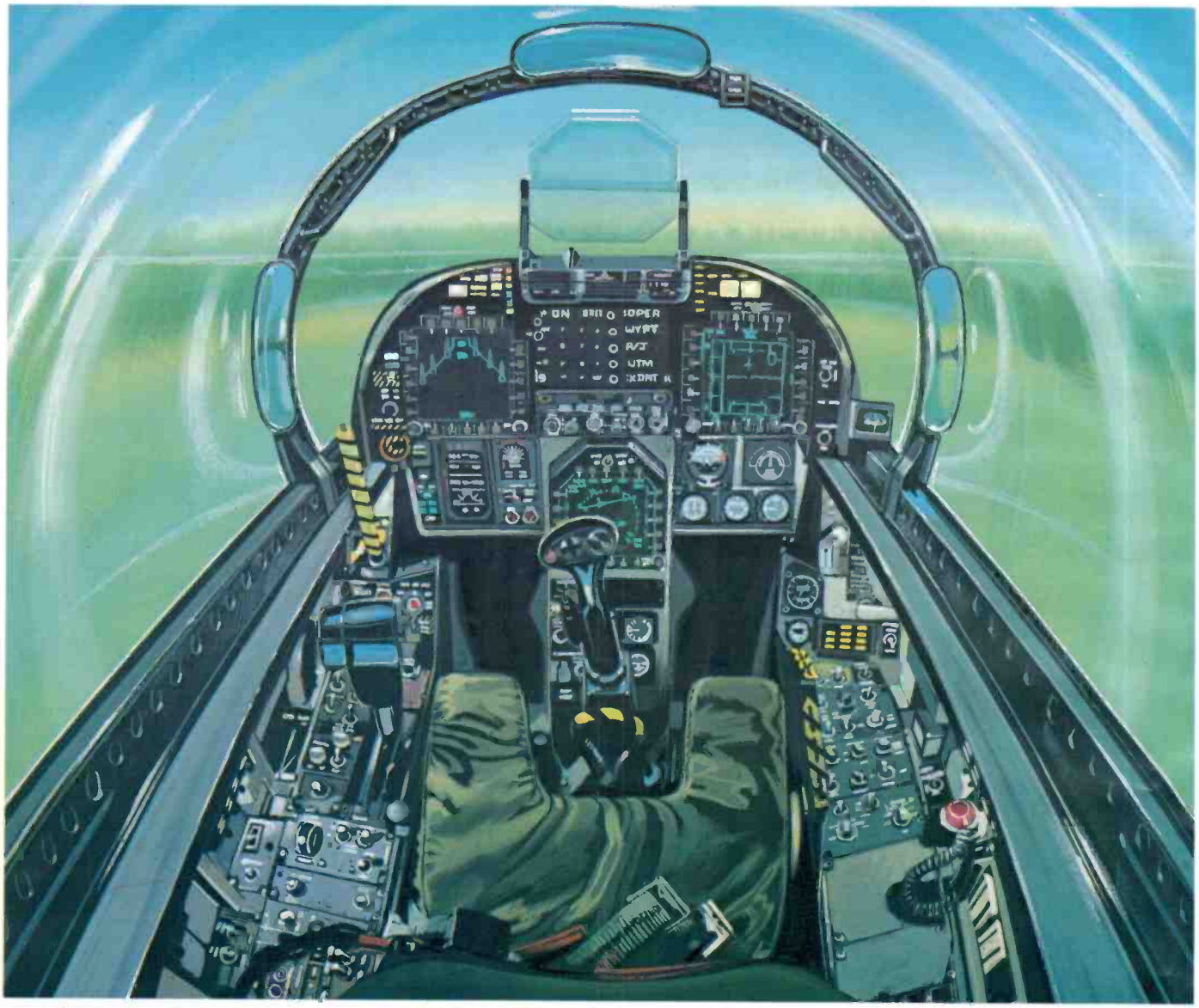
HP-75 Portable Computer Reviewed

Radioteletype Converter for the MicroBee

How to Use DVM Modules

Motor Speed Controller for Drills, Blenders etc.

IF YOU'RE SWITCHED ON, THIS IS PARADISE.



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general

Two topical items of interest at the moment are robotics and scanning — hence the Micro-Grasp arm and a scanning receiver are featured on the cover this month.
Micro-Grasp pic courtesy Powertran
Cover design by Ali White

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4013	30c	7420	23c	74LS15	23c	74LS93	30c		
4015	55c	7430	23c	74LS20	23c	74LS123	30c		
4042	45c	7432	23c	74LS27	23c	74LS157	30c		
		7440	23c	74LS30	23c	74LS174	30c		
7400	23c	7442	45c	74LS32	23c	74LS240	75c		
7402	23c	7473	45c	74LS42	30c	74LS245	90c		
7403	23c	7474	30c	74LS74	30c				
7404	30c	7475	45c						
7405	30c	7476	45c						
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* Recommended retail price only

comment

The draft Radiocommunications Bill 1983 was released by the Department of Communications just as this issue was going to press. The Bill was released "... to facilitate public discussion." The closing date for comment was advised by the then Minister for Communications, Neil Brown, as 22 April 1983. The new Minister for Communications is The Hon. Michael Duffy and the D.O.C. advise that late comments will be accepted.

I recommend that, if you are the least interested in radio communications of *any* sort — be it shortwave listening, scanning, model radio control, amateur radio, maritime, satellite et al — get hold of a copy and read it *thoroughly*. Copies are obtainable from Australian Government Publishing Service bookshops in each capital.

The Bill is intended to replace the ancient Wireless Telegraphy Act, 1905 and is "... intended to control the use of the Australian radio frequency spectrum at a time of rapidly developing technological change."

The Bill is divided into nine sections, or parts. While all of it is of general interest, some parts will specifically interest hobbyists. For a start, it is intended that *receiver licenses* will be required, covering all receivers *other* than for public broadcasting or television reception. (See page 21, in our Scanning feature this month.)

Another section of the Bill that will be of interest to equipment users and manufacturers alike is that providing for common standards for receivers and transmitters. This has important implications for manufacturers, importers *and* home constructors, such as radio amateurs.

Clearly, there's too much in it to discuss in any depth here. I urge you, no matter how slight your interest, to get a copy of the Bill, read it through and send your comments to the *Secretary, Department of Communications, P.O. Box 34, Belconnen 2616*. Remember, the closing date is 22 April. The Bill may be withdrawn or ammended in the light of public comment, so *your comment counts*.

Roger Harrison
Editor

services

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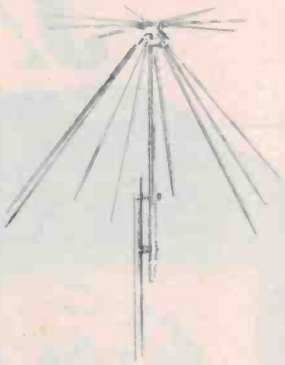
next month



SCANNER ANTENNA SYSTEMS

A follow up to the scanning feature in this issue, this article goes into the sort of antennas required, what there is available to buy, practical tips on installing them, plus how to build simple ones.

INTERFACING AND PROGRAMMING THE MICRO-GRASP

Full construction details of the interface board for the Micro-Grasp plus details on interfacing and programming this low-cost robot arm. You can configure it either as a memory-mapped peripheral or as a port-addressed peripheral — please yourself. It's versatile!

0-40 V/5 A LAB. SUPPLY

Here's a fully-protected lab-standard power supply with variable voltage control from zero right to 40 V, variable current limit from zero to 5A, plus voltage and current metering, that's economical to build.

HOW TO USE DVM MODULES, PART 2

Concluding part of this popular feature. Next month Ray Marston gives details of a multi-range digital multimeter, digital thermometers, a digital frequency meter etc, plus construction tips. Don't miss it.

VCR HEAD CLEANERS — DO THEY WORK?

A contentious subject. Next month we take a provocative look at VCR head cleaners and what they do and review a number of well-known brands on the market.

Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

JAYCAR ZERO~

ALL SPECIALS SHOWN ON THIS PAGE ARE EITHER

Fully Guaranteed $12.50

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INTRIGUING

For years and years 240V mains powered strobes have been selling for between $30 and $40. Even kits are around $36. So why is it that Jaycar can sell a 240V strobe – guaranteed – for $12.50?
We can tell you for a start that we're not selling them below cost. Even at $12.50 we're doing OK.
Why so cheap?
Well they were made for a well known electronics chain. Their Q.C. (Quality Control) Department rejected them on the grounds that around 5% of them were faulty. That was an unacceptable figure considering the very good name that the chain has in this country. All goods were rejected (even the 95% good ones) and sent back to the importer.
The importer came to us with his problem. We said that we would sell them PROVIDED we could offer a 90 day guarantee on the item.
Whilst all stock has been checked and the duds weeded out we STILL feel that even at $12.50 you deserve a comeback if we sell you faulty goods.
So that's it. You get a 240V strobe that is perfectly OK for $12.50. Compare THAT with the $36.50 that you will pay elsewhere.
It's almost too good to be true except for one thing. It's true.
FULL 90 DAY WARRANTY – Cat. XM7005

JUMBO SPEAKER CABLE

Now you can have super-quality cable without breaking the bank! Each conductor contains a MASSIVE 259 strands of 0.12mm wire!! It could carry 30 amps! Great for HI Fi or high power amps.

Only $2.50/m
100m $2.00/m
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4116 RAMs 150nS – GOING CHEAP

We have secured a quantity of 4116 (150nS) RAMs at a price which means great savings to you.
Why are they cheap? Well they don't actually have '4116' branded on them. They have '9016 FPC' on their little backs. They are used in a well known TV-game computer and this is the 'House Number' for their 4116. If you have ever had to buy a non-standard replacement part you will know that the 'House Number' part can be VERY expensive. We don't want to sell them as 9016 FPC's we want to sell them as 4116's – and at a great price. The normal (i.e. lower than most) price for our 250nS 4116 is $2.50 You can grab a 9016 FPC (150nS) 1 off for only $1.95!!!
For larger quantities see below:

Cat. ZZ8419

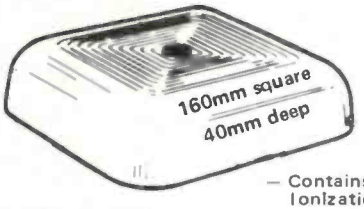
This price includes sales tax!!

1-9 pcs $1.95
10-24 pcs $1.85
25-99 pcs $1.75
100+ $1.65

GE Consumer Products

Smoke Detector

CONSUMER FLOP – CONSUMER FLOP
CLUB, HOTEL, HOSTEL & MOTEL MANAGERS
PLEASE NOTE



– Contains Americium 241 Ionization Chamber
– Contains very loud solid state buzzer
– 12 month factory warranty.

Cat. LA5006

FROM $12.50

One of the greatest consumer flops of the last decade was the Ionization Chamber Smoke Detector. Even though it is a brilliant product (reliable compact, easy installation, fail-safe etc) it just did not sell. Human nature being what it is finds safety-oriented products just not worth the investment. We all know that accidents and fires never happen to US!! As smoke is the greatest killer in a fire, the market research gurus thought that such a product would have a wide appeal. When they were $49.50 no-one wanted them. The price fell to a very reasonable $29.50 and still they stayed on the shelf. We have now been instructed to clear them for less than ⅓ of $29.50.

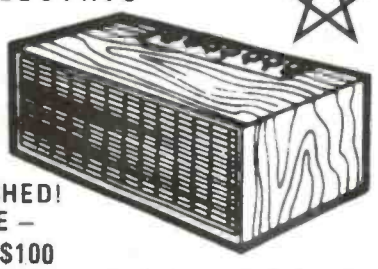
QUANTITY PRICES

1-$14.50: 2-5 $13.50ea: 6-10 $13.00ea: 10 up $12.50ea

Burglar Alarm

GENERAL ELECTRIC

FROM $23.95
Cat. LA5004



BURGLAR ALARM SLASHED!
HUGE SCOOP PURCHASE –
ONCE SOLD FOR OVER $100

Amazingly low price for a full feature ultrasonic proximity/burglar alarm. + Completely self contained + 12 month manufacturer guarantee + Instant or delayed alarm + Handsome imitation woodgrain + Cabinet measures 180(w)x85(h)x100(d)mm + Programmable multi-code disable switch + Single 9V Alkaline battery* lasts one year + unit beeps when battery gets low + Contains receiver element designed for greater sensitivity without false triggering + Uses state-of-the-art LSI circuitry + Worth the money in parts alone + Comprehensive 24 page manual included + Comes complete with 4 window deterrent stickers + Absolutely no installation needed * Battery extra.

1-$29.50: 2-5 $25ea: 6-10 $24.50ea: 10up $23.95ea

MORE HAVE BEEN FOUND!!

We keep surprising ourselves by finding more of the Smoke Detector and the Burglar Alarm – but it's true!
We still think that this is great news as these products have been very popular indeed. We have literally sold thousands and we will still sell the remaining stocks at fantastic low prices. The Smoke Detector is still selling for $14.50 and the Burglar Alarm is still ½ the price of its nearest competitor!

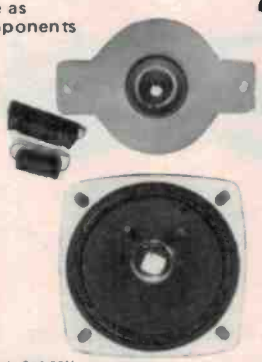
INFLATION SALE

THE SAME PRICE AS LAST YEAR – OR BELOW!

low cost hi fi system

FROM $24.98

Woofer not to same scale as other components

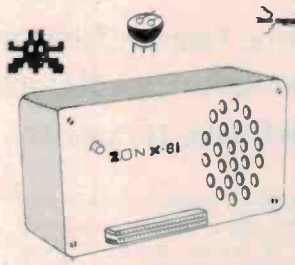


That's right a 3–WAY Hi Fi speaker kit from only $24.98!!
Each kit contains a massive 10" (250mm) woofer, cone midrange and DOME tweeter!! You also get, at no extra charge, the special crossover capacitors!
The system is rated at approximately 20 watts RMS so it is ideal as an economical but reasonably 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 $60.00 for the equivalent from major kit speaker suppliers so this represents an outstanding bargain!

BUT HURRY ONLY 250 PAIRS

Sensitivity of system 93dB/1m/1 watt
Cat. AK-3700
P.S. Bonus. These speakers are made in JAPAN, not a South Asian country.

3 – WAY SPEAKER SYSTEM
$29.95 a set
2 SETS (6 SPKR) FOR STEREO
ONLY $49.96



PRICE SLASHED!!
SAVE $10
$59.50
~~$69.50~~

SINCLAIR ZX-81 COMPUTER SOUND GENERATOR

Make amazing sound effects with your Sinclair Computer.

- The ZON X-81 SOUND UNIT is completely self-contained and especially designed for use with the ZX-81. It just plugs in – no dismantling or soldering.
- No power pack, batteries, leads or other extras.
- Manual Volume Control on panel – ample volume from built-in loudspeaker.
- Standard ZX-81 – 16K RAM pack or printer can be plugged into ZON X-81 Sound Unit without affecting normal ZX-81 operation.
- Huge range of possible sounds for games or: Music, Hellcopters, Sci-FI, Space Invaders, Explosions, Gun-Shots, Drums, Planes, Lasers, Organs, Bells, Tunes, Chords etc., or whatever you devise!
- Uses 3-channel sound chip giving programme control of pitch, volume of tones and noise, all with envelope control.
- Easily added to existing games or programmes using a few simple "BASIC" lines.
- FULL instructions with many examples of how to obtain effects and the programmes, supplied.
- Extension card at base of unit allows further use of Sinclair Expansion Card.

Cat. KJ6620

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But only at our Carlingford store. That's right, to encourage you to visit our Carlingford store you can buy the LATEST ISSUE of EA or ETI for ONE DOLLAR! That is definitely BELOW our cost price. But ONLY at the carlingford store.
(The post and packing charges make mail ordering EA & ETI uneconomical)
PLEASE DO NOT ASK FOR THIS OFFER AT OUR YORK STREET STORE

only $1 BELOW COST

GIANT EASTER SHOW BAG

UNBELIEVABLE SAMPLE BAG OFFER!
A huge 20" x 10" bag FILLED with goodies

$5.50 1983

Once again we have a GIANT Easter Showbag. This is the third year of our showbag and the 1983 bag is by far our best.
But we do not have nearly as many bags this year so it is VERY IMPORTANT to get your order in early! (We also don't have room to describe the bag in detail).
Once again the huge 20" x 10" bag is filled with goodies including:
Hardware pack, Resistor pack, Knob pack, P.V.C. (spaghetti sleeving), 3 x Hobby Electronics Mags, 1 x Phantom comic, a 2 watt Audio IC with circuit and dozens of other parts. (Note: not all bags are exactly the same and we reserve the right to delete some advertised items from the bag but promise to make it up with other components of equal or greater value).
ZERO INFLATION! THE SAME PRICE AS LAST YEAR $5.50
Post and packing on this item is $2.00 – because of staggering rate increases this year.

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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.

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Edge Connector No.2 Cat. HE-8656
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

1 – 9 $3.45
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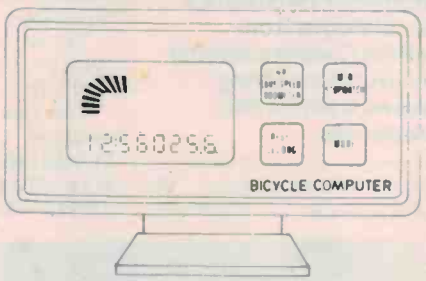

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Australian robot makers break into the US market

Flexible Systems, makers of the Tasman Turtle robot (see ETI, April-May-June '82), have gained an order from Harvard Associates of Massachussetts worth $2.5 million. Who said Australian technology couldn't make it in the US?

Flexible Systems was established in Hobart, Tasmania, a little under two years ago by Allan Branch and Adrian Firth.

The concept of a turtle-like robot was first developed in the US about 10 years ago and in 1974 the Elizabeth Computer Centre started using one.

About 1980 Allan Branch set out to update the concept and designed a high performance unit that could be used to accurately draw graphics, be easily interfaced to a computer and controlled with simple programs. After more than a year of development, the Tasman Turtle was born.

In January 1982, Allan and Adrian approached the Editor of ETI, Roger Harrison, about doing the Turtle as a project. It subsequently appeared in the April to June issues in 1982, kits being offered by Flexible Systems at a special price. It created a great deal of reader interest. Many educational institutions, businesses and hobbyists got their first taste of robotics from the Tasman Turtle project.

In January this year, Allan and Adrian went to the United States and appointed Harvard Associates as their distributor. They gained orders for over 100 Turtles in the first month and Flexible Systems expects to receive around $10 million worth of business over the next two years from the North American market.

Flexible Systems is only a small firm, currently employing two people full time and five part time. They expect to more than double this shortly, expanding to over 30 employees later.

The Tasman Turtle is available in a variety of configurations, ranging from a 'Minimum Turtle' at $495 through to a 'Standard Turtle' (with general purpose interface, etc) at $644, to a 'Talking Turtle' with voice synthesiser (vocabulary ranges from 150 words to 600 words) at $899. A variety of special interfaces, including Apple II and RS232 interfaces, are also available along with software in BASIC and Logo.

The Tasman Turtle has applications in many educational areas as well as business uses such as publicity work, etc.

Further details from **Flexible Systems, 219 Liverpool St, Hobart Tas. 7000. (002)34-3064.**

Educational system catalogue

Warburton Franki have a new catalogue from Heathkit/Zenith covering their problem solving courses, trainers and accessories.

The series of courses are now available in two formats. The textbook series for classrooms and group instruction is a complete training package with texts, workbooks, a fully detailed instructor's guide, trainers and training materials for hands-on experiments and examinations.

The self-study series provides effective training on-the-job or in-the-field.

The free catalogues can be obtained from **Warburton Franki Ltd, 372 Eastern Valley Way, Chatswood NSW 2067. (02) 407-3261.**

Standards in legislation

Australian standards are used by government departments as a means of specifying technical requirements in legislation.

But for these standards to be complied with people must not only know of the existance of the standards but also know whether or not they have a legal obligation to comply with a particular standard in the course of their business.

It's quite a daunting task for anyone to ascertain compliance requirements, considering that there are currently in excess of 3000 published Australian standards.

So to make life a little easier for us the Standards Association of Australia has published a handbook, HB 4 — Register of Australian Standards Referenced in Legislation, which identifies the 1100 standards which are referred to in legislation, be it Commonwealth, State or Territorial. It also records the legal nature of the reference.

As standards are subject to amendment, updated editions of HB 4 will be published, perhaps on an annual basis.

Copies of HB 4 can be purchased from any SAA office at a cost of $30 plus a $3.50 postal and handling charge.

Big dish to orbit

A large 'passive satellite' parabolic dish is under development at the Stanford Research Centre in Menlo Park, California.

To be called the "Space Mirror", the dish will be placed in a low geostationary orbit. Its purpose will be to reflect transmission from earth in the range 500 kHz to 10 GHz, according to reports.

The device will be constructed from a mesh of wires, each only a few Angstroms thick, the whole dish weighing less than a tenth of a gram.

The quiteron — a superconducting transistor

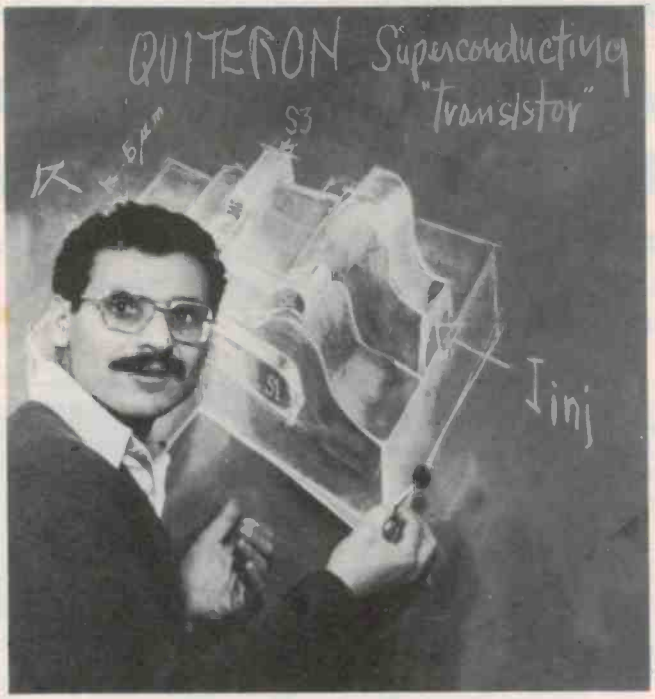
A new superconducting electronic device with operating characteristics similar to those of semiconductor transistors, but based on entirely different physical principles, has been experimentally demonstrated at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York.

Like the semiconductor transistor, the quiteron has been shown to amplify and invert incoming signals and to switch rapidly. But the quiteron can perform such switching at much lower levels of power dissipation, making it attractive for high-speed applications that require very high levels of circuit integration.

IBM claim that it is the first three-terminal superconducting device that can both amplify and switch, and therefore shows potential for application in analogue and digital circuits, although its design and operation have not yet been optimised.

The quiteron consists of two tunnel junctions formed by three thin films of superconducting materials separated from one another by two, even thinner films of insulating materials. It makes use of the non-equilibrium superconductivity phenomenon known as the heavy-Quasi-particle-Injection Tunneling Effect.

The as yet unoptimised quiteron is a nonlatching device with a small-signal power gain of 10 and large-signal (digital) power gain of 3 which, it is claimed, should be sufficient to drive other quiterons. It has a switching speed of less than 300 ps and a power dissipation about 1/100 of that of state-of-the-art high-speed semiconductor transistors.



Australian made call diverters

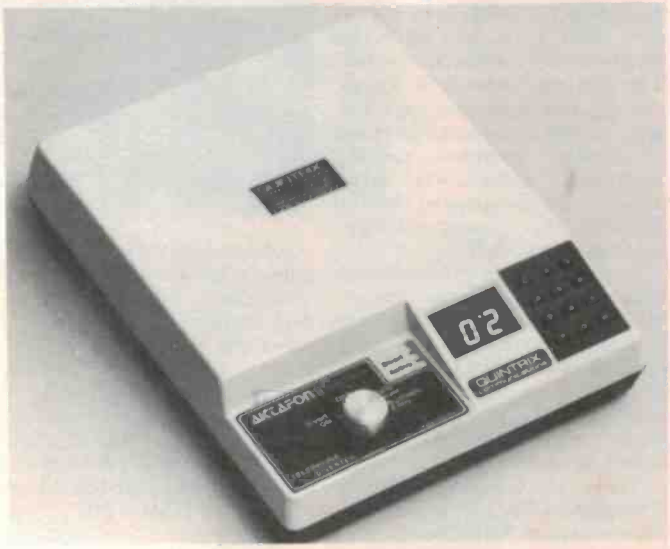
Quintrix is an Australian company which is trying to beat inflation and rising prices. Aren't we all?

Prices of its new range of Akafon 2 automatic telephone diverters start at $795 which includes many previously charged-for extras.

A recorded voice announcement, provided with any approved telephone answering machine, answers the caller while the Aktafon 2 diverts their call to another number. It can store up to seven telephone numbers and these can be remotely selected from any telephone using voice control.

Diversion can be remotely switched on or off and the rotary system and sequential call sharing are available at an extra charge.

Artafon 2 call diverters are being marketed Australia wide by Voca Communications and Quintrix Pty Ltd. **Quintrix** can be contacted at: **20 Mavron St, Ashwood Vic. 3147. (03) 277-2277.**



Latest publication from Tektronix

Tektronix has released the third issue of Teknews which is a quarterly publication distributed throughout the electronics and computer industries.

It includes details on seminars, training courses, other Tektronix product specific magazines and Tektronix product information.

Teknews is free and is sent to everyone currently registered on Tektronix' Information Program. Anyone from the electronics industry interested in receiving Teknews should contact their local Tektronic office or **80 Waterloo Rd, Nth Ryde NSW 2113. (02) 888-7066.**

Classifieds

Position Vacant: PARADISE RECORDING STUDIOS, SYDNEY. General Manager: 26,000 p.a. Commercial, technical, musical and sound engineering experience would be preferred. Please direct your resume etc. with as much information as possible, in writing to S.M. Allen, 70 Judge St, Woolloomooloo 2011. All applications will be received in the strictest of confidence.

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OWNERS OF MOD I, MOD III, & SYSTEM 80 COMPUTERS. Use your computer to transmit and receive Morse, RTTY & ASCII. Programmers delve into the secrets of your ROM. Amateurs. The RICHCRAFT books are the least expensive way of using your computer in these modes. Disks also available. Send SASE for full details. NORTHERN DIGITAL, BOX 333, CHARLESTOWN, 2290.

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SORCERER Disk Upgrade Kit with manual. Many Pro features. MICROPOLIS $44.95. EXIDY FDS $39.95. A must! Also free Soft. catalogues. PJB Box 252, Forestville 2087.

COMPUTER Clinic repairs and services Sorcerer Pet, Apple System 80, Super 80, Tandy and others. (07) 269 8573. P.O. Box 68, Aspley, Qld.

Australian-made 50 MHz dual-trace CRO breaks $800 price barrier

BWD's new Model 821 oscilloscope is a dual-trace unit with 50 MHz bandwidth, 1 mV to 20 V per division sensitivity range and a special 'mix-mag' expanded trace function and priced at $750 retail.

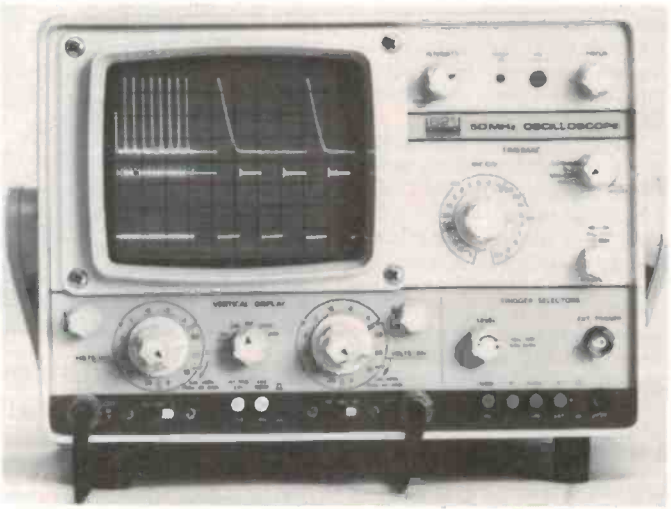
The mix-mag facility, unique to the BWD 821, enables you to get a ten times magnification of any proportion of the trace from 0% to 80% simply by pulling and turning a knob.

Normal x10 magnification is incorporated and the trace can be expanded to x100 using the mix-mag function to provide facilities similar to a delayed sweep CRO but without the complexity, BWD claim.

The mix-mag facility can be used to magnify each line to examine teletext, sync pulse or video signals of VCRs, television receivers or studio equipment.

Other features of the BDW 821 include: a 7 ns rise time from 5 mV/div., 20 ns/div. maximum sweep speed, 75 MHz triggering, TV line and frame triggering selection, bright trace with 6 kV EHT and internal tube graticule.

Two 100 MHz probes are included, a x10 and a x100. High sensitivity vertical amp. inputs enable low level signals to be viewed, such as from tape recorder heads, pickups and microphones, etc.



The BWD 821 is suited to use in communications, industrial control, research and development, video and microprocessor applications.

Full details can be obtained from BWD in Melbourne at **Miles St, Mulgrave Vic 3170; (03) 561-2888,** or Sydney at **10 Euston St, Rydalmere NSW 2116; (02) 684-1800.**

Free catalogues by Fluke and Datel-Intersil

The new Fluke 1982/1983 catalogue features all the equipment manufactured by Fluke Manufacturing Inc.

All products are organised into groups by function and performance together with their relevant specifications.

A new short form 48-page catalogue by Datel-Intersil contains product listing and information on hybrid and monolithic modules such as A/D and D/A converters, S/H and MUXs etc. It also includes analogue I/O boards, DPMs, digital panel printers and power supplies.

All products are organised into quick selection charts and are categorised by function and performance, making it easy to select the correct product for a given application. Ordering information is also included.

For a free copy of these catalogues contact any Elmeasco office. **Elmeasco Instruments Pty Ltd, 15 Macdonald St, Mortlake NSW 2137. (02)-736-2888.**

B&K-Precision 5 MHz sweep/function generator

The B&K-Precision model 3030 is a sweep/function generator which covers frequencies from .001 Hz to 5 MHz in eight ranges.

Kelvin-Variety dividers are used as start/stop controls to set the low and high end limits of the desired frequency sweep and sweep times are selectable from 10 ms to 100 s. Linear or logarithmic sweep operation is provided or the 3030 may be externally swept.

The symmetry control, continuously variable from 5% to 95% duty cycle, can alter the shape of any waveform selected. Open circuit output is 20 V_{p-p} or 10 V_{p-p} into a 50 ohm load. For gain or loss measurements three attenuator switches provide calibrated attenuation from 10 dB to 60 dB. Another control provides continuously variable attenuation to 20 dB.

In addition to conventional function generator applications, the 3030 can be used to generate toneburst signals for audio speaker tests, TIM distortion test in amplifiers, communications systems decoder alignment and audio compressor/expander attack/decay time measurement.

They are available from **Parameters Pty Ltd, 41 Herbert St, Artarmon NSW 2064.**

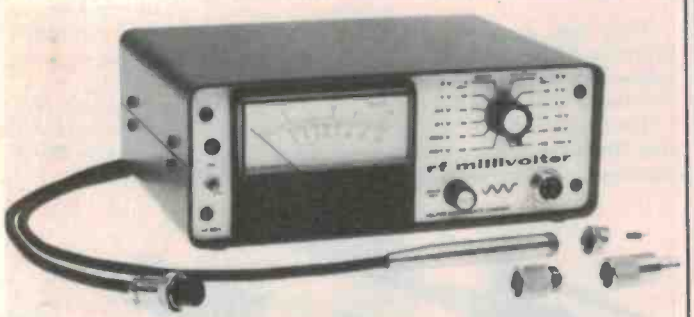
Multiplexer adds multichannel analyser capabilities

A multiplexing device which converts a general-purpose single- or dual-channel oscilloscope into an eight-channel instrument has been developed by GSC.

The new Model 8001 multiplexer functions in the same way as a simple logic analyser minus its memory. It allows simultaneous events on different channels to be compared and displayed in direct relationship to one another.

Input to the multiplexer is via eight BNC connectors and the instrument will accept signals of ±5 V (10 V peak-to-peak) with a frequency response which is flat to 12 MHz and 3 dB down at 20 MHz. Input impedance is 1 M.

Global Specialties Corporation is represented in Australia by **Vicom International Pty Ltd, 57 City Rd, Sth Melbourne Vic. 3205. (03)62-6931.**



RF millivoltmeter covers 300 uV to 100 V, to 1 GHz

A new wide-range, wide bandwidth RF millivoltmeter covering 300 uV to 100 V in 11 ranges and having a bandwidth of 1 GHz is now available from Vicom.

Manufactured by the US Helper Instruments Co., the new meter is known as the Model RF-801. It includes a unique probe design which permits low inductance ground connection for repeatable, accurate measurements.

Circuit loading in any measurement mode is claimed to be less than 2 pF. A separate teflon probe nose extension is also available with the unit.

The 1 mV (300 uV min. reading) to 300 mV ranges (−50 to 0 dBm) are direct-reading while the ranges to 100 V are via a 50 dB pad. Calibration is provided in both RMS volts and dBm.

Further details from **Vicom, 57 City Rd, South Melbourne, Vic. 3205. (03) 62-6931;** branches in NSW and New Zealand.

IC decoupling capacitor is no dill!

A high performance decoupling capacitor designed to reduce transient noise in pc board supply rails up to 10 times more effectively than conventional methods has been introduced by Soanar Pty Ltd.

Made by Rogers Micro/Q, the specially-packaged capacitor is claimed to be an entirely new concept in decoupling techniques.

Effective noise decoupling for optimum performance of large dual-in-line ICs has traditionally been quite difficult. The leads that connect ordinary decoupling capacitors to supply and ground rails can generate voltage 'spikes' owing to their relatively high inductance.

High transient current levels and fast waveform rise times produce quite high voltage spikes which can propagate via supply rails and interfere with proper system operation.

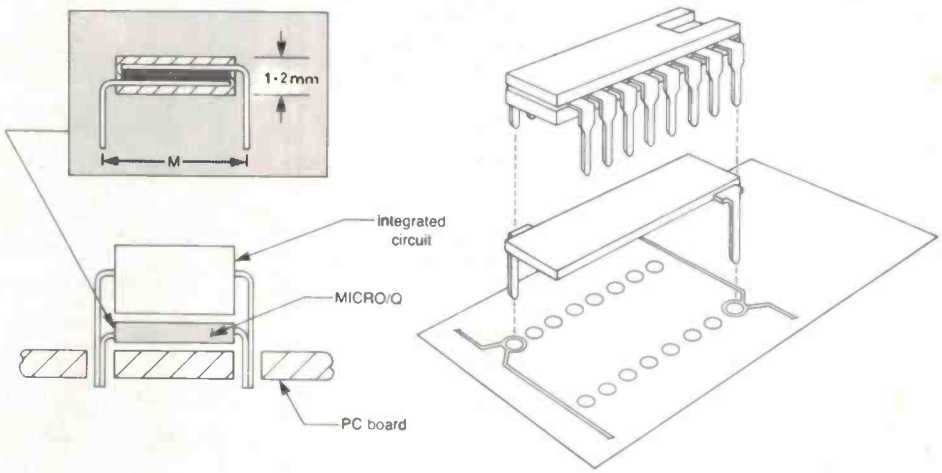
The only practical way to reduce voltage spike amplitude is to reduce inductance on the path leading to the decoupling capacitor.

With conventional capacitors, inductance can only be slightly reduced by special printed circuit board layout.

With Micro/Q decoupling capacitors, inductance can be cut by an order of magnitude, effectively reducing voltage spikes by the same degree, the makers say.

Micro/Q capacitors are flat and very thin (about 1.2 mm) and are designed for use directly under or over dual-in-line ICs. They are available in various lengths to suit 14, 16, 18, 20, 22, 24, 28, 40, 48 and 64 pin ICs.

TYPICAL INSTALLATION



They have very low inductance by using wide, closely spaced conductors. Their pins share the same holes as the IC pins, further minimising inductance and, since they fit directly under or over the ICs, absolutely no pc board redesign is necessary and increased IC package density is possible on double-sided and multilayer printed circuit boards.

Further information on Rogers Micro/Q capacitors is available from **Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill Vic. 3128. (03) 840-1222.**

Texas Instruments adds Rifa electronics

Texas Instruments Australia recently announced the appointment of Rifa electronics as its newest Australian semiconductor and IC sockets distributor.

The announcement was jointly made by Texas Instruments' Managing Director Mr. Peter Dixon and semiconductor Marketing Manager Mr. Ian Hawkins.

Rifa, headquartered in Melbourne, also has sales offices in Sydney and Brisbane, with a nationwide sales force in excess of 30. Rifa's Marketing Manager, Mr. Ian Hansen, said his company is excited about adding TI to its products as the TI name is associated with quality and innovation.

The Rifa account will be handled by TI's Sales Manager for southern regions, Mr. Kevin Routledge, out of TI's Melbourne sales office. Texas Instruments Australia will be moving into new headquarters in North Ryde NSW in December. Other TI sales and service locations are in Brisbane, Adelaide and Perth.

Plugs, sockets and fuseholders

Belling & Lee 3 mm test probe plugs, fixed sockets and free sockets will be useful to all test equipment manufacturers and users who require safe test probes.

They are available in red, green or black, have a current rating of 10 A and are safe to BS 415 and IEC 65 to 1000 VRMS.

The fuseholders meet Australian, British and European safety standards. All live parts are well within the body of the moulding, making them fully finger proof and probe proof.

For further information contact **Tecnico Electronics, 67 Mars Rd, Lane Cove NSW 2066. (02) 427-3444.**

One amp DIP bridge

Warburton Franki have announced the introduction of the IDMB series to International Rectifiers' line of single-phase diode bridges.

This DIP is rated at one amp and is available with V_{RRM} of 100, 200 and 400 volts. Like the HEXDIP, the IDMB is supplied in plastic tubes (80 units per tube) for automatic insertion equipment.

The IDMB can be used in power supplies, Ni-Cad battery charging, ac instrumentation or meter protection.

More information can be obtained from **Warburton Franki Ltd, 372 Eastern Valley Way, Chatswood NSW 2067. (02)407-3261.** ●

How to get in on the action.

M400 EO $459

There's nothing like being in on the action as it happens.
Fire, weather, rescue – all kinds of civil authorities are on the air constantly, reporting crises and emergencies the instant they happen. And they happen on frequencies most people can never hear.
The best way to tune in on the action is with a Regency Scanner, from the deluxe programmable 30 channel M400EO and the 10 channel M100EO models to the hand-held 6 channel H604E Pocket Scanner.
The M400EO Scanner allows you to select and programme 30 channels from around 15,000 frequencies, and then to scan them automatically, or manually select a channel. The priority function allows you recall to your favourite frequency. And you can use scan delay which allows you to hold a frequency before scanning resumes.
The entire range of around 15,000 frequencies is always available, however.
The search and search-hold features allow you to search between selected band edges. And you can adjust the band spacing. These features themselves are programmable.
And as well, it comes with a Nickel Cadmium memory battery, and an Australian Approved supply unit for your safety. Plus a DC cord for mobile use.
The M100EO gives you almost all the features of the M400EO but is for those who only wish to programme 10 channels.
The pocket scanner gives you three bands Lo VHF, Hi VHF or UHF, advanced circuitry, step control and two antennas all in this tough compact package.

H604E $179
(excludes crystals)

M100EO $359

Regency Scanners – whichever model suits your needs – are the best value for money in Scanners. Compare us with the opposition, and hear for yourself.
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Tasmania: Launceston: Gelston 27 2256. Advanced Electronics 31 7075. Hobart: Harvey Skegg 23 6751. Burnie: VK Electronics 31 7733. South Launceston: Graeme Thomson Electronics 44 4773.
Northern Territory: Darwin: Darwin Communications 85 3184.
Queensland: Brisbane: CW Electronics 397 0808. Gold Coast: Amateur's Paradise 32 2644. Townsville: Robco Equipment 72 2633. Gladstone: Jones Communications 72 1116. Cairns: R. E. Hunter & Associates Pty. Ltd. 51 5092. Enoggera: Elite Electronics 57 9400.
South Australia: Port Adelaide: International Communications 47 3688. Mt. Gambier: Set Services 25 2228. Whyalla: Gulf Communications 45 0208.

BURROWS DOBLE LAWRENCE VIC/ETI/412

SCANNING the world beyond shortwaves

Roger Harrison

A whole other 'world' of communications exists beyond 'the shortwaves'. There are thousands of communications channels in the very high and ultra high frequency bands (VHF and UHF). Aircraft, carphones, customs, taxis etc. What's it all about? Read on!

SHORTWAVE LISTENING has a history as long as the history of broadcasting, perhaps longer. In the 1930s, when 'the ultra highs' were first explored — that part of the spectrum beyond 30 MHz — radio amateurs did much experimenting, along with a few research and development teams. Short range communications began then, getting a great boost during World War II. The rapid development the war brought to VHF and UHF communications went beyond the cessation of hostilities and air-to-ground, mobile-to-mobile and base-to-mobile communications burgeoned.

Some radio hobbyists, using war surplus communications gear began 'listening around the ultra highs'. However, as most users of the radio spectrum above 30 MHz employed it for utilitarian purposes, and as the amount of on-air 'traffic' was very low, interest remained low. Nonetheless, commercially-made general coverage VHF-UHF receivers were available — hands up who remembers the Hallicrafters S27! During the late 1950s and the 1960s, the British Eddystone Co. produced several general coverage VHF-UHF receivers.

It seems that, in the 1960s, journalists discovered that ex-commercial VHF mobile transceivers could be bought cheaply and used to eavesdrop on 'useful' VHF channels occupied by the fire brigade, ambulances and police . . . gaining a jump on their colleagues for hot news stories.

Sitting listening to a VHF transceiver, rotating the channel switch for hours on end is not really a journalist's idea of fun, so it wasn't long before they sought out people who could modify the receivers of the equipment to provide automatic channel selection in sequence — scanning was born. ▶

The J.I.L. model SX-200 is a popular scanner having many features. Covering a frequency range of 26-88, 108-180 and 380-514 MHz, it uses a keyboard providing a selection of over 33 000 channels. Up to 16 frequencies may be placed in a non-volatile memory. Scanning can be carried out over a specific frequency range by programming upper and lower frequency limits.

Unique squelch circuitry is employed, having three modes, allowing the receiver to (a) stop scanning with open audio on carrier only, (b) to stop on carrier with closed audio until modulation is applied to the carrier, or (c) not stop at all until carrier and modulation are detected.

A front panel-mounted fine-tuning control ensures that all Australian-allocated two-way radio frequencies are covered. AM or FM reception is possible on all bands. Direct operation from 240 Vac or 12 Vdc is provided for.

ETI staff have used this scanner and found it very sensitive, free from spurii and easy to use. It has the greatest frequency coverage of any scanners we have seen.

A kit to expand the memory channels to 32 is available as is one for auto-AM reception.

Details from **G.F.S. Electronic Imports, 15 McKeon Rd, Mitcham 3132. (03)873-3939.**

The Saiko SC7000 is another scanner with very wide coverage that runs from 60-89 MHz, 108-138, 140-179 and 380 to 519 MHz. You can store up to 70 channels in memory or search between preset limits within a band. You can manually select any frequency or any of the memory channels. Both AM and FM signals can be received.

Control is via a calculator-like keyboard. A 'priority' channel feature is included so that you can program a particularly interesting frequency into memory channel 1. Any time you hit the 'priority' key, the receiver selects that channel. An 'aux.' function allows you to turn on an attached cassette recorder.

A single squelch delay of two seconds holds the scanner on a channel for that time when a signal is received. Certain channels may be 'locked out' of a scanning sequence via a lockout control.

We found this scanner relatively easy to use after a little practise, and it appears quite sensitive. It has the greatest number of memory channels on any scanner we've seen.

The SC7000 can be operated from the mains or 12 Vdc.

Contact **Imark, 167 Roden St, West Melbourne 3003. (03)329-5433.**

Clearly, some enterprising electronic equipment manufacturers got onto this and produced some equipment specifically for the purpose. Advertisements for scanning receivers seem to have first appeared in the US electronics press in the late 1960s.

Meanwhile, some dedicated VHF-UHF listeners were chasing long distance (DX) signals propagated way beyond the normal range by some abnormal means. Occasionally the lower atmosphere 'ducts' VHF and UHF signals beyond the horizon some hundreds to thousands of miles. The ionosphere — the electrified layers lying from 100 km to 800 km or so above the earth — will also 'bounce' VHF signals beyond the horizon on occasion. Some special modes conduct the signals almost half way round the earth.

'Sporadic E' (lying at 100 km) propagation will bounce signals distances of 500 km to 2000 km (see ETI, May 1978, p.82), while 'transequatorial propagation' (literally, across the equator) carries signals distances of 3000 km to 14 000 km (see ETI, July 1978, p.112).

Exploiting these modes, you can listen to taxis in Tijuana, aircraft in Auckland and communications links in Korea! Amateurs exploit these modes for some excitement on the 50 MHz, 144 MHz and 432 MHz bands.

When the CB boom came along in the early 1970s, many CBers expanded their interest in communications, some discovering VHF-UHF listening and scanners. At the same time there was a general increase in interest in communications and many shortwave listeners, having purchased HF receivers and explored that, sought further afield and discovered scanners.

Interest in the VHF and UHF bands began to rise markedly in Australia in the late 1970s and is currently enjoying something of a boom. Quite a variety of equipment is available and much of it is keenly priced.

The VHF-UHF spectrum

By convention, the VHF spectrum commences at 30 MHz and runs to 300 MHz. Likewise, the UHF spectrum commences at 300 MHz and runs to 3000 MHz. Each is divided, for purposes of allocating usage, into various segments or bands. For example, 66-88 MHz is 'business radio', 118-136 MHz is the 'aircraft band', 144-148 MHz is the 'two metre' amateur band, 480-490 MHz is 'electronic news gathering' (you can eavesdrop on the journalists now!), 476-477 MHz is the UHF CB band.

Large chunks of the spectrum are taken up for TV broadcasting and there's the 88-108 MHz broadcast band. Considerable portions are also occupied by the military. Some small segments are set aside for satellites, also; like some weather satellites around 136-140 MHz and the Space Shuttle around 240-250 MHz.

The bands are allocated channel spaces at fixed intervals. The interval between channels is called the channel *spacing*. This varies among different bands, depending on their allocated use, the number of users and the limits of available technology. Channels in the VHF band may be spaced at 12.5 kHz intervals, 25 kHz or 50 kHz, for example. On UHF they may be spaced at 25 kHz, 50 kHz or greater intervals.

As the VHF band is 270 MHz wide, if you wanted to search every 12.5 kHz channel for activity, you'd have to look at some 21 600 channels! Then there's the UHF spectrum. Considering 25 kHz channels, there's over 100 000 in 2700 MHz! However, much of the space is empty. Most of the 'action' is between 400 MHz and 550 MHz.

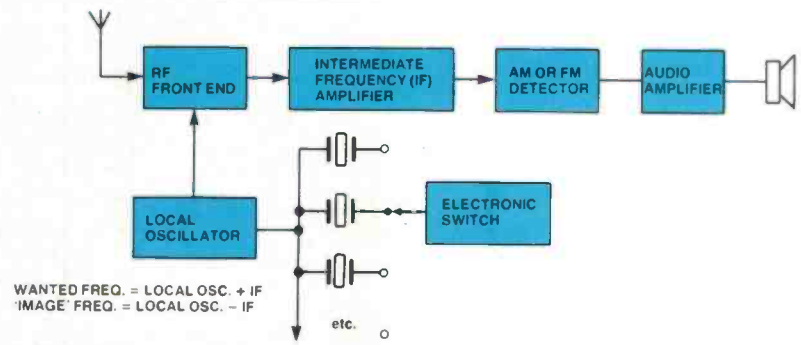


Figure 1. Block diagram of a simple scanner — a straightforward superheterodyne receiver. A suitable IF frequency has to be used so that front end selectivity will reject the 'image' frequency, avoiding possible interference from signals on that frequency. Channels were selected by switching between crystals.

Modern equipment

Compared to the receivers of a decade ago, modern scanners have moved from the horse-and-buggy era into the space age!

The first scanners were simple 'superhet' receivers covering maybe a dozen channels over a small sector (several MHz at best) of the VHF spectrum. Figure 1 shows the general arrangement. Mostly, the transmission mode was frequency modulation (FM), so the receivers had FM detectors. Some scanning receivers were put out in the mid-1970s covering just the aircraft band, which employs AM transmission. Figure 1 shows the general block diagram of these early receivers.

The local oscillator was switched between

several crystals, using a simple electronic switch and an oscillator to drive the switch so that the receiver scanned the channels. It's cheap, but effective if you only wish to cover limited channels. Modern pocket scanners are like this but are capable of covering a number of bands of interest in the VHF and UHF range.

A modern programmable scanner is a much more complex beast. Figure 2 shows a typical block diagram. The unit will have several 'front ends' and, instead of a switched oscillator, will employ a digitally controlled phase-locked loop (PLL) frequency synthesiser. Many employ a microprocessor to manage the channel selection logic and scanning sequences. Programming is via a calculator-like keyboard.

Two detectors may be incorporated, one for AM transmissions, one for FM. A 'squelch' circuit quietens the audio output when no signal is received on a channel. A signal detector circuit detects the presence of a carrier and will open the squelch and stop the scanning so that you can listen to what's on the channel. Many scanners have a timer so that the scan is only stopped on a channel for a certain short period while a signal is being received before continuing. If you want to listen further, you have to stop the scan there manually.

Most scanners available actually incorporate two IF amplifiers, not one as shown in Figure 2, the first being at quite a high ▶

The Regency 'Touch M400' scanner is a very compact, slick looking unit with a 'touch sensor' keyboard, 30 channel memory (inc. battery backup) and coverage of 66-90 MHz, 144-174 MHz and 440-512 MHz in six bands.

On VHF it steps in 5 kHz increments, 12.5 kHz on UHF giving you around 16 500 channels. Reception is FM only. Normal scan delay is 0.6 seconds, though a two second optional delay is available. The unit may be operated from the mains or 12 Vdc. A 'priority channel' feature is included.

Regency scanners have a reputation for quality, reliability and top performance. Contact Vicom, 57 City Rd, South Melbourne 3205. (03)62-6931. Branches in most Australian States and N.Z.

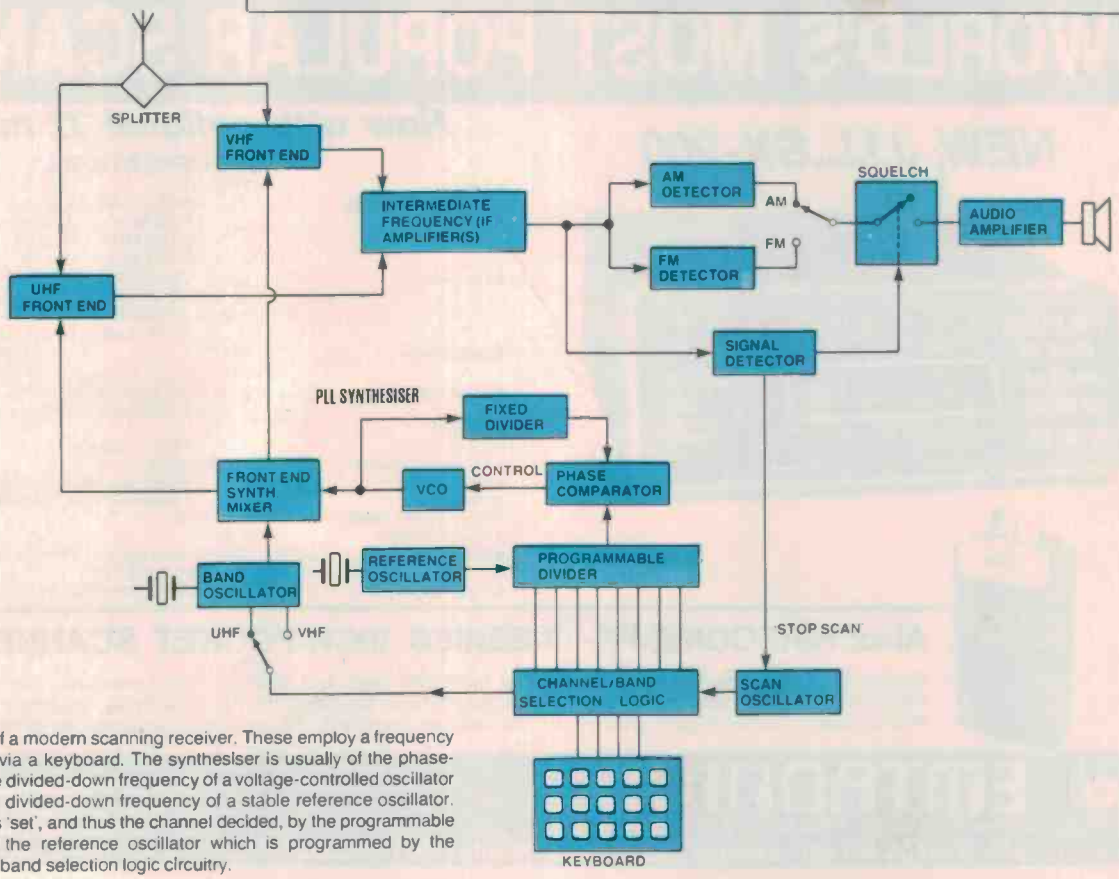


Figure 2. Block diagram of a modern scanning receiver. These employ a frequency synthesiser programmed via a keyboard. The synthesiser is usually of the phase-locked loop type where the divided-down frequency of a voltage-controlled oscillator (VCO) is compared to the divided-down frequency of a stable reference oscillator. The reference frequency is 'set', and thus the channel decided, by the programmable divider on the output of the reference oscillator which is programmed by the keyboard via the channel/band selection logic circuitry.

Dick Smith's PRO-40 scanner is a hot selling item, according to their marketing blurb. A 12 Vdc operated unit intended for mobile use, this receiver covers 68-88 MHz, 136-174 and 360-512 MHz. You can store 40 frequencies in its channel memory, which has battery backup.

The keyboard is a 'touch sensor' type, like you see on microwave ovens. The squelch delay holds the receiver on channel for three seconds when a signal is received.

Reception is FM only and you can scan in preset steps of 5 kHz, 10, 12.5 and 25 kHz on VHF or 10 kHz, 12.5 and 25 kHz on UHF. The PRO-40 has a 'priority' channel which is checked every four seconds regardless of what other scanning routine the unit is carrying out.

The PRO-40 seems to perform well from our limited experience of using it, but the keyboard is not as 'nice' as the calculator-type as it's easy to make mistakes. Nonetheless, the PRO-40 is keenly priced and has many desirable features. See your local **Dick Smith** store.

SCANNING
the world beyond shortwaves

frequency so that signals are not received on the 'image' of the wanted signal, the second IF being at a lower frequency (generally 10.7 MHz) where it is easier to obtain gain and selectivity.

While scanners may be able to cover from around 11 000 to 33 000 channels, users always have groups of 'favourite' frequencies. Hence, facilities are included to 'memorise' these favourite channels so that the scanner may be set to scan only those or a selected group of them.

Frequency readout is usually via a digital display, giving channel frequency directly in MHz down to 5 kHz. The display in many receivers also doubles as a clock.

Frequency bands covered vary from brand to brand and model to model, but generally, most scanners cover the 65 — 90 MHz band, 140 — 174 MHz and 400 — 512 MHz. Some cover wider ranges than those, some narrower, but that's roughly the spectrum segments covered.

Most scanners are made to operate from both 240 Vac and 12 Vdc. Some operate from 12 Vdc only and a plugpack or other dc supply is necessary for ac mains operation.

All come with some sort of antenna that simply plugs straight in to the antenna socket. While many signals are very strong, better results are gained by using an outside antenna mounted high and clear of buildings or other obstructions. The subject of antennas for scanners warrants a separate article! (Coming soon . . .).

Some models only have facilities to store 10 channels, others have 20, 40 or even 70 channel memories. Most models include provision for 'battery backup' for the channel memory so that the programmed-in channels are not lost if the receiver is switched off at any time. ▶

SCANNING

the world beyond shortwaves

Tandy's Realistic model PRO-2009 is a low-priced scanner that features an eight-channel memory and covers 68-88 MHz, 144-174 MHz and 410-512 MHz in six bands.

Control is via the usual keyboard and the channel memory has battery backup. Frequency limits for scanning are entered via the keyboard and reception is FM only. The unit can be powered from the mains or 12 Vdc. See you local **Tandy store** for this and other Realistic scanning receivers.

Legalities

Using a scanner *may* be illegal. The Wireless Telegraphy Act of 1905 (as amended) says that you cannot "... erect, maintain or use ..." equipment for transmitting or receiving messages without being duly authorised. With the exception of broadcast receivers (including TV), authorisation is the responsibility of the Department of Communications.

Radio amateurs, under the terms of their certificate of proficiency and licence, *may* have sufficient excuse to own and use a scanner, particularly as most cover at least one amateur band.

There is certainly opposition to scanners being available to 'the general public', particularly amongst police, security services and certain public service departments. And with good reason. They don't want what were once 'private' and 'secure' communications channels becoming the least bit 'public'.

It is probably less a matter of concern that you might own a scanner but of great concern as to what use you put it to. If you're chasing DX from Darwin and aren't interested in what's being said, OK. But, if you're eavesdropping on the activities of Customs in Cheltenham, with a view to pursuing something nefarious, it's not on.

There seems to be no current provision in the W.T. Act Regulations to permit licencing of scanners. The draft Radio Communications Bill 1983 has this to say:

Receiver not to be operated without receiver licence

36. (1) A person shall not, without reasonable excuse, operate a receiver except in accordance with a receiver licence.

(2) Without limiting the generality of the expression "reasonable excuse" in sub-section (1), it is a reasonable excuse if a person operated a receiver in the honest belief that that operation was reasonably necessary for the purpose of—

(a) securing the safety of a vessel or aircraft that was in danger;

(b) dealing with an emergency involving a serious threat to the environment; or

(c) dealing with an emergency involving risk of death of, or injury to, persons, or risk of loss of, or damage to, property.

Penalty: $2,000.

Receiver licence

37. (1) Upon application in accordance with the appropriate approved form, the Minister may, in his discretion, grant to the applicant a licence in writing to operate specified receivers or receivers included in a specified class of receivers.

The Department of Communications has sought comment on the draft Bill. So, if you have something to say, they'd like to hear it. Send comments to The Secretary, D.O.C., P.O. Box 34, Belconnen 2616. Closing date for comment was 22 April 1983, but as the Government has changed in the meantime, this may have changed. Copies of the Bill can be obtained from Australian Government Publishing Service bookshops.

Few prosecutions have occurred and the court decisions have set no clear precedents.

What's to be heard

Lots and lots of things! Taxis, tow trucks, fire brigades, ambulance services, hospitals, radio telephones, paging equipment, local councils, news services, radio and TV station communications services, real estate agencies,

Pocket scanner. Typical of the pocket scanners available is this 'Pocket Scan' receiver from Imark. It provides 10 crystal-controlled channels for FM reception in any of the three bands: 70-90 MHz, 146-174 MHz and 430-520 MHz. It is powered by four AAA dry cells or NiCads. See **Imark, 167 Roden St, West Melbourne 3003. (03)329-5433.**

engineering companies, surveyors, aircraft, radio amateurs, CBers, marine craft, satellites, transport companies, oil companies, mining companies, couriers, plumbers, servicemen, Government instrumentalities, beacons, bakeries, garbage disposals, hire cars, church groups, and on, and on . . . et al.

Clearly, there are just too many channels and services to list in the space available here, so here's just a short list of some interesting frequencies and the services that occupy them.

Sydney

76.700 MHz	FM	ambulance
78.065	FM	fire brigade
78.160	FM	bushfire brigade
115.400	AM	Sydney air info.
118.000	AM	Bankstown air
120.500	AM	Sydney tower
147.000	FM	Dural amateur rptr.
156.800	FM	maritime weather
167.770	FM	Dept. Main Roads
468.355	FM	TAA
469.725	FM	Maritime Serv. Bd.
480.900	FM	mobile telephone, info.
485.000	FM	rescue helicopter
488.600	FM	taxis

Melbourne

73.700 MHz	FM	Melb. City Council
76.250	FM	ambulance
77.240	FM	VicRail
82.200	FM	Radio 3UZ
118.100	AM	Moorabbin air
120.500	AM	Melbourne tower
129.500	AM	TAA
146.700	FM	Mt. Dand. amateur rptr
156.400	FM	harbour control
162.220	FM	State Elec. Comm.
163.120	FM	Country Fire Auth.
450.675	FM	Forestry Comm.
467.275	FM	Petrochemicals, Altona
468.525	FM	State Emergency Serv.

Brisbane

74.060 MHz	FM	fire brigade
79.875	FM	ambulance
147.000	FM	Brisbane amateur rptr
502.550	FM	mobile telephone

Adelaide

73.190 MHz	FM	ambulance
75.800	FM	Royal Auto Assoc.
147.000	FM	Adelaide amateur rptr
168.820	FM	fire brigade

Hobart

77.210 MHz	FM	fire brigade
76.940	FM	Forestry Comm.
77.330	FM	ambulance
146.700	FM	Hobart amateur rptr

Perth

77.090 MHz	FM	fire brigade
80.040	FM	ambulance
146.700	FM	Perth amateur rptr
168.520	FM	India-Pacific railway

This will grab you — the Micro-Grasp robot arm

Having obtained a computer and learned how to 'drive' it, the next step for a thinking computerist is robotics. No matter if computing is just a hobby or if it's your workaday job, robotics is an important step forward. Here is a low cost, down to earth way of learning what robotics is about — build this robot arm.

Richard Becker

Powertran, Andover, Hants, U.K.

THE MICRO-GRASP was designed as a low cost 'introduction to robotics' machine, priced as low as possible yet including everything to have it running immediately assembly is completed — i.e: inclusive of power supply and interface — no 'hidden extras'. Despite this major restriction, the Micro-Grasp has some powerful features.

It can be driven from any computer, even the humble ZX81, that has an expansion connector giving access to the data and address buss lines, plus the memory write and memory request lines.

The Micro-Grasp is an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about the base and there is a motor-driven gripper. Each of the arm movements is servo controlled i.e: there are position sensors feeding back information to the interface board where the current position of an axis is compared with the programmed-in intended position and the servo circuit automatically takes corrective action.

This servo action is independent of the computer, greatly simplifying the software to drive the robot. All programming is carried out with a small number of BASIC commands.

Mechanical design

Each of the four axes plus the gripper is driven by a small dc motor with integral gearbox. For the wrist and gripper motors, small in-line gearboxes are used. The three remaining axes use more powerful gearboxes housed in heavy duty zinc alloy castings. The shoulder and elbow joints are driven directly from their motor's gearboxes with both axes mounted on the 'upper' arm section. On the 'forearm' and shoulder support bracket are steel bushes clamping the gearbox shaft so that when the motors are driven, there is relative movement between the upper arm and forearm and the support bracket. The gripper is driven by a leadscrew which either pulls the jaws shut or pushes them open.

Position sensing potentiometers for the

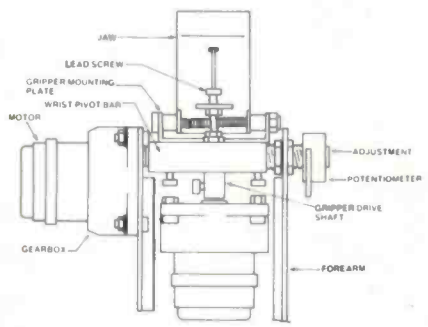


Figure 1. View of the wrist and gripper, showing the various components.

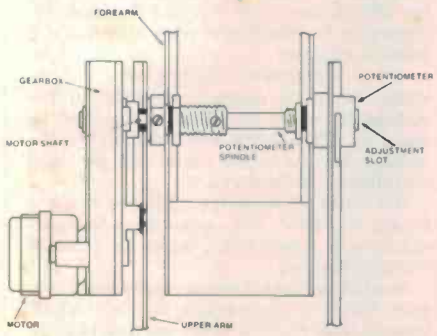


Figure 2. View of the elbow, showing how the motor drives the forearm assembly, plus the coupling to the position pot.

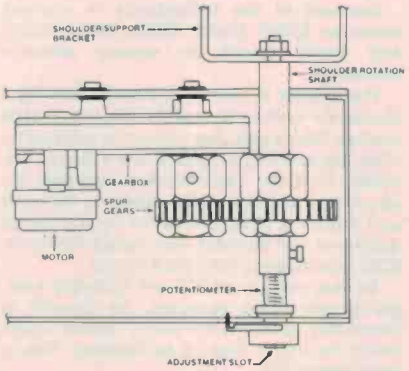


Figure 3. Simplified view of the rotation drive assembly. Note that the gearbox drive shaft comes out on the same side as the motor, unlike the shoulder and elbow drives.

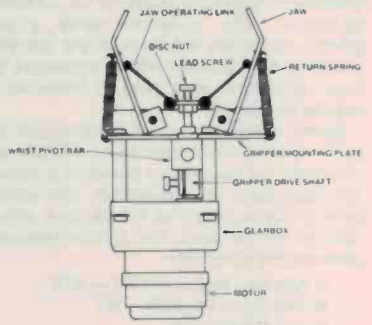


Figure 4. Side view of the gripper, showing how the lead screw, driven by the motor, operates the gripper jaws.

shoulder and elbow axes are also mounted on the upper arm. The joints rotate about plastic bearings mounted on the bushes of these pots. The shaft of each pot is held in a steel bush fitted to the forearm or support bracket.

The rotation axis has a more complex arrangement as it was not possible to arrange the gearbox shaft, the potentiometer and shoulder support bracket all in line. Drive is taken from the gearbox via a pair of spur gears. These have a 2:1 reduction ratio, resulting in a doubling of torque for the rotation axis. For this axis, the gearbox shaft is taken out from the motor side of the gearbox, rather than opposite as is the case with the shoulder and elbow gearboxes.

This arrangement is not perfect and some backlash is evident in the gears, but some compromise has to be accepted in order to keep costs down.

For raising and lowering the wrist, the gearbox shaft rotates a bar to which the position pot. and gripper assembly mounting plate are fitted. The drive shaft for the gripper leadscrew passes through this bar. When the leadscrew turns clockwise, the disc nut is moved toward the motor, pulling the jaws closed. When the leadscrew turns anti-clockwise, the disc nut moves away from the motor and the jaws are pulled apart.

The forearm and upper arm each have counterbalance weights fitted so that no voltage needs to be applied to the motors to hold the arm in a desired position, improving accuracy of the servo action. Without this balancing, an error signal would always be required for the arm to be motionless and a considerable torque would also have to be provided by the gearboxes, unduly straining them. ▶

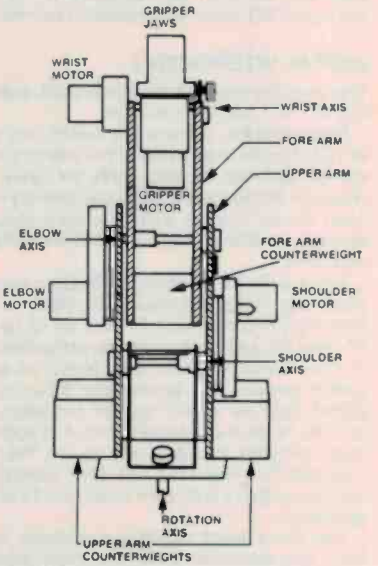
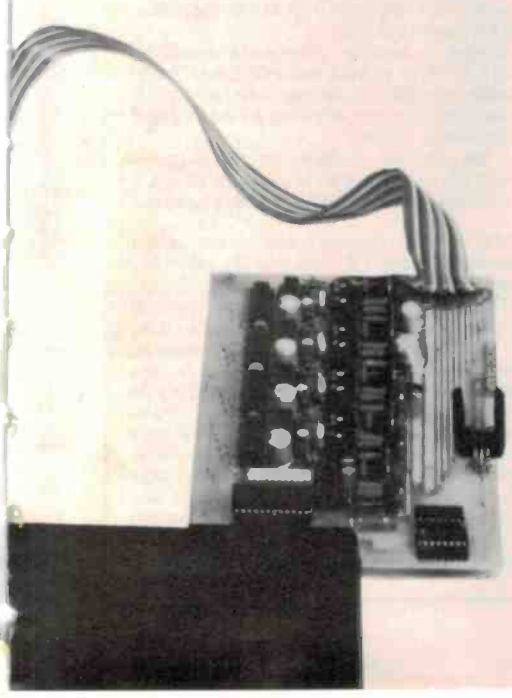


Figure 5. Overall view of the arm (simplified) showing each axis, the motors and counterweights. Note the 'sandwich' arrangement of the forearm and upper arm sidepieces and shoulder bracket.



FEATURES ETI-648 MICROGRASP

- Employs 'revolute coordinate' system with four degrees of freedom (four axes of movement).
  1. rotation about base
  2. shoulder bend
  3. elbow bend
  4. wrist bend
- Gripper mechanism on wrist.
- Each movement axis servo controlled (independant of programming).
- 'Universal' interface board permits interfacing the arm to virtually any computer.
- Interface acts as a memory-mapped peripheral, simplifying software for commanding the arm.
- Interface board is isolated from the mains.
- Straightforward mechanical assembly, requires no special tools or mechanical skills to set it up.

HOW IT WORKS — INTERFACE BOARD — ETI-648

The interface board contains both servo control and motor drive circuitry for the arm's motors, plus interface logic so that this can be 'commanded' from a computer. The whole interface board is designed to operate as a memory-mapped peripheral of the controlling computer. The on-board servo circuitry greatly simplifies the work of the computer, avoiding the requirement for extensive software specific to each type of computer that may be employed.

Some computers have input/output (I/O) ports by which data could be sent to the robot. However, the majority of personal computers available have an 'expansion' connector or buss giving access to all the address, data and internal control lines. The signals required to operate this robot are:

- Address buss lines A0 — A15
- Data buss lines D0 — D7
- Read/Write line
- Memory Request line

Although the interface connector choice could have been arbitrary, a keyed 23-way double-sided edge connector was chosen as they are common and because it fits the low-cost ZX81 computer expansion connector.

DIGITAL INTERFACING

This circuitry involves the 10-bank DIL switch, IC2, IC3, IC4, ICs 5A-D and IC9.

By setting the 10-bank DIL switch, any one of 1024 blocks of 64 bytes of the memory area can be selected. Actually, only six bytes are required, but to narrow down the memory area used would call for extra circuitry and, as memory is cheap, such extra complexity is pointless.

IC2 is a ten-bit comparator. Data on the ten most significant address lines (A6 — A15 inclusive) is compared with data set up by the 10-bank DIL switch. A closed switch puts a low (0 V) on the appropriate input of IC2, an open switch permits the appropriate input to be pulled high via a 4k7 resistor (resistors R1 to R10). When the data on the A6-A15 address lines matches the data set up on the DIL switches (i.e: when the computer selects an address within the 64 byte block) pin 13 of IC2 goes high.

The three least significant address lines from the computer drive the three primary inputs of IC3, a three-into-eight line decoder (sometimes also called a 1-of-8 decoder as only one out of the eight outputs is active at any one time). An output of the decoder can only be enabled (or activated) when the RW (write) and MREQ (memory request) lines are low and pin 6 is high. Now pin 6 is driven by the output of IC2 (pin 13). Thus, when a match occurs between the DIL switch data and the 10 most significant address lines, and RW and MREQ are low, an output of IC4 will be activated, which one depending on the data on the three least significant address lines.

The first four outputs (pins 15, 14, 13, 12 in that order) drive the four axis servo circuits A, B, C, D. If A0, A1 and A2 are all low, servo circuit A will be selected (rotation motor). If A0 is high and A1 and A2 low, servo circuit B will be selected (shoulder motor), and so on.

Thus, the computer addresses a chosen axis as if it were a memory location into which data is to be written. For example, if the top of the computer's address space is to be used, all the switches in the DIL switch bank would be set open, allocating addresses 65472-65535 to the robot. To move the rotation axis, (servo circuit A, remember) to the centre position the command would be POKE 65472,128 (128 being the centre of the range of positions, defined as 0 to 255. Each axis has 256 separate positions within its range of movement as you only have an 8-bit data buss).

Because of the redundancy in address selection 65480, 65488, 65504, 65512, 65520 and 65528 would be equally effective addresses.

The gripper is driven by a motor turning a leadscrew which either pulls the jaws shut or pushes them open. Jaw closure is initiated by IC9a, jaw opening by IC9b. IC9 is a dual monostable flip-flop. Each flip-flop operates for about two seconds, determined by R25/C14 and R28/C15. IC9a is enabled by the pin 10 output of the decoder, IC3, being activated. IC9b is activated by the pin 9 output.

As the outputs of IC3 are normally high, going low when activated, an inverter is necessary to drive the servo circuit inputs which require a high to be enabled. This is provided by IC4.

ANALOGUE CIRCUITRY

Servo circuits A to D are all identical, hence only servo circuit A is shown. Using the example given under 'Digital Interfacing', when the command POKE 65472,128 is received, pin 15 of the decoder (IC3) will go low and pin 2 of IC4a will go high, driving pin 11 of IC5A high. Now, IC5A is a 74LS373 8-bit latch. The data on the computer's data buss (128) appears on its inputs (pins 3, 4, 7, 8, 13, 14, 17, 18). When pin 11 ('latch enable') goes high, the data on the data buss lines is transferred to the outputs (pins 2, 5, 6, 9, 12, 15, 16, 19) which 'latch', holding the data there until the next time pin 11 is toggled high when another data value can be provided.

The outputs of IC5A drive the inputs of a digital-to-analogue (D-to-A) converter, IC6A (a DAC0808). The data written to IC5A is converted to a current output, from pin 4, the value of which is directly proportional to the value of the data. If 128 is the data value, the DAC0808 output will be halfway between 0 and its maximum value.

Pin 4 of IC6A drives the inverting input of IC7Aa, half of a 1458 dual op-amp. This converts the D-to-A converter's output into a voltage with a transfer ratio of 1 V/mA. The output of IC7Aa (pin 1) provides the 'desired position voltage' (DPV) to the motor drive circuitry.

A dual power amplifier, IC8A, arranged in a bridge configuration, drives the rotation motor. The position of the rotation axis shaft is sensed by a pot., RV101A, coupled to the shaft. A reference voltage of about 2 V is supplied to the pot. from 'Vp', derived from a voltage divider off the regulated +5 V rail (R11 and R12). When the rotation axis shaft is at its 'zero' position, the pot. wiper is near the 0 V end of the track. At the shaft mid-way position, about 1 V appears on the pot. wiper.

This 'measured position voltage' (MPV) is applied to one input of the motor drive bridge amp, IC8A, via a buffer, IC7Ab. RV2A permits varying the range of movement by restricting the range of the MPV variation.

IC8A compares the programmed-in desired position voltage (DPV) with the measured position voltage (MPV) and drives the motor backwards or forwards by applying a voltage that depends on how far away from the desired position the axis happens to be.

The DPV is applied directly to pin 8 of IC8A. Feedback via R22A makes the non-inverting input of this amp (pin 7) a virtual earth point elevated above 0 V by the voltage on pin 8 (the non-inverting input). The MPV forces a current into pin 7 via R21, resulting in a voltage at pin 10 which is equal to

R22A (DPV — MPV)/R21A

Similarly, the MPV drives the non-inverting input (pin 4) of the 'opposite' power amp and the DPV forces a current into the inverting input (pin 5), resulting in an output at pin 2 which is equal to

R20A(MPV — DPV)/R19A,

which is in the opposite direction to the voltage out of pin 10. These voltages will be equal as R20A=R22A and R19A=R21A. The voltage applied to the motor will be twice R22A(DPV — MPV)/R21A.

The motor will move the shaft until the MPV equals the DPV. The components selected result in a servo action which is close to critically damped.

An offset voltage is applied to pin 3 of IC7Aa, from RV1A, to compensate for the residual voltage from RV101A when the axis is at its zero position.

The RC networks on the outputs of IC8A a and b are the 'Zobel' networks almost universally used to stop power amplifiers from oscillating in the MHz region.

Capacitors C12A and C13A are for local decoupling and C105A, C106A are suppression capacitors fitted as close as possible to the motor. Without these the interference from the motor brushes is sufficient to make the computer abort its program.

Only four of the five axes are servo controlled as the gripper needs only to be either holding or releasing.

As explained under 'Digital Interfacing', the gripper motor is activated by triggering IC9a to close the jaws, IC9b to open them.

As with the axis drive circuits, a 2877 dual power amp (IC10) is used in a bridge configuration to drive the gripper motor. When IC9a is triggered, its Q output (pin 13) goes high for about two seconds. About 0.5 V appears across R27, owing to the voltage division provided by R26-R27. This will cause the output of IC10b (pin 10) to swing toward the +9 V rail and the output of IC10a to swing toward the −9 V rail. The motor will then drive the gripper jaws shut.

When an object is siezed, the motor will stall but the amplifier is fully protected and, as the stall period is less than two seconds, no motor overheating occurs.

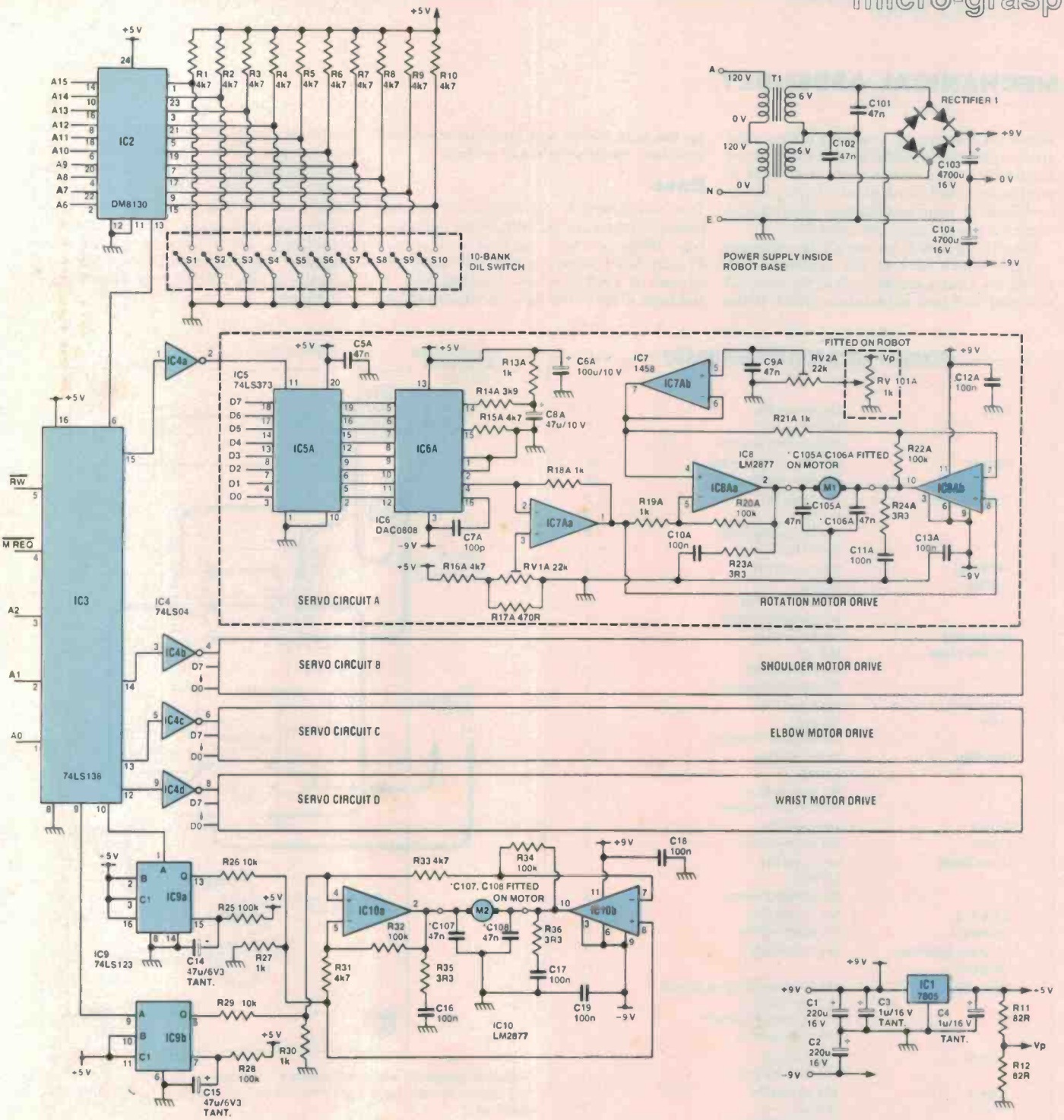
On triggering IC9b, the motor is driven in the opposite direction until it stalls with the jaws in the fully open position.

Gripper operating commands could be POKE 65477,0 to hold and POKE 65478,0 to release, though this data as indicated by 0 is quite irrelevant and anything between 0 and 255 could be written.

If the address allocated to axis 0 (servo circuit A) is A then axis 1 is A + 1, axis 2 is A + 2, axis 3 is A + 3, grip is A + 5 and release is A + 6.

The rotation shoulder and elbow motors take up to about 1 A each and the other two motors up to about 0.5 A each.

The reference voltage for the DAC and the position sensing potentiometers comes from IC1 (a 7805) which provides excellent stability. The amplifiers' requirements however are non-critical and an unstabilised supply is entirely adequate. The power supply circuit provides ± approximately 9 V. The supply is sited in the robot base where, as well as providing useful ballast at the rear of the base the mains connections are fully enclosed. The interface board is therefore free of mains and is safely operated whilst unenclosed and closely connected to the computer.



Electronic design

Despite the size of the interface board, the electronics is relatively simple. Four identical servo circuits are employed to drive the four axes motors. The gripper motor is driven from a slightly different circuit. Servo circuit *A* controls the *rotation axis*, servo circuit B controls the *shoulder axis*, *C* controls the *elbow axis* and *D* controls the *wrist axis*.

A 10-bank DIL switch sets the base address of the arm. The ten most significant bits of the computer's address lines (A6 — A15) are compared to the address set on the DIL switch. When these match, a three-to-eight line decoder is enabled, providing the memory write and memory request lines are low at the same time (they are *active low*).

The three least significant bits of the computer's address buss (A0, A1 and A2) are then used to select which axis is to be moved. Data is written to the appropriate address and the value on the data buss is then converted to an analogue voltage to drive the selected axis' motor. The servo circuitry then sets the position of that axis. As the address buss is eight bits wide, each axis can be positioned at any of 256 locations.

For example, as the wrist can move through an angle of 180° it can theoretically be positioned anywhere in its semi-circle of movement to an accuracy of 180/256, or about 0.7°. Mechanical tolerances will decrease this.

The elbow and shoulder axes have greater range of movement and could theoretically be positioned to an accuracy of about 1°, but again, mechanical tolerances will decrease this.

The gripper only has two positions — open and shut! The electronics is only toggled one way or the other to set the jaws as required.

Complete details of the circuit operation are given in the 'How It Works' panel accompanying the circuit diagram. ▶

MECHANICAL ASSEMBLY

While the mechanical assembly of this robot arm is relatively straightforward, constructors should be aware that a certain amount of mechanical skill is required. If you are not confident of your mechanical abilities, get someone else to tackle the assembly.

First thing to do is lay out all the parts and identify which part of the assembly they belong to. Take a careful look at the pieces of stamped and bent aluminium which make up the arm pieces and familiarise yourself with how the other parts fit to them.

Base

The base assembly consists of six stamped pieces of metal which fit together to make a box. These are held together with special Philips head screws which roll their own thread. A good assembly starting point is the base plate of the base on which is fitted the power supply and the rotation axis position sensing pot. (RV101A). The accompanying assembly diagram (Figure 6) shows the general construction. Bolt on the potentiometer and bridge rectifier first. Make sure you identify the rectifier terminals correctly and orient it accordingly (see the bridge rectifier pinout diagram). You can mark the base plate with something like 'Whiteout' or 'Liquid Paper' to help you.

FIXING PARTS FOR MICRO-GRASP

Feet	M4 16 mm PH	4
	M4 nut	4
	M4 serrated washer	4
Panels	M3 10 mm PH Taptite	24
	M3 plain washers	24
Transformer	M4 8 mm PH	2
	M4 nut	2
	M4 serrated washer	4
	solder tag	1
Terminal blocks	M3 16 mm PH	4
	M3 nut	4
	M3 plain washer	4
	M3 serrated washer	4
Solder tag on end plate	M3 8 mm PH	1
	M3 nut	1
	M3 plain washer	1
	M3 serrated washer	1
Capacitor clips	M4 6 mm PH	2
	M4 nut	2
	M4 serrated washers	2
Rectifier	M3 16 mm PH	1
	M3 nut	1
	M3 plain washer	1
	M3 serrated washer	1
Axis 0 motor	M4 6 mm PH	4
	M4 plain washer	4
Drive Shaft	M3 6 mm PH	1
	M6 nut	1
	M6 serrated washer	2
Axis 1, 2 motors	M4 10 mm CSK	8
	M5 plain washer	8
Counter balance weights	M4 10 mm CSK	8
Motor Bushes	M4 6 mm socket grub screws	4
	½" UNF half nut	2
	M12 serrated washers	4
	M8 nylon washer	2
Tie rod	M5 nylok nut	2
	M5 plain washer	2
Axis 3 motor	M3 12 mm PH	4
	M3 nut	4
	M3 plain washer	4
	M3 serrated washer	4
Square shaft of wrist	M3 6 mm PH	4
	M3 serrated washer	5
	M3 nylon washer	2
Axis 4 motor	M3 25 mm tapped spacer	4
	M3 8 mm PH	8
	M3 serrated washer	4
	M3 plain washer	4
Gripper Drive shaft	M3 6 mm PH	1
	M3 16 mm PH nylon	1
	M3 nut	1
	M3 nylon washer	1
Gripper plates	M4 50 mm PH	2
	M4 nylok nut	2
	M4 6 mm spacer	4

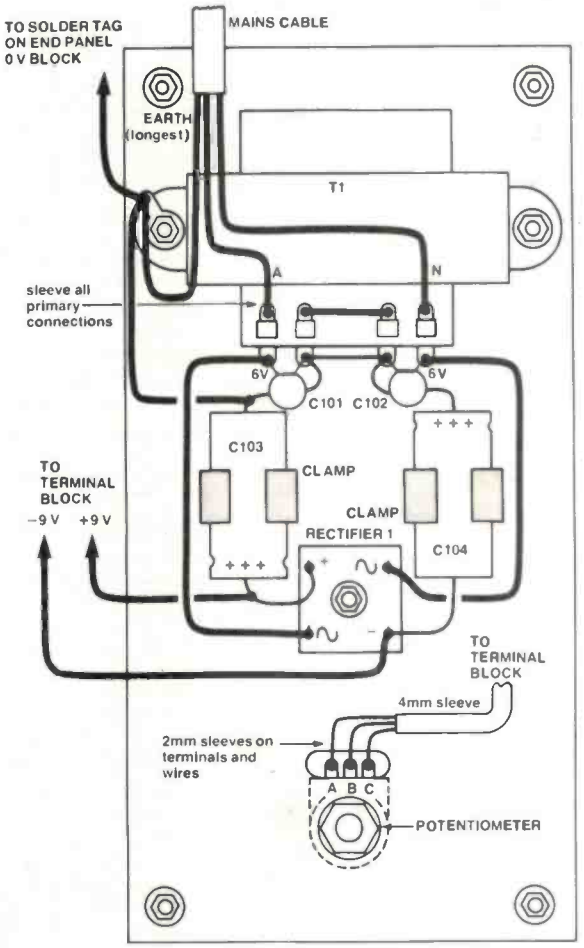
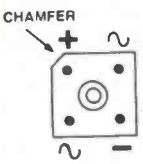


Figure 6. Assembly and wiring diagram of the power supply. Make sure the solder lug under the left hand transformer mounting bolt is securely earthed to the base plate.



Top view of the bridge rectifier showing pin connections.

PARTS LIST — ETI-648 ARM ASSEMBLY

Resistors

RV101A-D ..... 1k linear pots

Capacitors

C101, 102, 105A-D, 106A-D, 107, 108 .. 47n ceramic (12 off)

C103, 104 ..... 4700u/16 V axial electros (2 off)

Semiconductors

RECT.1 ..... 6 A bridge rectifier

Miscellaneous

T1 ..... 2 x 120 V pri./2 x 6 V sec.

Motors, mechanical parts, fixings, etc.

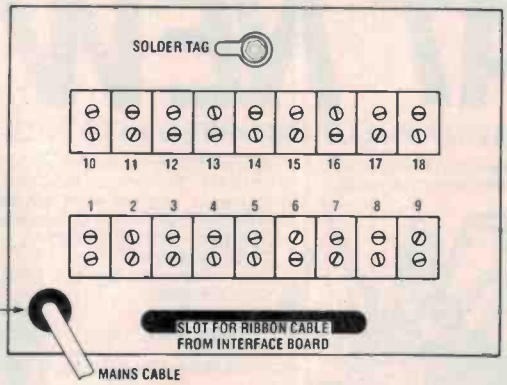


Figure 7. End plate assembly from the base (viewed from the inside) showing terminal block numbering. Make sure the bolt securing the solder tag gets a good 'bite' into the metal.

TERMINAL BLOCK	DESTINATION	WIRE COLOUR	PC BOARD CONNECTION POINT
1	rotation motor-red	grey	1
2	rotation motor-black	orange	2
3	shoulder motor-black	blue (left)	3
4	shoulder motor-red	black (left)	4
5	elbow motor-black	orange (right)	5
6	elbow motor-red	grey (right)	6
7	wrist motor-black	brown (right)	7
8	wrist motor-red	green (right)	8
9	gripper motor-black	black (right)	9
10	gripper motor-red	blue (right)	10
11	+ve, power supply	red	11, 12
12	−ve, power supply	blue	13, 14
tag	solder tag, base plate	black	15
13	RV101D, tag B	white (left)	16
14	RV101C, tag B	yellow (left)	17
15	RV101B, tag B	violet (right)	18
16	RV101A, tag B	green/yellow	19
17	0 V (anlg), RV101A, tag C	pink	20
	0 V (anlg), RV101B, tag A	pink (right)	
	0 V (anlg), RV101C, tag A	pink (left)	
	0 V (anlg), RV101D, tag A	pink (left)	
18	Vp RV101A, tag A	red	21
	Vp RV101B, tag C	red (right)	
	RV101C, tag C	red (left)	
	Vp RV101D, tag C	red (left)	

TABLE 1

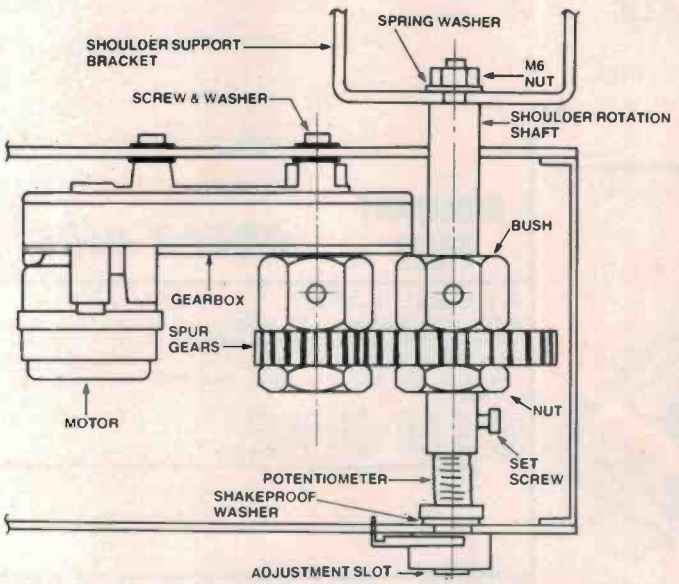


Figure 8. Rotation drive assembly. Install suppression capacitors C105A, C106A, as described later under the heading 'Wiring Looms', before mounting the motor.

NOTES FOR CONSTRUCTORS

To put this project together you'll need a heavy duty soldering iron, apart from an ordinary iron for electronic work, a medium-sized Philips head screwdriver, a small shifting spanner or set of small spanners, and perhaps a small hole reamer or fine rat-tail file — apart from your usual tools.

Bolt the transformer on next and then solder the two electrolytic capacitors in place, making sure you get them the right way round. Then solder C101 and C102 in place directly on the terminals of the 6 V secondaries. Bridge the two inner terminals of the 6 V secondaries. Also bridge the inner two terminals of the 120 V sections of the primaries.

Then wire the bridge rectifier to the transformer secondary and the earth tag to the connection bridging the two inner terminals of the secondaries (i.e: the centre tap).

Now assemble the end plate of the base (Figure 7). Bolt on the two terminal blocks and the solder tag. Attach the mains cord with a clamp grommet but make sure you leave about 15-200 mm of lead length so that it can be wired in easily.

Mark terminals 1, 9, 10 and 18 on the end plate using Whiteout or Liquid Paper so that you can readily identify the terminals. Then wire RV101A and the rectifier to the appropriate terminals, as per Table 1.

Now you can wire up the mains lead. Make sure the earth wire is the longest so that it's the last to break in the event of an accident. Don't attach a plug to the end of the mains cord yet, for safety's sake.

The power supply and rotation potentiometer can now be wired to the terminal block. Make up two looms as shown in the 'wiring looms' diagram, then wire them in place as per table 1 and Figure 6. When making up the looms, use a ruler to get exact wire lengths as only just enough wire is supplied.

Tackle the rotation drive assembly next. First take one of the motor-and-gearbox assemblies. What you have to do is turn the shaft over so that it comes out on the same side as the motor.

The gearbox has a cover plate held on by four Philips head screws and an aluminium rivet (located adjacent to the motor, at one end). The turnover on the rivet can be gently prised up using side cutters and the rivet slipped out. Then undo the four screws. Carefully take off the cover plate and examine the drive shaft and associated gears. By examining it, you will see how to slip out the drive shaft and turn it over so that it faces the opposite direction — it's easier to do than describe!

With the drive shaft now correctly oriented and the gears meshed, put the cover plate back on and slip the rivet back in place, turning over the end to secure it.

Take a look at the rotation drive assembly drawing (Figure 8). Attach the small spur gear to the gearbox shaft with the bush and nut, as shown. Fit the motor loosely to the top plate of the base assembly. Screw the side panels to the base (use washers under all screw heads) and then screw the top plate in place.

Assemble the shoulder rotation shaft, large spur gear, bush and nut to the potentiometer shaft, align the gears and secure in place. Position the motor so that the spur gears are firmly meshed without binding and tighten the motor mounting screws. At this stage, you can apply 9-12 V to the motor to see that the rotation shaft turns without the spur gears binding. If not, readjust the motor mount so that it does. ▶

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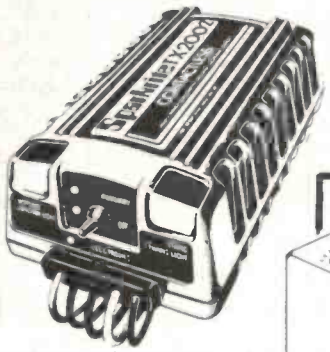

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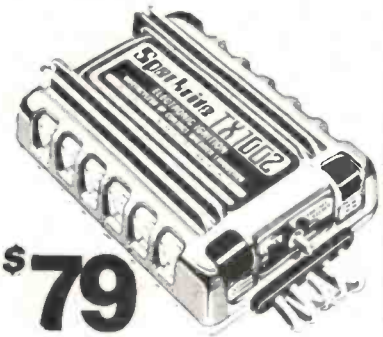

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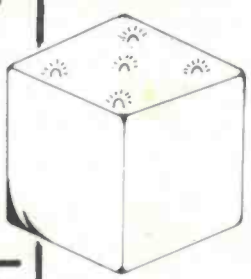

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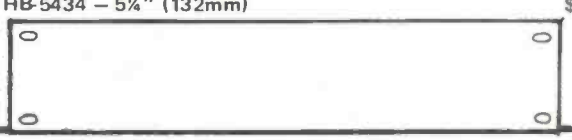

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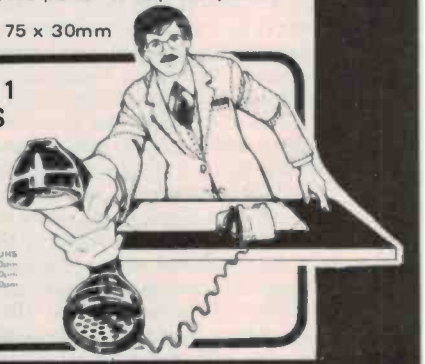


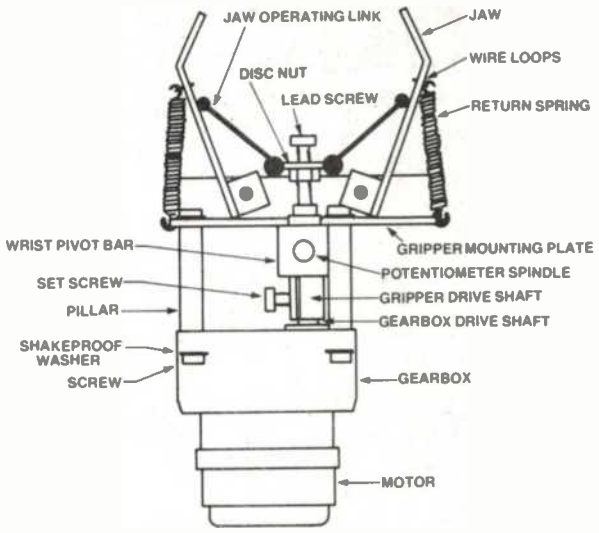


Figure 9. The gripper assembly showing motor mounting, jaw components and pivot bar, etc.

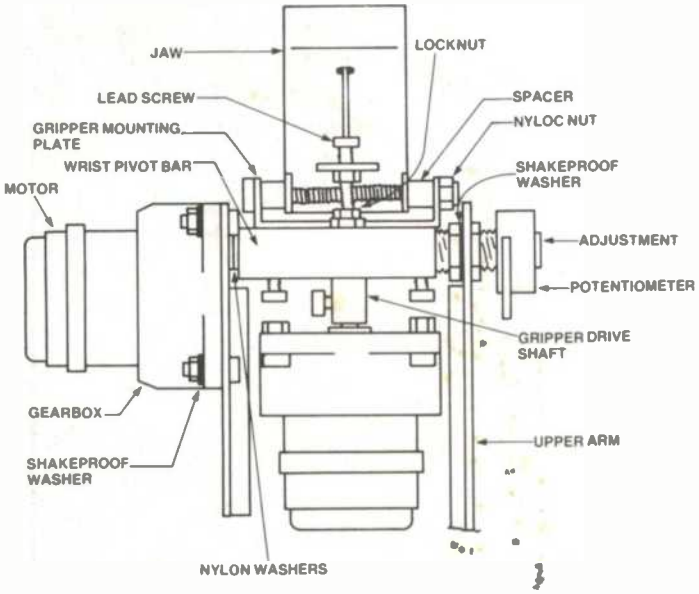


Figure 10. The wrist and gripper assembly, showing how the gripper fits to the wrist drive shaft.

Don't tighten the set screw to the pot shaft at this stage, otherwise you're liable to damage the rotation potentiometer through moving the rotation shaft at some stage of construction.

The end plates for the base are not screwed in place yet, that comes much later.

Gripper

The gripper assembly should be tackled next. The motor marked 'gripper' attaches to the gripper mounting plate, as shown in Figure 9, via four hexagonal pillars. The mounting plate is U-shaped and should have the open side of the U facing away from the motor.

The motor shaft should line up with the large hole in the plate. The wrist pivot bar (see Figure 10), fits flat against the hexagonal pillars and the gripper mounting plate. It only fits correctly one way round.

Two screws pass through the mounting plate into the pivot bar. The gripper drive shaft should pass through the pivot bar and over the gearbox drive shaft, where a set screw is used.

At this stage, apply about 12 V or so to the gripper motor and make sure the gripper drive shaft rotates freely. If not, re-check the orientation of the pivot bar. We found that some filing with a fine rat-tail file was necessary to obtain proper rotation.

The jaws are spaced between the U of the mounting plate by four cylindrical spacers, each about 5 mm long. Tighten the screws onto the lock nuts, but make sure the jaws can still move with only light pressure applied. The screw heads should be on the side where the pivot bar sticks out furthest.

The nylon leadscrew passes through a flat plate about 15 x 50 mm and into the end of the gripper drive shaft. Fit the jaw operating links to the flat plate and return springs with small wire loops. Apply power to the gripper motor once again and observe the action.

The leadscrew will require some adjustment to get the jaws to open and close completely. Once you have mastered the adjustment procedure, you may fix the leadscrew to the drive shaft with a drop of 'Loctite' or similar compound. DO NOT use epoxy or you'll never be able to adjust it again.

Forearm

Sort out the pieces for this assembly. This is the section that goes between the elbow and the wrist (naturally!). Note that the lips on the side plates face inwards.

Fit the couterweight between the two side pieces and loosely mount it with the four countersunk screws. Fit the wrist motor and potentiometer to the *outside* of the side pieces, as shown in Figure 10.

Fit the shaft securing bush (Figure 11) near the counterweight on the same side piece as the wrist motor is mounted on. Tighten it. The gripper may now be placed between the wrist motor and the wrist potentiometer, as per Figure 10.

Tighten the counterweight screws and the set screw on the motor end of the wrist pivot bar. The wrist pot. position should be adjusted by moving the shaft nuts to get the arm side pieces near parallel, but, more importantly, to allow the gripper assembly to rotate freely.

Upper arm

Sort out the pieces for this assembly. Note that the two side pieces assemble with the lips facing outwards.

The two motors and two position pots mount diagonally opposite one another on the two halves. Study the accompanying photographs to get the orientation right.

The potentiometers mount with plastic spacers and bushes to form a sort of floating bearing through the upper arm and shoulder support bracket. Because of this, the upper arm must be assembled through the other pieces so must be done last.

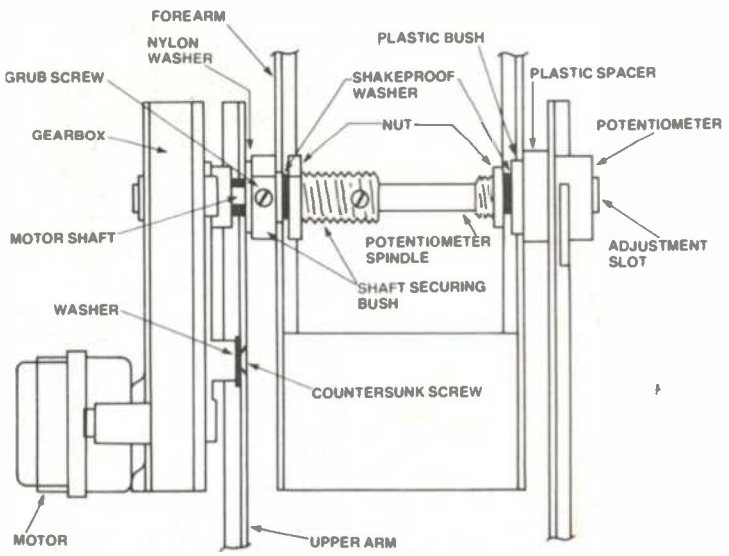
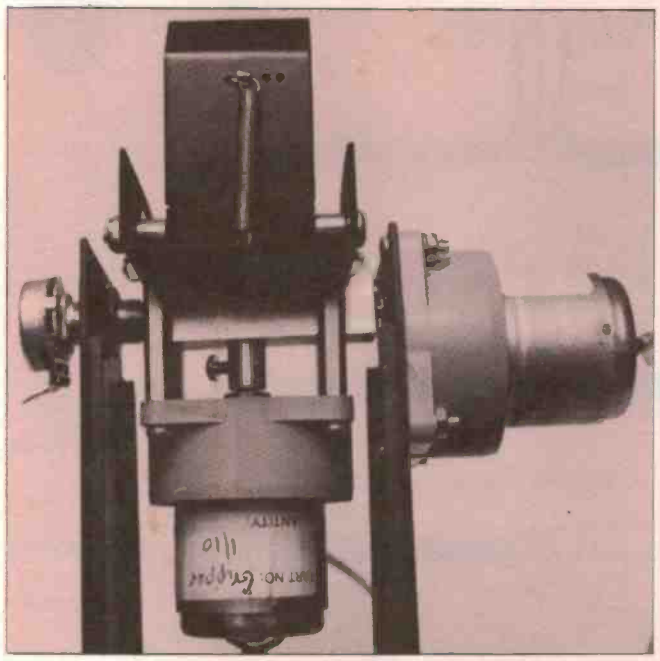
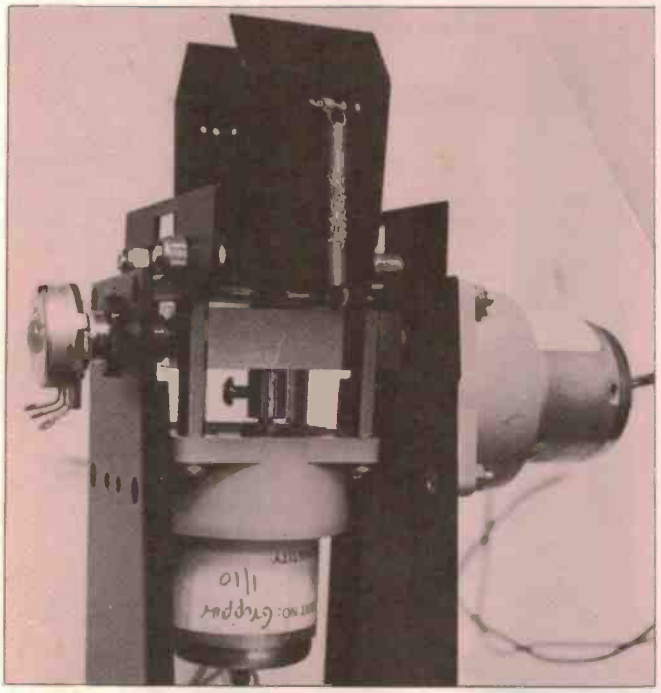


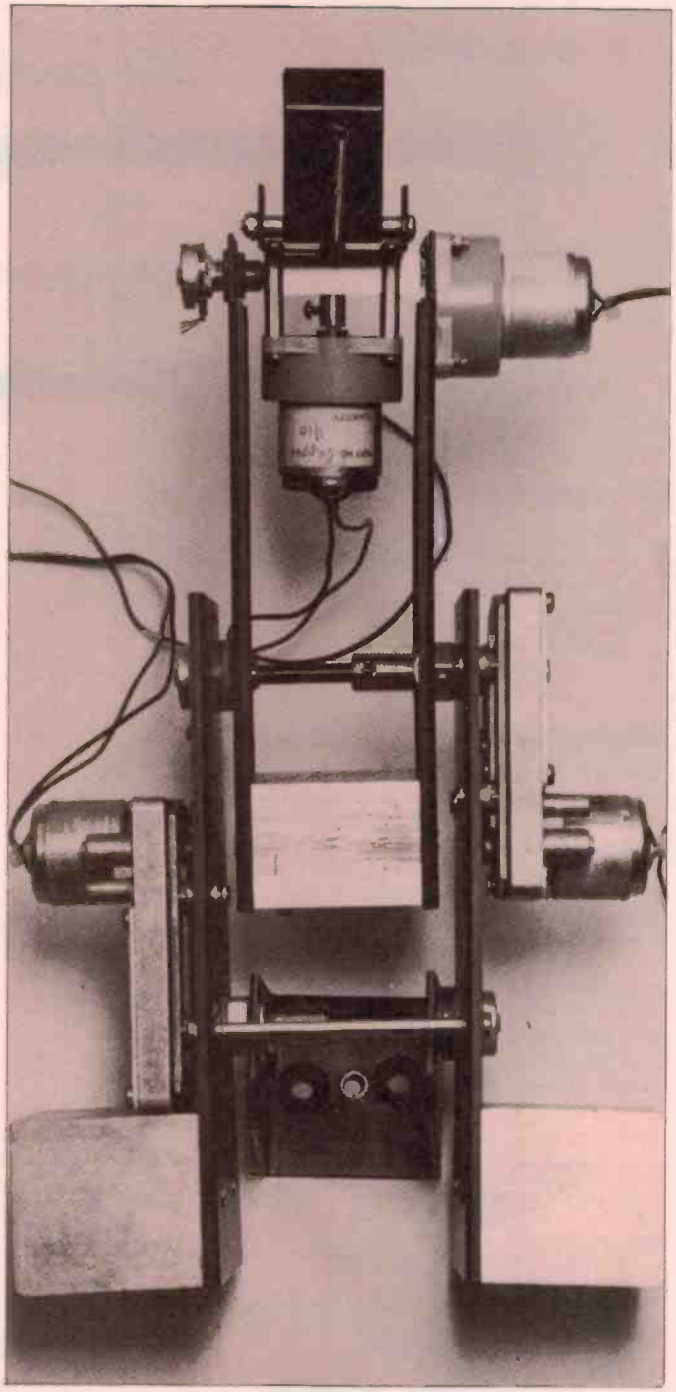
Figure 11. How the elbow is assembled.



The end. View of the wrist and gripper assembly.



Twisted. Angled view of the wrist and gripper assembly.



Assembled. Overall view of the completed arm assembly prior to mounting it on the rotation shaft and attaching the wiring looms.

Fit the two counterweights to the lower ends of the side pieces, on the outside. We found that the two pots on this arm section had to have 5 mm cut off their shafts. Check the fit by trial and error, assembling the upper arm before you chop off the pot. shafts!

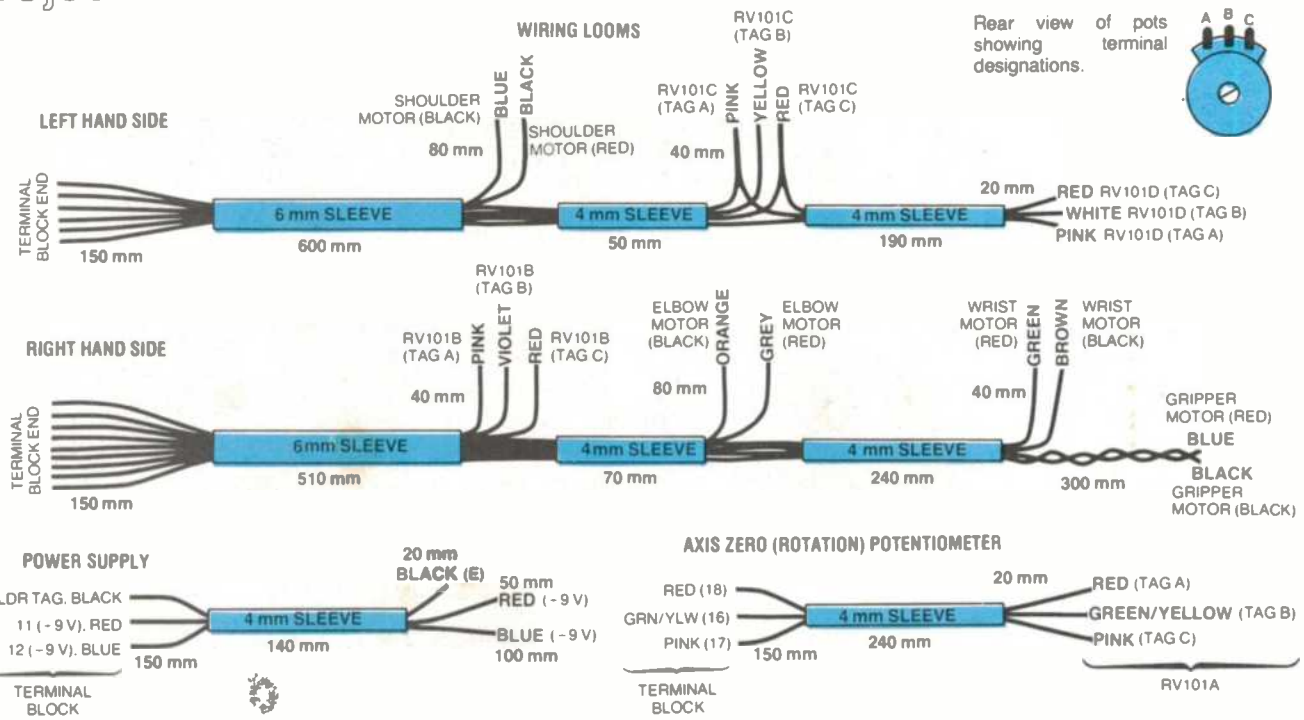
A metal rod with threaded ends is used to stabilise the upper arm near the counterweights and to limit the angle through which the arm can move relative to the shoulder support bracket. This rod passes through the outermost holes on the upper arm side pieces and when the arm is assembled, the rod fits on the side of the shoulder bracket that has the corners cut off. Two nyloc nuts secure this rod. Refer to the accompanying photographs. Don't forget the two rubber grommets in the base of the shoulder bracket.

Final

Place the shoulder bracket onto the rotation drive shaft, orienting the arm so that, from the power cord end of the base, the wrist motor is on the right. Tighten it.

Now secure all the gearbox drive shaft set screws, but not the potentiometer shaft set screws. Move each axis to the centre of its travel — gripper, forearm and upper arm all in line about 60° above the horizontal, with the arm pointing forwards.

Set each potentiometer to its centre position, i.e: equal resistance between the centre tag and each of the outer ones, by using a screwdriver in the adjustment slot. Then secure all the pot. shafts. ▶

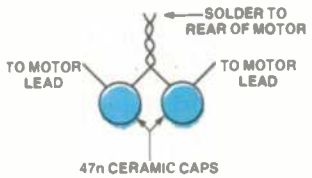


Wiring looms

Now for the wiring looms. Make up the left and right looms as per the Wiring Looms diagram. Use a ruler to cut the wires accurately as only just enough is supplied.

With each loom completed, wire them in place and then route them as shown in Figure 12, securing the looms with cable ties and stick-on cable grips, as shown.

The hash suppression capacitors are mounted on the rear of each motor as follows: take two 47n ceramic capacitors and twist two adjacent leads together, as shown in the accompanying illustration. Cut all leads to a length of about 10 mm.



Solder the joined leads to a convenient spot on the rear of each motor using a heavy duty iron. It is best to lay a blob of solder on the motor case first (i.e: 'tin' a small area), then solder the twisted leads to the blob. Make sure you get a secure connection.

Having done that, cut the motor leads short and solder each to a remaining capacitor lead.

The two looms pass through the grommetted holes in the base of the shoulder bracket, then towards the rear of the base and through the two grommetted holes on the top of the base. Don't wire them to the base end plate terminal blocks yet. Make sure to leave a generous loop near each axis of the arm. Only apply the cable ties loosely at this stage as you will undoubtedly need to adjust them. You can do this by applying power to each motor in turn and seeing that each has enough freedom of movement without fouling on the cable. The rotation shaft needs 180° of movement, so take care here.

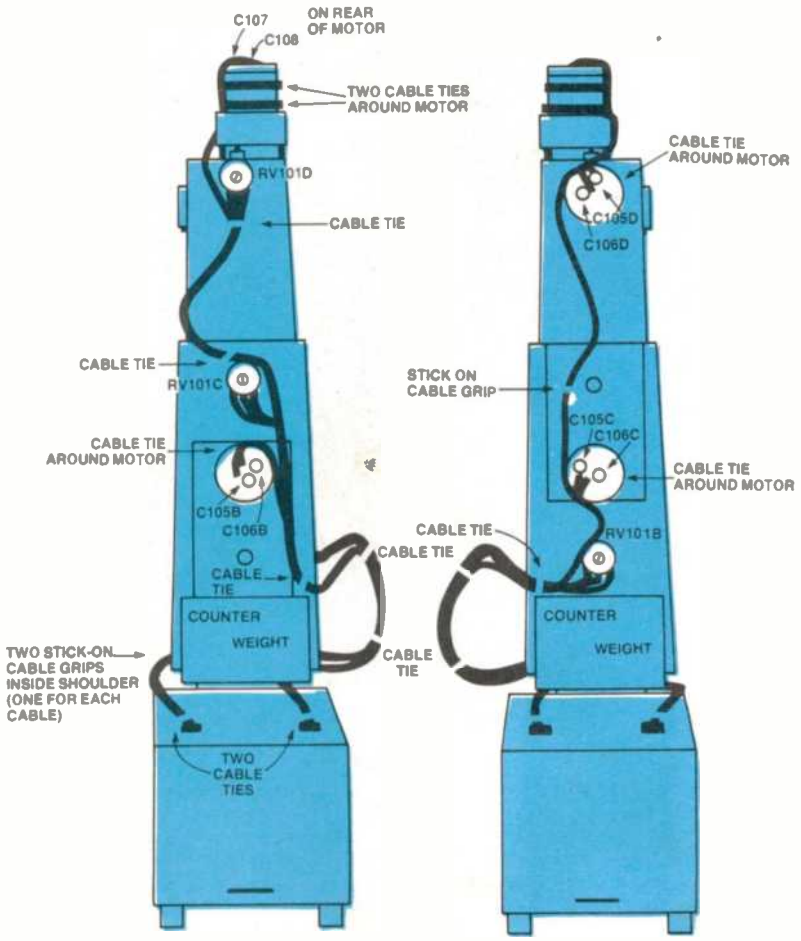


Figure 12. Attaching the wiring looms.

Now you can wire the looms to the terminal blocks, as per Table 1.

Check everything.

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test equipment and fault finding

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In this completely revised second edition, the author tells in simple language how helical VTRs work and how to operate and service them. Includes numerous examples of circuits and mechanical systems.

continued on page 133

Speed controller for appliances powered by a 'universal' electric motor

Electric drills, saws, grinders, food blenders etc, all benefit from having some sort of control over their speed. Simple electric motor speed controllers, while providing speed control, have limited ability to maintain motor speed constant over widely varying loads. This project overcomes the limitations of these simple units and, despite its simplicity and low cost, is remarkably effective.

Jonathan Scott

JUDGING BY users' remarks on the shortcomings of speed controllers on a variety of electrically driven appliances, and from much personal experience and observation, there is a *considerable need* for a well-designed speed controller for use with electric drills, grinders, saws, food blenders and other appliances driven by 'universal' electric motors.

The more expensive power drills now come with a variable control built into the trigger. Food blenders come *festooned* with an array of buttons marked with a ludicrous range of words with every synonym from 'mix' to 'masticate' represented!

These gadgets all have a severe limitation, namely, that they really only have voltage controllers, not speed controllers, for the motor in the unit. They vary the speed but provide little or no feedback speed control.

In the case of the power drill with a speed control in the trigger, the operator is in a position to adjust the trigger continuously in response to variations in the speed of the shaft, thus effectively becoming part of a feedback loop and serving as the speed *regulating* element.

The variable speed function of these latest drills is really not designed to allow the slow steady pace needed for delicate or laborious jobs, but to allow the unit to act as an electric screwdriver, when fitted with the appropriate bit, where constant speed is not necessary.

Blenders, however, are items which you typically want to turn on and add more and more ingredients (adding more load) as the process progresses. What happens? The jolly blender slows down as the load increases and it's a real bother to have to keep adjusting it. If you're not careful, or in too much of a hurry, you can stall the motor quite easily.

Older electric drills and most high rpm grinders never had any sort of variable speed adjustment, electrical or mechanical. Grinders fitted with a special 'pad' wheel are used for buffing, too. But you have to be quite deft, otherwise it's easy to buff right through the undercoat of a painted object because of the ferocity of the thing.

If you need to drill a particularly tough substance with an older drill, then you have to be prepared to wear out the fine, sharp drill tip very quickly.

So, there is a distinct requirement for some device which can be placed between the appliance plug and the mains that can be used to not only *set* the motor speed, but to *regulate* it as well.

The perils of simplicity

There seems to be fundamentally three degrees of complexity in the way one can design these circuits, each with advantages and disadvantages. All techniques employ some method of sensing the motor back-emf and adjusting the power delivered to keep the back-emf relatively constant.

For the sake of attaching 'handles' to each fundamental technique, I shall dub them — the *crude/economical* method, the *refined/economical* method and the *complex/ultimate* method.

For this project I have chosen the middle course for reasons which will become apparent shortly.

The crude/economical method is the simplest and for that reason has an extraordinary advantage in that it has a low parts count. This sort of circuit requires a diode or two, a pot, a couple of resistors or thereabouts and little else apart from the SCR switching element (see Figure 1). Now, it is hard to beat this sort of economy, but such circuits have a few annoying limitations.

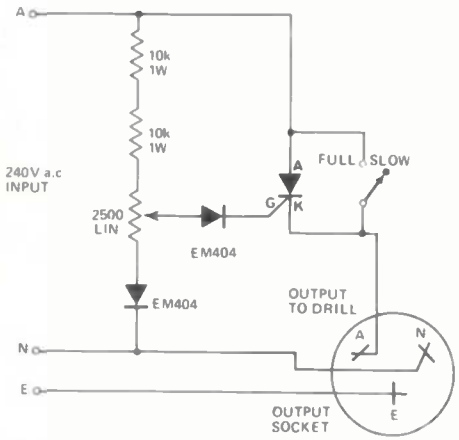


Figure 1. An example of the 'crude/economical' type of motor speed controller. This is the circuit of the ETI-525 Drill Speed Controller (Oct. '74).

Firstly, they will not usually drive anything but the most sensitive SCRs because they deliver very low gate currents. Secondly, some component values can be critical, resulting in touchy or erratic response if tolerances are a bit out or the unit is driving an unusual motor. Lastly, the lack of an amplifying element in the feedback means that the speed regulation, while being above normal for a universal motor, is nowhere near perfect and the speed does drop under load.

To separate the two further types of controller requires a reasonable familiarity with what goes on when controlling a universal electric motor, so I will discuss the technique I have used in this project now and then go on to the explanation of further refinement.

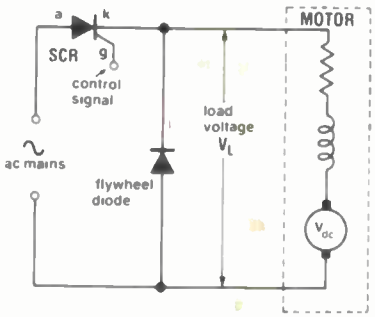


Figure 2. Fundamental circuit elements of the controller used in this project. Note that 'V_{dc}' is the back-emf of the motor.

Controller technique

A universal electric motor appears as a resistance, an inductance and a voltage source in series. The elements of the phase control system I have used — an SCR and a 'flywheel diode' — are connected as shown in Figure 2.

The voltage across the motor terminals during operation of this circuit will appear something like that shown in Figure 3. (Note that the vertical axis is not to scale.)

Considering the cycle from the peak onwards, let us examine the reason behind the appearance of each part of the waveform.

Say that, at some speed setting, the SCR is fired into conduction at about the 100° point of each positive half cycle. The load voltage jumps to a value very nearly equal to the mains voltage at that point (less the small drop across the SCR) and follows the mains cycle variation until the end of that half cycle (i.e. at the 180° point).

Thus, the point between 0° and 180°, of the positive half cycle, where the SCR fires, defines how much voltage is delivered to the load (the motor). Varying the delay before firing provides a means of varying the power delivered to the motor. This is known as phase control, for clearly obvious reasons.

At the point where the mains voltage falls below the back-emf voltage of the motor you would expect the current through the motor to become zero and the SCR to turn off. But, this is not quite the case as the load is not purely resistive. The inductive component of the motor forces its terminal voltage negative in an attempt to maintain motor current, and indeed, the load voltage would follow the mains negative for some way if it were not for the diode connected across the motor terminals.

This diode conducts as the motor voltage goes beyond about 0.7 volts negative and carries the 'flywheel' current from the motor's inductance, generated by the collapsing magnetic field, allowing the SCR to isolate.

The flywheel current persists until the energy stored in the motor's windings is exhausted. This takes typically two to five milliseconds.

Were the diode not there, a large negative-going pulse would result. This, in itself, is not a bad thing, but it is easy to block this and reduce the net dissipation in the SCR, allowing it to control a larger device for the same ratings and prevents the need to make the controller circuitry more complex to resist the negative-going voltage.

At any rate, some way into the negative supply half cycle, the inductance ceases to be the dominating voltage source within the motor and the back-emf becomes evident.

As you may see from the diagram, the motor voltage rises to a level defined by the apparent dc source within the motor equivalent circuit. (The 'back-emf generator'). This voltage is a result of residual magnetism in the metal of the armature and field coils and the relative motion of these two elements.

The actual back-emf developed depends on a number of factors, a major one being speed so it is a good representation of the motor's instantaneous speed.

There is some noise evident on the back-emf voltage, it is not a smooth dc level. This noise is partly due to commutation hash (high frequency spikes) and partly due to different amounts of residual magnetism in different armature segments etc. However, the noise is not sufficient to obscure the speed signal, or back-emf.

In a typical universal electric motor the back-emf would average around 10 volts at full rpm. The control circuitry in the ETI-1515 looks at this dc signal and varies the point at which the SCR fires, increasing the delay if the motor attempts to speed up under decreasing load, or decreasing

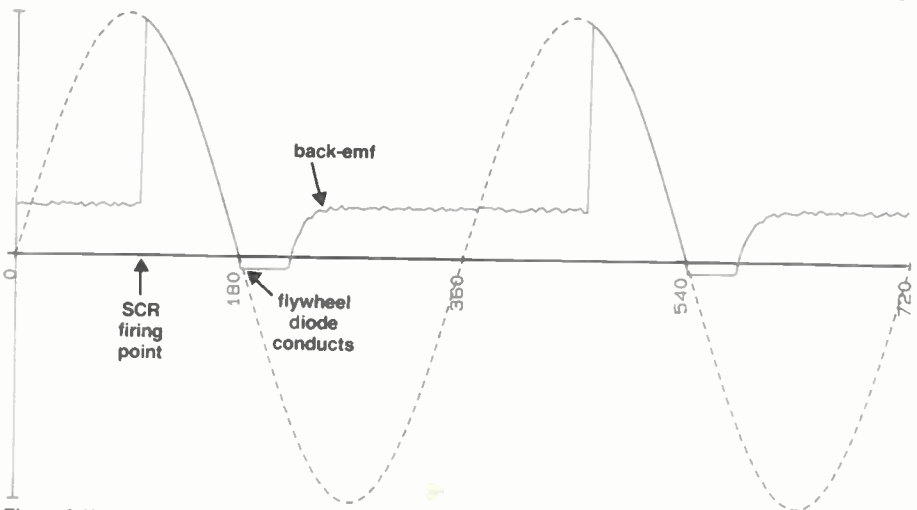


Figure 3. Waveform of the voltage across the motor when using the ETI-1515 speed controller. (Vertical axis not to scale.) The dashed line shows the mains input waveform.

HOW IT WORKS — ETI-1515

The speed of an appliance's motor attached to the project is controlled by applying the mains voltage to it at a set point of the mains positive half cycles, as seen in Figure 3. This is done by turning an SCR on at the appropriate point in the cycle. Turning on the SCR earlier in the cycle applies more voltage, increasing the speed, while turning the SCR on later applies less voltage, decreasing the speed.

The SCR (SCR1) is 'fired' by applying a positive pulse to its gate. This is effected by IC1, an optically-coupled triac driver containing a LED coupled to pins 1 and 2 and a bidirectional optically-operated 'switch' coupled to pins 4 and 6. When the LED in IC1 is off, the switch is off. When the LED is turned on, the switch conducts. If pin 4 is positive with respect to pin 6, it will forward-conduct from pin 4 to pin 6 and vice-versa if pin 6 is positive with respect to pin 4. So that only positive-going pulses are applied to the gate of SCR1, D3 ensures that the switch in IC1 can only conduct during mains positive half cycles.

Resistor R6 simply limits the current through IC1 pins 4 and 6 while R10 prevents false triggering of SCR1 due to small leakage currents.

The control electronics consists of Q1, Q2, PUT1, IC1, RV1 and associated components. The 'flywheel' diode is D6. Power supply for the control electronics is derived by a half-wave rectifier from the mains input. This consists of D2, R2 and C1. This supply is regulated by ZD1, a 33 V zener, R2 providing current limiting. C1 is charged up during the mains positive half cycles and substantially holds its charge during the negative half cycles.

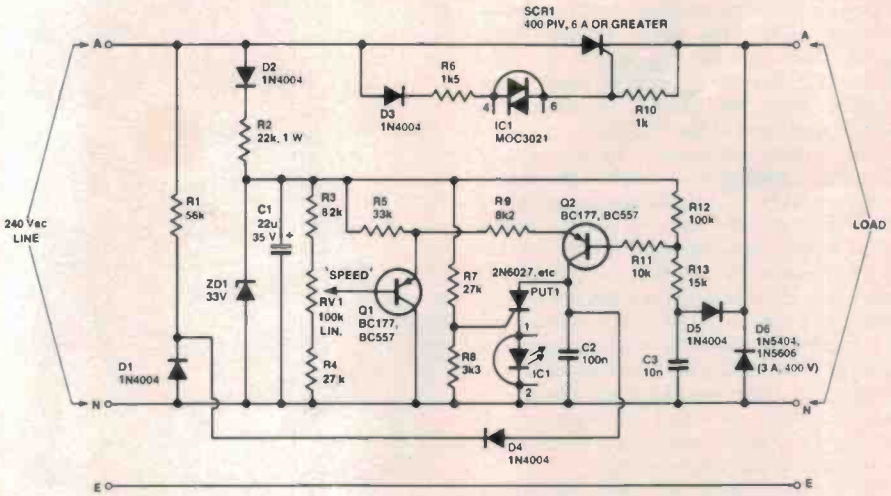
The SPEED control, RV1 is part of a potential divider — R3/RV1/R4. The wiper of RV1 sets a reference level on the emitter of Q1. This can be anywhere between about 4 V and 15 V (with respect to the neutral line), depending on the setting of RV1.

Now, let us see what happens from the point where the mains positive half cycle crosses through the zero point, going negative, at 180° assuming SCR1 has been fired during the preceeding half cycle.

Referring to Figure 3, as the mains crosses through zero, going negative, D6 (the flywheel diode) will conduct, holding the active (A) load terminal at about −0.6 V. The SCR then becomes reverse biased and ceases conducting.

Capacitor C3 will have been charged to a certain voltage (via R12/R13) but will now be discharged via D5. Any charge on capacitor C2 will be discharged via D4/D1/R1.

Diode D6 remains conducting until the inductive backlash of the motor (as explained in the text) dissipates. The voltage at the load active terminal (with respect to the neutral line) then rises to the back-emf level. D5 is now reverse biased, allowing C3 to charge again via R12/R13 until it reaches the level of the back-emf + 0.6 V (D5's forward conduction voltage). Small positive-going 'spikes' on the back-emf level are ignored (momentarily reverse biasing D5) due to the time constant of R12/R13 and C3. This prevents erratic control circuit operation due to this noise. Nevertheless, small fluctuations are still present in the negative peak level held by C3.



Transistor Q2 is forward biased by the voltage drop across R12. The collector of Q2 sources charging current to C2, but this is held discharged via D4/D1/R1 until the mains negative half cycle crosses the zero point and the next positive half cycle begins. When it does, and D1/D4 are reverse biased, C2 will commence charging at a rate determined by the collector current of Q2.

The programmable unijunction transistor (PUT1) has its gate held at about 4 V (with respect to the neutral line) by the potential divider of R7-R8. When C2 charges to 0.6 V above this level, the PUT will 'fire', delivering a current pulse to the LED in IC1. This will operate the switch in IC1 and SCR1 will fire.

The rate at which C2 charges determines at what point in the cycle the PUT, and thus the SCR, will be fired. There are two mechanisms for determining the rate at which C2 charges, and thus the point in the cycle at which SCR1 is fired.

Firstly, a reference level is set at the emitter of Q1 by the setting of RV1, the speed control. The collector-emitter current of Q2 will depend on the value of the voltage at this point and the value of R9, assuming the base voltage is held constant. Thus, varying RV1 varies the charging rate of C2, setting the point at which SCR1 fires.

Secondly, the base current of Q2 varies (and thus the collector current) depending on the voltage drop across R12. If the back-emf of the appliance motor falls, such as with an increase in motor loading, the voltage held on C3 will decrease (pulled down by D5 conducting current through the load) until it reaches the new value of the back-emf plus 0.6 V (D5 forward drop). This will increase the voltage drop across R12 and thus increase the base and collector current of Q2. Thus, C2 will charge more rapidly each mains positive half cycle, firing the PUT and SCR1 earlier in the cycle. This applies more power to the motor so that its speed is maintained.

If the back-emf rises, such as it would from a decrease in motor loading, the voltage on C3 will rise and the voltage drop across R12 will decrease, decreasing the collector current of Q2. Thus, C2 in this case will charge more slowly, causing the SCR to fire later in the cycle. This will reduce power to the motor so that the set speed is maintained.

The function of R11 is simply to limit the currents in Q2 during those parts of the cycle when Q2 is not responding to the back-emf signal.

the delay if the motor attempts to slow down under increasing load.

In other words, if the motor is slowed by a heavy load the back-emf will drop and the control circuit will fire the SCR earlier in the cycle than where it was originally set to fire. This applies the mains voltage to the motor for a longer period, bringing the motor speed back up again. If the motor speeds up when load is reduced, the opposite happens.

Thus, the motor speed will be held constant. It sounds as if the motor will slow down then speed up, or vice versa, but the control variation actually happens within one mains cycle or so and any variation in motor speed will not be apparent.

Readers familiar with control theory will notice that this mechanism forms a control feedback loop. Within the control electronics of this project I have included some amplification which enables the unit, firstly, to drive even quite insensitive SCRs, secondly, to reduce the speed error to a relatively small value and, thirdly, to have a relatively high impedance presented to the reference level (speed) control which is a voltage produced by a potentiometer. This overcomes the limitations of the cruder controllers.

However, the controlled element is a mechanical system with a lot of inertia which represents a significant pole in the transfer function. Hence, it can be anticipated that there will be a trade-off: increasing the amplifier's effective gain will improve regulation all right, but if it is increased too far the system will become unstable and the engine speed will 'hunt', or oscillate about a mean value at a low frequency.

The perils of complexity

It turns out that, in the case of most motors, a very satisfactory degree of speed regulation can be achieved with only a hint of hunting detectable at *very* low speeds. This is most fortunate as it means that one does not require to advance to the next step of complexity, namely using the third technique mentioned earlier — the *complex/ultimate* circuity with its own compensating system incorporated to guarantee the stability of the system under *all* conditions, despite large loop gain.

The reason that this type of circuitry is to be avoided, for the applications considered in the introduction to this article, is that it would require a great deal more electronics (and cost!). This would basically entail▶

a mechanism capable of smoothly holding the back-emf signal so it could be further processed, which means some kind of sample-and-hold gate plus some synchronising signal. Once isolated, the signal is easily dealt with, but the process is much more complex than the simple instantaneous method employed in the ETI-1515.

One further refinement in a complex/ultimate controller may occur to the astute reader: namely, having the circuit capable of using the full 360° (or very nearly) of the mains supply cycle. The systems described so far all assume that an SCR will be used to control the current delivered and not a triac. Hence, at most, only 180° of the mains cycle is available as the SCR must remain in a blocking state during the negative half cycle. Although a triac would permit use of the negative cycles, as would full-wave rectifying the mains before applying it to the SCR, these methods have one problem.

The sensing of speed, so that the speed may be regulated, requires access to the back-emf voltage, blanked immediately after a current zero. Hence, any attempt to employ near-continuous power application would be hampered by the inductive 'backlash' concealing the motor's true back-emf value. Any such system would have to be capable of operating in a mode which left only every fourth or sixth half cycle unemployed for the purpose of 'getting at' the back-emf for speed sensing.

While possible, this would not only require considerable circuitry, but would also tend to impart some roughness to the torque delivered. Hence, such methods are well abandoned for the applications for which the ETI-1515 has been designed. It is a realm of circuit complexity which returns benefits only with physically large machines.

Back to the project

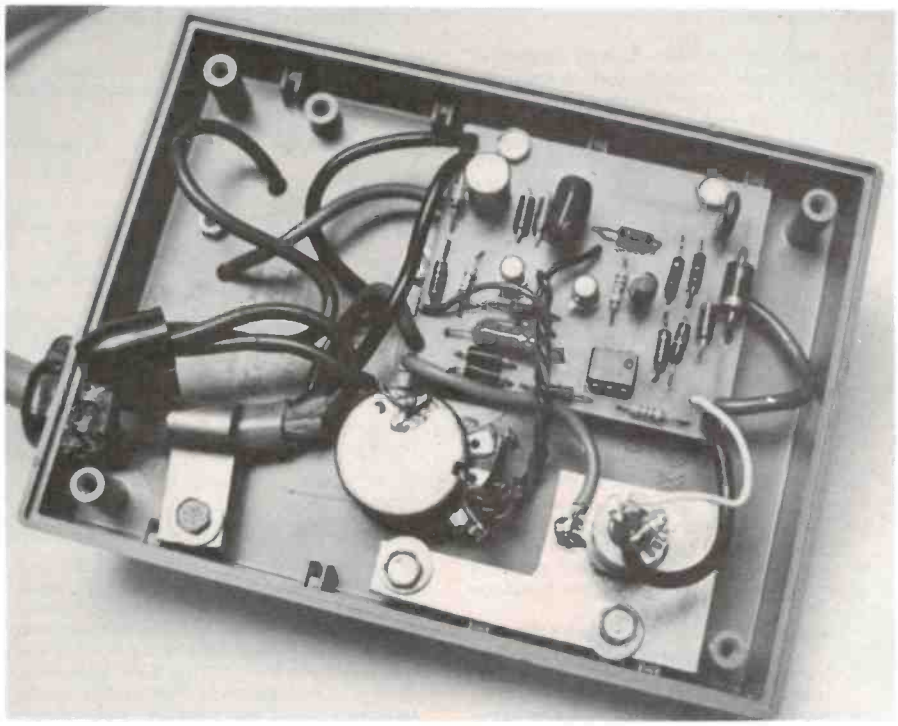
The ETI-1515 has been designed to be a good compromise between the crude/economical and complex/ultimate controller. Speed can be set from full rpm on no load (at 'half power') down to less than one-tenth normal. This is lower than you're ever likely to need. On low speeds and without any load there is a tendency for motors to 'hunt' about the set speed, power being applied in detectable jerks. But, even when only a light load is applied, this has the effect of damping the control loop, improving the control and smoothing out the variations.

The torque characteristics of the circuit are excellent, until you approach the 180° limit of the cycle — which is, in any case *way* beyond what you will need in common situations.

A good 'worst case' example is that of making houmous, a particularly thick and pasty (tasty, too!) dip, in a blender. Initially, the mixture is oily, but as the blending proceeds it changes to a *very* glutinous consistency and blenders invariably begin to labour *agonisingly* at this point. With the ETI-1515 in control — no problems!

Construction

Safety is a major consideration in a project such as this. Choosing a box in which to house the components has to be done carefully because the project will be used in a work environment and is likely to encounter more than the usual amount of rough treatment.



Inside. Construction is quite straightforward — but take heed of the safety precautions mentioned in the text! Note that, in use, there may be a slight 'dead band' at either end of the speed control rotation where nothing happens.

I chose a strong, but not brittle, plastic case which comes in two halves, secured by recessed self-tapping screws that set into plastic pillars in the bottom half of the case. The particular case used on the prototype was a 'Unibox', model P/N 140 which measures 135 mm long by 100 mm wide by 38 mm deep.

Shape is unimportant, along with size, just so long as all the components can be fitted with ease and the box is not cumbersomely large. If you choose a box with a metal facia or panel, make sure this is *securely* earthed. If you can, get a box which provides internal posts to which the pc board and SCR mount can be secured with self-tapping screws so that no metal parts attached to these can protrude through the exterior of the case. If you must use a case that doesn't meet this requirement, secure 'the workings' with nylon nuts and bolts. All this is for your own protection.

The potentiometer used was of the conventional type, having a metal case, bushing and shaft. I earthed the pot. case, as shown in the wiring and overlay diagram. If possible, it would be an even better idea to obtain a pot. with a plastic bushing and shaft.

The mains cable *must* be firmly secured with either a clamp-type grommet where it enters the case, or with an ordinary grommet followed by a cable clamp. I used both a clamp-type grommet *and* a cable clamp, for good measure. (That's probably overdoing it, but, please yourself — Ed.)

Best place to start assembling the project is by drilling the few necessary holes in the box. If you are making a direct copy of the prototype, then positioning of the major components is clear from the internal photograph. If you're using a different box then arrange the major components first and determine where you have to drill holes. Don't crowd the parts against one another. Use the blank pc board as a template for marking its mounting hole positions.

If you're using an SCR type that is not in a stud-mount package, then you'll have to arrange a suitable mount for it. I used a C220D type in a stud-mount, screwing it to a small piece of aluminium which also serves as a heatsink of sorts. SCR dissipation is small, so this heatsink/mount need only be small.

Just bolt the SCR to the heatsink, without any insulator, and use some thermal compound to improve thermal contact between the body of the device and the heatsink. REMEMBER — the heatsink will be at MAINS POTENTIAL, so make sure when mounting it that no securing bolts protrude through the case or use nylon nuts and bolts.

I mounted the SCR separately to the pc board so that a wide range of SCR types and packages could be readily accommodated, from the stud-mount C220D I used in the prototype to small, 6 A-rated, flange-mount plastic pack devices.

It is difficult to specify a 'load rating' for the project in terms of the SCR's characteristics because of motor surge current characteristics and the range of motor ratings in appliances. A 6 A-rated SCR will happily handle an appliance rated to draw a nominal 2 A under 'normal' load. The C220D used in the prototype will reliably handle an appliance rated at four to five amps, right up to full revs setting under almost-stalled-rotor conditions.

Before attaching the 3-pin panel-mount mains outlet socket to the outside of the case,

PARTS LIST — ETI-1515

Resistors ..... all ½W, 5% unless noted
- R1 ..... 56k
- R2 ..... 22k, 1 W
- R3 ..... 82k
- R4 ..... 27k
- R5 ..... 33k
- R6 ..... 1k5
- R7 ..... 27k
- R8 ..... 3k3
- R9 ..... 8k2
- R10 ..... 1k
- R11 ..... 10k
- R12 ..... 100k
- R13 ..... 15k
- RV1 ..... 100k/A linear pot.

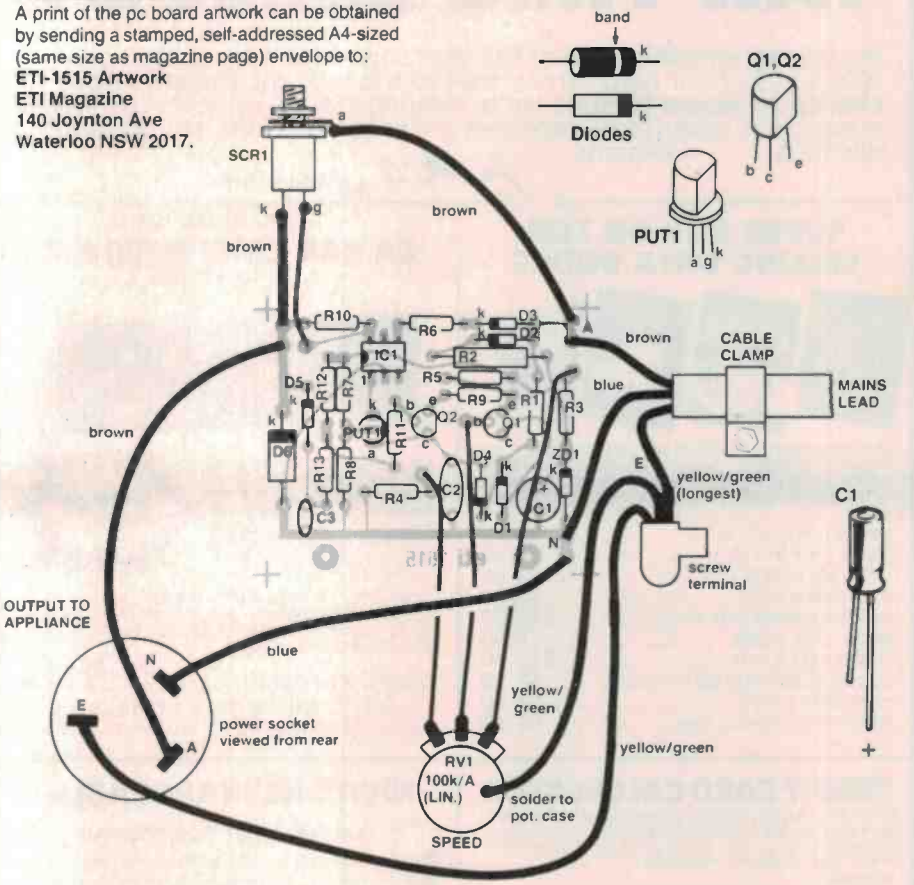
Capacitors
- C1 ..... 22u/35 V RB electro.
- C2 ..... 100n greencap
- C3 ..... 10n greencap

Semiconductors
- D1-D5 ..... 1N4004, EM410 etc.
- D6 ..... 1N5404, 1N5606 etc.
- IC1 ..... MOC3021 triac opto-isolator
- PUT1 ..... 2N6027, D13T1 etc
- Q1, Q2 ..... BC177, BC557
- SCR1 ..... any type, 400 PIV/6A or greater

Miscellaneous
ETI-1515 pc board; case — Unibox P/N 140 (135 x 100 x 38 mm) or similar size to suit; 3-pin panel-mount mains socket; mains cable and plug; small scrap of aluminium, self-tapping screws; screw terminal block; etc.

Price estimate
$20 — $24

PRINTED CIRCUIT ARTWORK
A print of the pc board artwork can be obtained by sending a stamped, self-addressed A4-sized (same size as magazine page) envelope to:
ETI-1515 Artwork
ETI Magazine
140 Joynton Ave
Waterloo NSW 2017.



Overlay and wiring diagram. Follow this to assemble the pc board and wiring up of the external components.

attach *colour-coded* wires to its terminals and thread these through the holes drilled for them in the case. Take care that you get the active (A), neutral (N) and earth (E) wires correct. Use wire from a short length of stipped-down mains flex.

When attaching the mains cable, cut back the sheath so as to expose some 150 mm of the three wires to provide connections later. Make sure the cable is very firmly secured.

Mount the potentiometer using nuts on *both sides* of the case panel and lock the bushing tight so that there's no possibility of the pot. body coming loose and being rotated when the knob is turned.

Assemble the pc board next, according to the overlay diagram. You'll find it easier to solder the diodes in place first, followed by the resistors, capacitors and the rest of the semiconductors. As usual, watch the orientation of all the semiconductors and the electrolytic capacitor (C1).

Having done that, *check it*. Make an especially careful examination of the soldering as diagnosis of problems will be dangerous and/or difficult later because the board operates 'live'. In other words, if you are going to make only one project work first time this year, make it this one.

Attach the three wires that go to the potentiometer. Better colour-code or mark these in some way to avoid confusion and wiring errors. Make sure they're long enough. Ordinary hookup wire will do for these. An ordinary piece of hookup wire can also be used for the lead to the SCR gate. The leads to the SCR anode and cathode carry mains potential and load current and should be wired using mains-rated wire. Get it from some stripped-down mains flex, like before.

Now wire up the mains input cable and the mains outlet socket to the pc board, then *check it*.

Note that the earth wire on the mains input cable should be longer than the active and neutral wires. Should the mains cable come adrift, the earth wire would then be the last to break.

The try out

When you're satisfied the project is correctly together it's time for a try-out. Just plug in your drill, blender or whatever into the outlet socket, set the speed pot. a bit up from minimum, plug the controller into the mains and switch on. See that the appliance's motor rotates at some low speed. Advance the speed control and see that the motor speed increases, as expected. If nothing's happening at this stage, switch off, unplug everything and go over your wiring (this assumes you *know* the appliance works).

If that works, then try applying a load with the motor set at some convenient speed and see that the controller maintains the motor speed, If not, you've got troubles on the pc board and you'd better unplug everything and go over it.

If you are using the unit with an unusual motor, where the inertia of the armature may be greatly different to that expected by this circuit, you can vary the gain of the feedback amplifier by simply changing the value of R9. This can be varied between a minimum of about 150 ohms and a maximum of 22k.

Thus, if the motor hunts excessively (especially at low speed settings), R9 may be increased from the 8k2 value shown, reducing feedback loop gain and restoring stability at a small price in speed constancy. If the reverse is the case, you can acquire tighter regulation by reducing R9 — but check that hunting is kept to a minimum.

Finally, several words of caution are in order. The power bursts which are applied to the motor by the SCR switching and the control system variations with the motor armature running at low speed, applies a lot of stress to the motor's brushes and armature windings, so the controller should not be used in applications where it's not really necessary. Wear from the controller's use is unlikely to significantly shorten the life of an appliance, but it is never good practice to strain a mechanical device unnecessarily.

In addition, many appliance motors, particularly drills, employ a small cooling fan on the armature. The cooling effect of the fan is reduced and extended periods of operation at low speeds should thus be avoided. ●

How to use digital voltmeter modules

Part 1

The popular DPM-05 digital voltmeter module with 3½-digit liquid crystal display is a very convenient 'workhorse' for a myriad of applications. This two-part feature tells you how to put it to use. The ETI-161 Digital Panel Meter is very similar and can be used in many of the circuits given.

Ray Marston

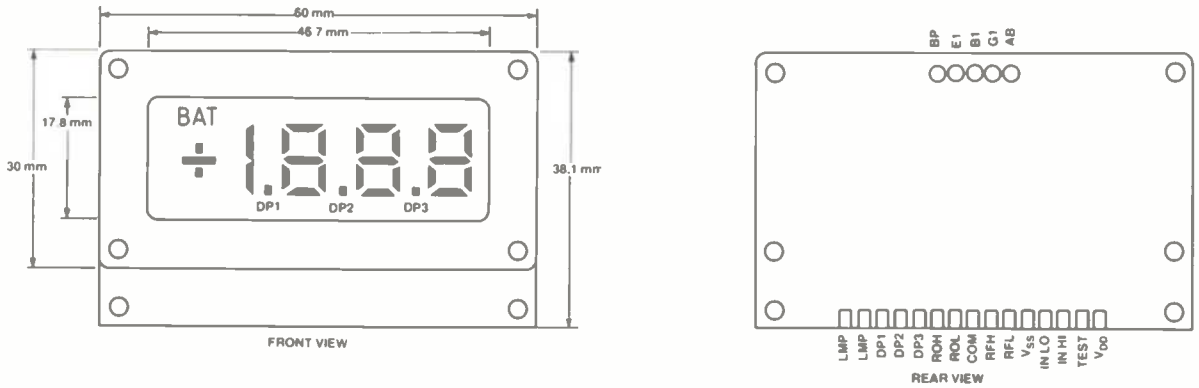
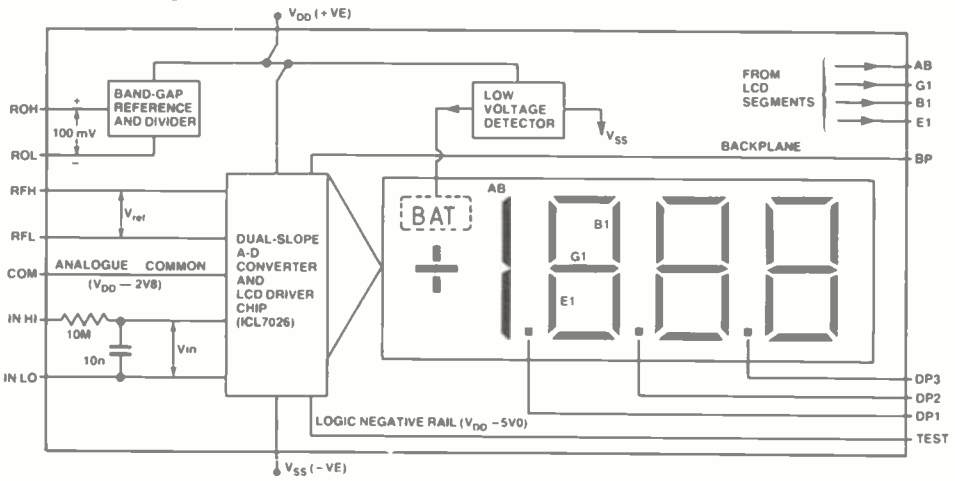


Figure 1. Physical details (left) and terminal notations (right) of the DPM-05 module.

CHARACTERISTIC	DATA (at 25 C)
Display	3½ digit LCD
Full scale sensitivity	±199 9 mV
Power supply voltage	9 Vdc nominal (range 7 to 10 V)
Supply current	1 mA typ, 2 mA max
Initial calibration accuracy	better than ±0 15% of reading + 1 count
Zero-input reading	±000 0 typ
Display resolution	1 count = 100 μV
Input leakage current (at V_{in} = 0)	1 pA typ, 10 pA max
Operating temperature	0 C to + 50 C
Clock frequency	40 kHz typ
Sample rate	2 5 readings/s
'Low battery' indication voltage	7 2 V typical

Table 1. Main parameters and features of the DPM-05 module.

Figure 2. Block diagram 'user view' of the DPM-05 module.



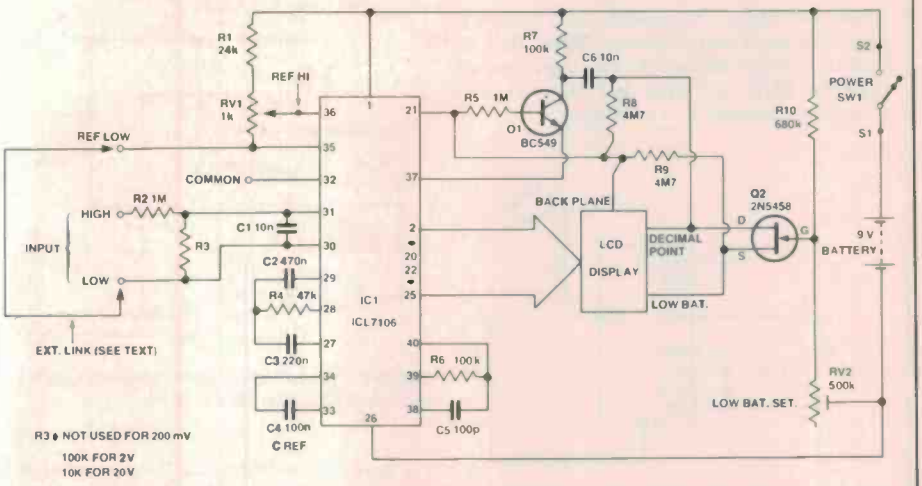
MODERN DIGITAL VOLTMETER (DVM) modules can be used to replace moving coil meters in virtually all important 'analogue' measuring applications. Most of these modules combine an Intersil ICL7026, 7126 or 7136 analogue-to-digital (A-D) converter chip and a 3½-digit liquid crystal display plus a band-gap voltage reference and a few other components, into a compact module that consumes less than 1 mA from a 9 V supply and costs little more than a good quality moving coil meter.

Usually, these modules have a basic full-scale measurement sensitivity of ±199.9 mV, with 100 uV (2000-count) resolution and a typical calibrated accuracy of 0.1% ±1 digit, but can be used to read any desired current or voltage range by connecting suitable shunts or potential dividers to the input terminals. When connected to suitable external circuitry, the modules can be made to indicate ac voltage or current, resistance, capacitance, frequency, temperature, or any other parameter than can be converted into a linear analogue voltage or resistance. I'll show you how later in this two-part feature.

Several companies manufacture 3½-digit LCD DVM modules. Generally, these modules differ only in details of their internal circuitry and displays and in the number and notations of their user-available terminals. The DPM-05 module manufactured by Printed Circuits International Ltd, imported and distributed here by Jaycar, is probably

the best known and most widely available model, and is very typical of the genre, so we'll refer to this specific device throughout the rest of this article. Figure 1 shows the physical details and terminal notations of the DPM-05 and Table 1 lists its main parameters and features.

The ETI-161 Digital Panel Meter module is very similar. This was published in the August 1982 issue and kits are widely available. The accompanying panel shows the circuit and a rear view of the pc board with equivalent connections to those of the DPM-05 annotated. Note that the ETI-161 does not include the band-gap reference. Lab Notes in the November 1980 issue gives circuit details of a band-gap reference that could be adapted to the circuits in this feature, if necessary.



ETI-161 Panel Meter. Circuit of the ETI-161 panel meter project which can be used in almost all the applications circuits given in this two-part series. Many circuits require direct access to 'REF HI' (RFH), in which case delete R1 and RV1.

DPM-05 basics

Figure 2 shows the block diagram 'user view' of the DPM-05, which is normally powered from a 9 V battery connected between the V_{DD} and V_{SS} terminals. The heart of this particular unit is an ICL7026 chip which is a complete dual-slope analogue-to-digital converter and LCD driver. In essence, this chip automatically compares the relative values (ratios) of V_{ref} and V_{in} and produces an LCD display of 1000 x V_{in}/V_{ref}, updating the display about 2½ times per second.

Thus, if V_{ref} is 100 mV and decimal point DP3 is activated, the display reads 10.0 with an input of 10.0 mV, or 199.9 with an input of 199.9 mV. The module automatically displays the polarity of the input signal, gives automatic zero adjustment, and gives over-range indication by blanking the three least significant digits of the display. The three decimal points of the LCD are externally available at the DP1 to DP3 terminals, and can be turned on by pulling the appropriate terminal to V_{DD}. The module also houses a 'low battery' detector, which turns on an 'annunciator' in the display when the battery voltage falls below 7.2 volts.

It is important to note that the DVM module actually displays the relative *ratios* of the input and reference voltages. To give maximum versatility, each of the voltages is applied to the module via a *pair* of terminals (RFH and RFL for the reference, IN HI and IN LO for the input), and the integrator chip responds to the differential values of these inputs. In use, these terminals must be tied (either directly or indirectly) to within 500 mV of the COM terminal. When correctly used, the terminals have typical input impedances of about 5000 megohms, and pass typical leakage currents of only a few picoamps. The IN HI terminal incorporates an integrating ripple-reduction filter.

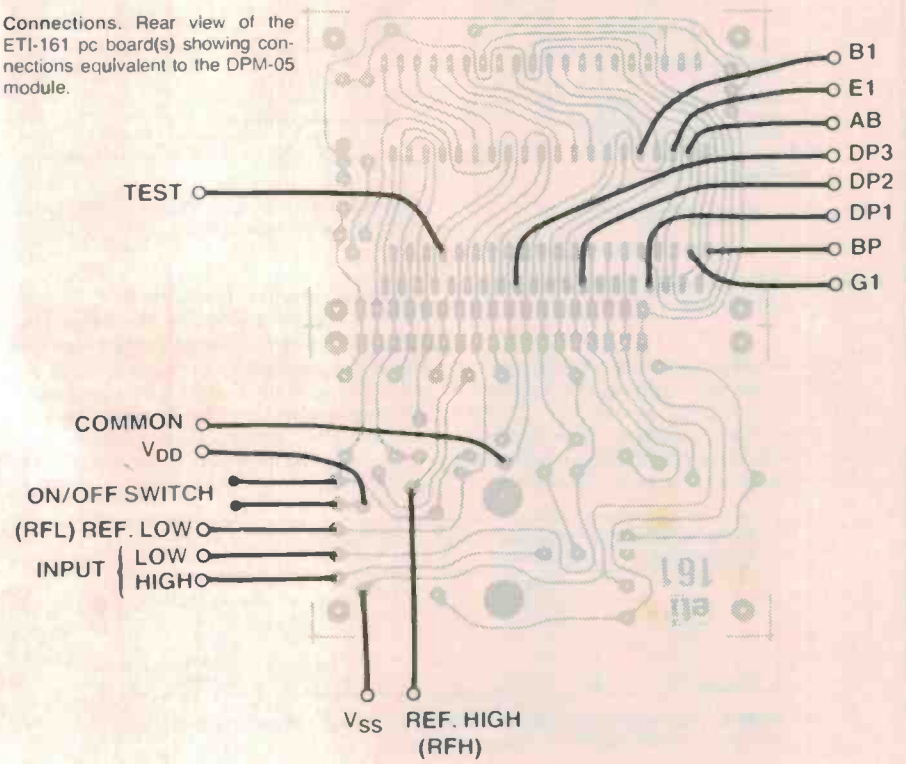
The module has two built-in reference-voltage sources. The voltage between the COM and V_{DD} terminals is zener-regulated at 2V8 and has a typical temperature coefficient of 80 ppm/°C, so any reference voltage below this value can be obtained by wiring a simple potential divider between▶

SPECIFICATIONS

Full scale readout	depends on setup. Full scale sensitivity is 199.9 mV
Resolution	100 uV
Accuracy	‹ 1 digit when correctly calibrated
Display	3½-digit LCD
Input Impedance	› 10^{12} ohms
Input bias current	approx. 2 pA
Polarity indication	automatic
Conversion method	dual slope
Reference	internally generated ±100 ppm
Power supply	9 V @ approx. 1 mA

ETI-161. View of the Panel Meter project published in the August 1982 issue.

Connections. Rear view of the ETI-161 pc board(s) showing connections equivalent to the DPM-05 module.



these terminals. The module also houses a precision band-gap reference. When ROL is tied to COM a stable 100 mV is generated between ROH and ROL and has a typical temperature coefficient of 50 ppm/°C.

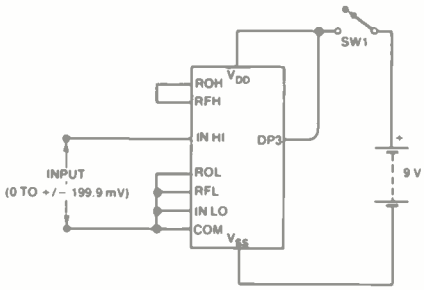


Figure 3. Standard '199.9 mV full-scale' connection of the DVM module.

Basic configurations

Figures 3 to 6 show four different ways of connecting the terminals of a DVM module to give different types of measurement action. Figure 3 shows the standard '199.9 mV full scale' DVM configuration. Here, the COM, IN LO, RFL and ROL terminals are all joined together, ROH is shorted to RFH so that the 100 mV band-gap reference is applied across the reference terminals, and decimal point DP3 is tied to V_{DD} so that the unit gives a reading of '100.0' when 100.0 mV is applied between IN HI and IN LO.

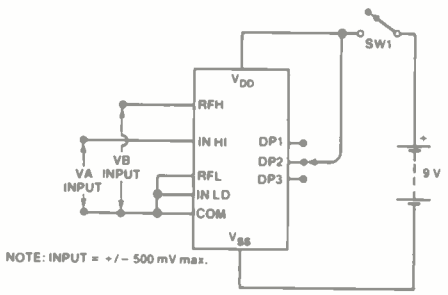


Figure 4. Basic ratiometric voltmeter connection. Display = 1000 x VA/VB.

Figure 4 shows the connections for making the module act as a ratiometric voltmeter which (ideally) gives a reading of '1000' when two input voltages have identical values, irrespective of the actual magnitudes of those values (up to a limit of 500 mV).

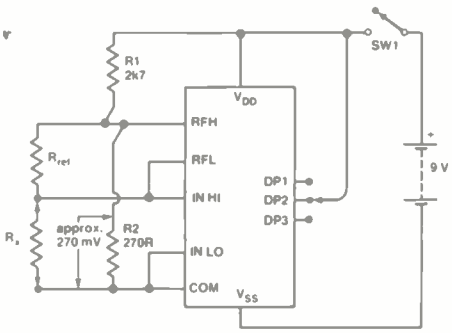


Figure 5. Precision resistance meter using ratiometric technique. Display = 1000 x R_x/R_{ref}.

Figure 5 shows the module connected as a precision ohmmeter. Here, potential divider R1-R2 generates roughly 270 mV between the R1-R2 junction and the COM terminals, and this voltage is used to energise potential divider R_{ref}-R_x. Identical currents flow through these two resistors, and the generated voltage of R_{ref} is applied across the RFH and RFL reference terminals, and the generated voltage of R_x is applied across the IN HI and IN LO input terminals. The display reading thus equals 1000 x R_x/R_{ref}. If R_x has a decade value (1k0, 10k etc), the display gives a direct readout of the R_x value, the reading being independent of the actual value of energising voltage developed across R2.

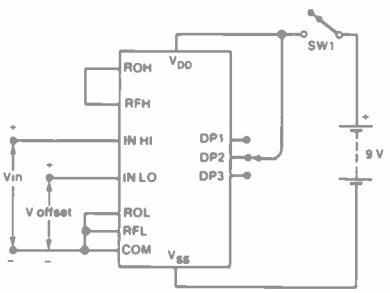


Figure 6. Method of applying zero-offset to the basic 199.9 mV DVM circuit. Display = $V_{in} - V_{offset}$.

Finally, Figure 6 shows how an offset voltage can be applied to the basic 'DVM' circuit so that the display reads zero when the input voltage is at a value other than zero. This circuit is useful in temperature-reading applications for example, in which a special IC is used to give an output of 1 mV/°K, thus giving an output of 273.2 mV at 0 C and 373.2 mV at 100°C.

PERCENTAGE OF FULL SCALE	NOMINAL READING	TRUE READING ACCURACY A	B
100%	199.9 mV	±0.15%	±0.05%
50%	100.0 mV	±0.2%	±0.1%
25%	50.0 mV	±0.2%	±0.2%
10%	20.0 mV	±0.5%	±0.5%
5%	10.0 mV	±1.0%	±1.0%
1%	2.0 mV	±5.0%	±5.0%

Table 2. True reading accuracies of 3½-digit DVMs with calibrated accuracies of (A) ±0.1% and (B) ±0.01% of reading ±1 count.

By feeding the output of the IC between the COM and IN HI terminals and applying a 273.2 mV offset voltage between COM and IN LO, the module (which reads the *differential* value of the input) can be made to give a direct reading of temperature in degrees Centigrade.

Some finer points

If you intend to use a DPM-05 or similar module in a project, there are some fine 'usage' points that you will need to know. Let's deal with these points under various sub-headings.

Calibration accuracy. As supplied, a DVM module is pre-calibrated to read 199.9 mV full scale, with a typical accuracy of ±0.1% of reading ±1 count, at 25°C, this calibration being valid *only* when the module is used in the precise configuration shown in Figure 3. It should be noted that the best attainable accuracy of a 3½-digit (2000-count) meter is ±1 digit, and this corresponds to an actual reading accuracy of 0.05% at full scale, to 0.5% at 10% of full scale, and to 5% at 1% of full scale. Table 2 shows the reading accuracies of two meters, having different calibration accuracies, at various percentages of full scale.

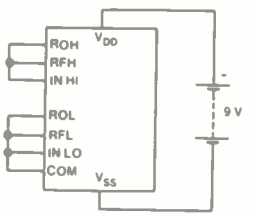


Figure 7. Ratiometnc-accuracy test circuit. Ideally, the meter should read '1000'. Typically, the reading may be '998' (= 0.2% low).

Ratiometric accuracy. The DVM is a ratiometric reading unit. If connected as shown in Figure 7, with identical voltages applied to the RFH and IN HI terminals, it should ideally read '1000' ±1 count.

In practice, modules typically give a reading that is about 0.2% below this figure. This discrepancy is caused by the potential divider action of the internal 10M filter resistor and the input impedance on the internal IN HI line.

When the meter is supplied for use in the 'voltmeter' mode, it is calibrated to allow for ratiometric errors.

Reference accuracy. The built-in '100 mV' reference (between ROH and ROL) of the module is factory-calibrated so that the meter reads '100.0 mV' with 100.0 mV input applied. The precise value of the reference voltage depends on the ratiometric accuracy of the meter. Thus, if the ratiometric accuracy is 0.2% low (reading 998), the reference is also set 0.2% low (at 998 mV) to give the correct 'voltmeter' accuracy.

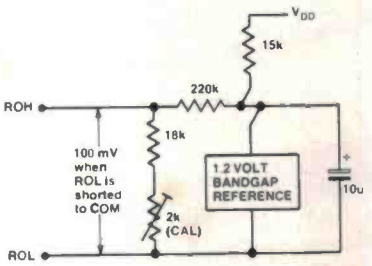


Figure 8. Typical bandgap reference circuit has an output impedance of about 20k.

input impedances and draw leakage currents of only a few picoamps. If the terminals are biased at voltages significantly different from COM, the input leakage currents may rise to several hundred picoamps, invalidating the auto-zero action of the chip. The chip may be damaged if the terminals rise above V_{DD} — 0.5 V or below V_{SS} + 1 V.

'COM' terminal. The COM terminal of the module is connected to the circuit of Figure 9 within the A-D chip, and this circuit enables the COM terminal to be used as either a precision voltage reference, as a current sink for external circuitry, or as an externally-biased analogue-reference point.

When used as a voltage reference, only very low external sink currents (below 100 uA) must be allowed to flow between V_{DD} and COM. Under this condition the basic calibration of the module is valid, and the COM terminal is held about 2V8 below V_{DD}, with a temperature coefficient typically less than 80 ppm/°C.

When used as a current sink, external currents of up to 30 mA can be allowed to flow between V_{DD} and the COM terminal (which has an impedance of about 15 ohms in this mode). In this mode, however, the basic calibration of the module may be invalid, and the RFH and RFL terminals may have to be driven from an external reference.

The COM terminal can source currents up to a maximum value of only 10 uA. Consequently, the common line of the A-D chip can be tied to a value that is more than 2V8 below V_{DD} by simply connecting the COM terminal to an external bias voltage of the required value. In this mode, the basic calibration of the module is invalid, and the RFH and RFL terminals must be driven from an external reference; the INPUT and REFERENCE terminals must be tied within 500 mV of COM (see Figure 12). Note that COM should not be allowed to fall to a value more than 4V7 below V_{DD}.

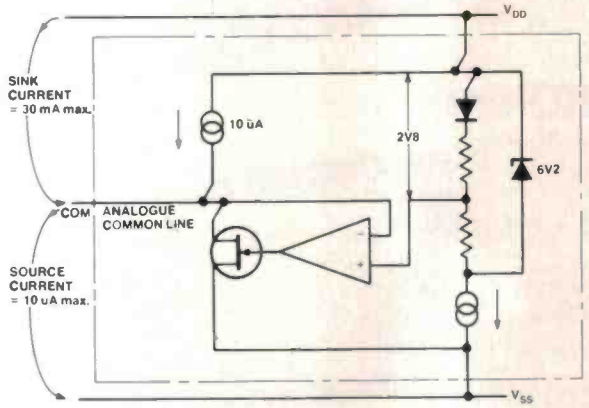


Figure 9. Analogue COMmon line biasing circuit within the A-to-D converter chip.

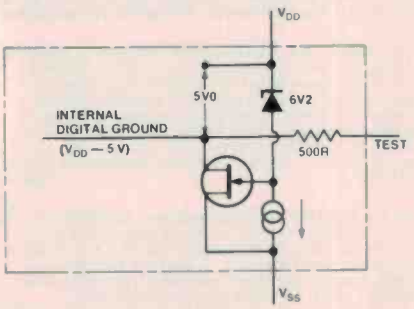


Figure 10. Internal digital ground biasing circuit of the A-to-D converter chip.

The reference output is accurate only when ROL is tied directly to COM (which is normally 2V8 below V_{DD}) and when ROH is loaded by an impedance greater than 50 megohms or so. Figure 8 shows the typical circuit of a band-gap reference. The output impedance of the circuit is about 20k so an external loading of 2M would introduce an error of 1%, and a loading of 20M an error of 0.1%. The high input impedance of the RFH terminal causes negligible loading.

Input connections. The A-D converter chip houses analogue and digital circuitry. All analogue action is internally referenced to the COM (common) line of the chip. Normally, the INPUT and REFERENCE inputs should be tied (directly or indirectly) to within 500 mV of the COM line, and under these conditions the terminals have very high

TEST & BP. The negative or ground rail of the digital circuitry of the A-D chip is internally biased at about 5 V below V_{DD} by the circuit of Figure 10 and is coupled to the TEST terminal via a 500 ohm resistor. This terminal can be used as the negative rail of external digital circuitry that is powered from V_{DD}, provided that the TEST currents do not exceed 1 mA.

If TEST is shorted directly to V_{DD} the LCD should read '−1888'; under this condition 10 mA flows into the TEST terminal and a steady dc voltage is applied to the LCD; this voltage may burn the display if sustained for several minutes.

The back-plane (BP) drive signal to the display switches fully between TEST and V_{DD} at the clock frequency divided by 800. With a 40 kHz clock, BP has a frequency of 50 Hz (giving a period of 20 mS). Note that the calibration accuracy of the module is independent of the clock frequency, which is thus not designed to be particularly stable.

Auxiliary terminals. The DPM-05 has a number of auxiliary terminals that are used only in special applications. The two LMP terminals give access to a backlight bulb fitted to the LCD in some special modules.

The AB terminal connects to the '1000' digit of the LCD, and the E1, B1 and G1 terminals connect to the E, B and G segments respectively of the '100s' digit of the LCD. These terminals can be decoded with the BP signal to detect the over-range (O/R) and under-range (U/R) states of the module and thence activate auto-ranging circuitry, etc. Figure 11 shows the external decoder circuit that must be used; the two ICs are powered from the V_{DD} and TEST terminals. ▶

continued on page 52

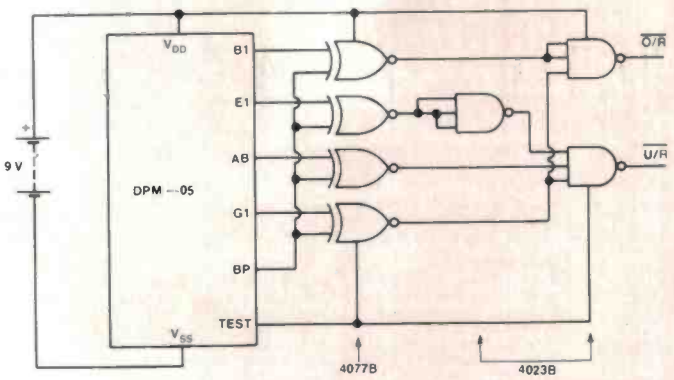


Figure 11. Circuit for developing under-range and over-range signals from the DPM-05.

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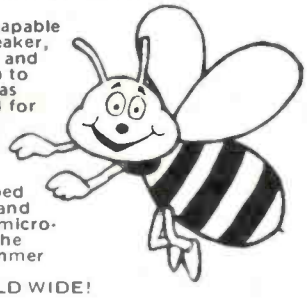
The Microbee is definitely the most versatile computer now available in Australia. Its ability to run complex software, and its friendliness to the user, have gained the Bee great acceptance, in the home, in small to medium businesses and in schools. In fact the Bee has recently been approved and recommended under contract by the N.S.W. and W.A. Education Departments. **Children are growing up with Bee's!**



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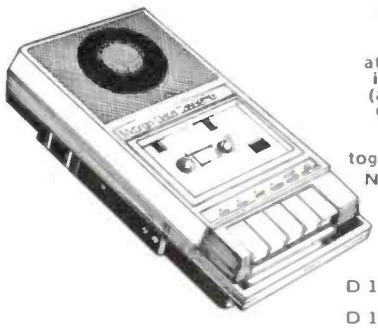

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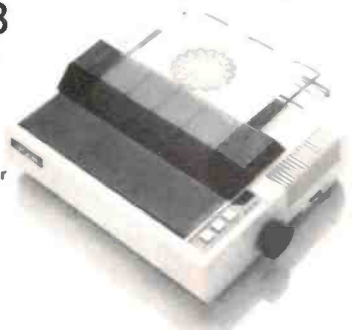

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Specifications:
Print Rate: 80 char. per sec. **Print Direction:** Bidirectional logic seeking. **Character Set:** Full 96 character **ASCII** with descenders plus 8 international char. sets. **Character Structure:** 9 x 9 text mode. **Character Size:** 3.1 (H) x 2.1 (W)mm. **Total of 32 Printing Styles:** Normal, Normal Enlarged, Condensed, Condensed Enlarged, Emphasized, Programmable. **Paper Feed:** Adjustable sprocket (4"-10") plus Friction Feed. **Interface:** Centronics 8 Bit Parallel.

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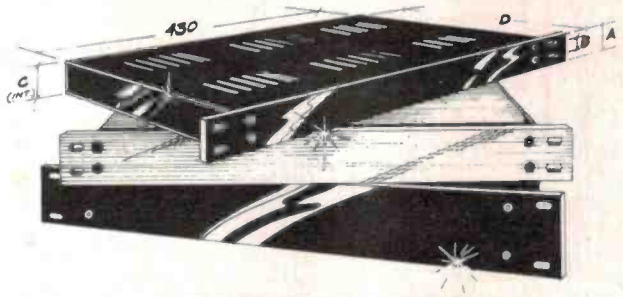

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See Review in Electronics Australia August 1982

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LW	145-360	KHz	SW3	9-22	MHz	VHF3	88-108	MHz
MW	525-1600	KHz	SW4	22-30	MHz	VHF4	108-136	MHz
SW1	1.6-3.8	MHz	VHF1	30-50	MHz	VHF5	144-176	MHz
SW2	3.8-9	MHz	VHF2	68-86	MHz	UHF	430-470	MHz

Power supply: AC 240V 50Hz. DC 12V (8 x "D" cells). Ext. DC 12V Car/Boat.
Speaker: 12.5cm Permanent Dynamic Speaker (3.2 ohm)
Antenna: Ferrite Bar Antenna for LW, MW and SW1
3 x Telescopic Antenna for SW, VHF and UHF
Controls: Power ON-OFF switch – Digital display ON-OFF switch – Tape-Radio switch, Wide-Narrow band selector switch, AM band selector (LW/MW/SW1/SW2/SW3/SW4), VHF band selector (VHF1/VHF2/VHF3/VHF4/VHF5/UHF), Ant. Selector (Telescopic ANT./EXT. ANT.), Tuning control (direct gear drive), volume control, Bass control, Treble control, Squelch control, BFO pitch control, RF gain control, Antenna adjustor control, Mode switch (USB-NOR-LSB/CW)
Terminals: Ext. Speaker/Headphone Jack, Tape IN-OUT jack, VHF/UHF ANT. connector (coaxial), SW EXT. ANT. terminal (Screw), Ext. battery jack
Meter: Tuning Meter
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Display: LW/MW/SW-1 KHz SW2-4/VHF1-5 MHz
Control: SW Calibrator **Dimensions:** 452mm (W) x 288mm (H) x 130mm (D)

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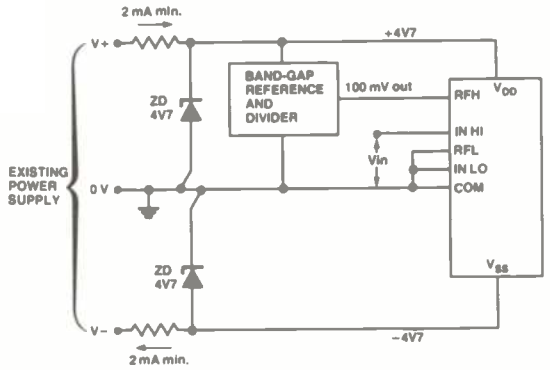


Figure 12. Method of building the module into existing equipment that is powered from split supply rails.

Power supplies

The most popular application of the DVM module is as a self-contained multimeter which is used as a general purpose test instrument. In this type of application the module is simply powered from a 9 V battery connected between V_{DD} and V_{SS}.

The module can, however, be built into existing equipment and used in dedicated measuring/indicating applications.

If the equipment is powered from a single-ended supply, the module must be powered from its own 'floating' supply, derived from either a battery or from a separate winding of a mains transformer.

In the case of a battery-powered instrument, the supply to the meter can be switched by a spare pair of contacts on the main switch.

If the equipment is powered from split supplies, the module can be powered from the existing power rails by using the connections shown in Figure 12, in which COM is tied to the common rail, V_{SS} is fed from −4V7, V_{DD} from +4V7, and the REFERENCE and INPUT terminals are referenced to the COM terminal. The RFH terminal must be driven from an external reference, as shown.

PRACTICAL APPLICATIONS

DC volt & current meters

The DVM module is supplied ready-calibrated to give a full scale reading of ±199.9 mV dc. The module can be made to give alternative full scale dc voltage readings by connecting the input voltage to the module via a decade potential divider, as shown in Figure 13, or can be made to act as a dc current meter by wiring a suitable shunt resistor across the input terminals, as shown in Figure 14.

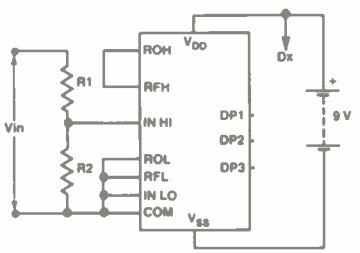
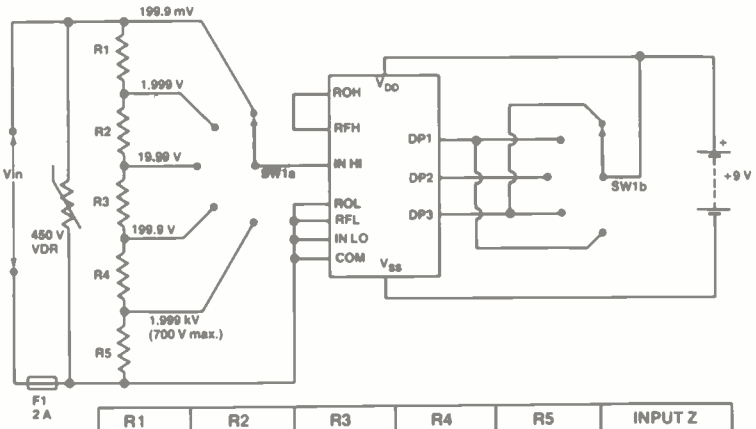


Figure 13. The DVM module can read alternative dc voltage ranges by connecting the input via a potential divider.



R1	R2	R3	R4	R5	INPUT Z
9M 10M	900k 1M	90k 100k	9k 10k	1k 1110R	10M 11.11M

Figure 15. Five-range dc voltmeter.

Note in both diagrams that the appropriate decimal point of the display must be tied high on each range, as indicated.

The module can be used as a five-range dc voltmeter by using the connections shown in Figure 15; the table shows alternative potential-divider component values to give input impedances of 10M or 11.11M.

Precision '9'-decade (9M, 900k, etc) resistors are used in most multimeters and are available from several component suppliers. Note that in multi-range applications the circuit should be provided with some form of overload protection, and in the diagram this is given by fuse F1 and by a voltage-dependent resistor (VDR) or 'transient suppressor' across the divider. Also note that on the '1.999 kV' range the maximum input is actually limited to 700 volts by the VDR.

The module can be used as a five-range dc current meter by using the connections shown in Figure 16. Note here that the generated voltages of the shunts are directly monitored by the DVM module, and that variations in the switch resistance of SW1a have no effect on the accuracy of measurement; a separate input terminal is used for the '2 Amp' measurement. The circuit is protected against positive and negative overloads by diodes D1-D2 and fuse F1.

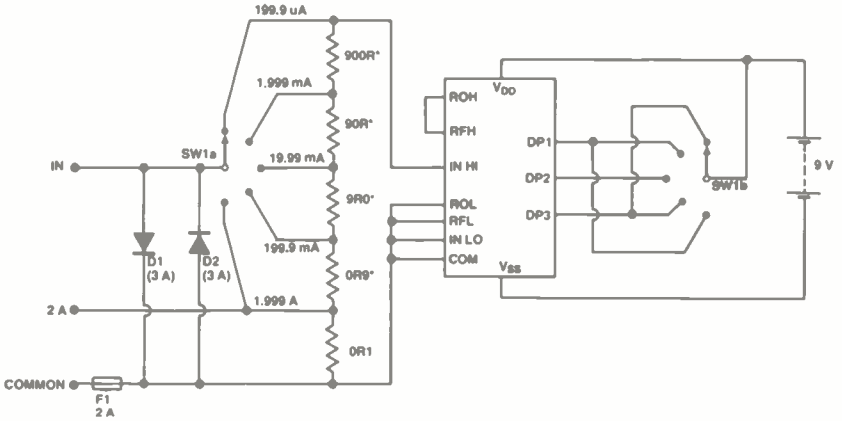


Figure 16. Five-range dc current meter.

R1	R2	V FULL SCALE	DECIMAL POINT HIGH
0	10M	199.9 mV	DP3
9M	1M	1.999 V	DP1
9M9	100k	19.99 V	DP2
10M	10k	199.9 V	DP3
10M	1k	1.999 kV	DP1

R1	I FULL SCALE	DECIMAL POINT HIGH
10k	19.99 μA	DP2
1k	199.9 μA	DP3
100R	1.999 mA	DP1
10R	19.99 mA	DP2
1R	199.9 mA	DP3
0R1	1.999 A	DP1
0.01R	19.99 A	DP2

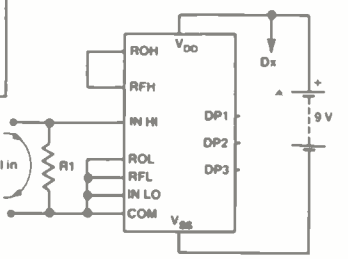


Figure 14. The DVM module can be made to read dc current by connecting a shunt resistor across its input.

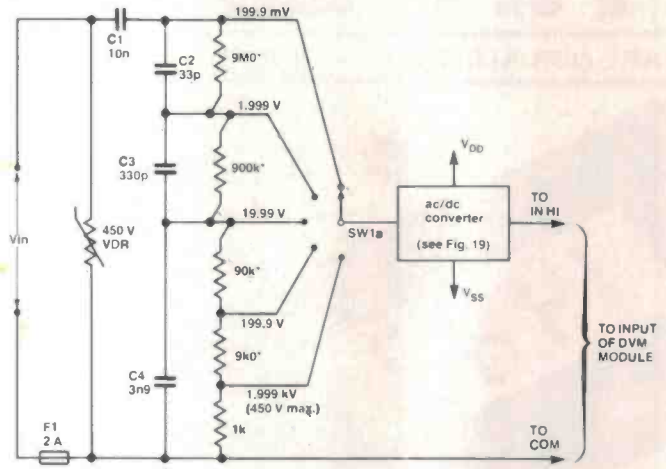


Figure 17. Modification of the Figure 15 circuit, to act as a five-range ac voltmeter.

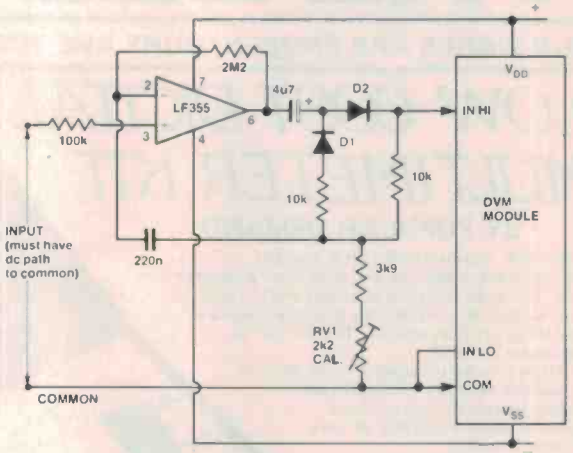


Figure 19. Precision ac/dc converter.

AC volt & current meters

Figure 17 shows how the Figure 15 circuit can be modified to act as a five-range ac voltmeter that has a frequency response flat within 1 dB to about 120 kHz.

Input signals are fed to the attenuator via dc-blocking capacitor C1, and the attenuator is frequency compensated by C2 to C4. The attenuator output is fed to the input of the module via a precision ac/dc converter, which gives a dc voltage output equal to the RMS value of a sinewave input.

Figure 18 shows how the Figure 16 circuit can be similarly modified to act as a five-range ac current meter. In this case it is not feasible to prevent dc currents feeding into the shunts: instead, dc-blocking is done at the output of the shunts via C1-R1, and the resulting ac signals are fed to the input of the DVM module via a precision ac/dc converter.

Note that the input protection network of this circuit differs from that of Figure 16 in that pairs of diodes are wired in series.

Figure 19 shows the circuit of the precision ac/dc converter for use with the above two circuits. The gain of the converter can be set to precisely 2.2 via RV1, to give a dc output voltage that is equal to the RMS value of a sinewave input.

The converter is powered from the supply rails of the module, and is designed around an LF355 op-amp, which can operate quite happily from the 2V8 between V_{DD} and COM.

Resistance meters

The easiest way to use a DVM module as a resistance (ohm) meter is to use it in the ratiometric configuration shown in Figure 5. This technique has two major advantages. First, it is very stable and inherently self-calibrating, the meter reading being equal to $R_x \times (RV/R_{ref})$, where RV is the ratiometric value of the meter when used in the Figure 7 test cicuit. RV is typically only 0.2% low, so measurement accuracy is determined primarily by R_{ref}. The second advantage is that very low test voltages are generated across R_x, the maximum voltage being ⅔ of the energising voltage (typically 100 to 300 mV) at full scale. Figure 20 shows how the module can be connected as a practical five-range ohmmeter. ●

Next month

In the concluding part next month will be a 25-range DMM, temperature, capacitance and frequency meters plus practical construction advice.

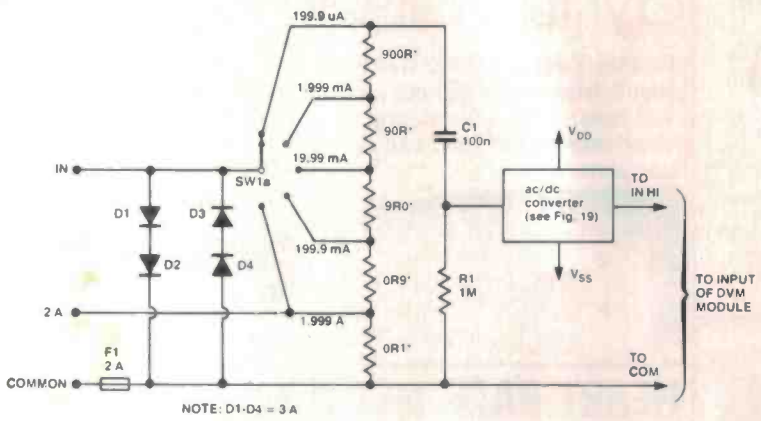


Figure 18. Modification of the Figure 16 circuit, to act as a five-range ac current meter.

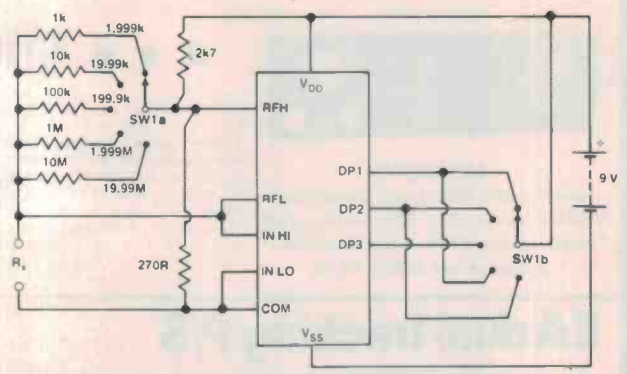


Figure 20. Five-range ohmmeter.

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	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.

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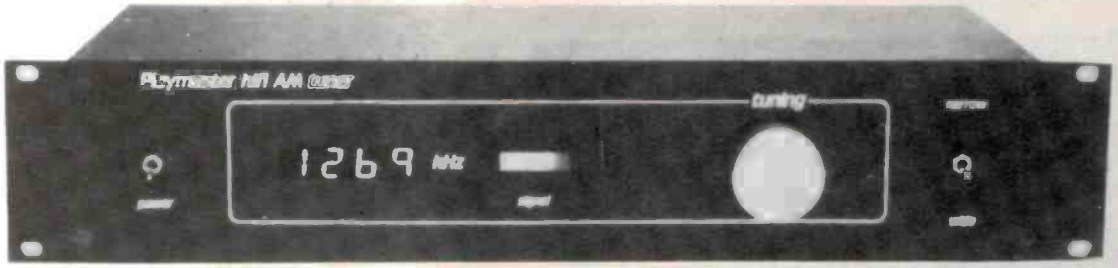
Ref: EA Dec-Jan 82-83

AM Tuner alignment kit ref: EA March 83 This simple project enables you to accurately align your EA wideband tuner. Cat. KA1515 $7.99



Australia is one of the few countries in the world where wideband AM is transmitted. In fact a good quality AM signal can be much better than its FM counterpart!!
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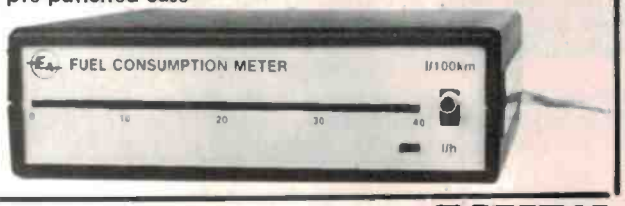

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SCRs, triacs and power control

Part two of Ray Marston's short series on these useful devices. In this part, he covers power switch circuits, electric heater controllers, lamp dimmers and motor speed controllers. A whole stack of applications circuits are given — as usual.

Ray Marston

LAST MONTH's Circuit File dealt at length with the fundamentals of SCR and triac circuitry and gave particular attention to the principles of synchronous and non-synchronous triggering. This issue we present a stack of practical circuits for use on 240 Vac power lines. In these designs, you simply select the triac or SCR rating to suit your own particular application.

Let's start off, then, by looking at some practical triac power switch designs for use in basic on/off ac power line switching applications.

TRIAC POWER SWITCHES

Non-synchronous designs

As was explained in part 1, triacs can be triggered (turned on) either synchronously or non-synchronously with the mains voltage. Synchronous circuits *always* turn on at the same point in each mains half-cycle (usually just after the zero-crossing point), and usually generate minimal RFI. The trigger points of non-synchronous circuits are not synchronised to a fixed point of the mains cycle, and the circuits may generate significant RFI, particularly at the point of initial turn-on. Triac turn-off is always automatically synchronised to the mains, as the device's main-terminal currents fall below the minimum-holding value at the end of each mains half-cycle.

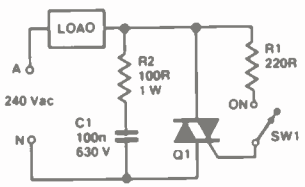

Figure 1. Simple ac power switch, ac line triggered.

Figures 1 to 8 show a variety of non-synchronous triac power switch circuits which can be used in basic on/off line switching applications. The action of the Figure 1 circuit was explained last month, being such that the triac is gated on from the mains via the load and R1 shortly after the start of each mains half-cycle when SW1 is closed, but remains off when SW1 is open. Note, in this circuit, that the trigger point is *not* synchronised to the mains when SW1 is initially closed, but becomes synchronised on all subsequent half-cycles.

Figure 2 shows how the triac can be triggered via a mains-derived dc supply. C1 is charged to +10 V on each positive half-cycle of the mains via R1-D1, and the C1 charge triggers the triac when SW1 is closed. Note that all parts of this circuit are 'live', making it difficult to interface to external electronic control circuitry.

Figure 3 shows how the above circuit can be modified so that it can easily be interfaced to external control circuitry. SW1 is simply

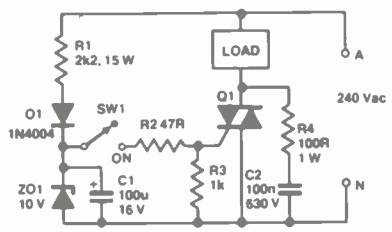

Figure 2. Ac power switch with line-derived dc triggering.

replaced by transistor Q2, which in turn is driven from the 'phototransistor' side of an inexpensive optocoupler. The 'LED' side of the optocoupler is driven from a 5 V or greater dc supply via R4. The triac turns on only when the external supply is connected via SW1.

Optocouplers have typical insulation potentials of 500 to several thousand volts, so the external circuit is fully isolated from the mains, and can easily be designed to give any desired form of remote operation of the triac by replacing SW1 with an electronic switch.

Figure 4 shows an interesting variation of the above circuit. In this case the triac is ac-triggered on each half-cycle of the mains via C1-R1 and back-to-back zeners ZD1-ZD2.

Note that the mains impedance of C1 determines the magnitude of the triac gate current but that C1 dissipates virtually no power. Bridge rectifier D1 to D4 is wired

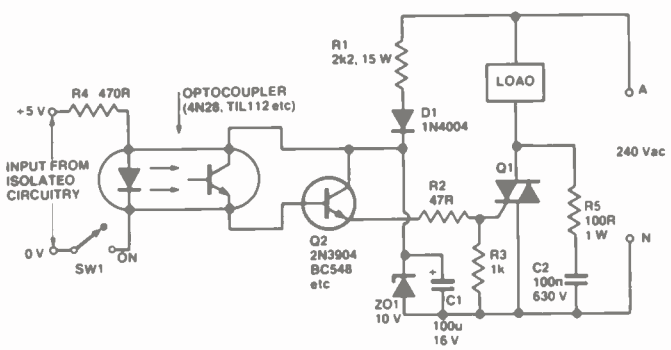

Figure 3. Isolated-input (optocoupled) ac power switch, dc triggered.

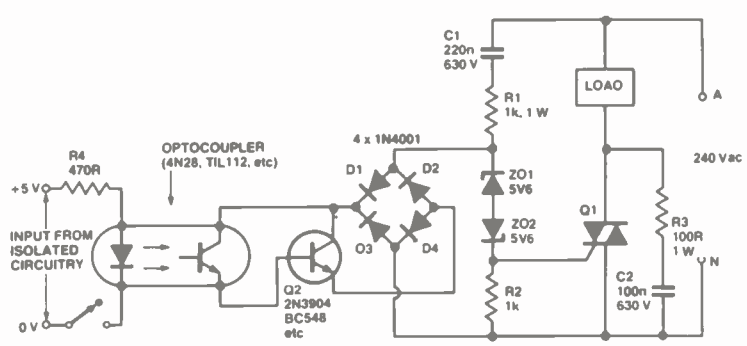

Figure 4. Isolated-input ac power switch, ac triggered.

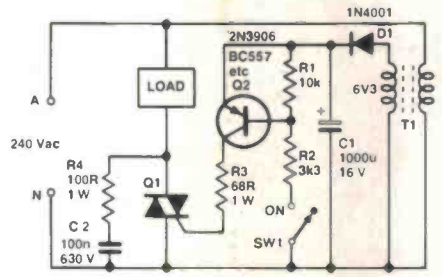

Figure 5. Ac power switch with transistor-aided dc triggering.

Figures 5 and 6 show a couple of ways of triggering the triac via a transformer-derived dc supply and a transistor-aided switch. In the Figure 5 circuit, the transistor and the triac are both driven on when SW1 is closed, and are off when SW1 is open.

In practice SW1 can easily be replaced by an electronic switch, enabling the triac to be operated by heat, light, sound, etc. Note however, that the whole of the Figure 5 circuit is 'live'.

Figure 6 shows how the circuit can be modified for optocoupler operation, so that it can be activated via fully isolated external circuitry.

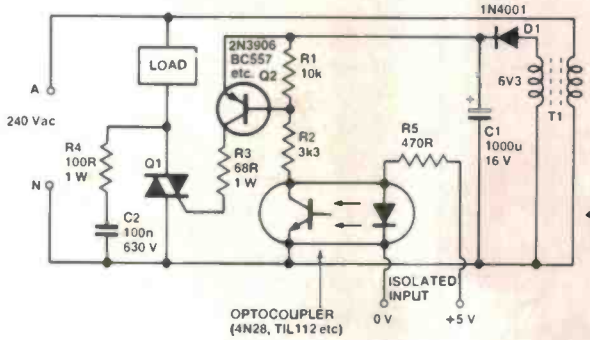

Figure 6. Isolated-input ac power switch with dc triggering.

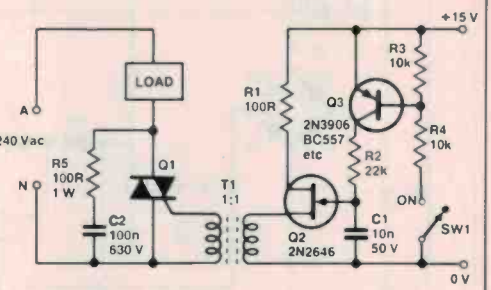

Figure 7. Isolated-input (transformer-coupled) ac power switch.

Synchronous designs

Synchronously-triggered triac circuits *always* turn on at the same point in each mains half-cycle. Usually, the trigger point occurs just after the 'zero-crossing' point at the start of each half-cycle, in which case the triac generates absolutely minimal RFI.

Figures 9 to 18 show a number of on/off power switching circuits that use this form of triggering.

Figure 9 shows the practical circuit of a 'transistorised' synchronous line switch that is triggered near the zero-voltage crossover points of the mains. The triac gate trigger current is obtained from a 10 Vdc supply that is derived from the mains via R1-D1-ZD1 and C1, and this supply is switched to the gate via Q5, which in turn is controlled by SW1 and zero-crossing detector Q2-Q3-Q4.

The action of Q5 is such that it can only turn on and conduct gate current when SW1 is closed and Q4 is off. The action of the zero-crossing detector is such that Q2 or Q3 are driven on whenever the instantaneous mains voltage is positive or negative by more than a volt or two (depending on the setting of RV1), thereby driving Q4 on via R3 and inhibiting Q5.

Thus, gate current can only be fed to the triac when SW1 is closed and the instantaneous mains voltage is within a few volts of zero. The circuit thus provides minimal switching RFI.

across the ZD1-ZD2-R2 network and is loaded by Q2. When Q2 is off, the bridge is effectively open and the triac turns on shortly after the start of each mains half-cycle: when Q2 is on, a near-short appears across ZD1-ZD2-R2 inhibiting the triac gate circuit, and the triac is off.

Transistor Q2 is actually driven via the optocoupler from an isolated external circuit, so the triac is normally on but turns off when SW1 is closed.

CONSTRUCTION OF T1, FIGS 7, 8

The core is a 30 mm long piece of 9.6 mm dia. ferrite aerial rod. The primary and secondary are each 30 turns of 0.4 mm dia. enamelled wire (26 B&S) closewound on the centre 15 mm of the core. Use two layers of plastic insulation tape between the two windings and cover complete unit with a further two layers of tape. Bring the primary and secondary leads out opposite ends of the core. Mark the starts of each winding (spots on circuit).

Finally, to complete this section, Figures 7 and 8 show a couple of alternative ways of obtaining triacs triggering from a fully isolated external circuit. In these two circuits the triggering action is obtained from a unijunction (UJT) oscillator (Q2) which operates at a frequency of several kilohertz and has its output pulses fed to the triac gate via pulse transformer T1, which provides the desired 'isolation'.

In the Figure 7 circuit, Q3 is wired in series with the UJT's main timing resistor so the UJT and triac turn on only when SW1 is closed. In the Figure 8 circuit, Q3 is wired in parallel with the UJT's main timing capacitor so the UJT and triac turn on only when SW1 is open. In both of these circuits, SW1 can easily be replaced by an electronic switch.

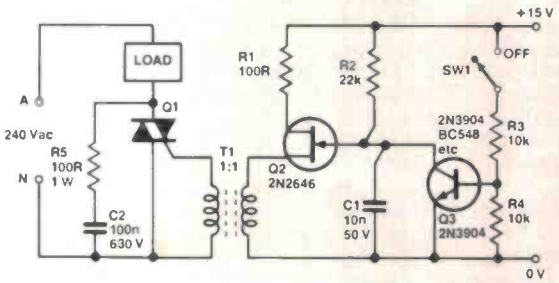

Figure 8. Isolated-input ac power switch.

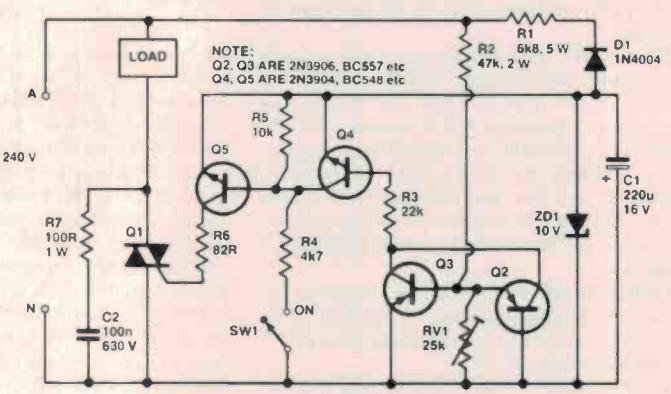

Figure 9. 'Transistorised' synchronous line switch.

Figure 10 shows how the circuit can be modified so that the triac can only turn on when SW1 is open. Note in both of these circuits that, since only a narrow pulse of gate current is sent to the triac, the *mean* consumption of the dc supply is very low (1 mA or so). Also note that SW1 can easily be replaced by an electronic switch to give automatic operation via heat, light, etc, or by an optocoupler to give fully isolated operation from external circuitry.

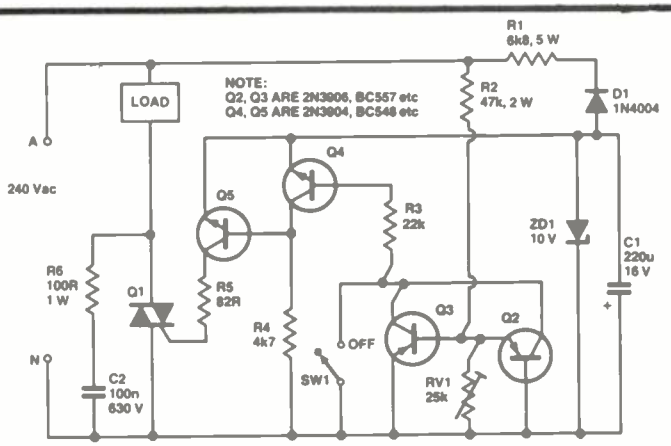

Figure 10. Alternative version of the 'transistorised' line switch.

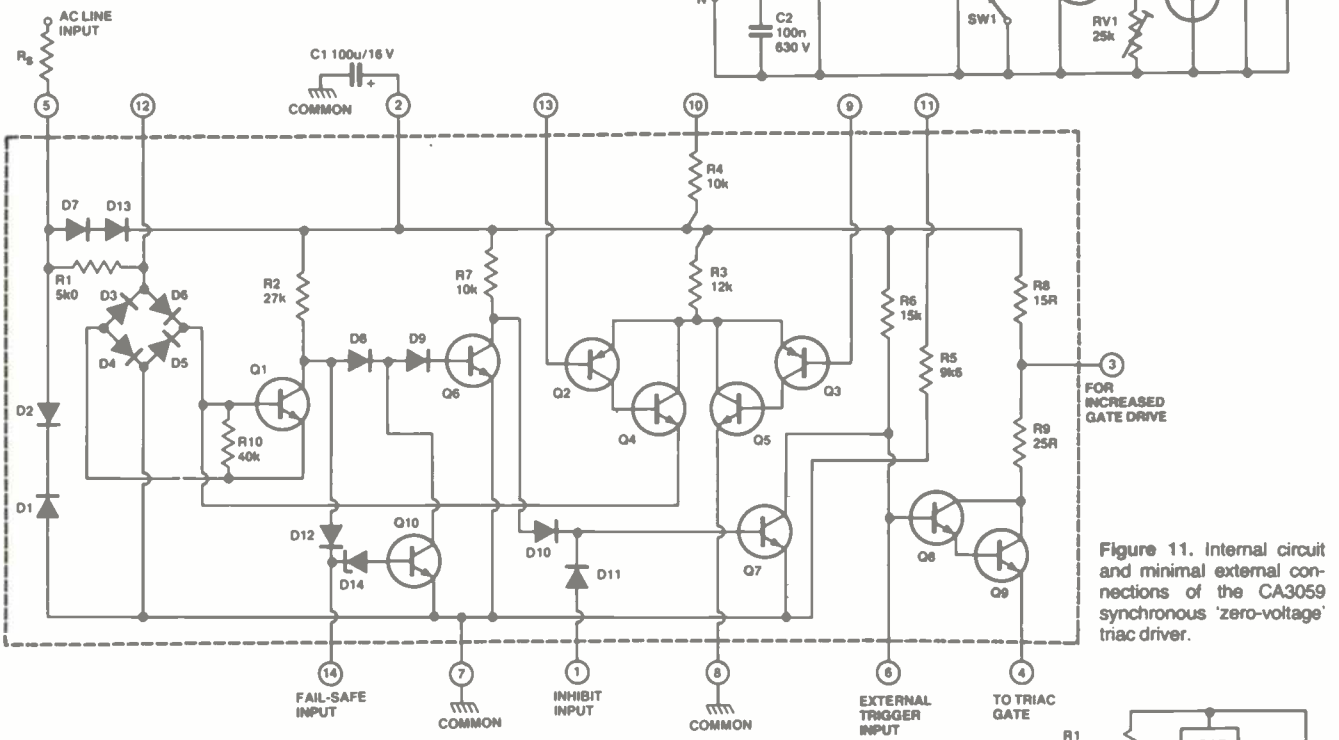

Figure 11. Internal circuit and minimal external connections of the CA3059 synchronous 'zero-voltage' triac driver.

A number of special-purpose synchronous zero-crossover triac-gating ICs are available, the best known examples being the CA3059 and the TDA1024. These devices incorporate mains-derived dc power supply circuitry, a zero-crossing detector, triac gate drive circuitry, and a high gain differential amplifier/gating network.

Figure 11 shows the internal circuitry of the CA3059, together with its minimal external connections. Mains power is connected to pins 5 and 7 via limiting resistor R_S (22k, 5 W or three 68k, 1 W resistors in parallel).

Diodes D1 and D2 act as back-to-back zeners and limit the pin 5 voltage to ±8 V. On positive half-cycles D7 and D13 rectify this voltage and generate 6.5 V across the 100u capacitor connected to pin 2. This capacitor stores enough energy to drive all internal circuitry and provide adequate triac gate drive, with a few milliamps of spare drive available for powering external circuitry if needed.

Bridge rectifier D3 to D6 and transistor Q1 act as a zero-crossing detector, with Q1 being driven to saturation whenever the pin 5 voltage exceeds ±3 V.

Gate drive to an external triac can be made via the emitter (pin 4) of the Q8-Q9 Darlington pair, but is available only when Q7 is turned off. When Q1 is turned on (pin 5 greater than ±3 V) Q6 turns off through lack of base drive, so Q7 is driven to saturation via R7 and no triac gate drive is available at pin 4. Triac gate drive is available only when pin 5 is close to the 'zero-voltage' mains value. When gate drive is available, it is delivered in the form of a narrow pulse centred on the crossover point, with pulse power supplied via C1.

The CA3059 incorporates a differential amplifier or voltage comparator, built around Q2 to Q5, for general purpose use. Resistors R4 and R5 are externally available for biasing one side of the amplifier. The emitter current of Q4 flows via the base of Q1 and can be used to disable the triac gate drive (pin 4) by turning Q1 on.

The configuration is such that the gate drive can be disabled by making pin 9 positive relative to pin 13. The drive can also be disabled by connecting external signals to pin 1 and/or pin 14.

Figures 12 and 13 show how the CA3059 can be used to give manually-controlled 'zero-voltage' on/off switching of a triac. These two circuits use SW1 to enable or disable the triac gate drive via the internal differential amplifier of the IC. Remember, the drive is enabled only when pin 13 is biased above pin 9.

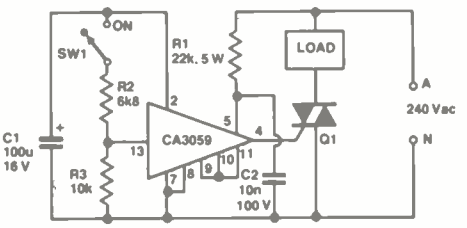

Figure 12. Direct-switched IC-gated 'zero-voltage' line switch.

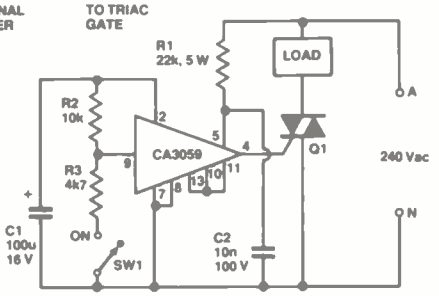

Figure 13. An alternative method of direct-switching the CA3059 IC.

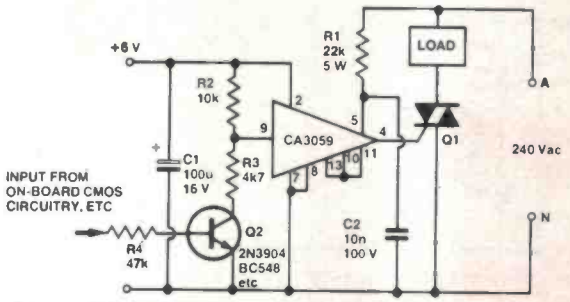

Figure 14. Method of transistor-switching the CA3059 via on-board CMOS circuitry, etc.

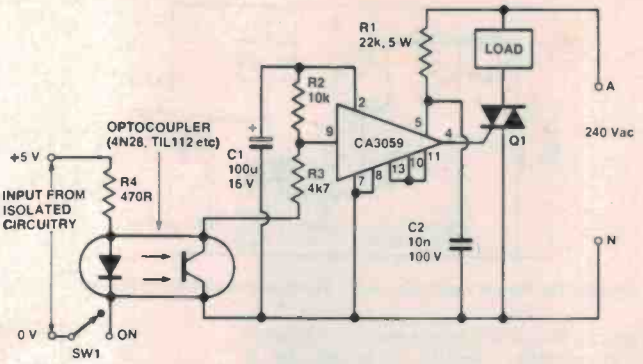

Figure 15. Method of remote-switching the CA3059 via an optocoupler.

In the Figure 12 circuit, pin 9 is biased at half-supply volts and pin 13 is biased via R2-R3 and SW1, and the triac turns on only when SW1 is closed.

In Figure 13, pin 13 is biased at half-supply and pin 9 is biased via R2-R3 and SW1, and the triac again turns on only when SW1 is closed. In both of these circuits, SW1 handles a maximum potential of 6 V and maximum current of only 1 mA or so.

Note, in these designs, that capacitor C2 is used to apply a slight phase delay to the pin 5 'zero-voltage detecting' terminal, and causes the gate pulses to occur slightly after (rather than to 'straddle') the zero-voltage point.

Note in the Figure 13 circuit that the triac can be turned on by pulling R3 low or turned off by letting R3 float. Figures 14 and 15 show how this simple fact can be put to use to extend the versatility of the basic circuit.

In Figure 14, the triac can be turned on and off by transistor Q2, which in turn can be activated by on-board CMOS circuitry (such as one-shots, astables, etc) that are powered from the 6 V pin 2 supply.

In Figure 15, the circuit can be turned on and off by fully-isolated external circuitry via an inexpensive optocoupler, which needs an input in excess of only a couple of volts to turn the triac on.

Alternatively, Figure 16 shows how the TDA1024 can be used in place of the CA3059 to give either directly-switched or opto-coupled 'zero-voltage' triac control.

Finally, to complete this section, Figures 17 and 18 show a couple of ways of using the CA3059 so that the triac operates as a light-sensitive 'dark-operated' power switch. In these two designs the built-in differential amplifier of the IC is used as a precision voltage comparator that turns the triac on or off when one of the comparator input voltages goes above or below the other.

Figure 17 is the circuit of a simple dark-activated power switch. Here, pin 9 is tied to half-supply volts and pin 13 is controlled via the R2-RV1-LDR-R3 potential divider.

Under bright conditions the LDR has a low resistance, so pin 13 is below pin 9 and the triac is disabled. Under dark conditions the LDR has a high resistance, so pin 13 is above pin 9 and the triac is enabled and power is fed to the load. The precise threshold level of the circuit can be preset via RV1.

Figure 18 shows how a degree of hysteresis or 'backlash' can be added to the above circuit, so that the triac does not switch annoyingly in response to small changes (passing shadows, etc) in ambient light level. The hysteresis level is controlled via R3, which can be selected to suit particular applications.

ELECTRIC-HEATER CONTROLLERS

Non-synchronous circuits

Triacs can easily be used to give automatic room-temperature control by using electric heaters as the triac loads and either thermostats or thermistors as the thermal feedback elements.

Two basic methods of heater control can be used, either simple on/off power switching or fully automatic proportional power control. In the former case, the heater switches fully on when the room temperature falls below a preset level and turns off when the temperature rises above the preset level.

In the latter case, the *mean* power to the heater is automatically adjusted so that, when the room temperature is at the precise preset level, the heater output power self-adjusts to balance the thermal losses of the room.

Because of the high power requirements of electric heaters, special care must be taken in the design of triac controllers to keep RFI generation to minimal levels. Two options are open to the designer, to use either continuous dc gating of the triac, or to use synchronous pulsed gating.

The advantage of dc gating is that, in basic on/off switching applications, the triac generates zero RFI under normal (on) running conditions. The disadvantage is that the triac may generate very powerful RFI as it is initially switched from the off to the on condition.

The advantage of synchronous gating is that no high-level RFI is generated as the triac transitions from the off to the on condition. The disadvantage is that the triac generates continuous very-low-level RFI under normal (on) running conditions.

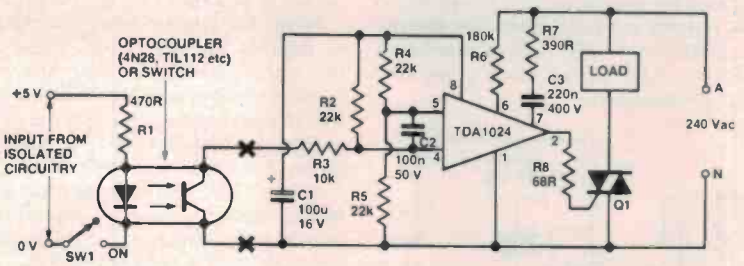

Figure 16. The TDA1024 used to give either directly switched or optocoupled 'zero-voltage' triac control.

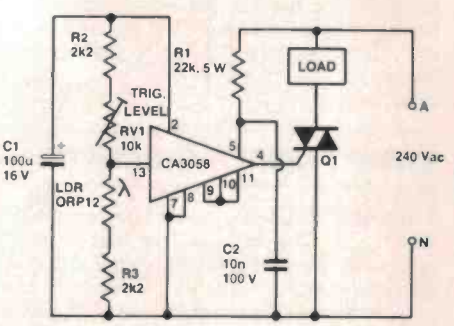

Figure 17. Basic 'dark-activated' zero-voltage switch.

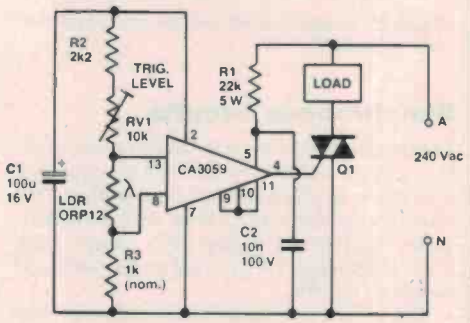

Figure 18. Dark-activated zero-voltage switch with hysteresis provided via R3.

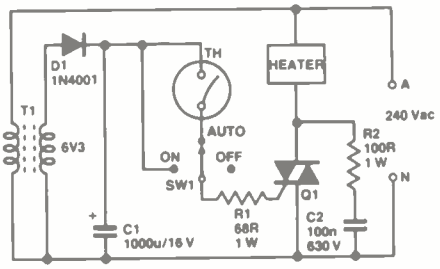

Figure 19. Heater controller with thermostat-switched dc gating.

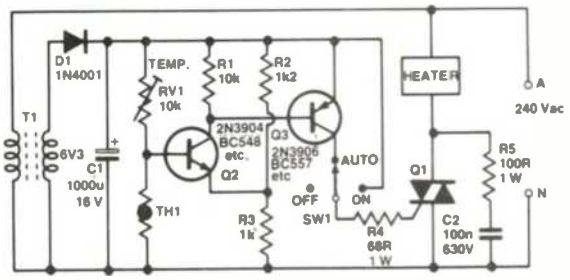

Figure 20. Heater controller with thermistor-switched dc gating.

Figures 19 and 20 show a couple of dc-gated heater-controller circuits, in which the dc supply is derived via T1-D1 and C1, and the heater can be controlled either manually or automatically via SW1. The Figure 19 circuit is auto-controlled via a thermostat.

The Figure 20 circuit on the other hand, is controlled by negative temperature coefficient (NTC) thermistor TH1 and transistors Q2-Q3, and calls for some explanation. RV1-TH1-R2-R3 are used as a thermal bridge, with Q2 acting as the bridge-balance detector. RV1 is adjusted so that Q2 just starts to turn on as the temperature *falls* to the desired preset level. Below this level, Q2-Q3 and the triac are all driven hard on, and above this level all three components are cut off.

Note, in the Figure 20 circuit that, since the gate-drive polarity is always positive but the triac main-terminal current is alternating, the triac is gated alternately in the I+ and III+ modes (or quadrants) and that the gate sensitivities are quite different in these two modes.

Consequently, when the temperature is well below the preset level Q3 is driven hard on and the triac is gated in both quadrants and gives full power drive to the heater, but when the temperature is very close to the preset value Q3 is only 'gently' driven on, so the triac is gated in the I+ mode only and the heater operates at only half of maximum power drive. The circuit thus gives fine control of temperature.

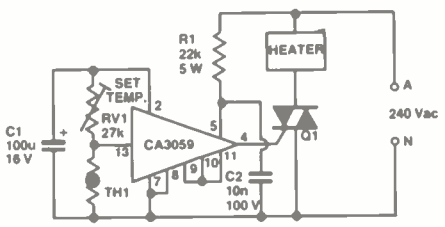

Figure 21. Heater controller with thermistor-regulated zero-voltage switching.

Synchronous circuits

Figure 21 shows how a CA3059 can be used to make an automatic thermistor-regulated synchronous electric heater controller. The circuit is similar to that of the 'dark-activated' power switch of Figure 17, except that NTC thermistor TH1 is used as the feedback sensing element.

The circuit is capable of maintaining room temperature within a degree or so of the value via RV1.

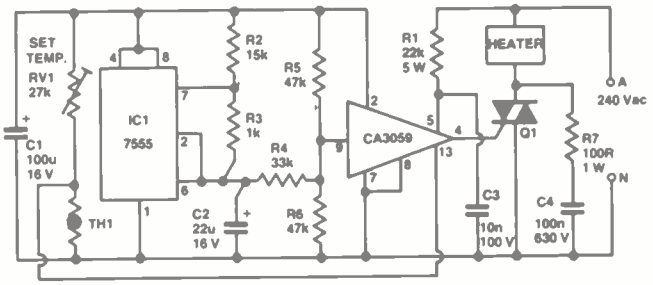

Figure 22. Heater controller giving integral-cycle precision temperature regulation.

Finally, to complete this 'heater controller' section, Figure 22 shows the circuit of a proportional heater controller which is capable of maintaining room temperatures within 0.5°C (depending on sensor placement). In this circuit a thermistor controlled voltage is applied to the pin 13 side of the CA3059's comparator and a repetitive 30 ms ramp signal, centred on half-supply volts, is applied to the pin 9 side of the comparator from CMOS astable IC1.

The action of the circuit is such that the triac is synchronously turned fully on if the ambient temperature is more than a couple of degrees below the preset level, or is cut fully off if the temperature is more than a couple of degrees above the preset level.

When the temperature is within a couple of degrees of the preset value however, the ramp waveform comes into effect and synchronously turns the triac on and off (in the 'integral cycle' mode) once every 300 ms, with a mark/space ratio that is proportional to the temperature differential.

Thus, if the mark/space ratio is 1:1, the heater generates only half of maximum power, and if the ratio is 1:3 it generates only one quarter of maximum power.

The net effect of this action is that the heater output power self-adjusts to meet the room's heating requirements. When the room temperature reaches the preset value, the heater does not switch off, but generates just enough output power to match the thermal losses of the room, giving very precise temperature control.

LAMP DIMMER CIRCUITS

Triacs can be used to make lamp dimmers, which vary the brilliance of incandescent lamps, by using the phase-triggered power control principles described in part 1. The triac is turned on and off once in each mains half-cycle, the mark/space ratio controlling the mean power fed to the lamp. All such circuits require the use of a simple LC filter in the lamp feed line, to reduce RFI problems.

The three most popular methods of obtaining variable phase-delay triggering are to use either a diac plus RC phase delay network, or to use a line-synchronised variable delay UJT trigger, or to use a special purpose IC as the triac trigger.

Figure 23 shows the practical circuit of a diac-triggered lamp dimmer, in which R1-RV1-C1 provide the variable phase delay. This circuit is similar to that described in part 1, except for the addition of on/off switch SW1 which is ganged to RV1 and enables the lamp to be turned fully off.

A defect of the simple Figure 23 design is that it suffers from considerable control hysteresis or backlash. If the lamp is dimmed by increasing the RV1 value to 470k, it will not go on again until RV1 is reduced to about 400k, and it then burns at a fairly high

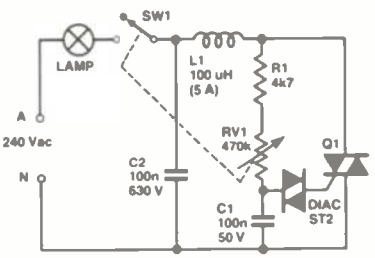

Figure 23. Practical circuit of a simple lamp dimmer.

brightness level. This 'backlash' is caused by the diac partially discharging C1 each time the triac fires.

The 'backlash' effect of the Figure 23 circuit can be reduced by wiring a 47R resistor in series with the diac, to reduce its discharge effect on C1. An even better solution is to use the gate slaving circuit of Figure 24, in which the diac is triggered from C2, which 'copies' the C1 phase delay voltage. But here, R2 protects C1 from discharging when the diac fires.

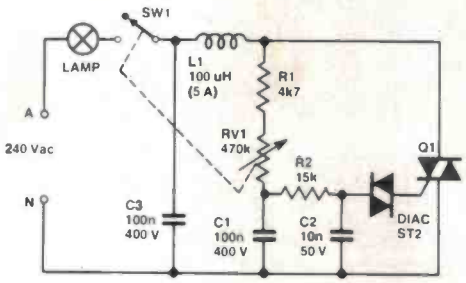

Figure 24. Improved lamp dimmer with gate slaving.

CONSTRUCTION OF L1, FIGS 23 TO 26

The core is a 30 mm long piece of 9.6 mm dia. ferrite aerial rod. Wind two layers of 20 turns, closewound, using the centre 15 mm of the core, with 0.63 mm dia. (22 B&S) enamelled wire. Cover with two layers of plastic insulation tape.

Finally, to complete this 'lamp dimmer' section, Figure 26 shows how a dedicated IC, the Siemens S566B 'Touch Dimmer' chip, can be used as a 'smart' lamp dimmer that can be controlled by either touch pads, push-button switches, or via an infra-red link.

The action of this chip, which gives a phase-delayed trigger output to the triac, is such that it alternately ramps up (increases brilliance) or ramps down (decreases brilliance) on alternate operations of the touch or pushbutton inputs, but 'remembers' and holds brilliance levels when the inputs are released.

The IC incorporates 'touch conditioning' circuitry, such that a very brief touch or push input causes the lamp to simply change state (from off to on, or vice versa), but a sustained (greater than 400 ms) input causes the IC to go into the ramping mode, in which the lamp power slowly ramps up from 3% to 97% of maximum and then down to 3% again, and so on.

The touch pads used with this circuit can be simple strips of conductive material; the operator is safely insulated from the mains voltage via R8 and R9.

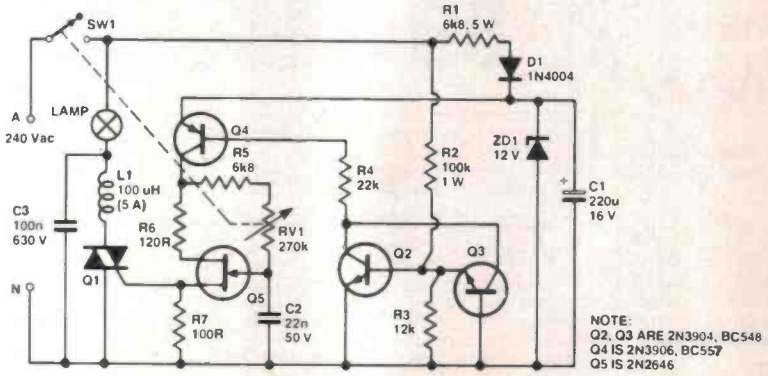

Figure 25. UJT-triggered zero-backlash lamp dimmer.

If absolutely zero backlash is needed, the UJT-triggered circuit of Figure 25 can be used. The UJT is powered from a 12 Vdc supply derived from the ac line via R1-D1-ZD1-C1. The UJT is synchronised to the mains via the Q2-Q3-Q4 zero-crossing detector network, the action being such that Q4 is turned on (applying power to the UJT) at all times other than when the mains is close to the zero-crossover point at the end and start of each mains half-cycle.

Thus, shortly after the start of each half-cycle, power is applied to the UJT circuit via Q4, and some time later (determined by R5-RV1-C2) a trigger pulse is applied to the triac gate via Q5. The UJT resets at the end of each half-cycle, and a new sequence then begins.

UNIVERSAL-MOTOR CONTROLLERS

Domestic appliances such as electric drills and sanders, sewing machines and food mixers, etc, are almost invariably powered by series-wound 'universal' electric motors (so called because they can operate from either ac or dc supplies).

When operating, these motors produce a back-emf that is proportional to the motor speed. The *effective* voltage applied to such motors is equal to the true applied voltage minus the back-emf. This fact results in a degree of self-regulation of the speed of the motors, since an increase in the motor loading tends to reduce the speed and back-emf, thereby increasing the effective applied voltage and causing the motor speed to return towards its original value.

Most 'universal' motors are designed to give single-speed operation. Triac phase-controlled circuits can easily be used to provide these motors with variable speed control. A suitable 'diac plus phase-delay' circuit is shown in Figure 27. This circuit is particularly useful for controlling lightly-loaded appliances such as food mixers, sewing machines, etc. However, you only get a limited range of control.

Electric drills and sanders are subject to very heavy load variations, and are not really suitable for control via the Figure 27 circuit. Instead, the variable speed-regulator circuit of Figure 28 should be used.

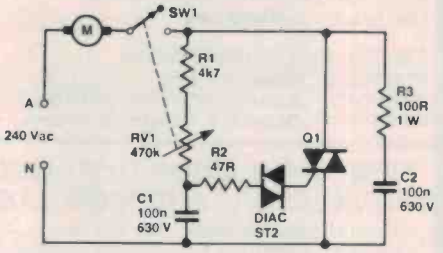

Figure 27. Universal-motor speed controller for use with lightly-loaded appliances (food mixers, sewing machines, etc).

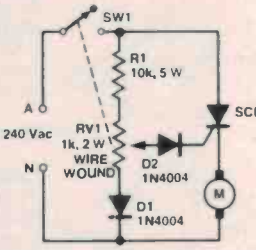

Figure 28. Self-regulating universal-motor speed controller for use with electric drills and sanders, etc.

This circuit uses an SCR as the control element and feeds half-wave power to the motor (this results in only a 20% or so reduction in available speed/power), but in the off half-cycles the back-emf of the motor is sensed by the SCR and used to give automatic adjustment of the next gating pulse, giving some speed regulation. The R1-RV1-D1 network provides only 90° of phase adjustment so all motor power pulses have minimum durations of 90° and provide very high torque.

At low speeds the circuit goes into a 'skip cycling' mode, in which power pulses are provided intermittently, to suit motor loading conditions. The circuit provides particularly high torque under low-speed conditions, but the motor 'chatters' somewhat. Like the previous circuit, only a limited range of control is provided. ●

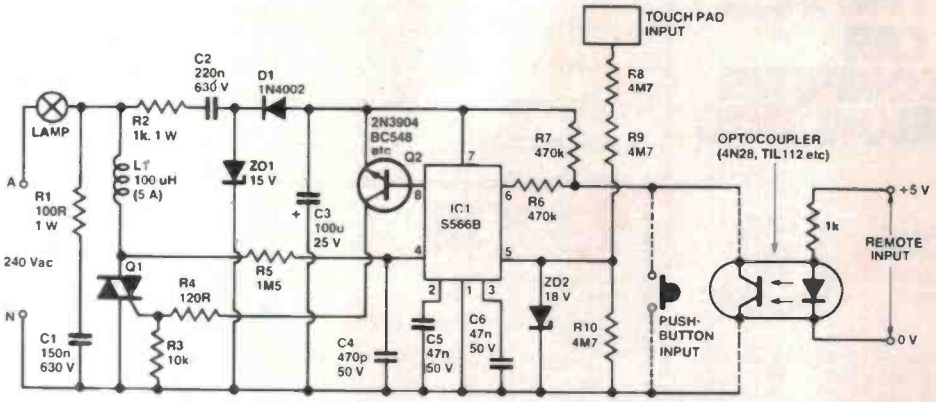

Figure 26. 'Smart' lamp dimmer controlled by a dedicated IC.

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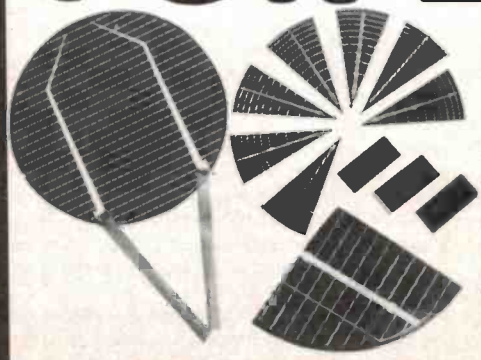

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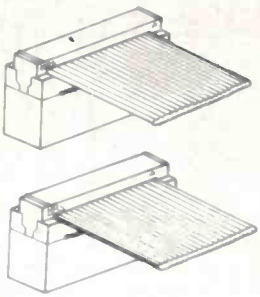

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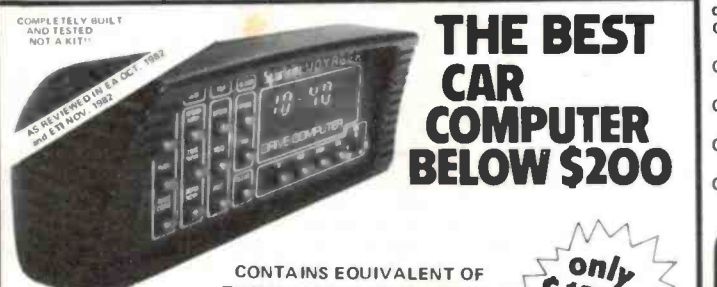

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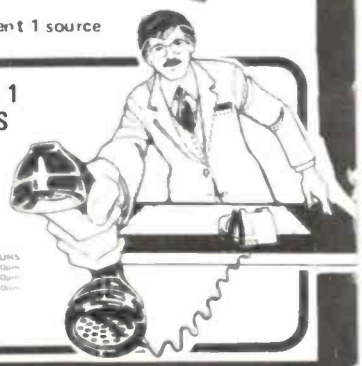

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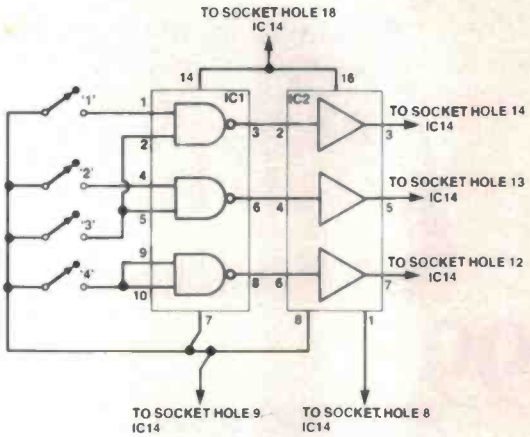
IDEAS FOR EXPERIMENTERS

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.



Second keypad for ETI-660

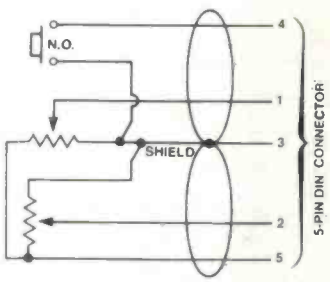
I.A. Curtis of Vale Park SA added a second keyboard to his ETI-660 computer so that he could enjoy two-player games.

This keyboard simply takes the place of RAM ICs 14 and 15, so take out ICs 14 and 15 (if they are in place) and store them in some conductive foam. Use thin solid core wire to plug in the keyboard to the socket IC14.

To read the value of the keyboard in a program use this program segment:

```
0600 AF00 I=0F00
0604 F165 V0:V1=MI
0604 rest of program
```

V0 and V1 now contain the value of the keyboard (lowest three bits). If no key is pressed then 0 will be returned.



Colour computer joystick

L.W. Brown of Burwood Vic. built a pair of joysticks for his TRS80C.

I used a Dick Smith 100k pot mounted inside a small plastic box. A small pushbutton of the normally open type was used for the 'kill' control. Four core shielded cable and a wide angle five pin DIN connector were used for connection to the computer.

The one difficulty with the project is that the cover of the DIN connector fouls on the TRS80C case. The solution to this problem is to solder the two metal shells of the connector together and then glue or solder the plastic cover only partially on to this.

LED bracket

An LED display with irregularities in the alignment and unevenness in the spacing between LEDs can make a project look very unprofessional.

David Samborsky of Bentleigh Vic. overcame this problem with a simple and effective method for mounting the LEDs in an array for display (typically for the ETI-438 audio level meter).

A piece of matrix board with standard spacing between the pre-punched holes was used. The pre-punched holes can be drilled slightly smaller than the diameter of the LEDs being used, so that the LEDs will fit securely into the holes drilled, without falling out.

The precise nature of the spacing between the pre-punched holes in the matrix board makes it an ideal mounting bracket for a display using an array of LEDs, as shown below.

Increased range for IR systems

A simple method of increasing the range of published IR projects is to place the IR LED at the focal point of a magnifying glass, says **Spencer Featherstone of Toowoomba Qld.**

With a little experimentation a parallel beam of light can be produced. The diameter of the beam will depend on the diameter of the lens and, in some cases, its focal length.

In theory the beam will have a constant intensity with distance and will only be attenuated by its passage through the atmosphere. In practice it is difficult to focus the beam this accurately. However, ranges in excess of one hundred metres are possible and this means that the IR trip relay (ETI-570) can be used as a perimeter alarm, with the aid of a few mirrors.

This idea can also be applied to the IR remote control system (ETI-599). In this case it would be better to place the IR LEDs just inside the focal point of the lens to create a slightly divergent beam. While this will limit the maximum range, it will make the transmitter easier to aim over long distances.

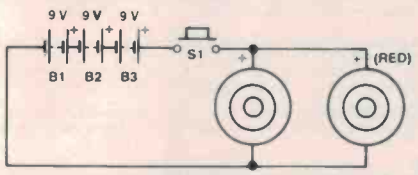


Figure 1. An ear-piercing output.

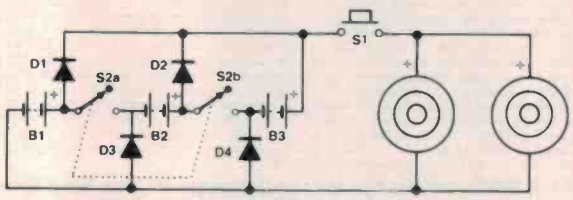


Figure 2. Moderated sound level.

Pea-zo whistle

A friend of a friend of **M.J. Gempton of Nth Parramatta NSW** referees local soccer matches on weekends. This referee friend suffers from asthma and even though he is just able to keep up with the play, can only wheeze into his whistle instead of blowing it. M. Gempton was inspired to help.

The solution required something small, efficient, battery operated, having a high output and natural sound. I thought of a modulated piezo transducer, found the device I was after in Dick Smith's catalogue, and bought two in case one was not loud enough. Then I realised that the two transducers were of slightly different frequencies and the resulting beat produced an excellent rendition of a high pitched pea whistle.

When operating on three 9 V batteries in series (27 V) the sound level was quite deafening, so the lower output option, as shown in Figure 2, using all batteries in parallel, was developed. To keep it small a DPST switch was used. With parallel operation there is, of course, the voltage drop across a forward biased diode but with S2 closed (series operation) all diodes become reverse biased and the full 27 V is available.

For anyone with the application, this series/parallel idea can easily be expanded for N batteries using a single throw switch with N-1 poles and 2(N-1) diodes.

The only special component is the transducer (DS cat. no. L-7024). The diodes used were 1N4004s because they were on hand but anything similar would do.

The original 'Pea-zo whistle' was housed in an aluminium case approximately 52 mm x 25 mm x 140 mm and, when presented to the referee, was gratefully received. That weekend, however, he was laid up in bed, voiceless, so he first used his new whistle for paging his wife.

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Operates in two modes depending on the configuration of the second oscillator (VCO2), which can either run at audio frequencies or as a voltage controlled low frequency oscillator (LFO). In audio mode, VCO2 will track VCO1 perfectly over its entire range. A Thumbwheel allows manual control of oscillator pitch or filter cut-off frequency, depth of LFO modulation, etc., and internal power amplification will drive headphones or a monitor loudspeaker.

SPECIFICATIONS (BRIEF)
* Keyboard – 2½ octaves (30 notes) may be stepped through 5 octave range from 16' to 1' using the "Range" switch. * VCO1 – 10Hz to 10kHz, triangle output to VCA, ramp and square outputs to VCF. * VCO2/LFO – VCO mode 10Hz to 10kHz. LFO mode 0.1Hz to 30Hz. * Sub octaves – 2 divide-by-2. * Noise – white noise source with level control. * Envelope – attack and release times variable 0 to 10 seconds. * Retrigger – causes the envelope shaper to retrigger itself with a repeat time equal to the sum of the attack and release times. "Sustain" operates in 3 modes, manual, auto and hold. * VCF – state variable filter with manual control of roll-off frequency. * VCA – controls output volume of synthesiser. * Sample and Hold – analogue memory samples instantaneous output voltage from VCO2/LFO each time envelope ends. * Sweep. * Thumbwheel – Manual level control. * Power amp – output 2 watts into 8 ohms plus headphone socket. * Sequencer socket. * Size: 19½" x 14" x 5½". Weight: 10lb. Power: 240V AC 5W.

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LIVE PERFORMANCE – Feed in, store, and play complete Music Pad of around 60–100 Backing Scores up to a total of approximately 3,000 Chord changes, each up to eight Beats in length, on more than 120 different chords.
Program Intros, Chorus Repeats, Codas, Key changes and modulations on single or multi-tune sequences. Use simple Playback procedures for live performance, including optional foot operated controls.
PRACTICE SOLOISTS – Instrumental or Vocal Soloists grow to full four piece BAND performance played in any Key, Tempo, and Rhythm style for demanding practice sessions with unlimited, but controlled, Chorus repeats.
ELECTRO-MUSIC RECORDING/COMPOSITION – Full Chord sequence and Rhythm programmability for three instrumentalists enables creative Composing and Arranging for both Professional and Amateur applications.

SPECIFICATIONS (BRIEF)
* Music simulation capacity – three backing instrumentalists. Over 3,000 programmable stored chord changes. 132 different chords plus additional inversions. * Chord instrumentalist – four note chords, four waveform options, four envelope options sixteen permutations for piano, organ etc, twenty four programmable rhythm patterns. * Bass instrumentalist – four voice /envelope combinations, eight rythmic figures. * Drums – twenty four programmable patterns, eight tracks selecting eleven instrument sounds. Sticks, brushes & Latin American. Sequence operation up to 16 bar repetition. * Playback facilites – Keypad selection of score, display of selected score, variable tempo, switched selection of any key, in-play changes to key, tempo and all instrument voices, rhythmic patterns and levels, bar down beat indicator, all-beat indicator, unlimited chorus repeats, Coda key to cancel repeats, automatic stop, manual instant stop, automatic reset to beginning of selected score, measures/beat selectable to match 4 drumming styles. * Composition facilites. * Composition instructions. * Pre-recorded scores. * Musical compass – Tuning range one semitone, use alternative key for gross pitch change, Bass compass 16 notes, F1 to G2 44Hz to 104Hz, chord instruments 18 notes E3 to A4 165Hz to 440Hz, automatic chord inversion to fit compass. * Percussion instruments – Bass drum, low & high tom toms, snare, drum, rim-shot, cymbal, long & short brushes, high bongo, claves, and accent for dynamics. * Operator inetrfaces – numerous. * External socket: – numerous. * Size: 19" x 11" x 4½" overall. Weight 11lb. Power requirements: 240V 6W.

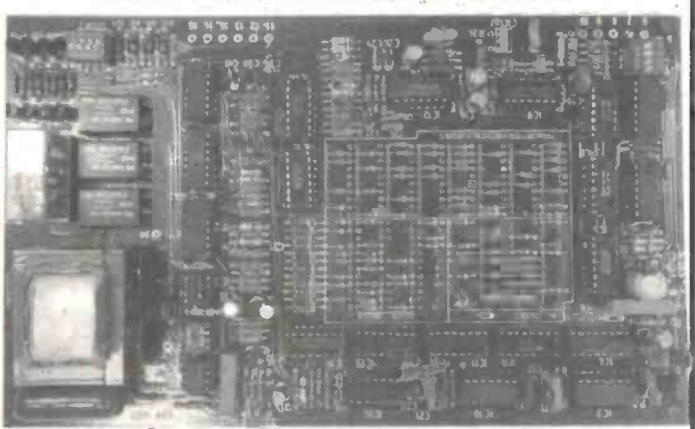
$699

WHAT A BOO – BOO! For the last 2 months we have been advertising the Band Box. We stated that the Master Rhythm Kit was $199 on top of the basic kit price. THIS IS TOTALLY WRONG! The Band Box kit DOES include the Master Rhythm kit at $699 – a totally different prospect – WE APOLOGISE FOR THE ERROR.

ETI 644 direct connect modem

Ref: ETI October 1982

" NEW UPGRADED MODEL FEATURING THE LATEST IMPROVEMENTS AND MODIFICATIONS"



Two models (i) Short form which contains ALL PCB components as specified by ETI (BEWARE!!). The genuine ETI PCB with plated-thru holes, solder mask and component overlay is supplied. We also supply at NO EXTRA CHARGE a full set of quality IC sockets. A must with plated-thru PCB's – Remember this when making comparisons (ii) Full kit. Includes: all of the above plus 12V plug-pack, case, front panel, switch and LED bezel and Cannon DB-25 RS-232 connector. Makes a complete stand alone modem. *Capable of a range of Answer/Originate operating modes * Selectable Baud rate * Software controlled. * Uses new patented technique * More reliable and faster than most acoustic modems. Arlec transformer as used in this project only $22.00

SHORTFORM KIT **$169**
FULL KIT **$189**

Function Generator

Ref: EA April 1982

FREE! TILTING BAIL WORTH $4.95 included

$99

"Pigeon Pair" companion to the new 500MHz DFM. Low distortion generator of sine, square and triangular waveforms. From below 20Hz to over 160kHz. Inbuilt 4 digit frequency counter in de-luxe Pac-Tec case. Only $85

JAYCAR EXCLUSIVE – 1% 50ppm metal film resistors used for stability and it's still only $85!!!

0-30V 1amp power supply

Ref: ETI December 1982

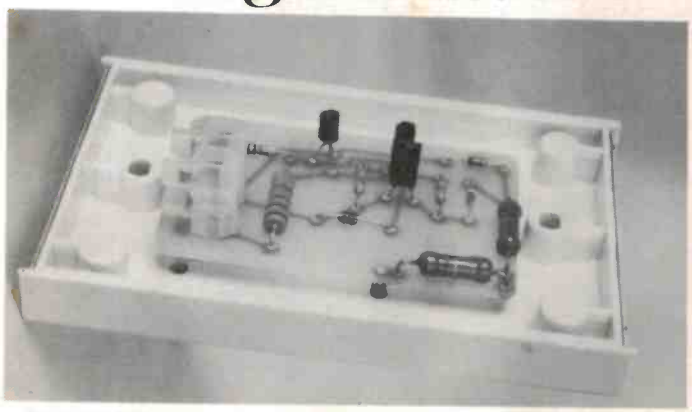
- Fully protected
- Output variable from 0-30V DC
- Selectable current limit
- Both voltage and current metering
- After a multimeter & soldering iron an absolute must for the enthusiast.

You will never own a more useful piece of gear.

$49.50 complete

- KITS BY JAYCAR

NEW Touch Sensitive Light Dimmer



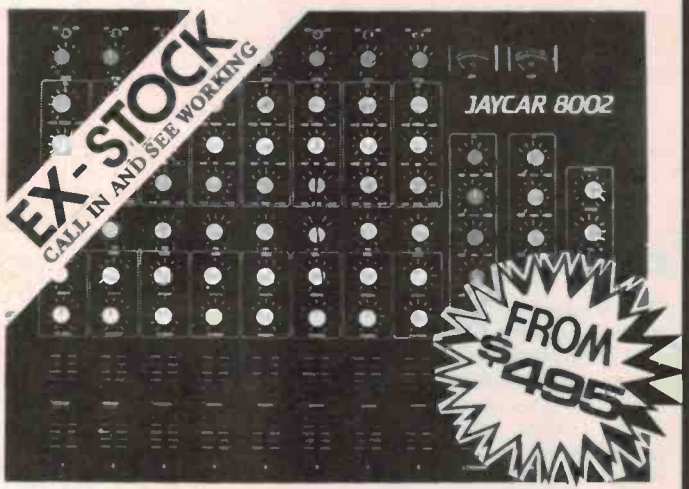
Ref: EA April 1983
Complete kit including quality HPM wall plate with attractive brushed metal insert.
The Jaycar kit is absolutely complete including a small dial spring which can be used to connect the PCB to the wall plate. (Beware of other kits that do not include this).
In addition to the above, we supply the High Voltage Resistors ALREADY SOLDERED in as a foolproof safety feature!
Buy the complete kit for this exciting project for only
Cat. KA-1508

only $19.95

8 CHANNEL MIXER KIT

- Balanced (600 Ohm) Mic. Inputs/Line Inputs.
- Cannon Connectors included in the price.
- Bass, Mid & Treble Equalization on each Input.
- "Effects" (i.e. Echo etc.) capability.
- Foldback and Stereo Pan on ALL 8 Inputs.
- 60mm Slide Faders used throughout.
- 19" Rack Mount capability (or Console Mount).
- Professional Black Front Panel with Format borders & multi-coloured knobs to assist function identification.
- VU Metering.

FEATURE PROJECT IN APRIL EA



The Jaycar 8002 Mixer was originally conceived to be the successor to the very popular ETI414 Master Mixer. The 414 was basically configured as a 'stage' mixer and suffered from a number of severe technical limitations — notably poor signal-to-noise figures. Enormous advances in Audio IC's have occurred since the 414 was designed. Jaycar engineers have taken advantage of this. The incredibly low noise and distortion figures of the 8002 are a testimony to the sound basic design of the mixer coupled with the performance capability of these IC's. Whilst the 8002 is the ideal 8 channel compact stage mixer, other applications have been kept in mind.
AS A "STUDIO" MIXER. The prime requirement of a studio mixer is that it must be quiet — i.e. have good S/N. Due to the fact that the "miracle" 5534 IC's are used in the 8002 studio applications are entirely feasible. In addition to this, metal film resistors are used in critical signal areas.
AS A DISCO MIXER. The balanced input feature of the 8002 is not really necessary for disco use. This section can easily be bypassed with either a moving magnet (Dynamic Cartridge) preamp, or a moving coil preamp The sensible format of the 8002 and tremendous equalization facilities should make this mixer popular for disco use.

AS DESCRIBED ETI MAG. APRIL 1983

ROBOTICS

JAYCAR – FIRST IN AUSTRALIA WITH THE VERY LATEST IN THE FIELD OF ROBOTICS

Jaycar is the first major electronics company in Australia to stock useful robots in kit and built-up form.

MICRO GRASP

ONLY **$499**

The Micro Grasp is the first low cost true robot. Basically the unit has an articulated arm jointed at the shoulder, elbow and wrist positions. The entire arm rotates on its base and has a motor driven gripper on the end of the arm. Each of the arm movements is SERVO CONTROLLED so there are position sensors feeding back information to the interface board where it is compared with the programmed in intended position. Any positional error is automatically and continuously corrected. This servo action is independent of the computer, simplifying greatly the software to drive the robot. All programming is carried out with a small number of common BASIC commands. The interface board is memory mapped using only 64 bytes at any of the 1024 switch selectable locations.
Control of the Micro Grasp as a computer peripheral is accomplished thru the parallel expansion port of most small computers. To keep the cost to an absolute minimum and to increase the learning factor the Micro Grasp is supplied as a self-assembled kit. All components down to the last nut and bolt are included, as is the power supply.
MICRO GRASP KIT INCLUDING POWER SUPPLY Cat. KR1000 – SPECIAL INTRODUCTORY PRICE $499.00
UNIVERSAL COMPUTER INTERFACE BOARD (in kit form) Cat. XR1010 ONLY $179.00 (not required for Sinclair ZX81 computer)
23 + 23 way edge connector at $9.95 ZX-81 peripheral/RAM pack splitter board $10.95
CALL IN TO OUR YORK STREET SHOWROOM AND SEE WORKING!!

Digital Thermometer

EA2/82

Read the temperature in your room (or outside) from 0 degrees C to 100 degrees C in fact to within 0.1 degree C. Fantastic resolution on a bright easy-to-read display. Includes case.

$69

DIGITAL CAPACITANCE METER Ref: EA3/82

This kit once again uses the amazing DPM 200 LCD /driver module. Capable of measuring capacitance from 1pF to 19,99uF. It is a must in every workshop or lab.

$69

AMAZING VALUE

STEREO SYNTHESIZER

NEW ECONOMY SHORT FORM KIT

NEW

All parts necessary to construct this project to PCB stage.
(Please note that plug pack and case are extra).
A great project for the Stereo HI FI lovers. Turns mono sound into realistic "stereo"
Cat. KA-1510

$11.95

Jaycar

NUMBER 1 FOR KITS

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CARLINGFORD
PHONE 872 4414
MAIL ORDERS TO BOX K-39 HAYMARKET, SYDNEY 2000

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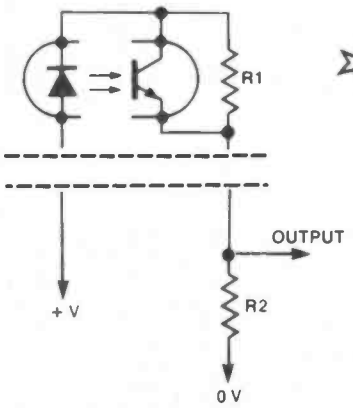
$5 – $9.99 ($1.50) $10 – $24.99 ($3.20)
$25 – $49.99 ($4.50) $50 – $99.99 ($6.50)
$100 up ($8.00)

NEW SHOP HOURS
Mon – Fri 8.30 to 5.30pm
Sat 8.30 to 12.00pm
Thurs night to 8.30pm

Mail Order By BANKCARD
Via Your Phone

IDEA OF THE MONTH



Two wires for opto-switch

F. Arfort, Melton South, Vic.

Here's a simple way to run two wires instead of four to a remote opto-switch, as in the case of a wind speed indicator which provides pulses proportional to the rotational speed of a perforated disc.

An opto-coupler consisting of a LED and a phototransistor, either of the packaged variety or made from discrete devices, normally requires four connections. However, twin-pair cable is common, cheap and convenient and it's more economical (and more elegant) to use two wires rather than four for a remote sensor. The further away the sensor may be located from the indicator, the more attractive a two-wire system becomes.

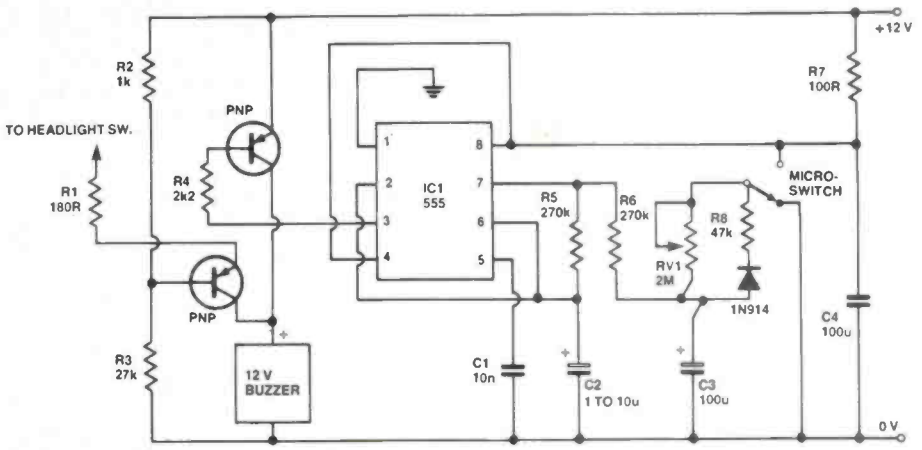
In the circuit, resistor R1 provides a 'starting' current for the LED. Current through R1 and R2 will provide a certain dc level at the output when the path between the LED and phototransistor is blocked. When the path is unblocked, the phototransistor saturates, virtually shorting out R1, thus providing more current through R2, increasing the output dc level. This change can be sensed and used as required.

Choke and headlight warning

D.K. Modra of Elizabeth South SA kept forgetting to push in the choke and/or switch off the headlights of his car. So he designed this circuit to sound a buzzer intermittently, after a preset period, when the choke button had been pulled out.

The microswitch is mounted on the carburettor so that C3 slowly charges up via RV1. When the voltage on C3 reaches two thirds of Vcc IC 555 operates in an astable mode as long as the choke control is 'out'. Oscillation ceases when the choke button is pushed in, discharging C3 via R8 and the diode.

The buzzer sounds continuously if the lights are left on after the ignition is switched off.



'IDEA OF THE MONTH' CONTEST

NEW 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, Murray Publishing, Offset Alpine, Australian Consolidated Press 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.

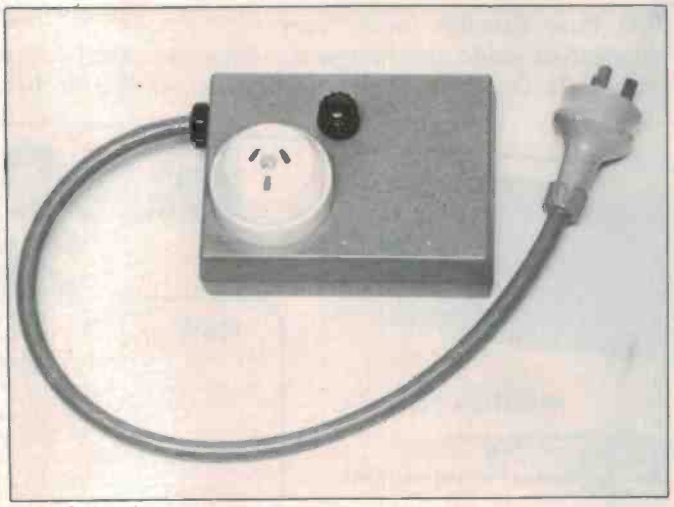
SHOP AROUND

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-1515 motor speed controller

This simple, inexpensive project should be very popular and it has wide support among the kit suppliers. Suppliers indicating they'll be supporting the project include: **Altronics** (Perth), **Dick Smith** stores (all over), **Electronic Agencies** (Sydney, two stores), **Jaycar** (Sydney, two stores), **Rod Irving Electronics** (Melbourne) and don't forget to try **All Electronic Components** in Melbourne while you're shopping around.

If you're putting the project together from parts largely on hand and just need a few of the bits, the following suppliers may be able to fill your requirements: **Billco** (Melbourne), **David Reid** (Sydney), **Delsound** (Brisbane), **Diggerman** (Sydney), **Ellistronics** (Melbourne), **Kalex** (Melbourne), **Magraths** (Melbourne), **Moss Components** (Sydney), **Radio Despatch Service** (Sydney) and **Truscotts** (Melbourne). Printed circuit boards are available from the suppliers listed on page 50 of the March issue.



Fast or slow. The ETI-1515 Motor Speed Controller promises to be a fast-moving kit. It uses all bog-standard components and features performance not seen in other speed controllers.

ETI-733 RTTY-computer decoder

Turn your computer into a 'glass teletype'! It's easy. There's nothing unusual about this project, both the 4046B and the LM324 are commonly available, as are centre-zero (stereo balance) meters. Kits will be available from **Rod Irving Electronics** and **Jaycar**. You could also try **All Electronic Components** in Melbourne.

Printed circuit boards are available from the suppliers listed on page 50 of the March issue.

DVM modules

The DPM-05 LCD digital voltmeter module featured in Lab Notes this month is imported and distributed by **Jaycar**. Apart from Jaycar's two Sydney stores, you'll find DPM-05 modules stocked by **Altronics** in Perth, **Electronic Agencies** (Sydney, two stores), **Ellistronics** and **Rod Irving** in Melbourne plus **Tomorrow's Electronics** in Gosford (NSW).

For those who'd rather build a DVM from the ground up and use the ETI-161 LCD Digital Panel Meter module (August '82), kits are stocked by **Dick Smith Electronics** (stores all over), **Rod Irving Electronics** (Melbourne) and **All Electronic Components** (Melbourne).

New Altronics/Jaycar dealer

Popular NSW central coast electronics dealer, **Tomorrow's Electronics**, has been appointed a dealer by two of Australia's 'big' kit and component suppliers — **Altronics** and **Jaycar**.

Tomorrow's Electronics will be stocking many of the popular lines marketed by these two firms.

The store is located at 68 William St, Gosford. Call in and see owner Cliff Strathearn and his friendly staff for your requirements in electronic bits, kits and products, or phone (043)24-7246.

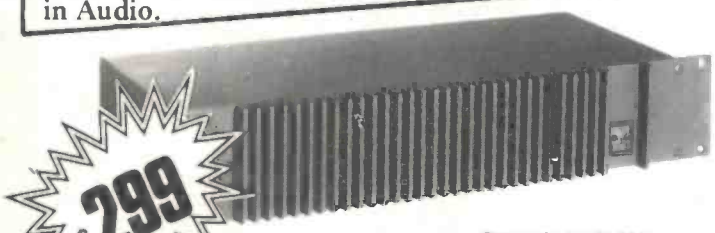
ETI-648 Micro-Grasp

This is a fully-imported kit, produced by Powertran in Britain, imported and distributed here by Jaycar. Space requirements within the magazine and production time necessitate the project being split over two months. However, a small instruction manual is provided with the kits. This month in ETI we present full mechanical construction details plus an explanation of how the electronics works. Next month electronic construction detail will be completed and we'll include programming hints and tips. The complete kit is available from Jaycar, or through Jaycar agents, for about $500.

SO PURE, IT'S WICKED

The ETI 5000 System. Pristine. Pure. Cocaine for the ears.
And to think that they are Australian made and designed. They can stand comparison with any kit or ready-built available – anywhere. In fact we still think that they are the world's best amplifiers. We should be justifiably proud of this achievement in Audio.

MAGNUM 200



Cat. KE4200

We regret to advise that among other things, metal-work and sales tax increases have forced us to increase our prices slightly. Whilst we could have kept our costs down by using inferior components, we refused to take this course of action.

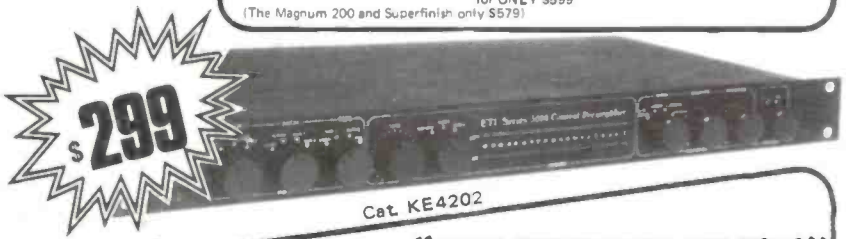
SPECIFICATIONS

POWER OUTPUT	Around 100W RMS into 8 ohms
FREQUENCY RESPONSE	8Hz to 20kHz, +0 – 0.4dB 2.8Hz to 65kHz, +0 – 3dB Note: these figures are determined solely by passive filters
INPUT SENSITIVITY	1V RMS for 100W output
HUM	– 100dB below full output (flat)
NOISE	– 116dB below full output (flat, 20kHz bandwidth)
2nd HARMONIC DISTORTION	<0.001% at 1kHz (0.0007% on prototypes) at 100W output using a ±56V supply rated at 4A continuous
3rd HARMONIC DISTORTION	<0.003% at 10kHz and 100W
TOTAL HARMONIC DISTORTION	<0.0003% for all frequencies less than 10kHz and all powers below clipping
INTERMODULATION DISTORTION	Determined by 2nd harmonic distortion (see above)
STABILITY	<0.003% at 100W (50Hz and 7kHz mixed 4:1)
	Unconditional

NEW! – LOW COST 5000 SERIES AMP

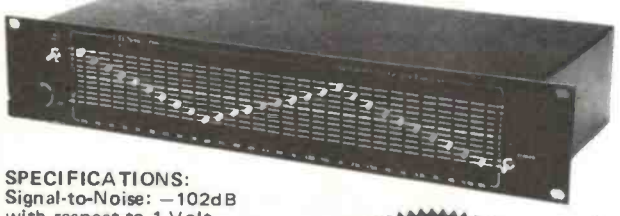
Now we have 2 models of the fabulous 5000 series amplifier. The original "Black Monolith" which is the total no-compromise refinement of this magnificent design. Unfortunately due to massive sales-tax increases and cost increases we had to put the price up to $319 in January. At this price we still felt that it is excellent value for money, however some people claim that they cannot afford to pay this much.
So we have a new economy model which we called the "MAGNUM 200"
The Magnum 200 still has such exclusive features as the Superfinish heatsink front panel. It has the following exceptions from our Black Monolith.
– Standard Heatsinks (the original design) on the BF469/470 driver transistors
– No ventilation grilles in the case
– Standard mica washers instead of Beryllium Oxide TO-3 washers
– Single 3-pin DIN AC outlet.
But that is ALL that you miss out on!
So why compromise yourself with the inferior kits when you can now get a superior Jaycar kit for no more?
The Magnum 200, 200 watts of power with IDENTICAL performance figures to the Black Monolith is only $299!
If you still want the Black Monolith it is available for $319.
APRIL SPECIAL! Buy the 5000 "Blueprint" preamp and the Black Monolith this month for ONLY $599
(The Magnum 200 and Superfinish only $579)

5000 SERIES GRAPHIC EQUALISERS



Cat. KE4202

Latest addition to the thoroughbred 5000 Series stable! David Tillbrook has once again produced a 'No Compromise' design. This new component, a 1/3 octave equaliser, gives you ABSOLUTE CONTROL over the acoustics of your particular listening enviroment. You get 3 SEPARATE CONTROLS for every octave of audio bandwidth to virtually eliminate the subtle nuances that are particular to your listening area.
1/3 octave equalisers have been used by professional engineers in Recording Studios and Live Concerts for over a decade now. It is no accident that the advent of the 1/3 octave equaliser and studio quality live sound have gone hand-in-hand. BUT THERE'S A CATCH. One of these equalisers is not enough. You will have to buy 2 (for stereo). Quite a lot of money – but worth it if you want the best. The Jaycar kit includes a fully pre-punched plated chassis, pre-punched heavy gauge front panel with silkscreened front panel to match the other 5000 components. It is absolutely original. You can purchase the kits one at a time for $199 each or, for two, $389 – a $10 saving. If you are one of the hundreds of happy 5000 users we are convinced that you will be just delighted with this unit.



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 irrepective of cut or boost)
Current consumption (DC) Approx 100mA @ ±15V (Requires 30V AC CT)
Output short-circuit proof.

$199

BUY 2 AND SAVE $10 – ONLY $389

AUSTRALIAN (NOT HONG KONG) MADE – SPECIAL BUILT RACK CABINET – QUALITY!!!

ALL IC SOCKETS PROVIDED

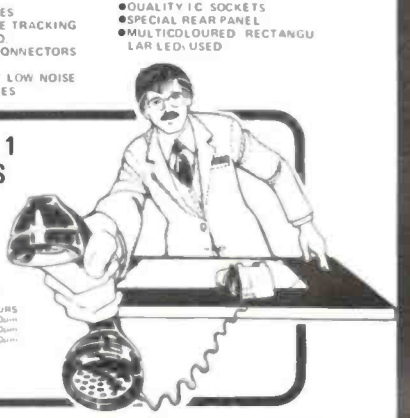
Cat. KE4204

"BLUEPRINT"

"One Swallow does not make a spring"
– Neither does a few gold RCA sockets!
Several of our competitors are imitating our "Blueprint" preamp by adding a few bits and pieces, notably gold plated RCA sockets to their standard kits. Unfortunately they have missed the point. We supply gold plated sockets in our "Blueprint" preamp but only where it makes sense to do this, i.e. on the inputs – NOT the outputs. 16 gold sockets are provided by us. This, however, does not make a "Blueprint". THIS DOES:
– Low capacitance screened cable – 12 metres of it, NOT Taiwanese cable as supplied in other kits. Our cable costs us NEARLY 5 TIMES MORE than the Taiwanese stuff.
– Original ETI designed front panel. Not an "ADAPTION". Our front panel is by far the nicest.
– Factory pre-tinned PCB's to reduce chances of dry or noisy solder joints.
– Quality LEDs, polished finish, multicoloured display.
– IC sockets on line amp board.
– Special rear panel.
– Special low noise selection LM394H NOT CH device in M.C. preamp.
– Thermalloy (U.S. made) heatsink on 7805 regulator.
– English Lorlin selector switches.
– Apart from the 16 gold RCA's we throw in a pair of gold plated line RCA plugs – worth $5.
– Special Nylon rear panel grommets.
So don't "Swallow" the facts before they are properly digested!!
You can't make a silk purse out of a sow's ear. Send SAE for full specs.

FUNCTIONS
- MOVING COIL INPUT
- MOVING MAGNET (DYNAMIC CART)
- INPUTS (2 OFF)
- TUNER INPUT
- AUX INPUTS (2 OFF)
- TAPE INPUTS (2 OFF)
- INPUT LEVEL CONTROL
- TAPE OUTPUTS (2 OFF)
- 400Hz CALIBRATION OSCILLATOR
- LED AVERAGE (VU) & PEAK
- LEVEL METERS –48dB TO +9dB
- MODE SWITCH, STEREO BALANCE CONTROL LINE OUT, MONITOR OUT, MONITOR VOLUME CONTROL

FEATURES
- EXTREMELY CLOSE TRACKING TO RIAA PHONO EQ.
- GOLD PLATED CONNECTORS ON ALL INPUTS
- ENGLISH 'LORLIN' LOW NOISE SELECTOR SWITCHES
- LOW NOISE 1% 50ppm METAL FILM RESISTORS USED
- TINNED FIBREGLASS PCB'S
- LOW CAPACITANCE SCREENED CABLE USED THROUGHOUT
- QUALITY IC SOCKETS
- SPECIAL REAR PANEL
- MULTICOLOURED RECTANGULAR LEDS USED



Jaycar NUMBER 1 FOR KITS

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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 up ($8.00)

NEW SHOP HOURS
Mon – Fri 8.30 to 5.30pm
Sat 8.30 to 12.00pm
Thurs night to 8.30pm

Mail Order By BANKCARD Via Your Phone

Drake's progress

Drake equipment first came to notice in the late '50s when single sideband was a controversial 'new' mode on the amateur bands. To own Drake meant you were 'serious' about high performance.

Who remembers the Drake 1A, or the Drake 2B receiver? For valve equipment, they were economically designed but gave top performance on the air. What has solid-state wrought?

Well, it has wrought a great deal in some areas, but few gains have been made in others. That goes irrespective of a rig's pedigree.

Drake's TR5 HF transceiver is a typical example of modern solid-state amateur gear. Operating SSB and CW over all the HF amateur bands, including the new 10, 18 and 24 MHz bands, plus the 1.8 MHz band, it features a broadband front end and power output stage so that the only tuning control is the VFO. Frequency display is digital, directly in kilohertz.

Receiver sensitivity is quoted as 0.5 uV for 10 dB S+N/N while two-tone dynamic range is given as 85 dB and third-order intercept as 0 dBm. That's a pretty fair performance spec.

On transmit, power input is given as 150 W PEP or max. CW with spurii quoted as greater than 40 dB down. Carrier suppression is given as —50 dB and undesired sideband as —60 dB.

A passive double-balanced mixer is employed in the receiver front end, preceded by a low noise, high dynamic range bipolar rf amplifier.

You can select an optional crystal filter independent of the MODE switch. A wide range of filter bandwidths are available, and installation can be accomplished in minutes. The standard bandwidth is 2.3 kHz, automatically selected in transmit.

All the usually-required controls are there on the front panel: VOX, RIT, METERING, GAIN(s), MODE, BAND etc. Full break-in CW operation is obtained via a switch on the VOX DELAY. Provision is there for a noise blanker — which is optionally available.

The TR5 is a well-engineered, solidly constructed unit. Modular construction is employed — a great plus for servicing. Each module is designed to perform a specific function, and the open, accessible layout of the transceiver greatly simplifies any required alignment and troubleshooting.

The handbook is clearly written and well illustrated. A circuit and servicing information is included.

On the air (as VK2ETI, of course!) the TR5 acquitted itself very well. Audio quality was reported as very clear, excellent etc. CW was clean. Working the DX was no problem, except in pile-ups where we had to compete with many stations running high power and big beams.

As an acid test of the transmitter, we loaded the unit into a long wire via an L-coupler with two variable Cs and a roller inductor. The VSWR, as you could imagine, would commence off-scale, but the TR5 didn't object once. The test was repeated on a short vertical with similar results. Drake sure have made the output stage tolerant! Getting rid of those 'tune' and 'load' controls (and RF peak) is very convenient.

On receive, the TR5 pulled in the signals as you'd expect. We compared it to an ancient Galaxy V (valve) rig — and there was no discernable difference between them; well, perhaps a little more bass end on the audio from the Galaxy!

Overall, the TR5 is a very simple rig to operate. Convenience and operator facilities — that's Drake's progress.

The TR5 can be operated from a 12 Vdc supply or a choice of two 240 Vac supplies (optional extra — PS7, $499 or PS5, $299). Note that the microphone is optional too. There are several models to choose from.

The TR5 sells for $1594, plus sales tax, which puts it somewhat behind the eight-ball in a very price-sensitive market. However, if what you desire is well-engineered, American made gear, the TR5 is worth a very close look.

Contact **Elmeasco, P.O. Box 30, Concord NSW 2137. (02) 736-2888.** Branches in Melbourne, Brisbane, Adelaide and Perth. ●

Radioteletype-computer decoder

This simple project allows you to hook up your MicroBee to a receiver and print radioteletype messages on the VDU screen. A simple bit of software does the decoding. The project can also be adapted for use on other Z80-based systems.

Tom Moffat VK7TM
39 Pillinger Drive, Fern Tree, Tasmania 7101

IF YOU OWN a MicroBee, or other Z80-based computer, you can now set up your own teletype listening post. But you can forget the old bucket of bolts teleprinter, the computer now serves that purpose.

Besides the computer itself, you'll need to write in the 'Bees parallel input port, build the new ETI-733 RTTY decoder and have a decent HF receiver capable of copying single sideband signals.

You may remember, back in August 1979, a project called the ETI-730 Radioteletype Converter. That design worked well then and it works well now. It's still quite current and it appears that hundreds of them have been built around Australia. This new design is meant to complement the ETI-730. Under rough reception conditions, the '730 will win every time, but under reasonable signal conditions the ETI-733 comes out ahead in ease of operation, speed range and general usefulness. Perhaps a head-to-head comparison is in order; see Table 1.

The performance differences are due to completely different design concepts. The purpose of a decoder is to turn a varying audio tone into a dc voltage proportional to the incoming tone frequency. In the case of radioteletype there are only two frequencies representing two dc levels . . . 'mark' and 'space'. The tones are separated by an amount known as the 'shift' (see the accompanying panel).

The ETI-730 uses filters to recover the two tones from whatever other rubbish may be coming out of the receiver. It compares the level of the tones and whichever one is stronger gets the nod from the logic circuitry. There is another filter in the logic area that discourages transitions faster than 50 per second. The effect of all this is to allow the copy of signals that are sometimes even too weak to hear.

	ETI-730	ETI-733
Ease of Construction	Moderate	Easy
Cost	Moderate	Cheap
Ease of Operation	Fiddly	Easy
Weak Signal Performance	Good	Fair
With Interfering Signal	Good	Poor
High Data Speeds	Poor	Good
Decode Analogue Signals	No	Yes

Table 1. Comparing the '730 and '733.

Gasp! . . . a PLL!

The ETI-733 is based on a phase-locked loop. This will bring screams of anguish from RTTY purists. They'll tell you phase-locked loops are no damn good on HF signals and only marginally useful on VHF. I must admit I experimented with an NE565 PLL chip during the design of the ETI-730 converter and I found results were hopeless. But now, some three years later, from the depths of a CMOS logic data book, comes the *4046 Micropower Phase-locked Loop*, and it goes like a ripper. Why this one should work when the 565 didn't, I can't explain, but work it certainly does.

You've probably heard of PLLs as part of frequency synthesisers. When the cost of crystals shot out of sight, PLLs became a necessity in multi-channel transceivers. The basic PLL has a voltage controlled oscillator and a phase comparator. The signal to be decoded is fed into the phase comparator along with the output of the VCO. The comparator generates an error voltage that's fed back to the VCO (that's the loop part). The VCO then adjusts its frequency to match that of the incoming signal. So the VCO output is a cleaned-up carbon copy of the signal from the receiver and the error voltage is our recovered data signal.

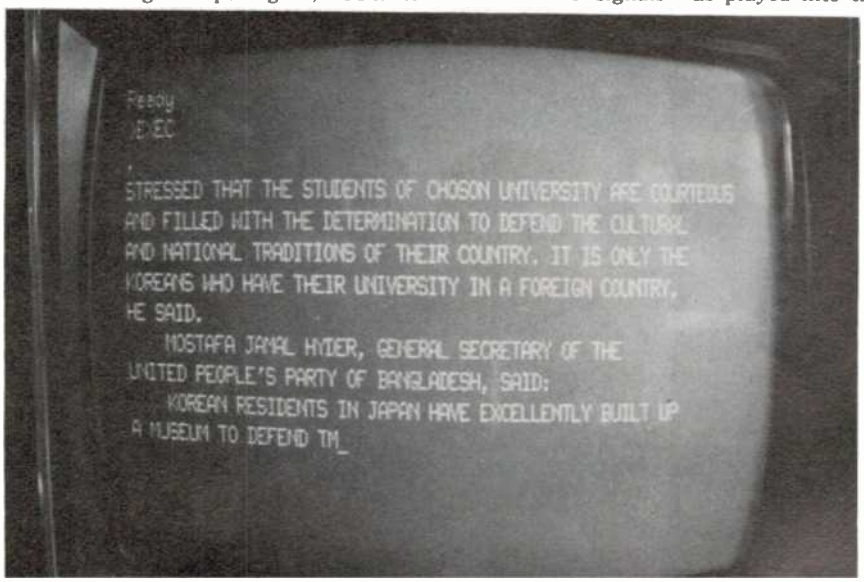
When everything is hanging on and the VCO is following the input signal, the PLL is said to be 'in lock'. If the incoming signal is too high or too low in frequency, beyond the range where the VCO can be pushed to match it, the whole procedure falls apart and the PLL 'loses lock'.

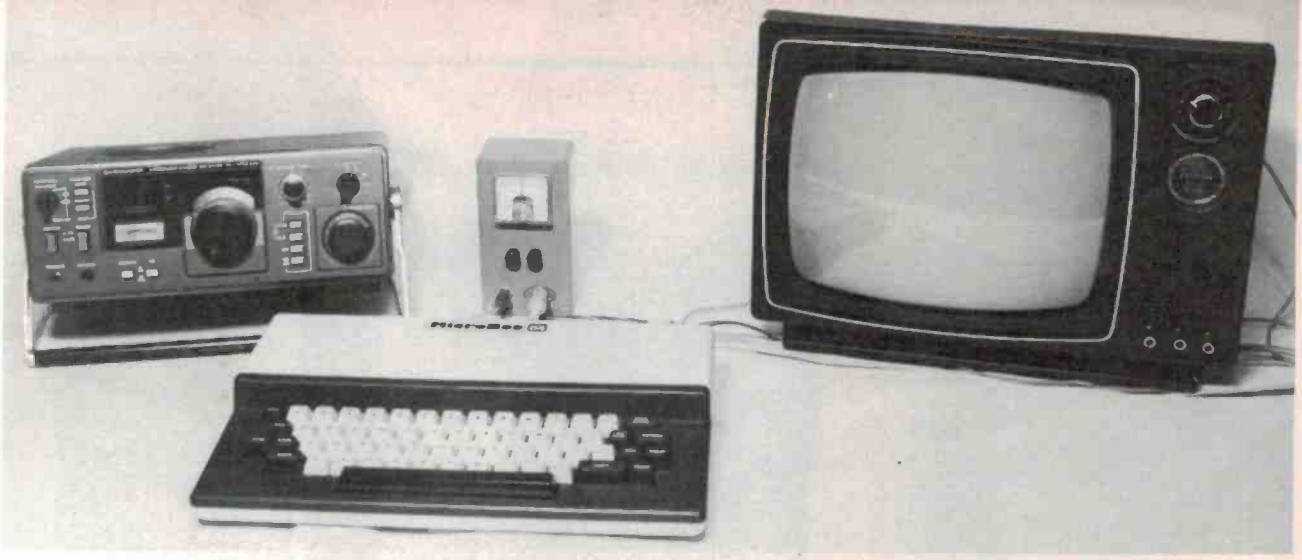
One of the advantages of the PLL system is that you can put a low pass filter in the line between the phase comparator and the VCO which effectively averages out higher frequency noise on the incoming signal, allowing the loop to remain in lock. A disadvantage is that it will always lock onto the strongest signal within its locking range, even if it's not the signal you're trying to receive.

The 4046 chip has a few extra goodies. One is a second phase comparator working on a complicated 'digital' principle. There's also a source-follower to buffer the loop signal for output, and even an on-chip zener diode for power supply regulation. In this design we've ignored the zener diode and the digital phase comparator. The latter was thoroughly tested but the 'normal' phase comparator worked better in this application.

Overall design

Circuit constants were found strictly by the eclectic empiricist method (i.e: trial and error!). After starting with the data book's suggested values, a tape of rather scruffy off-air RTTY signals was played into the





Your 'glass teletype' terminal. Add a general coverage receiver, the 733 decoder and a MicroBee (or similar Z80 system)!

PLL and the results sent to the mechanical teleprinter. A count of errors was made, a circuit constant changed, and then the same bit of tape was played again to see if the errors got worse or better.

It was a slow business but I managed to zero in on what appears to be the best performing circuit.

The lock range is from 1400 to 3400 Hz, in the higher part of the receiver's audio passband, and the loop filter constants are such that signals beyond 300 baud can be recovered.

As well as the PLL chip, the ETI-733 decoder uses an LM324 quad op-amp for input and output conditioning. One section raises the audio level from the 'recorder' output of the receiver to a level more suitable for the PLL.

The PLL output goes to two inputs of another op-amp used as a comparator. One input gets the PLL signal, lightly filtered. The other also gets the PLL signal, but this time via a very long time constant filter to produce an average of the PLL swings. This line is buffered by an op-amp, which also drives a tuning meter.

The arrangement causes the comparator to make a firm decision as to whether a mark or a space is being received, while allowing the signal to drift all around within the PLL's lock range. Shift selection is no longer required . . . anything that crosses the comparator threshold is considered valid, and signals down to 170 Hz shift work nicely.

Since the PLL lock range is 2000 Hz, a lot of receiver drift is tolerable before copy is lost.

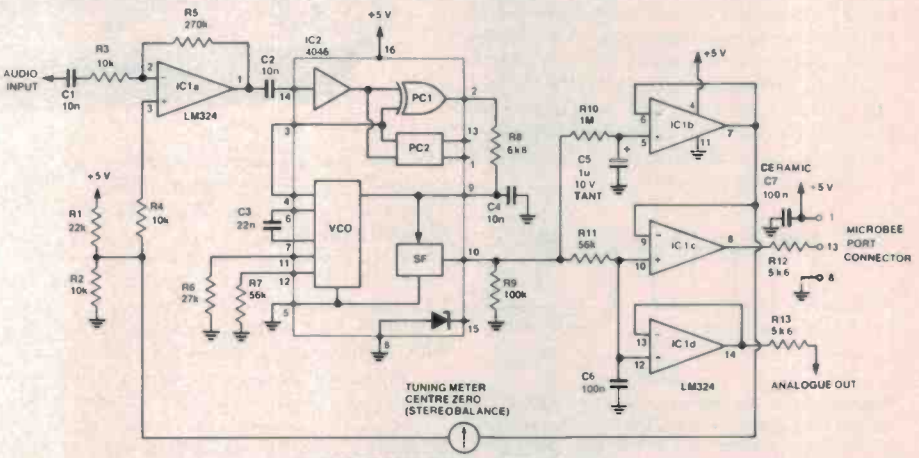
There is one disadvantage with this averaging system . . . teletype signals sent slowly, by hand, will be hard to copy. This is because the signal is spending most of its time on 'mark' and the comparator will drift toward mark, losing its centre reference. But that's of little worry, most interesting signals are sent by machine anyway.

Another op-amp enables a feature that has been examined by oscilloscope, but not properly tried yet . . . an analogue output. The PLL can track anything, not just two discrete audio tones. This opens the door for signals using frequency modulation, such as satellite pictures, weather maps, any facsimile-type signals — and these abound on the HF bands.

When one of these is being received an oscilloscope shows a nice video signal from the analogue output. A signal restricted to peak black and peak white appears on the digital output. A bit of playing around with a computer should result in a method of displaying analogue material on the screen. That's certainly one to work on.

Once the digital signal is available at the decoder's output, you can send it one of two places: to a teleprinter, or to a computer. For the teletype option you can pinch the loop driver circuit from the ETI-730 article.

(See ETI, August '79, page 43. Delete the two resistors, R29 and R30, and LED1 from the emitter circuit of Q2 and take the emitter directly to earth. Feed the PLL decoder output to the base of Q2 via R27.) ▶



HOW IT WORKS — ETI-733

The heart of the decoder is IC2, a 4046 'micropower phase-locked loop' IC. The incoming signal from the receiver consists of two audio tones — one to represent the 'mark' signal, the other to represent the 'space' signal. The 4046 converts these to a two-level digital signal, which is filtered, then buffered and sent to the computer.

IC1a and associated components forms an ac amplifier with a rolloff below 1.5 kHz (i.e: high pass) and a passband gain of about 27. Resistors R1 and R2 form a voltage divider providing a reference level for IC1a of about 1.6 V.

The amplified signal from IC1a drives the signal input of the PLL, IC2, via capacitor C2, which enables the self-biasing input amplifier of IC2 to work with weak signals.

The PLL phase capacitor, PC1, output is filtered by R8 and C4 to obtain an error signal for the PLL's VCO which should oscillate near the incoming frequency present at any particular time. The VCO frequency is 'pulled' according to the actual mark and space frequencies of the incoming RTTY signal.

The free-running frequency of the VCO is about 2.4 kHz, set by C3 and R6. The lock range of the VCO is determined by R6/R7 and is about 1.4 — 3.4 kHz.

The error signal out of PC1 of IC2 is buffered and appears at pin 10 of the PLL. A low pass filter, formed by R10, C5 and IC1b, removes the fast-changing data components of the error signal, leaving a nominally-dc component at the output of IC1b.

The PLL error signal is also fed to IC1c via another low pass filter formed by R11 and C6. IC1c is connected as a comparator with a reference signal on its inverting input set by the nominal dc level from the output of IC1b. This comparator 'extracts' the data from the error signal. This scheme relies on the input not containing long periods of only one input tone, which is usually true.

The tuning meter connects between the 1.6 V reference provided by R1/R2 and the output of IC1b. This indicates when the receiver is producing audio tones shifting within the PLL lock range. When correctly tuned, the current through the meter is zero, hence the necessity of a centre-zero meter.

The data low pass filter, R11/C6, has a roll-off around 30 Hz, which ensures clean data out. However, some experimentation can be carried out with different data rate signals. You can vary C6, decreasing its value for high data rates, settling on a value which gives best results.

Software

The program that follows was written for the MicroBee, but since it's in machine code it should work on just about any Z80-based machine with only minor modifications to some addresses. Here's how it works:

The aforementioned in/out port is first set up in what's called the 'control' mode . . . you specify some bits as inputs and others as outputs, and no 'handshaking' signals are required. In this case I've called all the bits inputs, although only bit 0 is used to bring in the teletype signals decoded by the ETI-733.

A teletype signal is made up of a start pulse, five data pulses, and an extra-long stop pulse (start and stop refer to shaft rotation that takes place in a mechanical teleprinter). Refer to Figure 1, below. A pulse, in the case of 50 bauds, is 20 ms long.

The program first looks for a start pulse which unleashes the following series of events: Bit 3 of an 8-bit register (register C in the Z80) is set high. Thirty milliseconds later the transmitting teletype should be in the centre of its first data pulse . . . this is read and pushed into the right end of the C register. Everything already in C is shoved to the left to make room. Twenty milliseconds later comes the next data pulse, this is loaded into C and everything else shifts along. After five data pulses the bit originally set in C falls out the left hand end, telling the program that a character is finished. Register C now contains, in its first five bits, a binary number between 0 and 31.

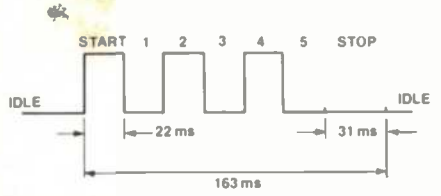


Figure 1. How the teletype signal is made up. For 45.45 baud speed standard, the first five pulses are 22 ms long, followed by a 31 ms 'stop' pulse giving 163 ms per character, while a 50 baud system uses 20 ms pulses with a 30 ms 'stop' pulse, giving 130 ms per character.

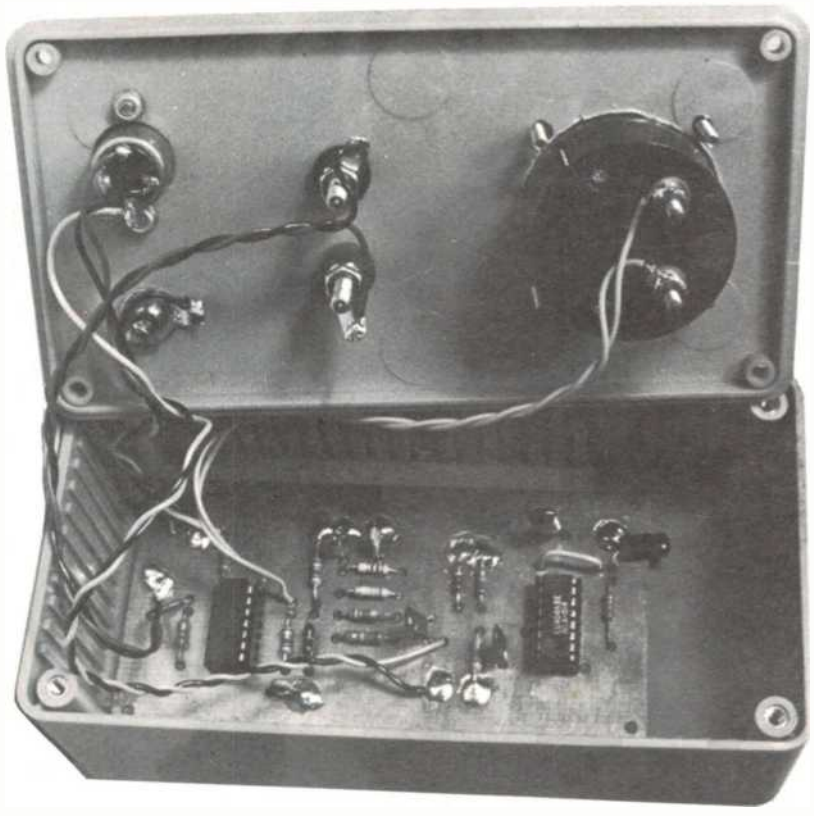
In the next part of the program the character in C is inspected to see if it's a figures or letters shift. If so, a flag (register E), is set accordingly. Now register pair HL is set to point to a table of ASCII characters. The number in C is doubled and then added to HL, making HL point to a pair of table entries. Which entry of the pair gets selected depends on flag E which, if zero, gets even numbered entries (letters characters). If E is one, HL selects odd numbered entries (figures and punctuations).

The ASCII character eventually selected is loaded into register B and then sent off to the MicroBee's VDU routine, where it's displayed on the screen. The program then goes back to looking for another start pulse for the next character.

If your MicroBee is a BASIC-only version, getting the program into it could be a problem. Although there are only 139 bytes in the program, they can only be entered in memory by 'poke' statements, but then there's no easy way to save the program on tape. If you want to try it anyhow, first convert the hexadecimal values in the 'code' column, eight bits at a time, to decimal. Then poke them into the hex addresses in the 'ADDR' column.

Then again, you could take the easy way out. For the sum of 12 miserable dollars, sent to the author, you will receive a postpaid cassette tape which can be loaded into your MicroBee with the usual 'load' command.

This tape contains an extended 'bells and whistles' version of the RTTY program, with such goodies as baud rates from 45.45 to 300, selectable while the program is running, selectable page or tape display mode, and signal inversion at the touch of a key.



Construction

All the 'electronic' bits go on a pc board measuring about 120 mm by 60 mm. Only the tuning meter and input/output connectors are mounted separately. As a concession to the 'RF purists' I used a double-sided pc board with a groundplane on the component side of the board. As we're dealing only with audio signals here, you can ignore the groundplane if you so wish. As for sockets for the two ICs — please yourself, they have no effect on circuit operation.

Assembly of the pc board is straightforward. Probably the easiest way to tackle it is to solder the resistors in place first, followed by the capacitors. Watch the orientation of the 1 uF tantalum, C5. Install IC1 and then IC2. Note that the latter is a CMOS type and the usual static and soldering precautions should be taken. Note that there is one link on the board — near one end of IC2.

Finally, attach the wires that go to the meter and input/output terminals. If using a double-sided pc board, some components are soldered on the top *and* bottom side of the board — denoted by a • on the overlay.

You can mount the decoder in a box if you wish; any suitably-sized jiffy box will do nicely. The meter and input/output terminals can be mounted on the box's lid. Nothing's critical, so exact construction details are left up to you as individual requirements will undoubtedly vary a great deal.

Hooking it up

Figure 2 shows the general idea of how the

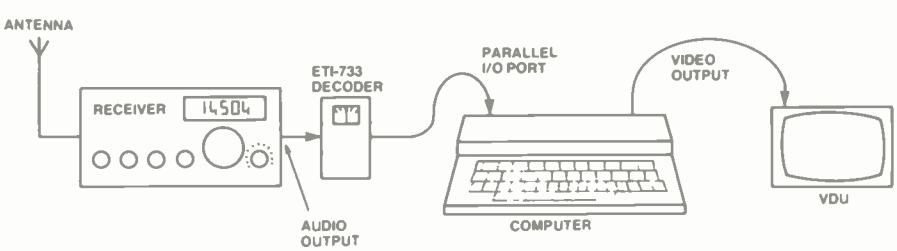


Figure 2. The hookup. Audio output from the receiver can be taken from across the speaker, a headphones output, a recorder output or other suitable auxiliary audio output.

PARTS LIST — ETI-733

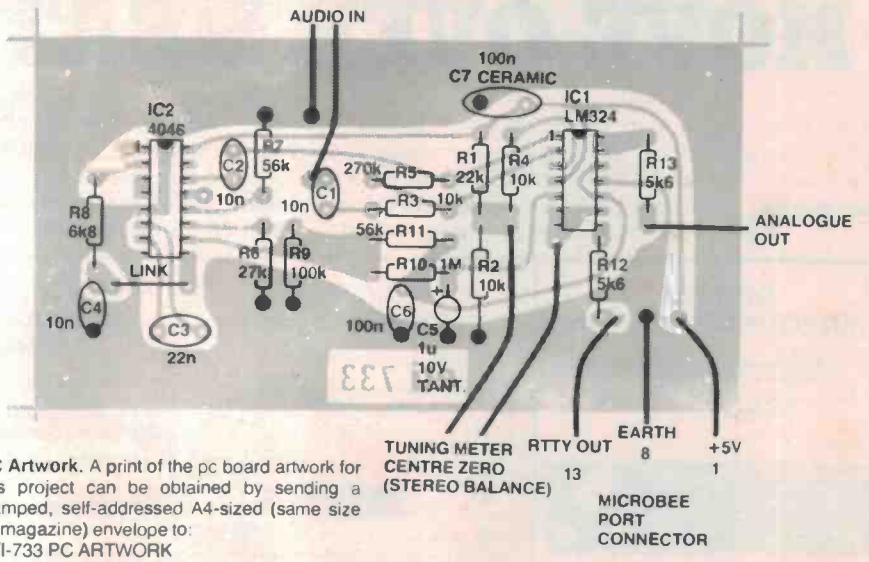
Resistors ..... all ½W, 5%
- R1 ..... 22k
- R2, 3, 4 ..... 10k
- R5 ..... 270k
- R6 ..... 27k
- R7, R11 ..... 56k
- R8 ..... 6k8
- R9 ..... 100k
- R10 ..... 1M
- R12, R13 ..... 5k6

Capacitors
- C1, 2, 4 ..... 10n greencaps
- C3 ..... 22n greencap
- C5 ..... 1u/10 V tant.
- C6 ..... 100n greencap
- C7 ..... 100n ceramic bypass

Semiconductors
- IC1 ..... LM324
- IC2 4046

Miscellaneous
ETI-733 pc board; M1 — centre-zero tuning meter; DB15 plug; wire, etc.

Price estimate $16 — $20



PC Artwork. A print of the pc board artwork for this project can be obtained by sending a stamped, self-addressed A4-sized (same size as magazine) envelope to:
ETI-733 PC ARTWORK
ETI Magazine
140 Joynton Ave Waterloo NSW 2017.

decoder fits in the system. The audio output from the receiver can be taken directly across the speaker, from any auxiliary audio output or a headphones output. Less than one volt of audio will provide adequate drive to the decoder.

To use a MicroBee computer you'll first have to arrange a parallel input/output port. If this was not supplied with your computer, you'll have to install it yourself. All that's required is the 15-pin ('DB15S') socket which you can buy from your local electronics store and wire it in yourself (very carefully). While it wires straight in, note that bit 0 of the port comes out on pin 13, not pin 11, as the pc board overlay or kit construction manual indicates. The output of the ETI-733 decoder connects to bit 0 and it gets power supply from the computer via pin 8 of the port connector.

All you need now is some means of converting the decoder output to characters on the VDU screen. That's where we need a little software.

For other Z80-based computers, we'll have to leave the details to you as individual systems vary. Have a close look at your system's technical manual.

On the air

To test your new decoder, here are some frequencies to try:

11 030 kHz AXM, coded weather info. 50 bauds
13 779 kHz Voice of America News, 75 bauds
14 700 kHz Christchurch to McMurdo, 75 bauds
16 100 kHz Chinese News Agency, 50 bauds

With the receiver set for the upper sideband mode, tune for centre reading on the decoder meter. If the signal is garbled, try it on the other sideband. An off-centre meter reading under no-signal conditions is normal. Happy spying. ●

SOFTWARE

```
ADDR   CODE     LINE   LABEL  MNEM    OPERAND

               00100 ;RTTY RECEPTION PROGRAM FOR 50 BAUDS
               00110 ;(SHORT VERSION) by Tom Moffat
               00120
0400           00130          DEFR    16      ;ASSUME HEX NUMBERS
0400           00140          ORG     0400
               00150
               00160 ;5-bit serial input routine, through PIO BIT 0
               00170
0400 3ECF      00180          LD      A,0CFH  ;SET PIO FOR "CONTROL"
0402 D301      00190          OUT     (1),A
0404 3EFF      00200          LD      A,0FFH  ;SET ALL BITS "INPUT"
0406 D301      00210          OUT     (1),A
0408 DB00      00220 INPT     IN      A,(0)   ;LOOK FOR START BIT
040A CB47      00230          BIT     0,A
040C 20FA      00240          JR      NZ,INPT
040E 0E0B      00250          LD      C,8     ;SET UP COUNTER BIT
0410 CD4204    00260          CALL    DELAY1  ;START BIT IS LOW, ...
0413 CD3F04    00270          CALL    DELAY2  ;DELAY TO CENTRE OF DB-1
0416 DB00      00280 LOOP     IN      A,(0)   ;BRING IN DATA BIT
0418 CB3F      00290          SRL     A       ;SHIFT DATA INTO CARRY
041A CB11      00300          RL      C       ;SHIFT CARRY INTO C
041C CD3F04    00310          CALL    DELAY2  ;ONE BIT TIME
041F 30F5      00320          JR      NC,LOOP ;RPT TILL COUNTER BIT OUT
               00330
               00340 ;Conversion to ASCII, BAUDOT character in C.
               00350
0421 214C04    00360          LD      HL,TABLE
0424 0600      00370          LD      B,0
0426 1600      00380          LD      D,0
0428 79        00390          LD      A,C
0429 FE1B      00400          CP      1BH     ;IS BAUDOT CODE (FIGS) ?
042B 2002      00410          JR      NZ,$+4  ;SKIP NEXT IF NOT FIGS
042D 1E01      00420          LD      E,1     ;SET FLAG "FIGS"
042F FE1F      00430          CP      1FH     ;IS BAUDOT CODE (LTRS) ?
0431 2002      00440          JR      NZ,$+4  ;SKIP NEXT IF NOT LTRS
0433 1E00      00450          LD      E,0     ;SET FLAG "LTRS"
0435 CB21      00460          SLA     C       ;LET C = C * 2
0437 19        00470          ADD     HL,DE   ;ADD FLAG TO POINTER
0438 09        00480          ADD     HL,BC   ;ADD CHR TO POINTER
043C 46        00490          LD      B,(HL)  ;ASCII CHAR INTO B
043A CD0C80    00500          CALL    800CH   ;OUTPUT CHAR TO VDU.
043D 18C9      00510          JR      INPT    ;GO BACK TO START
               00520
               00530 ;Time delay subroutine
               00540
043F CD4204    00550 DELAY2   CALL    DELAY1
0442 3E78      00560 DELAY1   LD      A,120D  ;DO 120 TIMES FOR 50 BAUD
0444 060B      00570 LOOP1    LD      B,0BH
0446 10FE      00580          DJNZ    $       ;JUMP TO YOURSELF IF NZ.
0448 3D        00590          DEC     A
0449 20F9      00600          JR      NZ,LOOP1
044B C9        00610          RET
               00620
               00630 ;ASCII lookup table arranged by BAUDOT value
               00640
044C 0505      00650 TABLE    DEFW    0505    ;(BLANK)
044E 5435      00660          DEFW    3554    ;T 5
0450 0D0D      00670          DEFW    0D0DH   ;(CR)

ADDR   CODE     LINE   LABEL  MNEM    OPERAND

0452 4F39      00680          DEFW    394FH   ;O 9
0454 2020      00690          DEFW    2020    ;(SPACE)
0456 4800      00700          DEFW    0048    ;H (STOP)
0458 4E2C      00710          DEFW    2C4EH   ;N ,
045A 4D2E      00720          DEFW    2E4DH   ;M .
045C 0A0A      00730          DEFW    0A0AH   ;(LF)
045E 4C29      00740          DEFW    294CH   ;L )
0460 5234      00750          DEFW    3452    ;R 4
0462 4724      00760          DEFW    2447    ;G $
0464 4938      00770          DEFW    3849    ;I 8
0466 5030      00780          DEFW    3050    ;P 0
0468 433A      00790          DEFW    3A43    ;C :
046A 563D      00800          DEFW    3D56    ;V =
046C 4533      00810          DEFW    3345    ;E 3
046E 5A2B      00820          DEFW    2B5AH   ;Z +
0470 4400      00830          DEFW    0044    ;D
0472 423F      00840          DEFW    3F42    ;B ?
0474 5327      00850          DEFW    2753    ;S '
0476 5936      00860          DEFW    3659    ;Y 6
0478 4625      00870          DEFW    2546    ;F %
047A 582F      00880          DEFW    2F58    ;X /
047C 412D      00890          DEFW    2D41    ;A -
047E 5732      00900          DEFW    3257    ;W 2
0480 4A87      00910          DEFW    874AH   ;J (BELL)
04B2 0404      00920          DEFW    0404    ;(FIGS)
04B4 5537      00930          DEFW    3755    ;U 7
0486 5131      00940          DEFW    3151    ;Q 1
0488 4B28      00950          DEFW    284BH   ;K (
048A 0B0B      00960          DEFW    0B0BH   ;(LTRS)
0000           00970          END
00000 Total errors

LOOP1   0444    TABLE   044C    LOOP    0416    DELAY2  043F
DELAY1  0442    INPT    0408
```

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Use of the latest LSI circuitry ensures impeccable performance from the completed unit. This is further ensured by our use of top grade components.

NOTE: (Altronics use only the specified Intersil LSI — beware of inferior kits that do not conform to the original design.

Frequency measurement to 500mHz (with optional Prescaler) in 3 ranges – 0–10MHz, 0–50MHz, 10–500MHz • 4 gating times – 0.01, 0.1, 1, 10 seconds.

Period measurement for accurate low frequency counts, 4 ranges – 1, 10, 100, 1000 input cycles • resolution 0.1us.

High Input Sensitivity – 10MV to 30MHz. 100MV at 50MHz @ 1MOHM input impedance, 200MV @ 500MHz @ 75 OHMS input impedance.

Accuracy – typically better than 0.005% uncalibrated.

Exclusive Altronic Kit Features

- IC sockets provided throughout
- low aging 10.000 MHz XTAL.
- Genuine Fairchild High Brightness FND 507 display's.
- Quality ABS plastic case – deluxe front panel.
- Complete kit as specified by EA includes instructions, all cables and every last nut, bolt and washer.

K2500. . . . . $119.50

DECIMAL POINT FOR K2500

READ FREQUENCY DIRECTLY IN MHz and PERIOD IN US.

K2502. . . . . $7.50

PRESCALER FOR K2500

ALLOWS FREQUENCY MEASUREMENT TO 500MHz

K2501. . . (essential option) . . . $26.00

FUNCTION GENERATOR

(with digital display)

Sine, triangle and squarewaves : 15Hz – 250KHz.

The most essential piece of test gear (second only to a good multimeter) on any hobbyist's bench is some kind of audio signal generator. This design utilizes the latest circuit techniques to produce stable, low distortion waveforms.

A truly versatile unit at a bargain price.

- 4 digit frequency readout (eliminates tiresome dial calibration) —typical accuracy ± 2%.
- 3 overlapping ranges x1, x10, x100.
- 600 OHM Nominal Output — continuously variable 3MV—2.5V P—P.
- Distortion — sinewave : less than 0.7% @ 1KHz.
- Linearity — triangle wave : better than 1% @ 1KHz.
- Squarewave rise time — 6V/uz maximum output.
- Amplitude stability — better than 0.1dB on all ranges.

With the exception of the display all components mount on a single PCB making this kit suitable for all constructors.

K2505. . . . . $85.00

ANALOG / DIGITAL STORAGE CRO ADAPTER

(See EA Nov 1980 and March 1981).

Unit enables indefinite storage of non-repetitive waveforms at a fraction of the cost of conventional storage CRD's. National semiconductors A—D/D—A conversion techniques allow analog signals up to 100KHz to be stored • two channels while in digital mode • positive and negative edge triggering • AC/DC/HF and LF rejection • timebase tracer for accurate frequency measurement • accurate down to 1.9Hz Analog mode — 1us Digital Mode • delayed trigger 10us-1s • sensitivity — 160MV P—P — 1 MEG (Analog)* standard TTL and CMOS levels 3-15 volt supply (Digital).

The features of this unit are to numerous to list, yet is simple to operate.

Be assured of quality with an Altronics Kit.

1. Genuine National A—D conversion chips not second sourced dropouts.
2. All IC sockets provided (27 total — you pay no more)
3. Low capacitance coax and a full metre of rainbow cable.
4. Full instructions and every last nut, bolt and washer.
5. Deluxe mini rack cabinet.

K2600. . . . . $189.00

STEREO SYNTHESIZER FOR TUNERS & VCR's

(See EA Sept. 1982)

Synthesize realistic stereo from virtually any monophonic source by simply connecting this unit between the source and your stereo amplifier.

ENJOY THE PLEASURES OF STEREO SOUND

- Quality Phillips MN3001 (not second source dropout)
- Provision for 2 different signal sources.
- Selection of either source via front panel switch.
- Normal or stereo sound selection.
- Complete kit includes all hardware, cables etc., even solder.

Important * beware of Kitset suppliers who sell this kit for less * you get less!!.

K5810. . . . . $55.00

TRANSISTOR TESTER

Electronics Australia Project. Tests Bipolar Transistors, Diodes, Fets, SCR's and PUT's. Excellent service aid for the hobbyist and serviceman. Complete kit and instructions.

K 2525 . . . . . $19.75

DIGITAL CAPACITANCE METER

Electronics Australia Project. Measures capacitance of both polarized and non polarized capacitors from 1 picofarad to 99.99 microfarads in 3 ranges.

Check values of unmarked capacitors, especially those little trimmers that are never coded.

Select precise values for filters and timing networks with ease.

• • • • Exclusive to Altronics • • • •

Each kit includes precision measured capacitors for accurate calibration of each range.

K2520. . . . . $49.50

OVER 1000 SOLD LAST YEAR

POWER SUPPLIES

OUT BEST SELLING POWER SUPPLY KIT EVER

3–32 volt output at 1 amp UNDER $40

THE ALTRONICS POWER SUPPLY

Based on EA LM 317K Project

Every workshop, school and hobbyist should get one now ! ! !

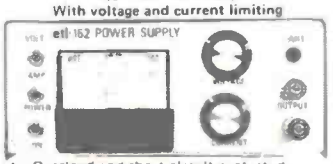
- Fully projected from thermal runaway and short circuits.
- Voltage and current metering.
- To—3 regulator plus powerfin heatsink.
- Fully documented, every last part included.

K3200. . . . . $39.95

ETI 162 BENCH SUPPLY

1.3 – 30V @ 1 Amp

With voltage and current limiting



- Overload and short circuit protected.
- Voltage and current metering.
- Regulation – better than 0.2% zero to full load
- Hum and noise on output – less than 1MV at full load.
- LED indication of current limit.

Exclusive — fully S.E.C. Certified Mains Transformer supplied.

If you're considering buying this kit from your local supplier or one of our competitors — first ring and ask them if the mains transformer is S.E.C. certified to ASC126 — chances are that it won't be.

So why not give us your order? An Altronics Quality Kit speaks for itself and with our overnight Jetservice we guarantee to deliver to your door faster than your local supplier.

K3205. . . . . $49.50

2-32 VOLT 5 AMP POWER SUPPLY

Following in the steps of our K 3200 power supply comes BIG BAD BROTHER! Based around the national LM338K variable regulator this supply offers exceptional value for money.

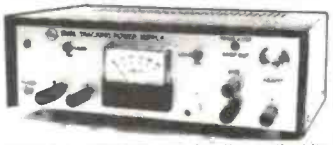
- 2-32 Volt Output of 7 Amps.
- Peak Currents of 7 Amps.
- Protected from both short circuits and thermal runaway.
- Continuous voltage adjustment.
- Dual Metering enables Continuous Voltage and Current Display.

The Handiest Power Supply Kit Ever for Workbench, Laboratory etc.

K 3300 $129.50

DUAL TRACKING POWER SUPPLY

± 1.3 to ± 22V @ 2 AMPS : + 5V @ 0.9 AMPS



The ideal power supply for the audiophile experimenting with linear OP amp designs in which split supply operation ensures improved distortion and noise figures.

- Fully protected against short circuits, overloads and thermal runaway.
- LED indicator for regulator dropout.
- Floating ground.
- Uses 0.25% linearity 10 turn pot — tracks within 1MV.
- Voltage adjustable to within 10MV.

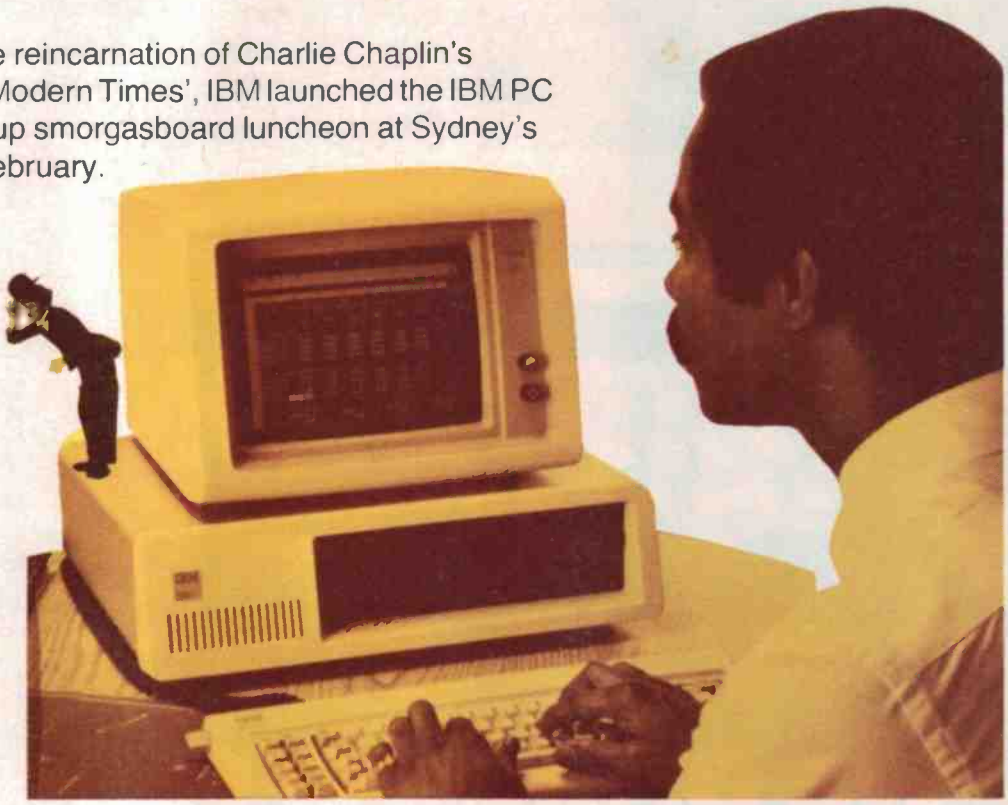
K3220. . (EA MARCH 1982) . . $86.00

ALTRONICS

For address, phone number and despatch details see our advertisement on page 51

The personal computer for modern times— from IBM

With that slogan and the reincarnation of Charlie Chaplin's character from his film 'Modern Times', IBM launched the IBM PC in Australia with a slap-up smorgasboard luncheon at Sydney's Sebel Town house in February.



Parked out front was a bright red Porsche sporting 'IBMPC' number plates while inside was a small array of IBM PCs demonstrating their prowess.

From the literature handed out from IBM, and from what one has read in the copious reports in overseas journals, it seems IBM have a winner on their hands.

Priced at $3224 inc. sales tax for a 'minimum' system, the IBM PC is supported by an impressive array of software for business, educational and 'home' applications.

An enhanced version of the popular Microsoft BASIC programming language and easily understood operation manuals are included with every system. They make it possible to be using the computer within hours and to develop personalised programs quite easily.

The system comes with an 83-key detachable keyboard featuring a sculptured key face and adjustable typing angle, up to 544K of user memory (64K standard) and self-testing capabilities that automatically check the system components, all driven with a powerful 8/16-bit microprocessor.

The standard display is 25 lines of 80 characters, plus graphics capabilities. Colour is available too — but only NTSC (American) standard at present, PAL to come later (you'll need an NTSC monitor).

The colour-graphics capability allows you to display up to 256 characters in any of 16 foreground and eight background colours, graphics in four colours.

The system unit is the heart of the IBM PC. It contains the central processing unit (CPU), power supply etc, and one or two diskette (5¼") drives. It's about the size of a portable typewriter and includes a speaker for audio or musical applications. The diskette drives can provide 160K each of mass storage.

A 'starter' system consists of a keyboard, system unit, monochrome display and diskette drive. It can then be expanded to a system with its own printer, additional storage diskettes, communications adapter and colour/graphics display monitor. Using the communications facilities information from centralised data banks such as The Source can be accessed.

A ninety-day warranty is provided. Service will be by exchange of elements for printer, keyboard and display. System units will be retained for repair and then returned to the owner. Service will be carried out by IBM principally, but authorised dealers may also offer service.

Technical backup will be via dealers in the first instance, maybe IBM in the last resort, according to information given in answer to questions at the press conference.

It is IBM's intention to acquire locally-developed software from IBM and non-IBM sources.

Program packages available for the IBM Personal Computer cover popular business and home applications. For example, EasyWriter will store letters, manuscripts and other text for editing or rapid reproduction on the printer.

Multiplan and VisiCalc are available for applications ranging from financial analysis to budget planning. Microsoft Adventure — the doyen of text computer games, is also available.

IBM, in conjunction with Microsoft, Inc., has adapted an advanced disk operating system to support IBM Personal Computer programs and software development. CP/M-86 and UCSD p-System have also been adapted to the Personal Computer to provide users with the opportunity to transfer hundreds of widely used applications programs to the IBM Personal Computer with minimal modifications.

Authorised dealers have been appointed in all states. For information, contact Ian Penman, IBMs Personal Computer Dealer Marketing Manager, via **P.O. Box 3318, GPO Sydney 2001 NSW. (02) 234-5678.** ●

COLOUR GENIE

The Versatile Computer

Enter the exciting world of computer with the EG2000 Colour Genie

* Low Priced — Compare the Features.
* Clear & Defined Colourfull Graphics.
* Fully Expandable — Compare the Prices.

- Children & Adults love Video Games.
- Home Accounting.
- Small Business Computing.
- Educational Purposes.

CALL OR WRITE FOR LOCATION OF YOUR NEAREST COLOUR GENIE DEALER.

$449.00

INCLUDES CASSETTE RECORDER

WE DARE TO COMPARE

FEATURES	COLOUR GENIE	VIC 20	TRS 80 COLOUR	ATARI 400
ROM	16K	8K	8K	10K
RAM on Board	16K	5K	4K	8K
Max. RAM on Board	32K	5K	32K	16K
Professional Typewriter Keyboard	YES	YES	NO	NO
R.F. with sound modulators built-in	YES	NO	YES	YES
Built in Power Supply	YES	NO	YES	YES
RS-232C Built-in	YES	NO	YES	NO
Sound	YES	YES	YES	YES
Screen Display	24 x 40	22 x 23	16 x 32	24 x 40
Programmable Characters	YES	NO	NO	NO
Upper/Lower Case Characters	YES	YES	YES	NO
Dedicated Graphics	YES	YES	NO	YES
User-Programmable Function keys	8	NO	NO	NO
CPU	Z80	6502	6809E	6502
Clock Speed	2.2MHz	1 MHz	0.89MHz	1.8MHz
Baud rate	1200	300	1200	1200
Price including Cassette Recorder (approx RRP)	$449	$399	$784	$758

FOR FURTHER INFORMATION CONTACT BERTAS INTERNATIONAL PTY LTD
P.O. BOX 294 BOX HILL, VIC. 288 7708

Allah be praised, the Colour Genie arrives!

Latest contender for the colour home computer market is the Colour Genie featuring a Z80 microprocessor, 16K user memory, 63 key typewriter-type keyboard, high speed cassette interface, eight colours, 128 dedicated graphics symbols and a high-resolution graphics mode of 160 x 96 pixels.

It comes with Microsoft extended BASIC, including graphics and colour commands. The video display format is 24 lines of 40 characters with the full 43 ASCII character set in upper and lower case.

A graphic character set of 128 dedicated symbols is provided with symbols printed on the keytops for your convenience. An additional 128 programmable characters can be obtained.

The Colour Genie has both direct video and modulated RF output for connection to either a colour monitor or TV set. The sound is modulated onto the RF output too so that sound effects can be heard in the TV's loudspeaker. A separate audio input connector is provided.

The 16K RAM can be expanded to 32K internally. Built-in interfaces allow the attachment of printers, disk drives, cassette recorder, light pen and joystick controls.

Two manuals are supplied with the Colour Genie written in a simple to understand, entertaining style providing a training course in BASIC programming from first principles.

The cassette interface, for cheap mass storage on standard audio cassettes, runs at 1200 baud. You can save a 15K program in 100 seconds, the makers claim.

The Colour Genie is made in Hong Kong by EACA International Ltd who made the very successful Dick Smith System 80 (now ceased production). It is being imported and distributed by **Bertas International Pty Ltd, 347 Scoresby Rd, Ferntree Gully Vic. 3156. (03) 288-3107.**

The Computer Company launches Panasonic's JB-3000 against IBM PC

One of the first IBM PC clone/competitors on the market was Matsushita's Panasonic JB-3000, configured to be directly software compatible and keenly price/hardware competitive.

The Computer Company, who market Panasonic computers in Australia, released the JB-3000 here shortly before IBM's PC launch lunch.

So, what does the JB-3000 offer against the IBM PC? Taking the keyboard as the most important component for the operator, the makers point out that the keyboard, while having a similar key layout, has colour-coded keys for ease of learning and use. Dedicated cursor control keys are included in the standard 'T' format, plus a wrist rest at the front of the keyboard. Typing angle is not adjustable.

The main processor cabinet, housing the CPU etc, has a front-mounted power switch and indicator, plus a reset switch which does not interrupt the power supply. Disk drives are not housed on the processor cabinet, but come as separate attachments.

Either 5¼" diskette or 8" disk drives can be fitted to the JB-3000. The diskette drives are capable of 640K, the 8" drives 1.26M each. Drives simply plug in.

Output to VDU is composite video. Colour is included as standard. Colour output is eight colours maximum and all can be displayed on-screen at once.

Output to printers is via RS-232 or Centronics interface, the latter is included as standard.

The JB-3000 has three internal expansion slots and an add-on expansion unit to give a total of eight expansion slots. The JB-3000's 64K RAM can be expanded to 256K with the addition of one memory card.

The JB-3000 runs Microsoft's MS-DOS operating system. CP/M-86 is available for the machine, also. A whole range of software packages will be available for the JB-3000 through dealers, including business, finance, word processing etc.

The Panasonic JB-3000 will be marketed through department stores, not computer specialty shops. Angus & Robertson, Grace Bros. and Myer stores will be handling it. Free training is provided with the machine and courses are available from Metropolitan Business Colleges around Australia.

Further details from **The Computer Company, 4 Cliff St, Milsons Point NSW 2061. (02) 436-1733.**

READ THIS-

STOP important notice GO FOR COMPUTERS AT REALISTIC PRICES

ALL QT COMPUTER PRODUCTS NOW AVAILABLE ONLY FROM PRE-PAK

FOLLOWING A RECENT AGREEMENT BETWEEN MR BOB STEIN, OF QT COMPUTER SYSTEMS (AUST) AND MR I. RALPH, OF PRE-PAK ELECTRONICS PTY. LTD. ALL COMPUTER PRODUCTS PREVIOUSLY SOLD BY QT COMPUTER SYSTEMS DIRECTLY, WILL NOW BE SOLD BY PRE-PAK ELECTRONICS AT THEIR SYDNEY STORE. "THIS WILL ALLOW US TO DEVOTE MORE TIME TO MANUFACTURING AND SYSTEMS DEVELOPMENT", SAID MR STEIN, "HOWEVER, WE WISH TO KEEP FAITH WITH OUR MANY 'BUILD-IT-YOURSELF' CUSTOMERS". MR RALPH STATED THAT "MOST QT PRODUCTS ARE CURRENTLY EX-STOCK AND PRICES ARE SUBSTANTIALLY THE SAME AS LAST YEAR'S"."OUR EXTENDED TRADING (6 DAYS), IS A BIG ADVANTAGE", HE ADDED.

QT COMPUTER SYSTEMS

...all revealed in our

1983 CATALOGUE

GET YOUR COPY TODAY!
Sent free to Schools, Government Depts, Companies etc, otherwise send 70¢ to cover postage.

A LARGE RANGE OF KITS, PARTS, METALWORK

QT SILENCE+ MOTHERBOARDS

The SILENCE+ has become one of the most tried and proven motherboards on the market. Using a unique grounding matrix, each line is completely surrounded with ground shielding which eliminates necessity for termination and gives the unit a very high cross-talk rejection. Has been used as high as 14MHz w/o tere.

PRICES:	no Tax	incl Tax
6 slot bare board	$ 31.00	$ 37.20
6 slot A&T	$ 81.00	$ 87.20
8 slot bare board	$ 33.00	$ 39.60
8 slot A&T	$104.00	$110.60
12 slot bare board	$ 39.00	$ 46.80
12 slot A&T	$138.00	$145.80
18 slot bare board	$ 61.00	$ 73.20
18 slot A&T	$178.00	$190.20

QT CARD CAGES

QT card cages are strong, cadmium-plated steel frames, punched ready-to-accept card-guides and motherboard. Perfectly suited for industrial control applications with the addition of CPU and memory card with the Silence+ Motherboard.

	no Tax	incl Tax
6 slot Card Cage	$ 30.00	$ 36.00
incl motherboard, etc	$117.00	$140.40
8 slot Card Cage	$ 33.00	$ 39.60
incl motherboard, etc	$145.00	$174.00
12 slot Card Cage	$ 39.00	$ 46.80
incl motherboard, etc	$189.00	$226.80

DUAL 5¼" DRIVES
432mmL x178mmH x508mmD

DUAL 8" DRIVES
432mmL x244mmH x532mmD

MAINFRAMES

- Power and Reset switches on front
- Fully professional

The QT Mainframes are, we believe, the most versatile models on the market. They will accomodate 6, 8 or 12 slot card cages using the Silence+ Motherboards. Any 5¼ inch, 8 inch standard or slimline disk drives can be fitted. Adequate space is available for a fan and power supply (these are included in assembled and tested versions). Just add a CPU, memory board, disk controller and terminal and you have an inexpensive, high quality computer system. The finish is beige with brown cover.

Prices are for 5¼" or 8" sizes.

	No Tax	Incl Tax
Bare cabinet	$198.00	$237.60
incl 6 slot M/board (A&T)	$552.00	$662.40
incl 8 slot M/board (A&T)	$581.00	$697.20
incl 12 slot M/board (A&T)	$612.00	$734.40

All parts available separately, let us quote!

DISK DRIVE CABINETS

The QT cabinets are professionally designed and finished and are ready to accept power supplies and disk drives.

PRICES:	no Tax	incl. Tax
5¼" Mini Single cabinet	$ 35.00	$ 42.00
incl. power supply (A&T)	$129.00	$154.80
5¼" Dual Mini Cabinet	$ 39.00	$ 46.80
incl. power supply (A&T)	$159.00	$190.80
8" Single Cabinet	$ 89.00	$106.80
8" Single standard drive or dual slim-line cabinet incl. power supply (Assembled and Tested)	$295.00	$354.00

S100 CONNECTORS

100 pin standard connector for S100 bus. Specially plated contacts for maximum efficiency. Made in USA.

$7.45 INCL. TAX

TAX FREE $6.20 EA.

FANTASTIC VALUE

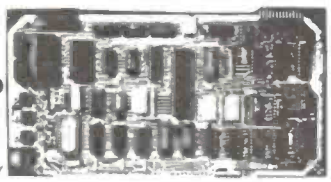
Z80 SINGLE BOARD S100 COMPUTER SBC 2/4

$239
$199 NO S/TAX
KIT PRICE.

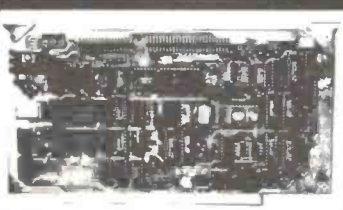
BUILT & TESTED. **$299.00** $249 no Tax

BARE BOARD PLUS MANUAL. **$79.20** $66 no Tax

ADD FREIGHT: $4.00 ONLY



FEATURES:
The QT Computer SBC 2/4 Processor Board may be used as a stand-alone computer or as the host CPU of a large system. It works reliably with dynamic RAM boards and more importantly with soft sectored disk controllers, and hence standard versions of CP/M. This gives access to the largest software base for microcomputers. 2 or 4 MHz switch selectable. ● 1K RAM (can be located at any 1K boundary) ● one each serial and parallel I/O ports ● power on jump to on board EPROM (2708 or 2716) addressable on any 1K or 2K boundary ● full 64K use of RAM in shadow mode ● 2 programmable timers avail. for use by programs ● DMA capability allows HRQ signal generation on CPU board or elsewhere in system under DMA or front panel control ● programmable baud rate 110-9600



DISK DRIVE CONTROLLER

CCS2422A CALIFORNIA COMPUTER SYSTEMS BOARD

ASSEMBLED AND TESTED WITH EXTENSIVE MANUALS

NO TAX $400 INCL $480

CP/M for controller-
8" $120 5¼" $140 + S/Tax

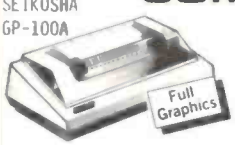
The CCS2422A controller supports up to four drives in any combination of 5¼" and 8" single or double-sided drives, reads and writes soft-sectored diskettes formated to the IBM standards and is fully supported with ROM-resident firmware. CP/M 2.2 is available in either 5¼" or 8" format. Compatible with S100 bus system.

LOOK

SUPER DEALS ON ... COMPUTER PERIPHERALS

(ALL PLUS SALES TAX: 20%)

SEIKOSHA GP-100A



10" Tractor Feed Parallel, 30 CPS $415

OKI MICRO-LINE 80

$499 10" Tractor/Friction Parallel, 80 CPS

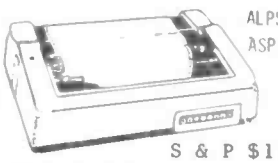
C. ITOH PRO-WRITER 8510

10" Tractor/Friction Parallel or Serial, 110 CPS
P $699 S $785

C. ITOH PRO-WRITER II 1550

15.5" Tractor/Friction Parallel or Serial, 120 CPS P $1060 S $1175

ALPS ASP-3500



16" Tractor Feed Parallel and Serial, 180 CPS
S & P $1695

BIG value in small printers

DATA DISPLAY TERMINAL

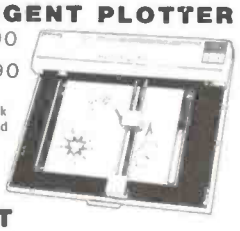
With detachable keyboard, 12" 24x80 screen, 128 ASCII characters, RS232 or current loop.

$875

INTELLIGENT PLOTTER

Single pen $1290
6 Colour $1490

Uses standard ink pens or water and oil based pens. 7 bit parallel ASCII code.

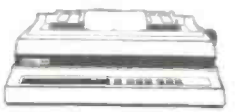


DAISY WHEEL PRINTERS

C. ITOH PRINTMASTER F10

16" Tractor/Friction Parallel or Serial, 40/55 CPS
P $1460 S $1520

DIABLO 630



16" Direct/Form Feed Serial input, 32/40 CPS
S $2845

MONITORS

$199

- 12" GREEN SCREEN
- HIGH RESOLUTION
- 80x24 CHARACTERS
- Not a converted TV!

$129

12" dual monitor/TV, economical B/W model, 12V DC or 240V AC.

FANTASTIC VALUE!

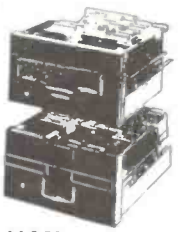
DISCOUNT DISK DRIVES 5¼" and 8"

TEAC 5¼"

40 Track SS	$275
77 Track SS	$405
80 Track SS	$405
40 Track DS	$405
80 Track DS	$515

MITSUBISHI 8"
Slim-line or standard size drives.....ea.$525

MPI and YE-data drives also available.



MAIL ORDERS: ADD $6

PROTOTYPE BOARDS

$29

$100 bus, room for up to 56 16pin or 21 40pin IC sockets + 4 regulators.

PROM PROGRAMMER

$1595

Programs over 250 bipolar PROMS and MOS EPROMS, RS232 I/O serial port, 6X LED display, copies, checks and verifies, inc. 2 personality modules.

PRE-PAK electronics p/l

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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 !

Printout

South Australian school gets VIC- 20 computers

Commodore Australia has donated thirteen VIC-20 microcomputers to the South Australian Education Department.

The computers, worth $13 000, will be used by students in years 5 to 8 at The Heights School at Modbury, an Adelaide suburb. Twelve computers will be located at the school and one will be kept at the Education Department, Angle Park Computing Centre, where it will be used to support the school's activities.

The VIC-20 computers will be used for the investigation of educational activities with young computer students, including keyboard skills, simple word processing, basic programming skills, recreational computer programming and elementary computer assisted instruction.

The computers are all fitted with 16K memory expanders. A classroom set will also have two disk drives, a printer, cassette recorder, joystick and a variety of cartridge software. A simple networking system will allow up to eight microcomputers to be plugged into each disk unit and the printer. The network approach to school computers is in line with the recently announced Education Department policy for school computers.

AED takes over Applied Tech.'s S100 cards and systems

AED has taken over the complete range of S100 cards and systems formerly handled by Applied Technology, including the very successful DG680 computer board and '640 VDU.

As Applied Technology wanted to concentrate on the MicroBee, and as AED had built up a reputation as a supplier of S100 systems and products, it seemed logical that they take on S100 lines formerly handled by Applied Tech.

AED can offer complete consultancy services to DGOS owners and can also supply a broad range of CP/M-based software suitable for the systems. AED also aim to offer additional S100 I/O cards etc, as well as floppy and hard disk sub-systems.

As an example, you can get an 8" IBM-standard floppy disk system with CP/M 2.2 and Microsoft BASIC-80 supplied. The system is compatible with the IBM single density standard as well as running double density 256, 512 or 1024 byte sectors automatically. AED supply the systems in single or double drive as well as single or double density versions.

As a convenience, AED can also provide repair facilities on a return-to-base basis as well as service contracts for owners within the Sydney region.

Further details from **AED Microcomputer Products, 130 Military Rd, Guildford NSW 2161. (02)681-4966.**

Morrow business system

A new low-cost high performance microcomputer designed to be 'ultra-kind' to small businesses is being released in Australia by Archives Computers (Australia).

The Morrow, from Morrow Design, is claimed to be "the easiest way yet devised for the novice user to enter the computer age."

Archives' General Manager, Mr Gower Smith, told journalists and dealers at the Melbourne launch that the Morrow was also extremely friendly in two other ways.

"The Morrow is the best value for money of any system yet been offered in Australia, and has the versatility to accept disks from four other top selling micros," Gower Smith said. Seven major software programs are included with the system.

Immediately the unit is switched on a menu appears with all the functions the user needs to know to use the system. This can be suppressed when the user is familiar with the system.

All system errors that could result in loss of data are 'trapped' before they become serious, and the error messages appear in clear comprehensible English.

The Morrow also has automatic hardware diagnostics and a feature called Virtual Drive.

This means that when sent to a non-existent disk drive the system will revert back to Drive A without getting 'hung' in a never-ending search.

The Morrow system package will sell in Australia for under $3000 (plus tax), a price which includes over $2000 worth of software.

The Morrow also has the ability to read and write to high density disks formatted for Osbourne 1, Xerox 820 and the IBM PC under CP/M-86 format.

A suite of business accounting software will be sold with the system.

The Morrow System is being distributed by **Archives Computers (Aust), 163 Clarendon St, South Melbourne Vic. 3205. (03) 699-8377** and the **Australian Business Solution, 59th Floor MLC Centre, Martin Place NSW 2000. (02) 235-1151.**

Few palates could tell that McWilliam's Chablis didn't come from this small French village.

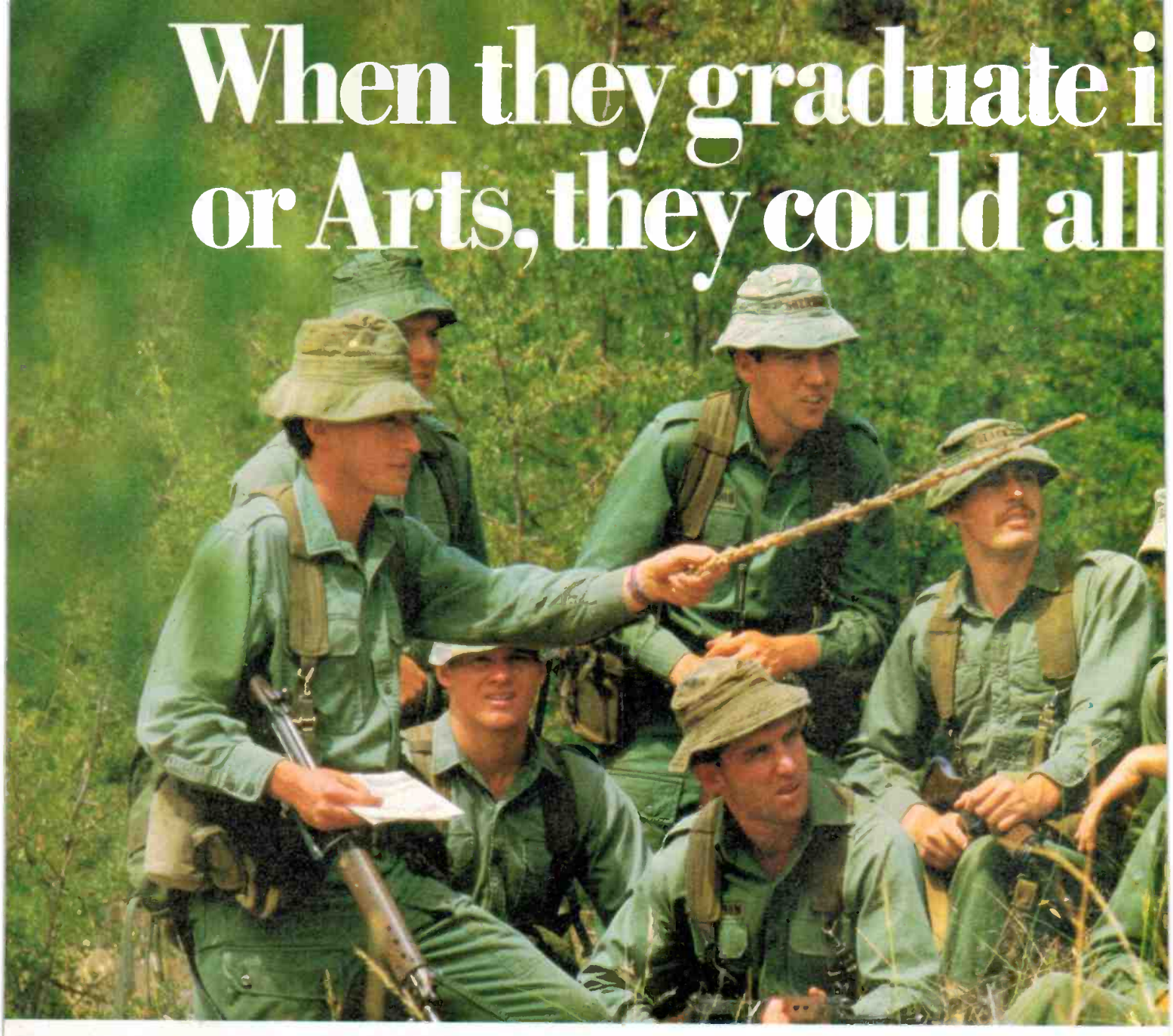
This little village in Burgundy has been making an attractive dry white wine for quite a while now. The wine has long been called after the name of the village...Chablis.

They make it primarily from the Chardonnay grape, so do we. Their soil is ideal for Chardonnay, so is ours. Their wine has a delicate bouquet, pleasing fruit on the palate with a clean, crisp, dry finish, and so has ours.

Their prices are astonishingly high, McWilliam's prices are astonishingly affordable...vive la Australie! **McWILLIAM'S**

AB 1671/82 MC1178F

When they graduate i or Arts, they could all



Some in communications. Some in engineering. Some in artillery. Others in ordnance, transport, or intelligence. Or any one of many other different careers available to an officer in the Army.

But whichever career you seek, we can promise you this: there'll be more to do than just sitting on your backside pushing paper. And that's more than can be said for most other professions.

However, first you must graduate.

WHAT OTHER PROFESSION OFFERS A CHOICE OF SO MANY CAREERS?

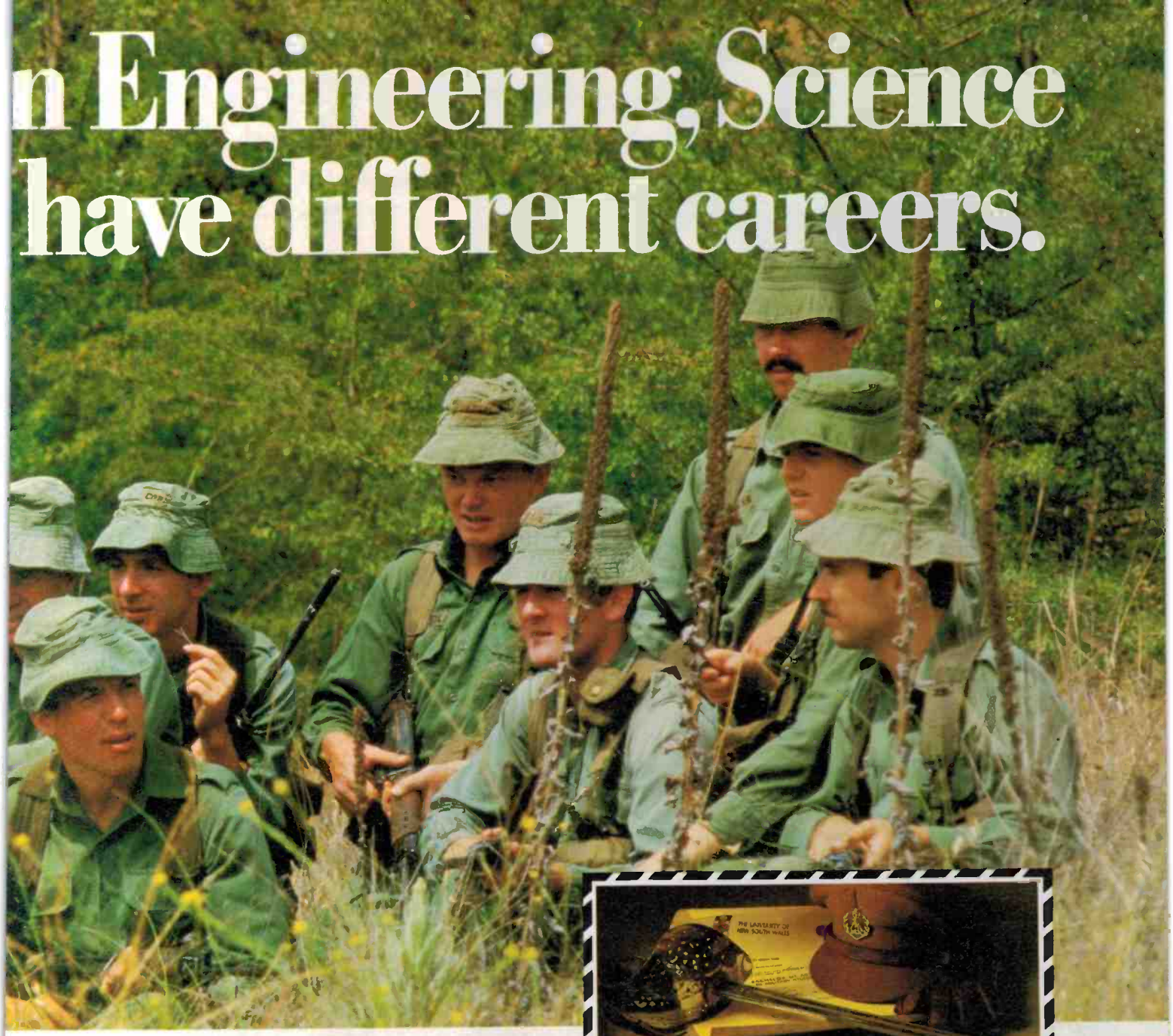
The officer cadets pictured are on exercises from the Royal Military College, Duntroon. There they are taking degrees as various as Arts, Science or Engineering. But in between times there's some military activity.

Doing your degree at Duntroon is not quite the same as doing it at a civilian University. It's better. For a start, you're paid a salary. You also have a job guaranteed at the end of it.

And, unlike most other professions, you have 4 years in which to decide on your career path. It is only in your final year at the Royal Military College that you choose which corps you wish to join.

To enter Duntroon you must be an Australian Citizen between the ages of 16½ and 19½ on January 1st of your year of entry. You must also meet the Army's other selection requirements, have matriculated or be doing your matriculation this year.

n Engineering, Science have different careers.



If you're not doing your matriculation until next year, you may be eligible for a Royal Military College, Duntroon scholarship to help you through.

Either way, ring an Army Careers Adviser or fill out the coupon and we'll send you more information.

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PERTH	(09) 325 6222
ADELAIDE	(08) 212 1455
HOBART	(002) 34 7077
BRISBANE	(07) 226 2626

You'll be surprised to find how many careers there are in the one profession.

Application forms are available now.
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☐ The RMC, Duntroon Scholarship

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RMC44.DPS.13

Army Officer

Authorised by the Director General of Recruiting, Department of Defence

"Timed to perfection,
The Black Douglas is matured
in oak for at least 8 years.
It's a smoother, mellower,
far superior whisky.

The Black Douglas.

A name honoured in Scotland
for centuries . . . and still making history."

Club Call

A new club for Microbee owners has started up on Sydney's north shore. **The Northside Microbee Computer Club** meets on the third Saturday of each month, from 1-5pm at the McMahons Point Community Centre. This is at the junction of Lavender St and Blues Point Rd, just a short walk from North Sydney Station.

A monthly newsletter is produced with software and harware information and members' advertisements. Club membership is $20 per year.

For more information phone Tony Williams on (02) 267-7747 during business hours or send a stamped self-addressed envelope to Microbee Users Club (Northside), 6 Tunks St, Waverton NSW

The lack of distributor support for Hitachi Peach Personal Computer owners has resulted in the formation of a club. **The New South Wales Peach User Club** now has more than forty members.

Weekly meetings are held on Saturdays from 2pm at 'Cybernetics Research', 120-122 Lawson St, Redfern.

$10 is charged for each six monthly membership period. This fee entitles members to newletters, access to the club software and technical library, and technical advice. Daniel Soussl, the secretary, can be contacted on (02) 698-8286.

The Devonport Computer Interest Group will hold its first meeting in Tasmania on Monday, April 18th at a time and place to be notified in the local paper.

For further information contact John Steveson, R.S.D. 422, Sheffield Tasmania 7306. (004) 92-3237.

The Adelaide Micro-User Group now conducts meetings at a new venue in Unley, near the Unley Shopping Centre.

It's the Senior Citizen Centre at 18 Arthur St, Unley, on the corner of Beech St.

The Group is for people interested in 6809 and Z80 based computers which includes the various TRS-80s (including the Color Computer), System 80, PMC 80 etc.

QT Computers/Pre-Pak agreement

Pre-Pak is handling all trade and retail sales of computer products, both imported and locally manufactured, previously sold by QT Computers.

Imported products include exclusive distribution of products from California Computer Systems, Teletek, Scion, and Bytek.

Locally manufactured products include a range of mainframes, disk-drive cabinets and power supplies, S100 card cages, S100 motherboards, the SBC 2/4 single board computer and a number of RAM boards up to 256K.

Pre-Pak is also selling peripheral products such as Teac, Mitsubishi and YE-Data disk drives, Itoh, Epsom and Diablo printers, as well as terminals, plotters, diskettes, cables, plugs, sockets and all accessories.

As long as you send a 70c stamp to cover postage costs, you can obtain a free 46 page catalogue from **Pre-Pak Electronics, 1A West St, Lewisham NSW 2049.**

50 Mbyte Lark hard drive unit

SME Systems has released a 50M computer data storage for organisations with large data base requirements.

The Lark hard disk system provides 25M of storage on a removable cartridge and 25M on a fixed disk. It can be used with all S100 Z80 microcomputer systems.

The unit with controller will sell for $8200 and a second unit for $6500.

The Lark sub-system will supplement the SME Systems Unicorn MPU-100 microcomputer system and can be mounted in a standard 19" rack system.

Further technical information is available from **SME Systems, 22 Queen St, Mitcham Vic. 3132. (03) 874-3666.**

THE VIC-20 COLUMN

THIS INTRODUCES our (hopefully) regular column for Commodore VIC-20 enthusiasts. Share your enthusiasm, programs, hints, tips and routines with fellow enthusiasts via this column. Remember, we pay for all contributions. You won't make a fortune from contributions, but it should be some recompense for your efforts — and enable you to buy more midnight oil!

For this first column, we kick off with a South Australian reader's contribution on using joysticks in your own programs. Inspired? Dash off your own contribution and rush it to the Editor immediately.

USING THE VIC JOYSTICK IN YOUR OWN PROGRAMS

Don Thorpe, Glenunga SA.

The first listing shows how this can be done. The two POKES set the joystick I/O lines to INPUT mode. The joystick operates four switches, which I have called north, south, east and west. Any one switch, or any two adjacent switches may be closed by the appropriate movement of the stick. For example, a north-east movement closes the north and east switches. A separate switch is used as a 'fire' button.

The locations 37137 and 37152 hold information about the state of the five switches:

```
37137 BIT 2  N switch     37152  BIT 7  E switch
          3  S switch
          4  W switch
          5  fire button
```

Any of these bits will be zero unless that switch is closed. Line 20 ends by PEEKing at these locations.

In line 30 we meet two less familiar concepts of BASIC.

1. **AND** This operator compares two binary numbers bit-by-bit and forms a new binary number. If the two bits are **both** '1' then a '1' is recorded in that position of the new number. Otherwise a zero is recorded.

Example: Suppose memory location 37137 contains the number 250, and the accumulator contains the number 4. Let's AND the two numbers:

```
250    11111010
4      00000100
```

In none of the eight columns is there a '1' in the first row AND in the second row. So the result is:

```
       00000000
```

Thus the statement (250 AND 4) = 0 is true.

Similarly (250 AND 8) gives 0 0 0 0 1 0 0 0. So (250 AND 8) = 0 is a false statement.

2. In VIC BASIC, a true statement is assigned the value −1 and a false statement is given the value 0.

Example: ((250 AND 4) = 0) = −1
((250 AND 8) = 0) = 0

There are nine joystick positions, usually numbered in the order shown:

```
7 0 1
6 8 2
5 4 3
```

When the user selects one of these joystick positions, numbers are stored temporarily in locations 37137 and 37152. These numbers are shown in decimal form below.

37137			37152		
234	250	250	247	247	119
238	254	254	247	247	119
230	246	246	247	247	119

Together, PEEKs P and Q allow the VIC to produce (in a rather messy way) nine unique sets of inputs from the four switches.

POSITION 7		POSITION 0	POSITION 1
N	−1	−1	−1
S	0	0	0
W	−1	0	0
E	0	0	1
POSITION 6		POSITION 8	POSITION 2
	0	0	0
	0	0	0
	−1	0	0
	0	0	1
POSITION 5		POSITION 4	POSITION 3
	0	0	0
	1	1	1
	−1	0	0
	0	0	1

In line 30, we see how AND together with true/false set the required bits.

If the fire button is depressed, bit 5 at location 37137 will be '1'. This will AND with the number 32 to make (PEEK(37137) AND 32 = 0) a true statement. Thus, the variable F will have the value −1 when the fire button is depressed and will be zero otherwise.

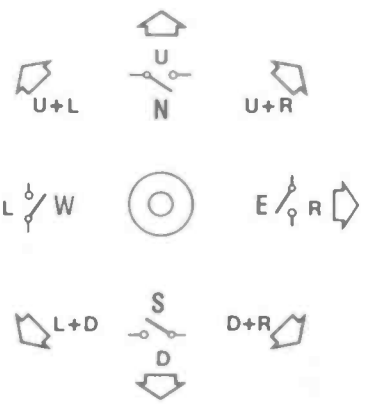
The next POKE restores bit 7 to normal. This is necessary because VIC normally uses this to scan the keyboard.

The final part of the program sets up an array of nine numbers and produces a variable J which can be used in programs.

SMARTIES

The second listing is a program which illustrates the use of the joystick routine. It produces lines of 'SMARTIES' in eight different directions. The colours can be altered using the 'fire' button. If the screen colour is selected, SMARTIES can be erased as required.

A challenging game is to attempt to produce concentric squares, each of a different colour.



The 'directions' indicated by movement of the joystick shaft.

JOYSTICK ROUTINE

```
20   POKE 37139,0  : POKE 37154,127  :
     P = PEEK(37137) :  Q = PEEK(37152)
30   N = ((P AND 4) = 0) : S = -((P AND 8) = 0) :
     W = ((P AND 16) = 0): E = -((Q AND 128) = 0) :
     F = ((P AND 32) = 0)
40   POKE 37154,255
50   DATA 7,0,1,6,8,2,5,4,3
60   FOR C = 0 TO 2
70   FOR D = 0 TO 2
80   READ A(D,C)
90   NEXT D,C
100  J = A (E + W + 1 , N + S + 1)
```

SMARTIES

```
10   PRINT"■": X = 10 : Y = 10 : K = 2
200  V = 7680 + X + 22 * Y
210  W = 38400 + X + 22 * Y
220 ON (J + 1)GOTO 300,230,240,250,260,270,280,290,310
230  X = X + 1 : GOTO 300
240  X = X + 1 : GOTO 310
250  X = X + 1 : Y = Y + 1 : GOTO 310
260  Y = Y + 1 : GOTO 310
270  X = X - 1 : Y = Y + 1 : GOTO 310
280  X = X - 1 : GOTO 310
290  X = X - 1
300  Y = Y - 1
310  IF F = -1 THEN K = K + 1 : IF K = 8 THEN K = 0
320  IF X > 21 THEN X = 21
330  IF X < 0  THEN X = 0
340  IF Y < 0  THEN Y = 0
350  IF Y > 22 THEN Y = 22
360  POKE 36875,128 + (RND(1) * 18 * K) : POKE 36878,15
370  POKE V,81 : POKE W,K
380  POKE 36857,0
390  RESTORE
400  GOTO 20
```

$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v(du/dx) - u(dv/dx)}{v^2}$ $i^2 = -1$

$\int e^u du = e^u$ $y = \frac{\tan k^4 5267}{(4 \times 783)}$ $\int_x^{x_2} \sin(x)/x$

$(3.14159 + 7.32i)(c + 100i) = (3.14159c - (7.32i \times 100i)) + ((3.14159 \times 100) + 7.32c)i$

$= (3.14159c - 732i^2) + (314.159 + 7.32c)i$

$F(t) = \frac{1}{2\pi i} \int_{c-i\infty}^{c+i\infty} e^{st} f(s)\, ds$ $[r(\cos\theta + i\sin\theta)]^p = r^p(\cos p\theta + i\sin p\theta)$

$\hat{A} \cdot \hat{B} = \hat{A}\hat{B}\cos\theta$

....or get a new Hewlett-Packard HP-15C.

They're the options.

You can spend hours with a pencil working out a seven-equation problem or you can spend around 28 seconds with the HP-15C.

It's possible because of the two new sets of functions, never before built into a Hewlett-Packard calculator: Matrix and Complex number operations.

Once matrix elements are defined, matrix arithmetic inversions and transpositions are keystroke-easy.

Up to 64 matrix elements can be stored in the calculator's memory and these can be distributed among five different matrices, this model also has solve and integrate keys.

In addition, the HP-15C's arithmetic and transcendental functions (exponential, logarithmic, trigonometric and hyperbolic) operate on complex and real numbers.

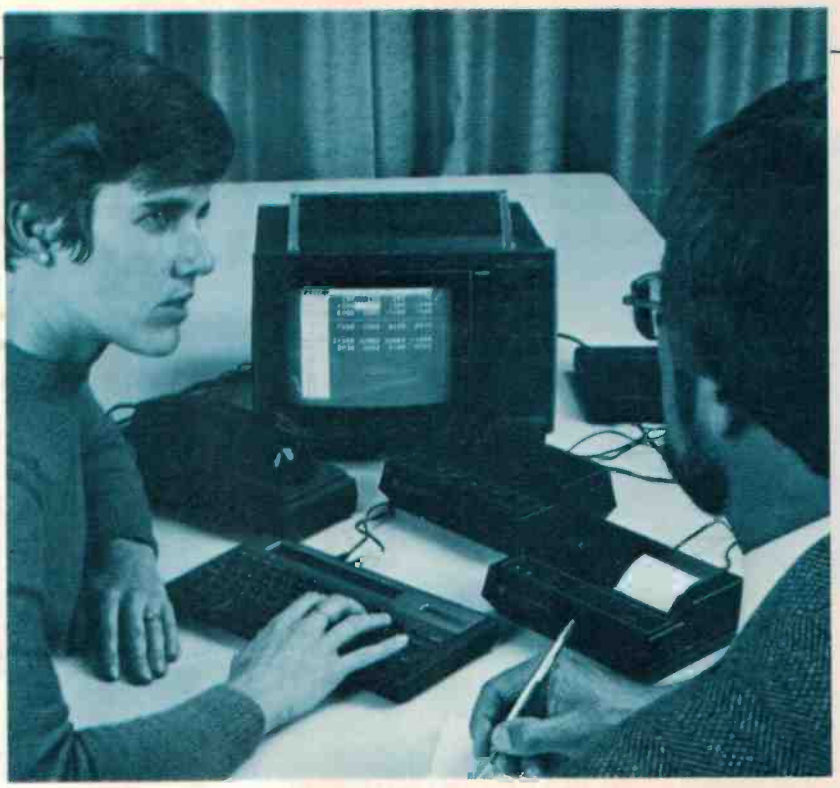
And to make your decision even easier, the HP-15C programming features include up to 448 lines of dynamic continuous memory, five user-definable keys, 25 program labels, insert/delete editing, 10 flags, 12 conditional tests and indirect-programming control.

Do you really have any choice?

To see the new HP-15C calculator, call Hewlett-Packard Personal Computation Group for dealer locations.
Sydney: 887 1611; Melbourne: 890 6351;
Adelaide: 272 5911; Perth: 383 2188;
Brisbane: 304 133; Canberra: 80 4244.

HEWLETT PACKARD

HP78R/2



HP-75C portable computer

Jonathan Scott

A powerful beast. The first of a new species of portable computers which fit in a briefcase. Though designed for the business person, anyone will find it useful. Good value, but limited by the current size of the user memory, though probably not for long . . .

A REVIEW OF A TECHNICAL PRODUCT gives an assessment of a product's relative standing in the marketplace and compares it technically and subjectively with its competition. The reviewer, experienced with similar products, usually gives an opinion of the product's value for money. However, the HP-75C is the first one of its class in Australia so it's not possible to review it in the usual manner.

Don't let anyone tell you that it can be compared with programmable calculators or home computers of the Apple/MicroBee species. It is also not in direct competition with the 'hold in the hand' BASIC machines offered by Sharp and Tandy.

A rare beast

The HP-75C is labelled a 'portable computer' and is primarily aimed at the businessman. The scientist or traditional calculator user will find it useful too but it is not targeted or tailored for them. What we have here is a new and novel beastie.

So what is a portable computer? This review aims to answer that question and explain the differences between the HP-75C and other species. What it can do and what it is not suitable for will also be explained. In this review you'll also be given a feel for the 75C in a purely engineering sense, analogous to describing the sensuality of driving a proper sports car.

The handbag computer

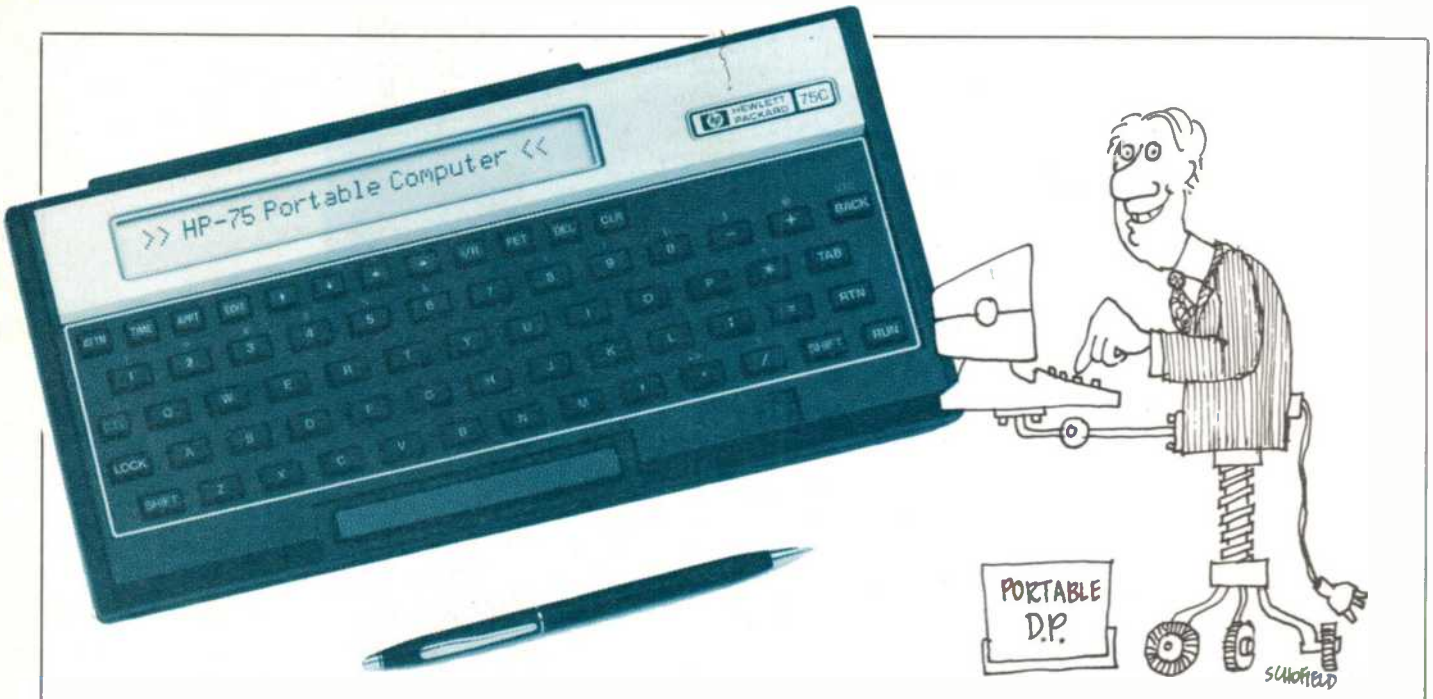
The 'portable computer' has often been described as being aimed at the 'briefcase' market. The computer is packed with capabilities beyond the needs of a home enthusiast. And it's packaged so that it will fit comfortably in a briefcase. This means it can be operated on your desk or while perched on your lap when you are on the train on the way to the office.

Several manufacturers have already released or are currently in the final stages of testing such models. Digital Equipment have the WC11 (which runs PDP-11 and LSI-11 software) at the prototype stage. Tandy, Commodore and Texas Instruments are also talking about their models which should come out soon. But Hewlett-Packard have already released the 75C worldwide.

A market research firm called Future Computing Inc. estimates that the market for pocket and briefcase units will top $1500 million by 1987. So the early arrival of the 75C will no doubt be an advantage. It is safe to assume that there will be, as always, imitators of HP, but the first *good* item on the market has a strong head start.

So what is the HP-75C?

It is a small package about 125 x 260 x 30 mm in size. It sports a small tactile feedback QWERTY keyboard with a number of additional control keys as has been the excellent practice on all HP desktops for many years. There is also a 32-character LCD display (lower case has descenders making the display quite pleasant and easy to read).



It has 16K of RAM as standard with expansion to 24K available now. Expansion to 32K is slated for release when memory becomes dense enough to allow 16K to be packed into the RAM expansion pocket, which is in the battery compartment.

There are three ROM drawers in the front of the machine and each of them will accept a 16K ROM module — more of this later.

The operating system is a hefty 48K (compare this with the total of 16K of BASIC and OS in the Apple II plus). It will be immediately obvious to the well versed user that this system will be astonishingly rich and comprehensive.

There are connectors on the back for the charger and the HP-IL interface which is HP's own small machine buss system.

Finally, almost small enough to go unnoticed at the front of the keyboard, is the entry for the on-board manual card reader/writer. This brilliant mechanism provides file storage on magnetic cards pulled through the reader by the operator's own hand, saving the cost and trouble of the mechanical drive system of previous generation card readers.

Before you reread the last few sentences to clear the glut of exciting thoughts, let me say that we will discuss each of the features in a little more detail shortly. Think about this — it is a machine with large home computer facilities, mass storage, display and keyboard, buss connection ability, expandability and low power consumption. And all this in a wrapper that fits inside even the thinnest executive briefcase or a handbag.

It also has three hidden properties which push it beyond what you have previously seen on your side of a system terminal.

(1) It always keeps time, from date to millisecond, making it available to both user and program. It can even fine-tune its own on-board reference crystal when compared to a standard.

(2) It is never totally 'off' and will keep track of appointments years ahead if necessary, sounding one of several different sorts of alarms at the required moment and giving any message you entered.

(3) It has a *file-structured operating system* which allows tremendous power and generality in its programs. This last item is the key to the understanding of the power and scope of the operating system.

It is more friendly, in the software sense, than any terminal I have ever used. Yet it reminds me of the full file-structured arrangement on a Cyber mainframe from Control Data.

So that's it in a nutshell, well, briefcase. What it will do and what it will not do will be discussed next.

Tortoise characteristics

The HP-75C is slow. This is because it was necessary to be stingy with regard to power, considering the power required to put so much on line for 20 hours between charges (i.e: 20 operating hours). For a battery unit it is, in fact, damn fast. A for-next loop (a good benchmark) takes about 2.5 ms. 'Sine' takes nearly 50 ms. Dividing one variable by another takes 2 ms. There are mains powered home computers on the local market that are slower, but I will spare them the embarrassment of being named. The 75C is many times faster than certain other LCD types of 'pocket computer'.

It is excellently engineered but a necessary trade off puts it in the slow class. Consequently, forget about using it for numerical problems of a scientific nature if they are heavy on CPU time. You could run it for a week and be well behind a VAX run of 20 minutes.

It should also not be recommended for real time control operations, but then it is hardly likely to be asked to do this. A little slow but intelligent data logging is the limit. I do not regard this as a limitation. It is only an annoyance. For instance, although the keyboard permits touch typing, I can easily outrun it if I type at my normal speed as it has but one stroke of input buffer on the keyboard interface.

Dinosaur characteristics

Another limitation is the current size of the user memory (16K). It is quite untenable to run any program which requires overlaying. To use the on-board card reader would require the operator to stand around and be the mass storage device. Even though the HP-75C can be connected via the HP-IL to a microcassette drive, which looks like a disk does to a terminal, the speed is predictably terrible. It takes some 20 seconds to record a typical file on tape. This is an excellent system for backup and storage of programs not in immediate use, but not acceptable as a midprogram reference.

The 75C is built for programs of just a few kilobytes using no vast arrays of data, and is not slated for elevation to the 64K-plug memory bracket. If anything holds it back from great success it will be this property. A year ago I used machines of comparable size with 64K of RAM, although they didn't have all the other features. So in today's market this is a small memory machine. The under-2K type of pocket computer is even more ridiculous, of course, but then they do not pretend to be the same class of machine. They are more a computer user's pocket calculator.

So there are the limitations. If you can accept these, the 75C can be regarded as probably the best machine available to do your job. It is almost as fast to enter a program in HP BASIC into this unit as it is to create a program on a pocket calculator of the 15C type, yet you have a relatively vast amount of memory and a truly extensive operating system and range of commands. Thus it is almost as useful in the small job situation, such as one finds in the lab, as is a pocket unit. It is rather more cumbersome for direct, nonprogrammed mathematical calculations, but it will do them. In addition, it can tackle many problems that devices like the HP-41CV would find just too large.

The inner intricacies and finer points will now be described. If you are not academically ▶

About the only thing conventional in a Cromemco Computer System

From the beginning, Cromemco products were designed for the high end of the microcomputer market. Today Cromemco is widely recognised for producing high quality and performance computer products that are used in such diverse applications as engineering, science, research, education, process control, medicine, business, word processing and a wide range of other applications.

The variety of software available for Cromemco computers includes, COBOL, FORTRAN, BASIC, RPG, LISP, C, RATFOR, Multi-user, Multi-tasking, disk operating system, Networking and IBM communications protocol, as well as the wide range of CP/M compatible software.

For further information about the range of professional Cromemco computer products, contact the professionals:

Cromemco

ADAPTIVE ELECTRONICS P/L

418 St. Kilda Road, Melbourne. 3004.
Tel: 03-267 6800.

The Professional Personal Computer

POWERFUL AND LOW-PRICED

From the beginning, Cromemco products were designed for the high end of the microcomputer market and now, the company has released the professional personal computer. The new and powerful low-priced C-10 is more than just a sophisticated home computer. The Cromemco C-10 is perfect for the serious personal computer user, the executive work station, for distributed data processing or as a front end for a mainframe computer. The new C-10 is based on the industry standard high speed Z80A microprocessor and has 64K bytes of internal user accessible RAM and 24K bytes of internal ROM.

COMMUNICATIONS AND NETWORKING CAPABILITIES

The powerful C-10 comes with an integrated intelligent high resolution 12 inch CRT with a detached, light and easy to use keyboard. It has all the necessary communications ports built-in and has been configured so that it can take advantage of C-Net, Cromemco's local area networking system which is capable of linking individual computers together to form a distributed processing system or "automated office". In this way, one of the normal network functions capable of being implemented by C-Net's network control software is electronic mail storage and delivery. The electronic mail program is a post office simulator that not only delivers electronic mail, but also holds mail for users who are not logged onto the network.

WIDE RANGE OF APPLICATION

One of the most powerful uses of the C-10 is seen to be in networking applications. Under C-Net, C-10 microcomputers are able to communicate with each other and share peripheral resources such as printers and hard disk drives. In this way, executives using C-10 work stations can create, edit and have documents printed and distributed at various other locations throughout the organisation.

Whilst the automated office is one very important application of local area network technology, it is not the only application of value. Factories and manufacturing plants are two other areas where C-Net can be combined with the power and cost-effectiveness of microcomputers to increase productivity. C-Net and Cromemco's new C-10 personal computer will also have a significant impact on schools and universities, and will enable the integration of computing power at many different levels. For example, under a C-Net local area network system, students can access and load centrally maintained data and system/library programs off a central hard disk and into their own machine, load test data via the C-10's floppy disk drive, execute the program locally and then print the results on a centrally located printer; students thereby being responsible for maintaining his or her own program and data diskettes.

POWERFUL SOFTWARE

The C-10 has a wide range of peripherals available including floppy disk drives and a low priced letter quality daisy wheel printer. Furthermore, the special Super Pack configuration includes a CP/M compatible operating system, 32K Structured BASIC, Word Processing and Financial Spread Sheet Software. Besides access to the entire range of other quality Cromemco software (such as FORTRAN, COBOL, RATFOR, LISP), because of its CP/M compatibility the C-10 gives the user access to the widest possible range of micro-computer software products available.

UPWARD COMPATIBLE

The C-10 is an important milestone in microcomputers as it is the first personal computer that allows upward compatibility through an entire family of computer hardware and software products. A user could start with a C-10 and advance to Cromemco's high performance D-Series 16-bit micro-computers.

AVAILABILITY

For further information on the new professional personal computer, contact your Cromemco dealer.

AE ADAPTIVE ELECTRONICS P/L

418 ST KILDA ROAD, MELBOURNE 3004. Ph: (03) 267 6800 (4 lines). Telex: AA32565

Peek and poke. Close-up view of the HP-75 LCD display and the array of function buttons (operating mode, cursor control and special function keys).

interested in the engineering of the 75C, and you are sure that this is not the machine for your needs, then this is the point to cease reading.

Time mode

The 75C has three distinct modes of operation — Time, Appointment and Edit. Edit is where the normal computing is done.

Time mode exists purely for setting the time and display formats, setting and adjusting the time itself and fine tuning the device's timekeeper. The date format can be US or European. The time is 24 hour or AM/PM. The calendar used by the appointment mode may be set to assume appointments to be less than one year ahead. Or it may be instructed to attend to years-ahead type of appointments if you wish to go to the effort and pay the memory bill.

The time may be set by either entering a date/time setting directly or by telling the computer the relative amount to be added or subtracted from the current time. If given two times spaced a week or so apart and told that both are 'exact', the 75C will compute a correction factor (soft implemented) to compensate for small errors in the internal reference.

The clock functions make four BASIC words available: TIME, TIME$, DATE and DATE$. TIME gives the time today in the form of the number of seconds since midnight, as a real number to three decimal places (milliseconds). TIME$ is a string looking like 'HH:MM:SS'. Date data is similarly available. DATE is in the form YYDDD (7th of January 1965 would be 65007) and DATE$ appears as 'YY:MM:DD'. Very useful indeed!

Appointment mode

Appointment mode allows the setting, inspecting and acknowledging of appointments which are data/time combinations stored in the memory with appropriate commands or messages. The 75C wakes up and executes commands or delivers messages whenever the appointment time arrives.

Appointments are simply set by means of a template. This means that when you wish to set an appointment you are given a display of the form 'Day Dy/Mo/Yr Hr:Mn**#1N!Note'. Next you type in the minimum of required data. For instance, if the appointment is for next Thursday, type 'thu' over 'Day' and skip all the date stuff which will be supplied by the HP to fit the very next Thursday from now. Then enter the time where the ** means 24-hr mode or AM/PM. The number after the # tells the HP what sort of noise you want as an alarm, from none to a perpetually occurring siren. The following alphabet character decides whether the alarm is to be a one-shot or whether it is to repeat at some interval. If repetitive, it will ask the interval with another template. Finally, the right hand field contains a message, or a BASIC command such as to run a program.

In Appointment mode you may thumb through the appointments currently in the file. Although associated with the special part of the OS which manages and responds to the entries, the file of appointments is a free file in the computer's memory. So it is possible to edit this file under program control or put it on mass memory or replace it with a different appointment file or even merge it with another appointment file. Thus the appointment system can be very flexible and, as the machine is always watching whatever file is called 'appt', it is quite powerful.

Because of the machine's size it is not much more difficult to carry around than a notebook. Consequently, one finds oneself putting all the things you have to remember into the appt file, confident that this 'book' will not only hold your appointments, but remind you to read it at the appropriate moments!

Edit mode

This is where the file handling and computing is done. There are appt files, key files, BASIC files, TEXT files, LEX files and LIF files.

The appt files, we have already noted, are associated with the appointment system. Only the one called appt (lower case, no quotes) is scanned by the appointment part of the OS, but other appointment files may reside in memory under other names. They may also be handled by any on-board process which does not specifically require some type of file. For example, they may be merged with other like files, but of course they can't be run as a BASIC file.

'Key' files are similar to appt files. The active key file is always lower case and not in quotes and is always taken into account by the OS. Other key files may reside, but only one is active. The active key file modifies certain or all of the front panel keys. Any keystroke may be redefined by use of the 'def key' statement which permits any string of characters to replace the character of the redefined keystroke. For instance, we might replace the '!' key with the command "run"prog1"". Now every time you go to type '!' the program 'prog1' will run.

Although any and all keys may be redefined it is usually stupid to redefine keys you are going to need a lot, for obvious reasons. You could turn all keys, shifted keys and control keys, into the symbol '9'. But that would mean that you could not do anything or regain control without resetting the whole computer and losing all memory. Unless you redefine it too, the command shift I/R will restore original keystrokes for one key, only by effectively telling the 75C to ignore keys for one input. You can override the off command by redefining its key under program control, etc. So the astute reader will now begin to appreciate the amount of deviousness which is possible by fooling about with the keys . . .

In general, it means that all your common commands or keystroke combinations can be reduced to one press each by having suitable redefinitions active. As most of the control-key combinations are not going to interest the user much there are plenty of keys on the keyboard which can be sacrificed to give you a repetoire of user keys. Several different repetoires may be built up. For example, you may have a set of key definitions useful when developing programs, another for running them and another for debugging. The one you need may be made the active one simply be renaming it as key (lower case, no quotes for the active file).

BASIC files are self explanatory. They are files containing only those characters it is legal to have in a BASIC file, which means most of the legal commands of the HP, inclusive of OS type functions such as editing commands, etc.

There is one property of HP interpretive machines which affects only BASIC files and with which you may not be familiar, because no other make of computer I have ever seen possesses it. Each line of a BASIC file is checked for syntactical errors as it is entered. Errors, which on another machine would only show up at run time, are instantly detected and brought to the user's notice while the line is fresh in the mind. No line containing an illegal statement can ever be entered. Lines with ambiguous mathematics, missing brackets, typos, unsupported functions, incorrect parameters, too many parameters, incorrect delimitiers or forbidden command sequences can never appear in a BASIC file because they are found as soon as you press return to enter the line. This is just beautiful. It is by no means new to the 75C, but it is worth a tremendous lot to a program developer. This asset is largely responsible for the unique degree of 'friendliness' achieved by HP machines.

TEXT files are files which may contain anything. The main difference is that no check is applied at the input to see that it is legal for the particular job, in the way that BASIC or appt files are checked. TEXT files may be converted to BASIC files and vice versa, but the checking is only applied to lines going into a BASIC file from a TEXT file.

TEXT files are primarily useful as data repositories. The HP implementation of BASIC has data and read commands as does the usual BASIC of other manufacturers. But as we've already said, it is in a file orientated environment so it is well equipped to use one file quite apart from the input data file being run in the program, as one does on a terminal in a large system OS. Such files, which might contain names and addresses or a shopping list or a company stock list, are TEXT files.

Similarly, output need not be printed or displayed but may be stored away as a TEXT file either for printing later, plotting or as a data file for another program to use as input. Or it can be used for all of these functions.

As an example, a BASIC file called 'ACCOUNTS' might act on input file▶

'FEBSALES' to produce 'BILLS' which will be used by 'PRTBILLS' to produce a set of account statements on a printer for posting. 'PRTBILLS' will use 'CLIENTS', as well as 'BILLS', to output the addresses to which the statements must be posted. When a payment is received 'PAYIN' will modify 'BILLS' to show what is paid as well as print out the receipt to be posted to the address that is supplied by 'CLIENTS'. And so it goes. 'FEBSALES', 'BILLS' and 'CLIENTS' could be organised as BASIC files, but it is probably easier to just have them as lines of text, searched by the BASIC program accessing them. They would then be TEXT files and could be typed in as they appeared in the record books of the last accountant

LEX files are 'Language Extension' files. These are binary files which make more command words available in the language. The user does not write these — they come from HP. As was mentioned earlier, there are three small drawers in the front of the 75C which accept 16K ROM expansion pods. LEX files, scheduled for release later, will most likely be available in this ROM form. Although it is possible to have a RAM-resident LEX file, it is perhaps better to have it in a ROM form as then none of the free (and precious) memory is lost. It is anticipated that these files will be specific to some discipline such as accounting or electronics, etc. The ROM pods, it should be made clear, do not need to contain LEX files alone. They may have runnable BASIC files or whatever else.

The final type of file is a **LIF file**, or 'Language Interchange File' These exist to facilitate the transfer of files from 75Cs to other types of machines. BASIC and TEXT files may be transformed to LIF files, and vice versa, for transmission or receipt of foreign files. This facility will be important to the user who wishes to hook up his 75C to a larger company system. Not useful otherwise.

Yours to command

As was pointed out earlier the OS is particularly rich and comprehensive. In such a short review as this it is not possible to mention all the ingenious and useful things the 75C can do. Briefly, some of the unusual commands are:

POP which kills the last subroutine call return pointer in case you decide that this subroutine should never return;

PUT which places a character in the keyboard buffer under program control (very devious and useful when appreciated);

LOCK which places a password on using the system, just like a terminal;

CALL which allows entire programs to be run separately as if they are subroutines, but without the interaction of variables;

EPS is the smallest non-zero entry;

INF is the largest entry;

DIV for integer division (or the '\' symbol).

ON TIMER # which establishes regular interrupts to one of any number of routines;

DEFAULT OFF/ON which disallows or allows the substitution of default values for results of otherwise illegal operations with a warning message instead of 'halt with error' message, e.g: use of a variable not previously defined or division by 0, etc.

These are just a few to stimulate interest.

There are also quite a few powerful (though not novel) development and debug commands which you may be surprised to find in this little box:

FETCH 'string', line no which seeks a particular string in the file being edited;

TRACE FLOW/VARS which enables a short form execution pathway explanation;

RENUMBER which renumbers all lines and adjusts all jumps and line references to match — particularly necessary for unanticipated **MERGE**s.

Is it worth it?

Supplied with the 75C given to ETI for review were the microcassette drive (HP-82161), the 'two-inch' thermal printer (HP-82908B) and the video interface (HP-82163). There are also available for the HP-IL buss a plotter, an 80/132 column impact printer and numerous application books. And soon to come are an interface to the IEEE buss, 8- and 16-bit straight interfaces, RS232-C interface and ROM plugs.

Prices without sales tax are:

HP-75C	$1395
Microcassette	$617
Thermal printer	$617
Video interface	$308
8K expansion (to 24K)	$275
7470 plotter	$2000
Impact printer	$1185
Books + cards of progs	$49 ea.

Commenting on value is very difficult, as was pointed out earlier. The 75C is a machine whose OS stands out as supreme and I am thus tempted to say that it is excellent value because of this. However, the OS has evolved over more than a decade and is remarkably similar to the one in the HP-85 and 87 and indeed the 200 series desktops. (There are plans for the release of a cross-development package for the transfer of 85/87/9836/9826/9816 software, even in Pascal, to the 75C.) This implies that there are fewer development outlays to be written off in the initial costs of the 75C firmware than one would have thought at first. So the price does seem high. Nevertheless, it is not bad value for your money. It's the price one would expect to pay for a sophisticated product. You may rely on the fact that you are not getting a raw deal on the 75C itself.

The 8K of expansion is excellent value. I would have advised that you shouldn't think of buying a 75C without it. However, the impending release of a 16K expansion board would make the 8K obsolete. If you are able to pin HP to a date when the 16K expansion board will be available, then hold out for it. Considering the RAM size, it would be worth it at more than double the money. It could be agonising to find yourself with an 8K board in 12 months time!

The microcassette drive is an excellent piece of engineering in itself. It stores around 130K on a microcassette which is moved and read very fast by a battery operated unit. To program, it looks like a disk. It is driven using file specifiers within file names, like a mainframe system. However the 75C comes with its own mass storage which is not as nice, but not $617 either! I would say that this is the only way to go if you plan to do serious business programming like the accounting example I gave earlier. Talk your company into buying you one, but I do not think you will get value for your own dollar, already having a card reader.

If you develop programs larger than a few kilobyte it is painful to do without a printer. And I must, in all honesty, say that I used the printer. But I recommend that you try to do without one. It is costly and nasty in the size sense. The two-inch species of printer is not really worth it. One such printer would be good value shared between three to six 75C users, each with their own 75C, but not otherwise. With the HP-75C's impending ability to hook up to big brothers, the printer can be circumvented.

The impact printer would need some justification in view of its cost, but if your application looks like needing a document quality printer then consider it. ETI has not seen it and so is not in a position to comment on this unit's value. It is my personal (but definite) opinion that a better way to go would be an interface (RS232-C?) and something like a letter-quality Olivetti daisywheel printer/typewriter. One should be able to get a superior printing system of immaculate quality for around the $3000 mark.

In a nutshell, avoid the printer if possible. This is *not* to be taken as a reflection of the printer's engineering quality. The small thermal printer is a good example of its genre. It is fully self-contained and battery powered. Compared to a mains powered thermal printer, this printer is fast! It has a buffer allowing the system to avoid being slowed down on small print jobs. *It is a good printer, but costly for what a user of a continuous memory device with built-in mass storage will be likely to get out of it.*

The video interface is likewise a good piece of engineering. Perhaps I am not the person to comment on such a device as I have a strong aversion to any system that puts characters up on a plain TV or raster type monitor. The interface needs a good quality monitor in order not to strain the eyes. It has both TV and video outputs and keeps two screens of data in its memory.

If you have the printer you will find that it is relatively easy to do without the monitor facility. However, if you are going to use a program that puts a lot of data up for the operator to view simultaneously, you will need the video interface. I would suggest that you buy the 75C and familiarise yourself with it first, before making a decision about buying the video interface.

Although I did not see any of the application books, they are available and experience suggests that $49 each, including the contained programs on card, will be good value. Application packages tend to be general and thus rather inadequate for a user's specific job. But in the past HP have provided excellent explanations and documentation so you can modify their programs to suit your needs. This, coupled with the fact that the programs are on (modifiable) magnetic cards, means that the cards will be useful. Although sometimes the ROM based ones are not so useful.

All in all, I was very impressed with the HP-75C. Make sure that it will suit your requirements. But I have no doubt whatsoever that you will be continuously using this forerunner of a powerful line of portable computers. ●

ALL RIGHT, after last month's little 'hunt the missing program' game, now we know there are *lots* of eager readers of the MicroBee column. We didn't leave it out on purpose just to find out if anyone was reading the column . . . honest!

The following program was meant to go between the second last paragraph and the last paragraph of Michael Alexander's 'Cassette Backup' item. For reasons best known to the fairies that live at the bottom of the darkroom, it was omitted. (It had better be *here* — Ed.)

```
10 FOR R=0 TO 6:READ A:POKE R,A:
NEXT R:A=USR(0)
20 DATA 219,2,23,211,2,24,249
```

Try that.

All right all you Bee hackers, keep those hints, tips and programs coming!

GENERATION OF SIMULATED ROEHN FUNCTIONS ON THE MICROBEE

Tom Moffat, Ferntree, Tasmania.

Most students of high school mathematics would be familiar with Roehn functions. They were first discovered over 100 years ago and have since been applied to many fields of scientific endeavour.

It isn't generally known that the original UNIVAC computer, delivered to the United States Census Bureau in 1951, wasn't working exclusively on census figures. During 'unofficial' times, such as nights and weekends, it was put to use by a top secret task force calculating Roehn functions for the National Defence Office. Now days Roehn functions and their derivitives are being used by the National Space Agency, the Queensland Department of Primary Industry and the Korean Central Computer Office in Pyongyang.

It's also understood the guidance programs for the Cosmos 1021 surviellance satellite that made headlines in January this year were written around Roehn functions.

In the classical method, Roehn functions are generated by limited iterations of single-degree steps of the included angle, X. This is a long and drawn out process that explains why the power of UNIVAC was so quickly put to the job. But now the method has been much simplified, at the expense of a slight decrease in accuracy of the results.

In 1968 an East German scientist, Eduardo Gutenberg, discovered a way to calculate all the Roehn functions in one quick process. Gutenberg realised that by taking the largest function first and then decrementing each result into its previous haversine, it was possible to bring the whole process into itself with the result that a near-infinite number of Roehn functions could be produced with only one series of program steps. The collection of all these procedures is now commonly known as the Gutenberg Transform.

The Gutenberg Transform is easy to implement on the MicroBee, with a short routine that places the Roehn functions into the turnaround area of RAM and then brings them out again as a complete series, that is, as the whole circle. Since the concept as implemented on the MicroBee is somewhat fragile, it's suggested that you ensure the program is safely saved on tape before attempting to run it.

It's certain that anyone who experiments with Roehn functions and their simulation as the Gutenberg Transform will soon understand the true value of this technique.

```
00100 REM Gutenberg Transform program
00110 FOR A=62464 TO 62490
00120 READ B
00130 POKE A,B
00135 NEXT A
00140 A=USR (62464)
00150 DATA 205,42,128,33,0,248,17,255,255,126,47,6,8,23
00160 DATA 203,25,16,251,113,35,229,237,82,225,56,239,201
00170 END
```

Polemical solutions to Gutenberg-transformed Roehn Functions on page 137.

HARDWARE-SOFTWARE TIPS

Colin Johns, Waverton NSW

My MicroBee is now nine months old, and the following tips are intended to help other kit owners progress a bit faster than I did!

With a really good program the 'Bee is a fantastic machine for the money, but unless you want to buy all your programs on cassettes it is not easy to find suitable listings. TRS-80 programs are a good source if there are not too many POKE instructions as the 'Bee uses different memory locations for the screen, etc.

Remember to change any PRINT@ statements to CURS and change SET statements to SETH to avoid having the graphics inverted due to the 'Bee's different way of inverting the Y axis.

Change any HOME to CURS 1 and use INTEGER constants wherever possible and ignore any INT statements since your constants are already INTEGERS.

On the hardware side, the following ideas may be useful to kit owners. Originally, Applied Technology advised using a 3 V memory backup battery, but now a 4.5 V battery is recommended as this prevents odd bits being lost from programs. However, it is still good practice to switch the 'Bee *on after* your monitor and printer etc, and *off first* to avoid power supply glitches.

I cured a very annoying hum modulation problem by soldering the leads from the plugpack directly to the ends of diode D15 (after checking the polarity of the leads several times). I also replaced the input protection diode D14 with a 3 A type, the original ran too hot for my liking.

Finally, I took the two 5 V regulators off the printed circuit board and attached new ones, without the heatsinks, directly to the heavy metal base of the 'Bee where they remain delightfully cool. You have to run four leads to the printed board which makes service slightly more difficult, but the reliability should more than compensate. (You may need 1u tantalums across the OUTPUT and REF. leads of the regulators to preserve stability ... Ed.)

Two modifications to the 'Bee are very useful. First, buy an extra keyswitch and blank keytop and install these beside the spacebar on the bottom row of the keyboard. Wire one side of the switch to earth, the other contact to pin 24 of the Z80.

This is the WAIT pin and grounding it will halt execution of the program or listing without destroying any information.

Releasing the key allows the unit to continue. I found this a very useful addition.

The Z80 can function at over 4 MHz and this frequency is available from pin 9 of IC32. To run the 'Bee at 4 MHz, lift pin 8 of IC32 from the pc board and solder a lead from the IC (carefully) to one side of a SPDT switch (which I mounted beside the BREAK key). Connect a lead from pin 9 of the IC to the other side of the switch and from pin 8 to the moving arm — these last two leads are taken from underneath the board.

Press the WAIT key while changing the switch — strange things can happen if the Z80 misses a few clock pulses while it is operating! At 4 MHz the 'Bee really has a sting, even BASIC games such as Tennis become a challenge.

Note that this mod. is not an approved A-T one, but I have not found any problems in any machines which use it. Of course, the sound range is higher and cassette loading speeds are doubled too.

Learning to program the 'Bee would be easier if there were lots of programs available from which to pick up points and routines. The excellent game 'FOUROW' which was published in the June '82 edition of Microworld Report is a good example of the capabilities of the 'Bee, and useful routines such as the PCG Generator program by Harry Purvis (published in the December '82 edition of 'Your Computer') help tremendously.

The best book of programs for beginners I have found so far is 'The A to Z of Computer Games' by Thomas McIntire. This does explain how programs work, but there is a bit of recoding to be done (he uses P for one player, P1 for another etc), but using the GX function to change illegal functions will soon get things moving.

If your MicroBee programs do not work, look out for the following.

a. If you see STACK OVERFLOW ERROR after using a program for a little while, you have probably used an illegal exit from a FOR-TO loop, use the NEXT' construction as per this example:

```
10 FOR a=1 to 10
20 IF b=a THEN NEXT' 40
30 NEXT a
40 PRINT "b=a"
```

b. If your unit keeps showing "ILLEGAL VARIABLE" errors, look for a dimensional array problem. For instance, if you use DIM D(4,4) in a program and somehow refer to D=X or any other constant or variable then the 'Bee will quietly redimension D and the array D(4,4) is lost. This is not mentioned anywhere in the manuals and took me six months to figure out!

c. If you are using the IN#3 and OUT#3 commands, then make sure you clean the recorder heads frequently. I found this mode is not at all tolerant of errors.

Note that with the 'Bee's feature of INTEGRAL and REAL variables there is no ABS (absolute value) function available for integral variables.

Finally, some notes on the EDASM ROM set. If yours do not work, and were fitted by A-T, try swapping the chips around. This worked for me!

The manual supplied with the EDASM set now is much smaller than the original and many commands are not now listed although they are still in the ▶

MICROBEE COLUMN

ROM set. Try the following Monitor commands on your machine to check your ROMs:
(AAAA) is start address
(BBBB) is finish address
(EEEE) is auto execute address
(/) is space code — essential for commands to work.
FILL MEMORY MODE, will fill memory with whatever code is inserted for the letter (C) in the following statement.
F/AAAA/BBBB/C
e.g: to clear out a 32K Bee, F/0000/7FFF/0
COMPARE MEMORY MODE will compare two sections of memory and will show the differences.
C/AAAA/BBBB/AAAA/BBBB where the second set of start and end address codes are the start and finish of the second block of code. This is especially handy for verifying tape loading.

You can also save machine language, source language or BASIC language programs at 300 and 1200 baud rates with the following code:
To save at 300 baud
W/"NAME"/M/AAAA/BBBB/EEEE

To save at 1200 baud, change the W to D.

The letter after the name can be M for machine language programs, S for assembly language, and B for BASIC programs.

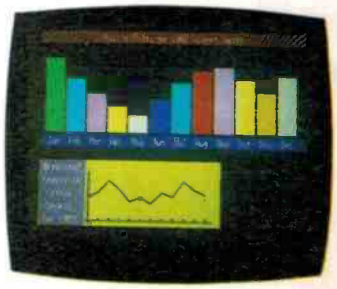
You cannot use this to save an A-T machine language MicroBee program as these are protected programs which self-modify after loading!

Here is a short program for the 'Bee. I will send some longer and better ones when my printer arrives. Note the use of the KEY function to avoid having to press RETURN to enter your answers, and the specific test for zero to avoid a letter giving a wrong answer (without the test for zero, typing any letter will give an answer of 0).

```
010 CLS: REM NICOMACHUS by C.J.
020 PRINT:CURS 20,2:PRINT "N I C O M A C H U S"
030 PRINT:PRINT"A puzzle from arithmetica of Nicomachus --
        A.D. 90!"
040 PRINT:PRINT"Please think of a number between 1 and 100."
050 PRINT:PRINT"Your number divided by 3 has a remainder
        of? ";
060 Q$=KEY:IF Q$="" THEN 60
070 IF Q$="0" THEN LET A=0:GOTO 90
080 A=INT(VAL(Q$)):IF A<1 OR A>3 THEN 60
090 PRINT A
100 PRINT"Your number divided by 5 has a remainder of? ";
110 Q1$=KEY:IF Q1$="" THEN 110
120 IF Q1$="0" THEN LET B=0:GOTO 140
130 B=INT(VAL(Q1$)):IF B<1 OR B>5 THEN 110
140 PRINT B
150 PRINT"Your number divided by 7 has a remainder of? ";
160 Q2$=KEY: IF Q2$="" THEN 160
170 IF Q2$="0" THEN LET C=0:GOTO 190
180 C=INT(VAL(Q2$)):IF C<1 OR C>7 THEN 160
190 PRINT C
200 PRINT:PRINT"Let me think a moment."
210 FOR I=1 TO1000:NEXT I
220 D=70*A+21*B+15*C
230 IF D<=105 THEN  260
240 D=D-105
250 GOTO 230
260 PRINT:PRINT"Your number was ";D;", right?  Type Y for Yes
        N for No."
270 Q0$=KEY:IF Q0$ = "" THEN 270
280 IF Q0$ = "y" OR Q0$ ="Y" THEN 320
290 IF Q0$ ="n" OR Q0$ = "N" THEN 330
300 PRINT"I don't understand ";Q0$;" try Y for Yes or N for No"
310 GOTO 270
320 PRINT"How about that!!":GOTO 350
330 PRINT"I feel your arithmetic is in error."
340 PRINT
350 PRINT"Let's try another."
360 GOTO 40
370 END
```

A STAR IS BORN

Business Graphics



Arcade Games

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To take advantage of the new ColourBee you'll need a converted colour TV or RGB monitor.

Colour Conversion — Any MicroBee can now be converted to run in brilliant colour, (as featured in the March edition of Your Computer), with 26 background plus 26 foreground colours and up to 80 characters per line on a converted colour TV or RGB monitor. MicroBee colour is fully software compatible with black and white MicroBee programmes. Conversion also includes the new Microworld colour BASIC and high speed operation at 3.375 MHz and 80 x 24 display option for any 16K or 32K MicroBee. Please note that because of the high resolution achieved, colour encoders and modulators are not recommended. The ColourBee must be operated with a specially converted colour TV or any RGB monitor.
Colour Option **$169**

Professional quality Daisy Wheel Printer (40 CPS) will turn your MicroBee with WordBee into a top quality word processor capable of producing print to match that from systems costing many times as much. Please check with your local MicroBee dealer for recommendations of the models available.

High Speed Dot Matrix Printer — MicroBee operates well with any printer such as Epson. Please check with your local MicroBee dealer for suggestions.

Any low cost cassette recorder can be used to load and save MicroBee programmes. These units have been extensively tested in our engineering department and found to be ideal for operation at 300 and 1200 baud.
Data Cassette Recorder **$39.50**

The cost effective MicroBee 16K Plus is supplied with Microword BASIC in ROM with room for additional ROM firmware such as WordBee or EDASM. User area is 16K or battery backed CMOS RAM which retains programme even after switching off. I/0 is an 8 BIT programme port, RS232 seriel port 300 and 1200 baud, direct video cassette interface 300 and 1200 baud. Screen is 16 lines of 64 characters upper and lower case with low resolution 128 x 48 and PCG high resolution 512 x 256 graphics. Fully expandable to colour, 32K or even 64K as your needs grow.
MicroBee 16K Plus **$449**

The clever MicroBee 32K Plus has BASIC in ROM with room for additional ROM based software such as WordBee or EDASM. Has full 32K of CMOS battery backed user RAM as well as 4K screen and graphics RAM. Operates in 64 character x 16 line format as well as high resolution 512 x 256 PCG graphics. A powerful machine equally useful in the classroom, home or almost anywhere. Fully expandable to colour and 64K operation.
MicroBee 32K Plus **$549**

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New Release — The MicroBee monitor also includes a built-in power supply for your MicroBee. Display is high resolution on a green screen. **$199**

For economy use a black and white converted TV monitor — Ready to use for **$149**

Direct Connect Modem — Soon to be released. This advanced design modem incorporates auto answer and auto dialling and operates a 300, 600 and 1200 baud.

XY Plotter — Digiplot is the intelligent plotter for the MicroBee. Ideal for line drawings, geometric designs, computer art, bar charts and contour plotting. Automatic selection of up to six different coloured pens.

MicroBee Disk Drives — Connects directly to any 64K MicroBee and operates under CP/M world standard disk operating system for 8 BIT micro processors. Massive 380K formatted storage on each double sided-double density drive. Supplied with comprehensive software including Microworld disk BASIC, EDASM, WordBee and a full library of utility programmes. Also accepts Osbourne and other popular disks. Single drive unit complete with disk controller and power supply. **$799**
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Wide range of support software on disk, cassette and ROM. Educational, business, games and support programmes now available. Call your local MicroBee dealer for more details.

The mighty MicroBee 64K Plus can be used as a free standing personal computer or coupled with disk drives to produce a top performance system capable of running any of the world class software running under CP/M. Has programmable 80 x 24 and 64 x 16 screen format and can be fitted with optional colour to produce probably the lowest cost CP/M colour computer on the Australian market today.
MicroBee 64K Plus **$699**

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The MicroBee is supported by a wide range of software running in colour and black and white. High resolution, low resolution graphics and text freely mixed.

ROBOT MAN — You must move about the maze eating up the power food. Watch out for the Robot Men as they are programmed to destroy you before you complete your mission! **$14.95**

MICROSPACE INVADERS — Yes the arcade favourite! This fast moving version was written especially for MicroBee by Tim Morris-Yates and has become one of the most popular programs yet released. **$14.95**

MATHS ADVENTURE — Wander into the fascinating world of the Wizard of Aus. Test your mathematic skills and have fun at the same time. A highly recommended graphics adventure game. Fun for high school maths students and teachers. **$14.95**

TURTLE GRAPHICS — A very clever program allows the student to use the MicroBee to draw using high resolution turtle graphics. A booklet of procedures is available from the N.S.W. Department of Education. This is a very powerful graphics program which uses the PCG facility of the Microbee to its full extent. **$14.95**

WORK-A-BEE — A new release. Work-A-Bee is a program which can actually write educational programs almost automatically! Any teacher with little or almost no knowledge of BASIC can insert details as to question and answer, number of tries, marks per question and other controls. Any CAI program can be saved and reused and subroutines have been included to enable the student to go back over his work, printing answers, avoid error traps etc. **$14.95**

CHESS — Match your skills against the MicroBee chess master. You can select from 1 to 6 ply and also analyse any position. A built-in 'Help' feature enables the computer to play your current move for you. **$9.95**

CONCENTRATION — A real family favourite for 1 to 4 players to test your memory skills. If you call one player Merlin, the computer will play that turn so watch out! **$9.95**

BUSI-CALC — Yes, an electronic spread sheet running under microworld BASIC. Accepts text and numbers with easy cursor control. Commands include:— Average; Sum; Compute; Format; Recalculate; Load and Save. Ideal for cash flow projections, bill of materials and even classroom data. **$14.99**

BIORHYTHM/CALENDAR MAKER — Ideal for parties or carnivals. Requires a serial printer. You can print biorhythms for anyone. Also prints calendars for any year A.D. and B.C. **$9.95**

Z TREK — Captain! The warp drives are disabled, the Klingons are closing in on us, what will we do? In Z Trek you are the captain of the starship Enterprise, your five year mission to search out the Klingons and destroy them. There are ten levels of difficulty (0 - 9). Beware of this game — it is strangely addictive. **$9.95**

WUMPUS — THE ADVENTURE GAME Have you ever played the game Wumpus? If you liked it then you'll like this! The object is the same as the earlier version except that it's a lot harder. To say any more would spoil the fun. Good Hunting! **$14.95**

ESC KEY — This is a program for all of the two fingered typists in the world. The program allows you to enter BASIC key words in an abbreviated form. For instance, instead of typing 'list" the user would press the "ESC" key and then "1". The computer then types out the rest of the word for you. Suitable for 16K and 32K machines. Only. **$9.95**

GRAPHIC GAMES — This cassette contains five programs, 'Poker', 'Slots', 'Dodgem', 'Picture', 'Richochet'. 'Poker' is the main program on the cassette. In this game the computer is the bank and you have to beat it at Draw Poker. Warning — the computer plays a cunning game and is quite prepared to bluff! 'Slots' is a one armed bandit and for 20c a go you can try your luck. In 'Dodgem' the player must guide his car through a forest to the bottom of the screen — this game allows you to drive a car without the random breath tester getting you!! 'Picture' is an excellent game for the children. The final program on the cassette is 'Richochet', where the player has to decide where to fire a bullet through a hole in the wall. If you hit the wall you're dead. **$9.95**

PCG SAMPLER — The PCG Sampler cassette has eight programs on it. These programs show you how the graphics work and demonstrates their capabilities by way of games etc. The cassette is excellent for both beginners and experts. It allows you to design your characters on the screen, so you can see exactly what you are creating. Suitable for all MicroBees. **$9.95**

STARSHOOT/HANGMAN — Starshoot is perhaps one of the most deceptive games available on computer. It appears to be very easy: it isn't. Hangman is based on the popular school game that everybody knows. **$9.95**

ELIZA — Want someone to talk to? Eliza is possibly the person for you. (If you can get her to shut-up). Eliza is a program that demonstrates artificial intelligence. Eliza is prepared to talk about life, the universe and everything. **$9.95**

TYPING DRILL/SOLITAIRE — Want to become a touch typist? Typing Drill enables you to learn touch typing without paying an exorbitant fee to learn. Solitaire is a game in which the object is to remove all of the "pegs" from the board, leaving one peg in the centre of the board. Sounds simple, but, it requires skill to master it. **$9.95**

TARGET — Target is a game of hit and miss. Your task is to aim the cannon at the bottom of the screen and shoot down the U.F.O.'s (ET watch out). There are nine levels of play to this entertaining game thus making it suitable for any player. Suitable for all Microbees. **$9.95**

EDUCATIONAL GAMES — Learning Can be Fun: Educational games software has arrived. This set of 3 cassettes combines graphics with text to produce highly motivated teaching games. Uses variations of well known arcade games to enhance the learning process.
Volume 1A: GORILLA — Answer questions to avoid the barrels Kong is rolling. F RACE — A race game to teach fractions.
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Volume 1C: ADSTAR — Avoid the invaders. Shoot the space ship with the right answer. SQUARE — The Enterprise can save the Galaxy. You arm the laser cannons. **$9.95 each or $24.95 for the set of three.**

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HERE WE ARE BACK AGAIN with some software for Sinclair ZX computer owners (ZX80/81) after a considerable absence.

Like to see more programs — then send some in! The more we get, the more we can print. This issue, all programs are for the ZX81. Have you got an original program? — other enthusiasts would probably like to see it. All published contributions paid for.

BOMB

S. Austin, Karachi, Pakistan

Here's a fun game to try. The object is to completely destroy a group of buildings by dropping bombs from an aircraft (get rid of your negative aggressions!. . . Ed.). Your aircraft will take as many sweeps over the buildings as required, but each time the aircraft will fly at a slightly lower altitude. Fly into a building and you've had it!

To release bombs, press key B.

On each sweep, you are limited to two bombs. It is important to bomb the taller buildings first, otherwise you'll fly into them.

To make the bomber's task harder, the number of bombs for each sweep may be reduced to one by amending line 45 to read LET B=1 or by making the initial height of the aircraft lower than the initial value of the control variable at line 40.

Good luck!

```
1    REM "ZX81 BOMB BY S. AUSTEN"
5    RAND
10   CLS
15   FOR X = 0 TO 15
20   FOR Y = 16 TO 3 + RND*12 STEP -1
25   PRINT AT Y,X; "■ "
30   NEXT Y
35   NEXT X
40   FOR Y = 39 TO 13 STEP -1
45   LET B =2
50   FOR X = 0 TO 31
55   PRINT AT(43-Y)/2,X/2;
60   LET P = PEEK(256*PEEK 16399+PEEK 16398)
65   IF P<>0 AND P<>118 THEN GOTO 115
70   PLOT X,Y
75   IF INKEY$<>"B" OR B=0 THEN GOTO 100
80   FOR I = Y-1 TO 11 STEP -1
85   UNPLOT X,I
90   NEXT I
95   LET B=B-1
100  UNPLOT X,Y
105  NEXT X
110  NEXT Y
115  INPUT Q$
120  IF Q$="  " THEN GOTO 10
```

SIMPLE ALPHASORT

Malcolm Young, Dunedin N.Z.

Here is a simple 'Alphasort' routine that will sort letters in order. If, having run the program, you type in something like 'The quick brown fox jumps over the lazy dog', it will sort out all the letters and print them in alphabetical order. This program could well be used as a starting point for a more sophisticated alphasort routine, but in the mean time, it will illustrate how an alphasort works.

```
10   REM "ALPHASORT BY MALCOLM YOUNG,FOR THE ZX81"
20   REM "1982"
30   PRINT "ALPHASORT"
40   PRINT
50   PRINT "ENTER WORD OR PHRASE"
60   PRINT
70   INPUT I$
80   PRINT I$
85   PRINT
90   LET B=LEN I$
95   PRINT "SORTED LETTERS ARE"
100  FOR A=38 TO 63
110  FOR C=1 TO B
120  IF I$(C)=CHR$A THEN PRINT CHR$A; "   ";
130  NEXT C
140  NEXT A
150  PRINT , "THE TOTAL AMOUNT OF LETTERS IS ";LEN I$;
     "(SPACES INCLUDED)"
```

ZXART

Peter Moxom, Ryde NSW

Use your ZX81 keyboard to 'paint' on your TV screen! All the instructions are included in the program and appear on-screen when the program is run. Try writing your name! You can draw black on white or white on black.

The program consumes 2½K of memory. Lines 1000 to 1080 perform the screen inversion. To call up this subroutine you use lines 9000 and 9010. This routine inverts the screen in one-eighth of a second. Don't forget to key in the equation at line 30 at line 100 and the same for line 40 at line 110.

```
1    REM **ZXART AN ORIGINAL PROGRAM BY PETER MOXOM **
2    GOSUB 1000
3    SLOW
5    GOTO 2000
10   LET X=31
15   LET Y=22
20   PLOT X,Y
25   LET A$=INKEY$
30   LET Y=Y+(A$="6")+(A$="7")-(A$="A")-(A$="S")+(A$="Q")-(A$="W")
35   LET Y=Y+(Y<0)-(Y>43)
40   LET X=X+(A$="8")-(A$="5")-(A$="A")+(A$="S")-(A$="Q")+(A$="W")
45   LET X=X+(X<0)-(X>63)
50   IF INKEY$="P" THEN CLS
51   IF INKEY$="Z" THEN CLS
52   IF INKEY$="Z" THEN GOTO 2000
55   IF INKEY$="0" THEN CLS
56   IF INKEY$="0" THEN GOTO 6
57   IF INKEY$="U" THEN GOTO  99
58   IF INKEY$="I" THEN GOSUB 9000
59   IF INKEY$="L" THEN GOTO 9900
60   UNPLOT X,Y
90   GOTO 20
99   LET A$=INKEY$
100                *(same as 30)
110                *(same as 40)
120  PLOT X,Y
130  UNPLOT X,Y
140  IF INKEY$="I" THEN GOSUB 9000
144  IF INKEY$="Z" THEN CLS
145  IF INKEY$="Z" THEN GOTO 2000
150  IF INKEY$="J" THEN GOTO 20
160  GOTO 99
1000 POKE 16388,0
1010 POKE 16389,127
1020 LET M$="042 034 064 006 022 126 254 118 032 008 005 120 254 000
          032 005 024 006 198 128 119 035 024 237 201"
1030 FAST
1040 FOR M=32600 TO 32624
1050 POKE M,VAL M$( TO 3)
1060 LET M$=M$(5 TO )
1070 NEXT M
1080 RETURN
2000 PRINT " ********INSTRUCTIONS******** "
2010 PRINT " YOUR CONTROLS ARE AS FOLLOWS"
2020 PRINT "5 MOVES POINT LEFT","6 MOVES POINT DOWN",
     "7 MOVES POINT UP", "8 MOVES POINT RIGHT"
2025 PRINT
2030 PRINT "Q MOVES POINT UP LEFT","W MOVES POINT UP RIGHT","A MOVES
     POINT DOWN LEFT","S MOVES POINT DOWN RIGHT"
2035 PRINT
2040 PRINT "P CLEARS THE SCREEN","0 CLEARS SCREEN AND RESETS POINT",
     "I INVERTS THE SCREEN","U STOPS POINT PLOTTING","J RETURNS
     TO NORMAL PLOTTING","L STARTS DISPLAY RAPID INVERTING",
     "K STOPS THE RAPID INVERTING"
2050 PRINT
2060 PRINT "PRESS" "Z" "TO SEE INSTRUCTIONS"
2070 PRINT "*****PRESS ANY KEY TO START*****"
2980 PAUSE 4E4
2999 CLS
3000 GOTO 10
9000 PRINT AT 0,0;
9010 LET RR=USR 32600
9020 RETURN
9900 PRINT AT 0,0;
9910 LET RR=USR 32600
9920 IF INKEY$="K" THEN GOTO 20
9925 PAUSE 25
9930 GOTO 9900
```

NOUGHTS & CROSSES

David Pye, Happy Valley SA.

This program is a game of noughts and crosses for two players, but with a slight difference.

Upon running the program, the standard 'field' for noughts and crosses is drawn on the screen with "O PLAYS" underneath.

Pressing a key from 1 to 9 puts a '0' in the corresponding square. The "O PLAYS" then changes to "X PLAYS" and the X player can then press any key from 1 to 9 to put his X in whichever square he wants it. (But not on top of the existing 0 — the same goes when O plays.) Play then reverts to "O PLAYS".

If you fill all nine squares without either player getting three in a row, the words "END GAME PUSH KEY" will appear above "PLAYS". Pressing any key then resets the 660 and a new game can commence.

If a player gets three in a row, pressing key F will reset the computer to start a new game.

Now here comes the twist. If, during a game a player takes too long to press a key (about 15 seconds or so), the message "TOO LATE!!!" appears above "PLAYS" and a decreasing tone sounds. The message "TOO LATE" is then replaced by "END GAME PUSH KEY" and "O PLAYS" or "X PLAYS" is replaced by "O WINS" or "X WINS" as appropriate.

The time cutoff for making a move makes the game more interesting and the delay is not constant as you'd expect!

The program is structured as follows:

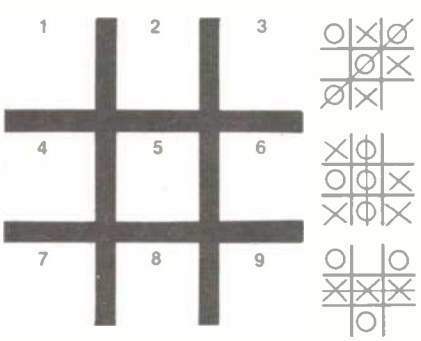
```
0602-0618:  display field (data at 0700-0716)
0620:       call 'display 0' routine
0622:       call 'display PLAYS' routine
0628-065C:  key calls for 0; keys 1 to 9
065E-0668:  go to start if 0 misses turn
0670-0672:  swap X for 0 before PLAYS
0674-0676:  end game
067A-06AE:  key calls for X; keys 1 to 9
06B0-06BA:  go to start if X misses turn
06BC-06C4:  data for PLAYS
06D0-06D2:  swap X for 0 before PLAYS
06D6-06E8:  data for 'TOO LATE !!!'
06EA-06F8:  display routines for 0 and X
06FA-06FE:  data for X
0700-0716:  field data
071C-0722:  display 0 at 1st square of field
0726-0778:  and so on for all squares of field
0786-078E:  spare memory
0790-07D8:  display X at squares 1 to 9
07DE-07F8:  routine to display "TOO LATE !!!"
0800-0816:  generate descending tone
0818-0822:  delay for 0 player
0824-082E:  delay for X player
0830-0838:  0 + 1
083A-0870:  call and display 'END GAME . . .'
0878-089A:  data for 'END GAME . . .'
089C-08A2:  X + 1
08A4-08A6:  call descending tone
08AC-08B6:  remove 0 PLAYS and show X WINS
08B8-08B9:  delay
08BA-08BC:  swap TOO LATE !!! for END GAME . .
08C6-08D0:  swap X PLAYS for 0 WINS
08D2-08D3:  delay
08D4-08D6:  remove TOO LATE, show END GAME . .
08D8-08E2:  routine to display WINS
08E4-08EE:  data for WINS
```

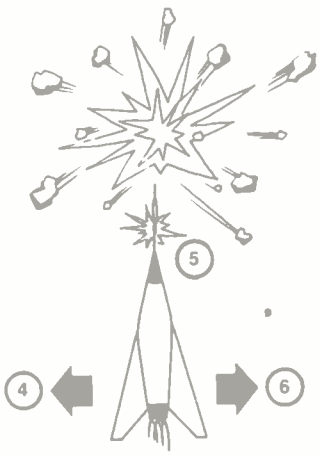
NOUGHTS & CROSSES

```
0600  00E0 6A0B 6B08 2700 6A0B 6B12 2700 6A14
0610  6B00 270C 6A20 6B00 270C 6A00 620F 6329
0620  26EC 2766 6D00 7D01 6C01 ECA1 171C 6C02
0630  ECA1 1726 6C03 ECA1 172E 6C04 ECA1 1736
0640  6C05 ECA1 173E 6C06 ECA1 1746 6C07 ECA1
0650  174E 6C08 ECA1 1756 6C09 ECA1 175E 6C0F
0660  ECA1 1600 3D90 1626 18A4 6400 620F 6329
0670  26EC 26F4 4A09 183A 7401 6C01 ECA1 1790
0680  6C02 ECA1 179A 6C03 ECA1 17A2 6C04 ECA1
0690  17AA 6C05 ECA1 17B2 6C06 ECA1 17BA 6C07
06A0  ECA1 17C2 6C08 ECA1 17CA 6C09 ECA1 17D2
06B0  6C0F ECA1 1600 3490 1678 18BE E8A8 E888
06C0  8EEA AAE4 A4A4 E080 E020 E00U 620F 6329
06D0  26F4 26EC 1624 EE4A 4A4A 4E8E 8A8E 8AEA
06E0  EE48 4C48 4EA8 A8A8 00A8 00FF 6100 F129
06F0  D235 00EE A6FA D235 00EE A0A0 40A0 A010

0700  A6FF DAB1 7A01 3A2B 1702 00EE A6FF DAB1
0710  7B01 3B1C 170E 00EE 00FF 00FF 6211 6301
0720  2830 1818 00FF 621C 6301 2830 1818 6227
0730  6301 2830 1818 6211 630B 2830 1818 621C
0740  630B 2830 1818 6227 630B 2830 1818 6211
0750  6315 2830 1818 621C 6315 2830 1818 6227
0760  6315 2830 1818 7A0B A6BC D235 7208 A6C1
0770  D235 7208 A6CE D235 00EE 6870 F815 F607
0780  3600 177E 00EE . . . . . .
0790  6211 6301 289C 1824 00FF 621C 6301 289C
07A0  1824 6227 6301 289C 1824 6211 630B 289C
07B0  1824 621C 630B 289C 1824 6227 630B 289C
07C0  1824 6211 6315 289C 1824 621C 6315 289C
06D0  1824 6227 6315 289C 1824 620B 6320 A6D6
07E0  D235 7208 26EC 7208 A6DB D235 7208 A6E0
07F0  D235 720B A6E5 D235 00EE . . . . . .

0800  6E0A 6710 7708 F700 FE15 FE18 F507 3500
0810  180C 3760 1804 00EE 6810 F815 F607 3600
0820  181C 166A 6810 F815 F607 3600 1828 16CC
0830  7A01 6100 F129 D235 00EE 6200 6320 A878
0840  D235 7209 610D 26EE 7206 A87D D235 7208
0850  A882 D235 7206 610E 26EE 7206 A887 D235
0860  7208 A88C D235 720A A891 D235 7208 A896
0870  D235 F00A 1600 00FF E98D CD8B EBEE 8AAE
0880  AAEA D8D8 A888 88EA AAEA 8A8E EA8A EE2A
0890  EAAE A8CC A8AE A0A0 4040 5000 7A01 A6FA
08A0  D235 00EE 27DA 2800 620F 6329 26EC 2766
08B0  620F 6329 26F4 28D8 277A 27DA 183A 27DA
08C0  2800 620F 6329 26F4 2766 620F 6329 26EC
08D0  28D8 277A 27DA 183A 720D A8E6 D235 7208
08E0  A8EB D235 00EE 8A8A AADA DA97 D4D7 B1B7
```





ASTEROID SHOWER

ASTEROID SHOWER

Peter Easdown, Kew NSW

Another animal in the asteroid games species. In this game, you start off with a cannon craft at the bottom of the screen and five asteroids plummetting toward you. The aim of the game is to dodge the asteroids while firing missiles at them. Each hit you score on an asteroid gains you one point. As the game is fairly easy, I have only provided one cannon craft.

When an asteroid crashes into you, the debris from the explosion fills the screen, the game stops and the score is shown. All the action is accompanied by sound effects.

Here are the keys to manipulate the cannon craft:

MOVE LEFT = KEY 4
MOVE RIGHT = KEY 6
FIRE = KEY 5

The program is straightforward, having a mainline at 0600-066C followed by three subroutines; the firing routine is from 0676 to 06A4, the end routine from 06A6 to 06C4 and the explosion routine from 0714 to 072E. A few other small routines are included for sound effects, etc. Variables used are as follows: V0,V1 — asteroid 1; V2,V3 — asteroid 2; V4,V5 — asteroid 3; V6,V7 — asteroid 4; V8,V9 — asteroid 5; VA,VB — cannon; VC,VD — missile; VE — score; VF — miscellaneous.

```
60C - 6E00  6A10  6002  6238
608 - C40A  740A  C60F  7618
610 - 632E  C10F  C30F  C50F
618 - C70F  6900  A6CE  D236
620 - D456  D676  D896  D016
628 - A6C6  6B20  DAB7  266E
630 - EFA1  2676  DAB7  6F04
638 - EAA1  7A5F  6F06  EFA1
640 - 7A01  A6CE  D236  D456
648 - D676  D896  D016  7102
650 - 7304  7502  7703  7903
658 - CFFF  FF00  FF18  00FF
660 - 00FF  00FF  00FF  00FF
668 - 4920  1604  161C  4F01
670 - 1714  6F05  00EE  26B8
678 - 8CA0  6D20  7DFF  A6D4
680 - DCD2  4F01  16BE  26F6
688 - 4DFF  16A2  167C  7E01
690 - 2704  A6D6  DCD8  6F10
698 - FF15  FF07  3F00  169A
6A0 - DCD8  A6D4  16DE  00EE
6A8 - 6C10  6D10  A7FF  FE33
6B0 - F265  F029  DCD5  7C04
6B8 - F129  DCD5  7C04  F229
6C0 - DCD5  FF0A  16E4  1038
6C8 - 6C38  386C  C600  1876
6D0 - DFED  6E18  1028  1842
6D8 - 2481  8142  4218  DCD2
6E0 - A6C6  00EE  00E0  1600
6E8 - 6F20  FF00  FF18  7FFF
6F0 - 4F10  00EE  16EA  6F01
6F8 - FF15  FF07  3F00  16FA
700 - DCD2  1712  6F30  FF00
708 - FF18  7FFF  4F20  00EE
710 - 1706  00EE  6200  C12F
718 - 7180  F100  F218  C3FF
720 - C4FF  A72E  D341  7201
728 - 3250  1716  16A6  8000
```

POLARIS

Tim Parish

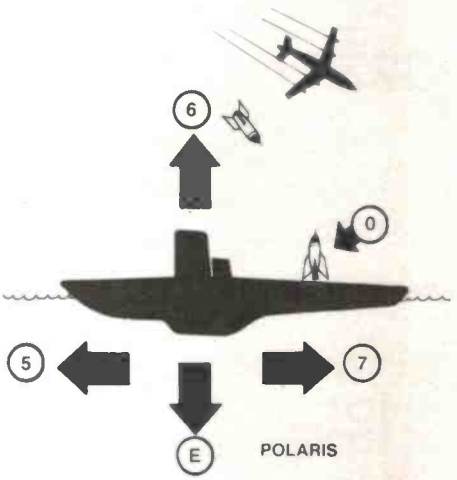
You have control of a submarine, using the keys 5 (move left), 7 (move right), 6 (move up) and E (dive). Key D is used to fire missiles at planes which fly from left to right. (Users with a hex keypad can change the instructions at addresses 0720, 0726, 072c and 0732 to select different keys for control.)

If you stay still, the depth charge dropped from the plane will not miss! You must also avoid the torpedo which is regularly launched from the left.

When you are hit by either the torpedo or the depth charge, your score is displayed, based on the number of planes shot down.

An added catch – a marker showing maximum depth for the submarine rises steadily with increasing score! It stops close to the surface, making things harder for the high scoring player.

Pressing key 8 will start a new game. (Would Tim Parish please contact the Editor.)



POLARIS

```
0600   6118 6000 a7d6 d011 7008 3040 1605 620c
0610   682c a6d4 d282 612f 6000 a7d0 d011 7008
0620   3040 161c 6300 6101 a7ce 6b20 6c20 dbc2
0630   a7cc 6d00 6e02 dde2 6700 6500 6a00 6900
0640   80b0 80d5 4009 164c 3008 1658 3b00 1658
0650   6200 a62d 6a04 d4a1 a7cc dde2 7d01 3d3e
0660   1664 6d00 dde2 80d0 3200 8024 3a18 1674
0670   8900 79ff 4a00 16d4 a62d 3900 168a 70ff
0680   d4a1 7b01 7a02 d0a1 16de d9a1 9ac0 169a
0690   7a01 9ac0 169a d9a1 16de a7d1 8ae5 d9a5
06a0   8090 7a02 80b5 3f01 16d0 6e06 8e05 6e0
06b0   4f00 16d8 6318 64ca a7d8 f533 f265 f029
06c0   d345 f129 7305 d345 f229 7305 d345 6008
06d0   e09e 16ce 00e0 16d0 d9a5 6a00 89a0 a7d7
06e0   3300 16e8 84c0 d341 d341 7301 d341 4030
06f0   80b5 3f01 170c 6e06 8e05 6e02 3f01 170c
0700   94c0 17c4 80c0 7001 9400 17c4 333e 1714
0710   d341 6300 80d0 8012 3000 175c a7ce dbc2
0720   6005 e0a1 173a 6007 e0a1 1740 6006 e0a1
0730   1746 600e e0a1 174c 175a 3b01 7bff 175a
0740   3b38 7b01 175a 3c19 7cff 175a 8680 9c00
0750   175a 70ff 9c00 175a 7c01 dbc2 a62d 6000
0760   e09e 1776 3700 1776 86b0 87c0 80c0 8012
0770   3000 77ff d671 4700 1640 d671 87e5 3702
0780   17c0 a7d1 d675 80d0 7003 8065 3f01 17b8
0790   5e06 8e05 6e02 4f00 17b8 a7cc dde2 82d0
07a0   6d00 dde2 6002 8052 3000 17b6 a6d4 d002
07b0   381c 78ff d082 7502 a7d1 d675 6700 1640
07c0   d671 1640 84e5 a7d1 d345 16b4 80f0 08fe
07d0   ff50 a850 a850 aac0 ----------
```

SQUASH

Tim Parish

Just like the original pub game! This program draws a squash court on the screen and you play the ball with a mind of its own. Your bat is on the left and the ball is served from the court area. The object is to keep it bouncing around the court. If you miss, it passes off screen to the right and you get another ball. The game starts off with five balls. The ball commences moving rather slowly (and you overshoot with the bat!), but each time you hit it, it speeds up, reaching maximum speed after 18 hits.

Below and to the left of the court, your score is displayed, progressively updated each time you hit the ball. At the lower right, the number of balls left is displayed.

Sound effects are included, the pitch of each bounce of the ball rising as the ball speeds up.

The game ends once you miss the last ball. Press 8 to start a new game. ●

MOVE BAT UP = KEY 5
MOVE BAT DOWN = KEY D

```
0600   6008 a619 6100 d011 6120 d011 7008 3038
0610   1604 6000 a6f4 d011 71ff 31ff 1616 a6f3
0620   fc65 a6f3 d893 26d5 26c8 fa00 6302 cd1e
0630   7d01 a6f4 d3d1 d3d1 3301 1640 6601 fc18
0640   3d01 1648 7701 fc18 3d1f 1650 67ff fc18
0650   332a 1578 8090 9d00 1668 7001 9d00 1668
0660   7a01 9d00 1668 1678 26d6 7401 26d6 66ff
0670   3a0a 7aff fc18 fa00 3330 1692 26c8 75ff
0680   45ff 1608 26c8 162c 5008 e09e 160a 00e0
0690   1600 a6f4 8364 8d74 d3d1 a6f3 6105 e19e
06a0   16ac 4901 16ac d893 79fe d893 610d e19e
06b0   16bc 491d 15bc d893 7902 d893 a6f4 6009
06c0   7001 90a0 1636 16c0 a6f0 f533 f265 f229
06d0   602b d0b5 00ee a6f0 f433 f265 f029 6010
06e0   d0b5 f129 7004 d0b5 f229 7004 d0b5 00ee
06f0   ---- --01 0101 0200 0501 012b 0f1c 2401
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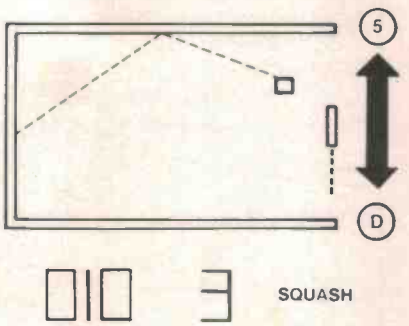

SQUASH

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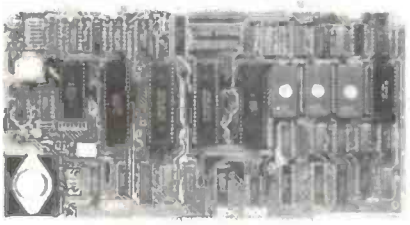

SBC-800. 4 Mhz Z-80 CPU, two serial RS232 ports, software programmable Baud rate gen., Centronics parallel port, 22 prog. I/O lines, real time clock (battery backed), 2K CMOS RAM, power on reset/power fail detect, battery backed as standard, etc. List Price $495.

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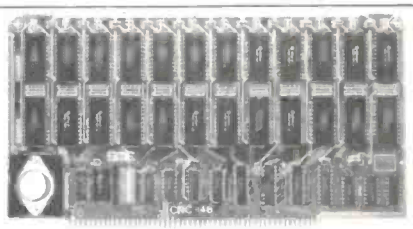
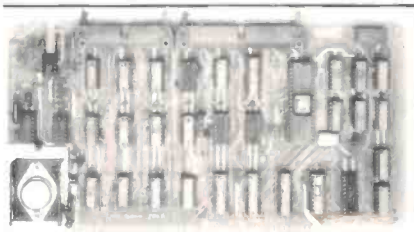


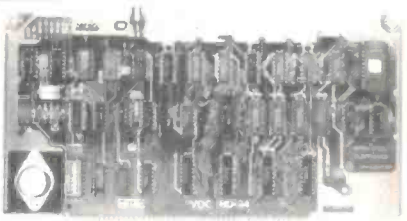
CRC-64. Fool-proof memory system. State-of-the-art 64K CMOS memory card with memory protection, on board battery back-up, compatible with DRC-II, write protection enable/disable. List Price $675.

$565 OUR PRICE



FDC-II. Enhanced floppy disk controller, IBM 3740 compatible, operates 5" & 8" and single/d. density drives, handles up to 4 drives, runs multi-density CP/M2.2 & MP/M 2. Vectored interrupt operation optional. List Price $465.

$370 OUR PRICE



VDC-8024. The low cost alternative to stand-alone terminal. Flexible 80x24 memory mapped video display board with full ASCII, semi graphics, Inverse & half intensity video, flicker free screen updating. Battery backed option offers diagnosis of system shut downs. List Price $325.

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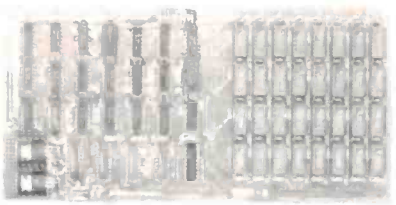

DRC-II. The board for multi-user installations. 64/256K dynamic RAM card, bank select, fast 4 Mhz operation, on-board memory prom, dip-switch selectable boundaries, bank mode allows up to 8 boards on bus, hidden refresh, phantom disable. List Price $600.

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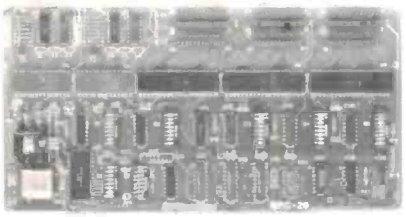
Please include me on your new product mailing list. I am mainly interest in systems for ☐ Hobby, ☐ Industrial use, ☐ Education, ☐ Business, ☐ Process control, ☐ Other.

KN428



SPC-29. High performance dual serial & 9 parallel port I/O CARD, with full I/O address decoding. Switch selectable baud rates. Link patch area, programmable modes for strobed/latched I/O. List Price $295.

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MINI CARD CAGE. Compact card cage frame with 5-slot motherboard plated through hole. Five edge connectors. Our Price $125.

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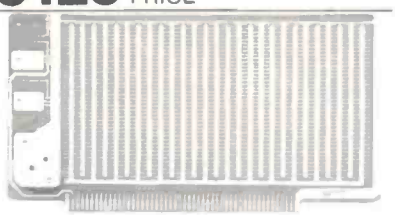

S-100 WIRE WRAP CARD. Gold-plated edge connectors, through hole plating, provisions for four regulators, distributed power rails. I/O connector provision on top of card.

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Getting rid of grease from your car engine used to be a headache. Then Kitten came along and invented two magic products that do the whole job quickly and thoroughly.
Simply ask for Degreezo or Jet Spray Degreaser from The Kitten System.

Jet Spray Degreaser eats oil and grease, swallowing the build-up on the engine and chassis.

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If you prefer a paint-on application to an aerosol, try Degreezo in the economical 750 ml pack.

Paint it on engines, extra dirty motor parts or your oil-stained driveway and stand back to watch Degreezo lift out the muck.

Degreezo's specially developed formula dissolves oil and grease, so all you have to do is hose it off, leaving your parts as bright as the day you bought them.

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As featured in Electronics Australia Projects June and July 1981.

Now Peerless introduces another major advance to kit-set loudspeaker technology. A bass speaker with a rigid polypropylene cone that clearly outperforms traditional paper composite cone speakers to provide: • Cleaner, tighter bass sound reproduction • Low colouration and distortion • High efficiency, suiting 25W to 100W amplifiers • Consistent rigid panel, low mass speaker cones.

Other outstanding features of Danish-built Peerless speaker kit-sets are: • Sealed back mid-range with excellent linearity and low distortion • Latest Peerless 1" soft-dome tweeter • State-of-the-art crossover networks • Exceptionally flat response extending to 25,000 Hz.

Choose from these EA/Peerless speaker projects:
- PAS 100 12" 3-way 100W (100L)
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- PAS 25 8¼" 2-way 60W (25L)

includes drivers, crossover, wiring and instructions.

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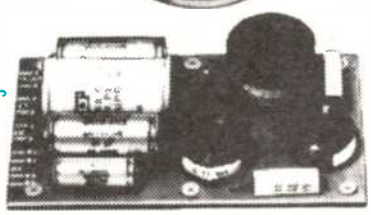

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It's looking good for the hi-fi industry

Hi-fi sound has, in the last year or so, appeared to be a quiet wallflower in comparison to the exotic entertainment offered by video. You could be forgiven for thinking that viewing the world through the rosy hues of a TV screen, with one's super-dooper-do-anything VCR recording even more programs, is the ultimate answer.

But the question is: what about life, the universe and everything to do with the pleasure of listening to good music? And that's what the members of the Hi-Fi Industry Association were asking at their last meeting in Sydney.

Mr. Ted Fawle, managing director of Marantz, led the discussions chaired by the president, Mr. Gary Fitzsimmons, distributor of Shure, DBX and other quality products. A campaign of action was planned to beat the economic recession and the strong influence of the Japanese market.

The Japanese are only interested in mass production and when hi-fi didn't respond to mass marketing techniques they concentrated on lower priced units. This eventually brought hi-fi down to radiogram prices and quality.

All the advertising to promote these cheap but good looking systems made the public believe that hi-fi could be bought for $699. The standards of the industry became depressed as everyone else was forced to cut corners and maintain sales to survive in a vicious and low-profit market.

But the signs are good as we begin the era of the digital audio disc player. This will focus the public's attention back on to good sound and the quality speakers and amplifiers necessary to cope with the transience and dynamic range of the digital audio.

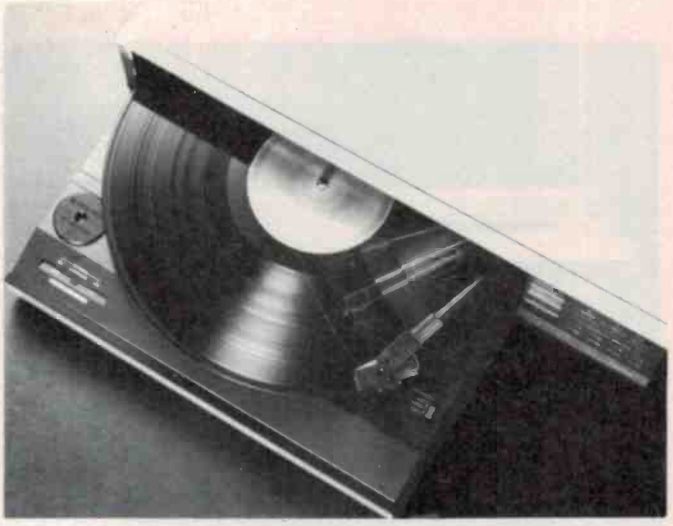
Optimism has returned to the Hi-Fi Industry Association. Companies such as Bose, AR and Mordaunt Short resigned from the association because they grew tired of the marketing politics. But now Bose and the Mordaunt Short distributor, Concept Audio, have re-joined.

The only Japanese companies still in are dedicated hi-fi manufacturers like Pioneer, Yamaha, Sony and the Philips owned Marantz, all of which want to see the hi-fi market returned to its up-market pedestal.

The association's plan of action covers:

- An ad hoc policy to not advertise hi-fi systems below $1200 to direct the public's attention to quality audio.
- Annual awards will be sponsored by the hi-fi industry based on selections by a panel of leading electronics writers. These awards will be in the areas of journalism, hi-fi product inventions, advertising and dynamic merchandising.
- Communication with the public will be improved by more press releases, a new audio guide booklet and an information kiosk to be used at all appropriate consumer shows. Communication within the industry will be via a quarterly trade and dealer newsletter, with meetings between common interest groups.
- Seminars will be held year round for the whole industry, including retailers, to try and lift the marketing of hi-fi to a more professional level.
- Larger budget promotions will include battle-of-the-bands contests, sponsorship of simulcasts and advertising campaigns.

An ideal opportunity for promoting hi-fi will be at the updated Sydney Consumer Electronics Show to be held at the Sydney Showgrounds in July. Roy Castle, of Total Concept Exhibitions, is now organising the show. Several companies have already signed up, including Marantz, TDK, R.H. Cunningham and Hanimex, and many others are expected to sign soon.



Pioneer's front loading turntables

The top-of-the-range front loading turntable, the PL-88F, features a platter assembly that glides in and out at the touch of a button.

The PL-88F can be placed beneath, or stacked between, your other components and can handle a load of up to 40 kg.

It also offers programmable, automatic conveniences such as music search which allows a total of eight different songs to be played back in any order, index scan, skip and repeat. Deck synchro allows the turntable to be operated in synchronisation with Pioneer cassette decks.

Pioneer claim that their newly developed Double Eye Sensor and Address Sensor, electronic and optoelectrical devices, provide smooth and accurate operation. The direct drive arm motor and moving coil cartridge are standard.

The recommended retail price is $599.

A second front loading model is the PL-44F which also has the functions of repeat play, music search and deck synchro. It has fully automatic operation and the platter is driven by a belt drive dc servo motor with stable hanging rotor. Wow and flutter is 0.045%.

The PL-44F retails for $329.

More information on these models can be obtained from **Pioneer Electronics, 178 Boundary Rd, Braeside Vic. 3195. (03)580-9911.**

Japanese to manufacture VCRs in Europe

Matsushita, Sanyo and Mitsubishi have stated that they intend to manufacture VCRs in Europe.

Matsushita said that it will produce VCRs in West Germany later this year, in a joint venture with Robert Bosch, GmbH. The VCRs will carry the Panasonic and Blaupunkt names. Blaupunkt Werke is a subsidiary of Robert Bosch and has been private-labelling VCRs in Europe which were made in Japan by Matsushita.

Sanyo is adding VCR production to its colour TV plant in Norfolk, England. Sanyo said that initially 5000 VCRs will be made per month which will be increased to 10 000 units per month. At first sales will be to the British market only.

Mitsubishi is expanding its existing plant in Haddington, England, to include VCR production and said it plans to bring on line a VCR facility in Scotland.

These disclosures came as European Economic Community called for voluntary VCR export restraints by the Japanese.

Fisher video cassette recorder

Fisher's Model FVH-P530 is a slim styled, top-loading unit featuring a 15-function infra-red remote control.

Recording and playing time on a VHS E-240 cassette is four hours and the programme timer lets you select programmes up to 14 days in advance with as many as five programmes selected in that time, subject to the length of the tape used.

Picture search in colour is possible at five times normal speed in both forward and reverse modes. Four other speed variations are provided including frame by frame and still frame.

The FVH-P530 is available now from selected outlets at a recommended retail price of $1428. For more information contact **Sanyo Australia, 225 Miller St, Nth Sydney NSW 2060. (02) 436-1122.**

This echo unit is back again, again . . .

Charlie Watkins, of Watkins Electric Music, London, has been visiting music shops throughout Australia re-introducing the WEM Copicat Echo Unit.

This unit was originally sold here years ago by Alan Rose. The machine is in the same format as the older unit but, of course, it has been updated with the latest electronic technology. It still has the same 'Shad' sound and now incorporates a 'variable speed' feature.

WEM have also introduced to the music scene a new range of speaker drive units. With an RMS power rating of 300 watts, these 10" and 12" models have been designed and constructed specifically for use in situations where high power is experienced over long periods, and where high efficiency and low distortion characteristics are vital.

The specially developed centre suspensions are fitted to the speakers, mounted upon steel platforms. The diaphragms are designed to provide response from 35 Hz to over 4 kHz, with an approximately doubled output in the region of 1500 Hz to 4000 Hz. At full power sound pressure levels in excess of 125 dB (at one metre) are being produced.

WEM have a computer program which will calculate the optimum reflex port size and length for any stated cabinet volume. This service is free to WEM 300 Series speaker users.

Monty Watkins is the boss of the Australian distributors. For more information write to **WEM, 13 Ilya Ave, Bayview NSW 2014. (02)99-3227.**

Is taping copyrighted television programs illegal?

The Supreme Court in the US will decide whether the 1976 Copyright Act considers home taping of copyrighted broadcasts 'fair use'.

In 1981 the 9th Circuit Court of Appeals in San Francisco ruled against Sony, in a case Sony originally won in a Los Angeles federal court after Universal and Walt Disney sued Sony and certain retailers for copyright violations.

Now Sony is arguing for the reversal of this lower court decision which makes it illegal to tape copyrighted television programs. Walt Disney and Universal Studios are against home taping.

Sony's attorney is arguing that program producers are improperly trying to restrict the use of free, over-the-air programming by viewers who receive the programs.

The attorney representing Universal and Disney has argued that VCR taping of copyrighted material is no different from commercial piracy and producers should be granted royalties on VCR sales.

Sony has denied liability for alleged illegal acts by its customers. Sony's attorney noted that a warning is included inside the Betamax package telling buyers improper use could violate copyright laws.

A decision is expected before the court adjourns in June.

New Ortofon cartridge series

Ortofon has released four new moving coil cartridges.

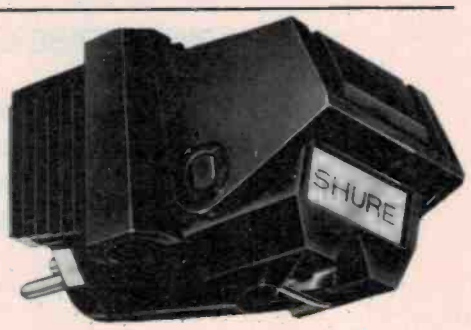
The MC 200 and its 'junior' version, the MC 100, are both integrated designs. They contain the same moving coil and wide range damping systems and ring magnet. The MC 100 also incorporates an aluminium cantilever with a nude, elliptical diamond stylus which has overhang adjustment facility and a user-replaceable stylus unit.

The technical specifications and performance of the Universal models, the MC 200U and MC 100U, are identical to those of their integrated counterparts. In their outer design the Universal versions resemble Ortofon's LM models, with certain modifications. The cartridge body is shorter than the LM design and the height has been increased. They both have fixed stylus assemblies.

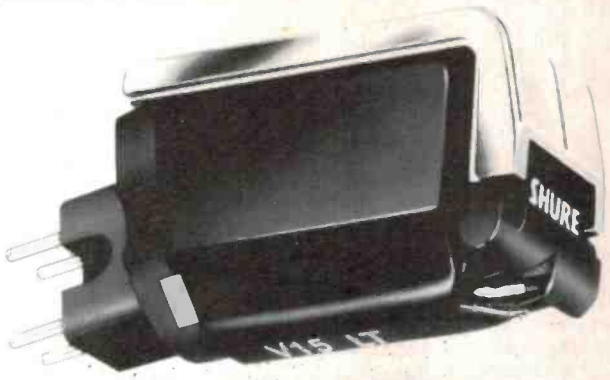
For further details of this series phone **Harmon Kardon Australia, 6 Byfield St, Nth Ryde NSW 2113. (02) 887-3233.**

When you're ready to 'face' the music we have a tip for reduced distortion.

The hyperelliptical stylus tip, acclaimed for its low distortion and high trackability, is now available in a whole series of Shure pickups. Whether you're seeking to reproduce the full dynamic range of today's new superdiscs, or simply to obtain maximum listening pleasure from treasured records in your collection, you'll find an HE pickup with the combination of features and performance that best meets your needs from the models below.



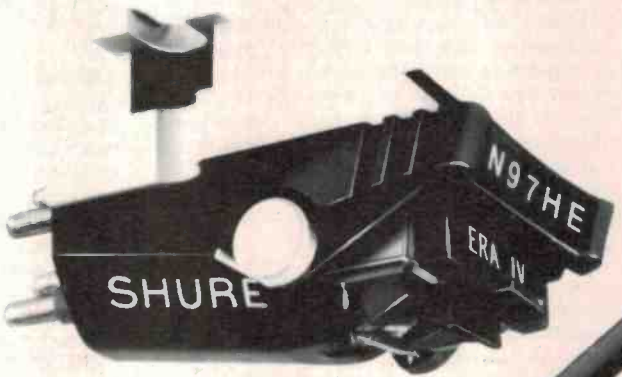
M95HE
Features high trackability, flat frequency response, low loss/high output magnetic pole piece, at a modest price.



V15LT & M97LT (Linear Tracking Models.) Get the most from advanced technology linear tracking turntables! Performance comparable to V15IV and M97HE respectively.

M97HE-AH "the Headliner". All the design and performance of the M97HE plus the simplicity of plug-in connection. Allows instant attachment to the tone arm of most turntables.

M97HE
Top of the line features and excellent performance at an intermediate price. Features Dynamic Stabilizer and SIDE-GUARD stylus protector.



MV30HE
Sleek, integral pickup/arm carrier combination for use with SME Series III and SME Series IIIS tone arms. Performance similar to V15IV.

V15 Type IV
Perfectionists choice! With unprecedented trackability, ultra-flat response, Dynamic Stabilizer, low effective stylus mass.

hi-fi

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(02) 29 6731

NOMIS ELECTRONICS
689 South Road
Black Forest SA 5035
(08) 293 4896

AUDIO ENGINEERS Qld
47 Castlemaine Street
Milton Qld 4064
(07) 369 9670

AUDIO ENGINEERS Vic
2A Hill Street
Thornbury Vic 3071
(03) 44 3295

MARKETEC
18 King William Street
Sth Fremantle WA 6162
(09) 335 8275

Glover & Assoc AE/12/2

Hear ye! Hear ye! Seven headphones tested

AKG K4 • AUDIO TECHNICA ATH-0.5 • EMPIRE LW-2 • NAKAMICHI SP-7

PIONEER SE-L90 • SENNHEISER MS100 • SONY MDR-80T

All ears? Every set of these lightweight headphones performs well. Testing was obviously a heady experience with low distortion levels and good frequency responses. No particular headphone stood out as being the best. You'd be pleased with any of them.

Louis Challis

WHEN MY LATE FATHER was a young man in Perth he built his first crystal set. He regarded that set as one of his most prized possessions and listened to the small number of amateur commercial stations with a primitive set of high impedance headphones. That early crystal set was improved by adding a valve. Then a second valve was installed and he and his sisters listened through three sets of high impedance headphones. He assured me on his 79th birthday that the intimacy of those headphones, with their limited frequency response, heavy dangling wires and the messy high outside aerial, made it all worth while. It opened up a new world of entertainment and information. The large outside world seemed to become smaller and closer.

Loudspeakers had been out for a while before my father bought his first one. Even though the radio receiver produced more audible power, he soon tired of his own handywork. In 1936 he purchased a magnificent seven valve radio with remarkably good local and short-wave reception and, in many respects, it was better than most modern receivers. But as he often told me, and I believe it to be true, even though the output was louder this did not quite compensate for the intimacy that the old headphones provided. It took more than 50 years before there was a resurgence in the use of headphones for personal listening.

The greatest attribute of headphones is that they do not disturb other people in the same room even when listening at high levels. The second attribute of the best headphones is that until recently they have been comparable to, and in many cases superior to, the majority of loudspeakers. The third attribute is the feeling of intimacy that they produce which is still not really matched by any but the best of loudspeakers.

New design concept

The design philosophy that pushed headphones back into the public's eye was primarily the work of the Sennheiser Company of Germany. They produced the first 'open ear' concept of lightweight headphones with the best known example being the HD414 series. The basis of the concept made use of a supra-aural transducer (external transducer) in lieu of a circumaural transducer (close coupled transducer). The weight of their new lightweight headphones was reduced to less than a third of what the competitors' headphones were and the long term listening comfort was improved by a factor of three. Those early Sennheiser headphones soon became the choice of radio announcers all around the world and that pre-eminent position was not really challenged by any other manufacturer until quite recently.

The status quo may well have stayed exactly as it was if it had not been for the development of the ubiquitous Sony Walkman lightweight portable stereo cassette player and all the other 'Mr. Me-Too' look-alikes which have appeared over the last three years. In that time the Sony Corporation has produced what must be literally millions of these units and the market for lightweight headphones has mushroomed at an absolutely astounding pace.

Of course there are many reasons for this phenomena and one of them is that the latest generation of personal portable cassette players provides two headphone jacks for shared listening. And it's also a fact that many users have been dissatisfied with the cheaper originally supplied headphones whose performance does not match that of the cassette player. However the most important reason may well be that the users are demanding better performance.

AKG K4

Manufactured: by AKG Acoustics, Vienna, Austria
Distributor: AWA, 554 Parramatta Rd, Ashfield NSW 2131. (02)797-5757.

AUDIO TECHNICA ATH-0.5

Manufactured: by Audio Technica Corp, Tokyo, Japan
Distributor: Rose Music, 17-33 Market St, South Melbourne Vic. 3205. (03)699-2388.

EMPIRE LW-2

Manufactured: by Empire Scientific Corp, Garden City, New York US
Distributor: Concept Audio, 22 Wattle Rd, Brookvale NSW 2100. (02)938-3700.

NAKAMICHI SP-7

Manufactured: by Nakamichi Corporation, Tokyo, Japan
Distributor: Convoy International, 400 Botany Rd, Alexandria NSW 2015. (02)698-7300.

PIONEER SE-L90

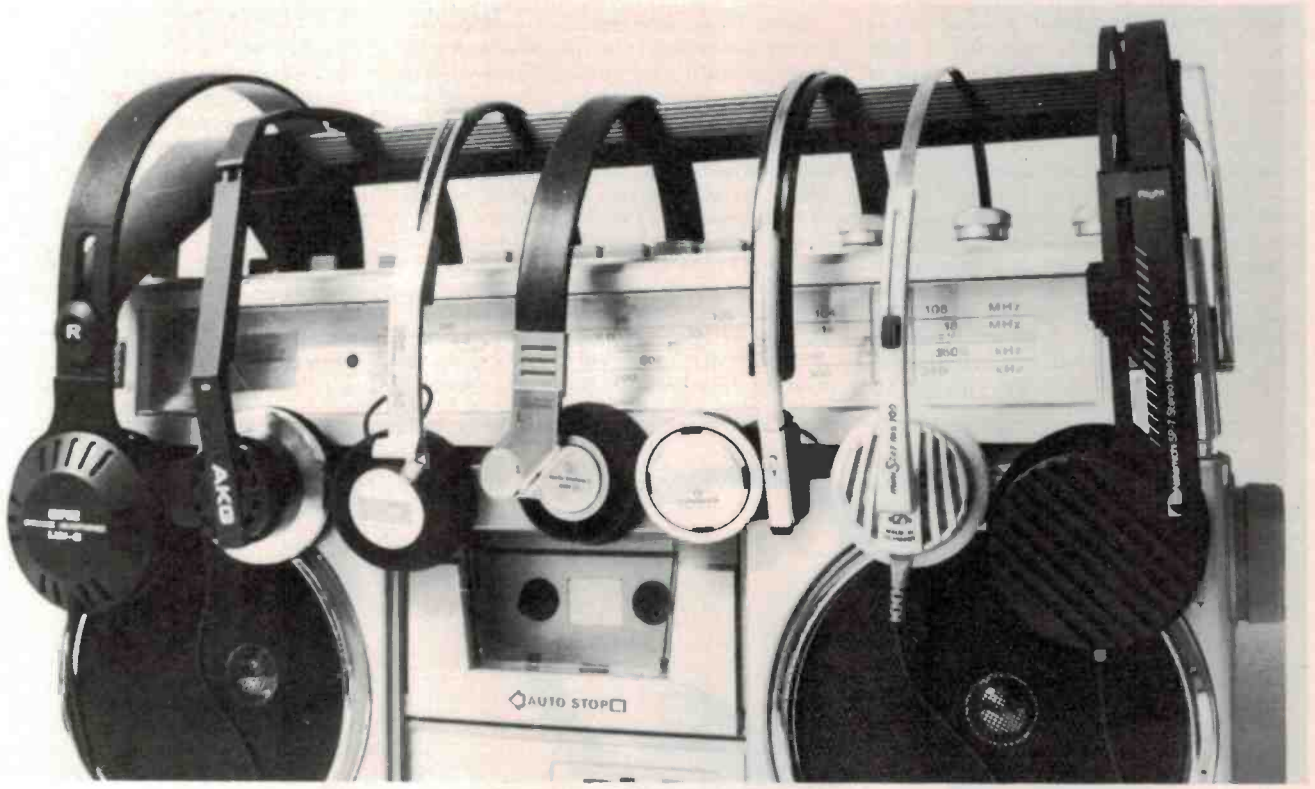
Manufactured: by Pioneer Electronic Corporation, Tokyo, Japan
Distributor: Pioneer, 178 Boundary Rd, Braeside Vic. 3195. (03)580-9911.

SENNHEISER MS100

Manufactured: by Sennheiser Electronic KG, Wedemark, Germany
Distributor: R.H. Cunningham, 4-8 Waters Rd, Neutral Bay NSW 2089. (02)909-2388.

SONY MDR-80T

Manufactured: in Japan by hi-fi audio division of Sony Corporation
Distributor: Sony, 453 Kent St, Sydney NSW 2000. (02)20221.



On test

I guess it was with these thoughts in mind that the editor decided it was time to undertake a comparison review of a representative sample of the newest and best lightweight, inexpensive headphones available on the local market. The sample group selected is not as comprehensive as some readers may like, but it is large enough to give you the opportunity to pick from units with prices ranging from $112 down to $40. Significantly we have evaluated the main technical features in terms of the most important and subjective parameters.

A typical set of new lightweight headphones incorporates a headband which is generally adjustable, a yoke assembly to provide for the swivelling action of the transducer, a pad or foam cover to achieve the comfort and correct spacing of the earpiece from the pinea (external ear) and a parallel cord connection which has a plug to connect the two separate circuits to your cassette player or receiver. Anyway that's the description that I used to think was appropriate for a set of headphones. However, the units that I received exhibited significant differences in each and every area, from headband right down to the plug.

The testing procedure that I have used to evaluate these headphones makes use of a number of specialised pieces of equipment, some of which are rare and not readily available. The testing determined the frequency response for each earpiece, the impedance, the distortion, the sensitivity and the attenuation (or reduction of external sound). We also weighed the headphones and measured the cord lengths and the clamping force in Newtons produced by the headphones when tested on a standard headphone force gauge.

The heart of the testing system is a Bruel & Kjaer Type 4153 artificial ear which incorporates a special Bruel & Kjaer Type 4134S quartz coated capacitor microphone. The Bruel & Kjaer artificial ear introduces some non-linearities of its own but these are less significant than those produced by the headphones. The most unusual piece of equipment is a headphone force gauge which we designed for associated measurement work on hearing protectors and ear muffs.

With seven headphones to test we decided to utilise a slightly different approach to our normal procedure in which we describe each piece of equipment in great detail. It was obvious that a cumulative tabulation was essential, apart from the individual result sheets which we also produced.

Objective test results

All of the headphones exhibit frequency responses ranging between good to extremely good. These typically extend from 50 Hz to beyond 10 kHz with some of them showing a remarkable linearity that only a few years ago would have been expected from headphones costing many times the price of these units.

It is clear from the frequency responses, and from my visit to Audio Technica in Japan three years ago, that most of the manufacturers have probably done exactly what we have done and used the Bruel & Kjaer Type 4153 artificial ear as their reference standard.

In terms of linearity of frequency response, the Nakamichi SP-7, Sennheiser MS100 and Sony MDR-80T are all close to being at the top of the list whilst the AKG K4, Audio Technica ATH-0.5 and Pioneer SE-L90 come close to matching that performance. The Empire LW-2, while still offering a fairly good performance, would fall into the third classification.

The power required for 90 dB at 1 kHz varies between 700 μW at one end of the range for the Sennheiser MS100 to a miniscule 76 μW for the Sony MDR-80T at the other end of the spectrum. Most of the units exhibit fairly smooth impedances with values ranging from 45 ohms to as high as 667 ohms for the Sennheiser at a frequency of 100 Hz.

The distortion figures were measured at both 90 dB and 120 dB. This is a fairly demanding test as 120 dB of sound pressure is above my pain threshold and is a sound level comparable with the loudest rock concert you are ever likely to go to. Surprisingly the Nakamichi SP-7 exhibited distortion figures that were less than 2% at 100 Hz whilst the AKG K4 produced a distortion level of 17.2% at the same frequency. Most of the other headphones produced distortion figures that were intermediate between these two figures. I was very impressed with all of the headphones' ability to perform well when producing sound pressure levels as high as 120 dB and in this respect the designs have improved dramatically in the last couple of years.

None of the headphones produced signifi- ▶

cant or even measurable external airborne sound attenuations until a point where the external frequency exceeded 3 kHz. Consequently it is possible to wear any of them while performing other tasks. This is particularly important for draftsmen, crane drivers and for those of you involved in a wide range of sporting and leisure activities.

An important parameter that most manufacturers are only now starting to consider is the clamping pressure that the headphones produce. These range from 2.13 Newtons to 4.8 Newtons with most of the headphones producing a figure close to a mean of 2.4 Newtons. Pressure, however, is not the only factor involved with comfort. The size and shape of the supra-aural pad and its swivelling abilities are equally important.

When I was carrying out a walking test I soon discovered that the headband construction is also a significant factor when one is actively moving around. The headband interacts with the shape of your head, the amount of hair on your head, the size of your ears and obviously the type of activity in which you are involved. I have produced my own personal rating for comfort with values as stars in the tabulation. However, your head and my head are not the same and consequently your comfort assessment will almost certainly be different to mine. My advice is to try on the headphones and mime the most violent action you are likely to be involved in, before finalising your selection.

Subjective test

The listening test was an interesting and yet difficult task. I was surprised at the overall comparability of these headphones when listening to a normal program content, particularly at sound pressure levels not exceeding 100 dB. Under these conditions there were fine differences separating the individual headphones in A-B testing.

At a normal volume all of the units exhibited moderately low distortion levels, although by and large, the Nakamichi, Audio Technica, Sony and Sennheiser tended to shine in this respect. At a higher volume the Nakamichi SP-7 proved to be an exceptional pair of headphones and generally provided a

MEASURED PERFORMANCE OF AKG K4

WEIGHT

(Phones & 100mm cord) 83 G

CLAMPING FORCE 4.8 Newtons

FREQUENCY RESPONSE:

(Typical) see graph

SENSITIVITY

(for 90dB SPL @ 1kHz) 400 mV (300 μW)

INPUT IMPEDANCE:

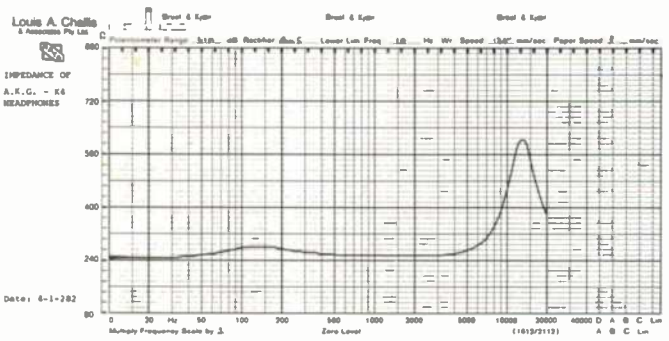
100 Hz	280 ohms
1kHz	256 ohms
6.3kHz	290 ohms

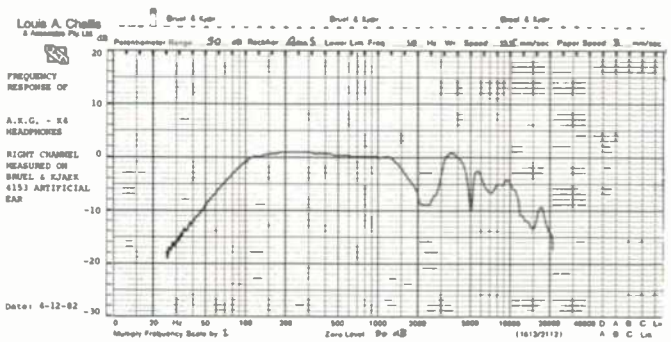
TOTAL HARMONIC DISTORTION:

	90dB	120dB
100 Hz	2.7%	17.2%
1kHz	0.06%	0.72%
6.3kHz	0.039	8.3%

REDUCTION OF EXTERNAL NOISE:

100 Hz	0 dB
1kHz	0 dB
6.3kHz	14dB





Manufacturer	Model	Price	Type	Cord length m	Plug mm	Max. input specification mW	Nom. impedance specification ohms	Sensitivity specification dB/mW
AKG	K4	$112	Es/Dyn	3	6.3	200	400	92
Audio Technica	ATH-0.5	$39.95	Es	1.33 +2m extension	3.5	250	—	100
Empire	LW-2	$59	Dyn	2.5	6.3	200	200	98
Nakamichi	SP-7	$80	Dyn	3	6.3	100	45	98
Pioneer	SE-L90	$69	Dyn	3	3.5	100	40	103
Sennheiser	MS100	$70	Dyn	3	6.3	250	600	96
Sony	MDR-80T	$89	Dyn	3	3.5	100	45	106

level of distortion which none of the other units could really match. Considering that its price falls almost halfway between the most expensive and least expensive units this is a real attribute.

On classical music, jazz, percussion and rock all of these headphones perform remarkably well. Surprisingly enough the AKG K4 provided an exceptional performance in this regard and even the Empire LW-2, whose frequency performance is not quite as good as the rest of the field, provided an above average subjective response.

The individual headphones, however, have many other features which are worthy of consideration. For example, if economy of battery operation is important then the Sony MDR-80T is truly an exceptional set of headphones, using a miniscule 76 μW for 90 dB, thereby stretching the battery mileage further than any of the other headphones. The Pioneer headphones provide a natty and very convenient facility for rotating the earpiece, so that the headphones can be conveniently packed into your briefcase, handbag or jacket pocket for travelling or when not required.

The designers in most (but not all) cases have provided adaptors for jacking into standard 6.3 mm tip-ring-and-sleeve stereo sockets or the newer 3.5 mm equivalent. In one case, Audio Technica ATH-0.5, this is achieved by an extension cable which simultaneously increases the overall cable length of the system.

In summation this would probably be one of the most difficult reviews that I have undertaken in the last fourteen years. Every set of headphones performs well with only a few of them providing exceptional performance in one or more areas. No single headphone stood out head and shoulders above the rest, although at least four of them have received four star ratings because of their outstanding performance in at least one area.

I could safely recommend any of these headphones to you in the knowledge that if you find them comfortable, I am sure you will also be pleased with the acoustical performance. ▶

MEASURED PERFORMANCE OF AUDIO TECHNICA ATH-0.5

WEIGHT

(Phones & 100mm cord) 55 G

CLAMPING FORCE 2.13 Newtons

FREQUENCY RESPONSE:

(Typical) see graph

SENSITIVITY

(for 90dB SPL @ 1kHz) 88 mV (186 μW)

INPUT IMPEDANCE :

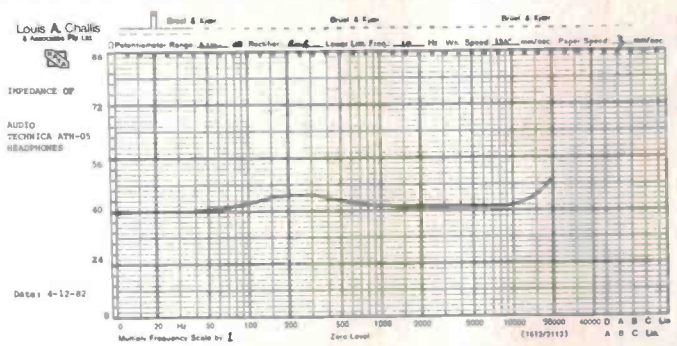
100 Hz	62.4 ohms
1kHz	61.6 ohms
6.3kHz	61.3 ohms

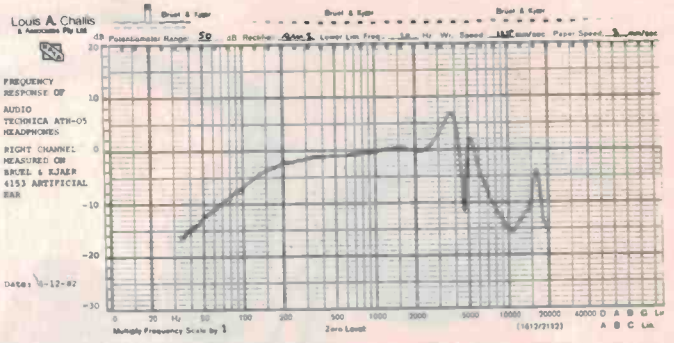
TOTAL HARMONIC DISTORTION :

	90dB	120dB
100 Hz	1.1%	12.0%
1kHz	0.03%	0.56%
6.3kHz	0.09	0.43%

REDUCTION OF EXTERNAL NOISE :

100 Hz	0 dB
1kHz	0 dB
6.3kHz	13dB





Ear cup material	Spare pads	Adjustable headband	Plug adaptor	Measured cup pressure (clamping force) Newtons	Measured weight grams	THD measured at 90 dB and 100 Hz	Comfort	Rating
Cloth on foam	No	Yes	Yes	4.8	85	2.7%	XXX	XXX
Foam	Yes	No swivel earpiece	Yes with cord	2.13	55	1.1%	XXX	XXX
Cloth on foam	No	Yes	No	3.21	152	0.9%	XXXX	XXX
Foam	No	Yes	No	3.1	154	0.17%	XXX	XXXX
Cloth on foam	No	Yes and rotation of earpiece	Yes	2.28	70	0.94%	XXX	XXX
Foam	Yes	Yes	No	2.3	48	1.2%	XXX	XXXX
Foam	Yes	Yes	Yes	2.39	68	0.6%	XXX	XXXX

MEASURED PERFORMANCE OF EMPIRE LW-2

WEIGHT
(Phones & 100mm cord) 152 G

CLAMPING FORCE 3.21 Newtons

FREQUENCY RESPONSE:
(Typical) see graph

SENSITIVITY
(for 90dB SPL @ 1kHz) 180 mV (138 μW)

INPUT IMPEDANCE:

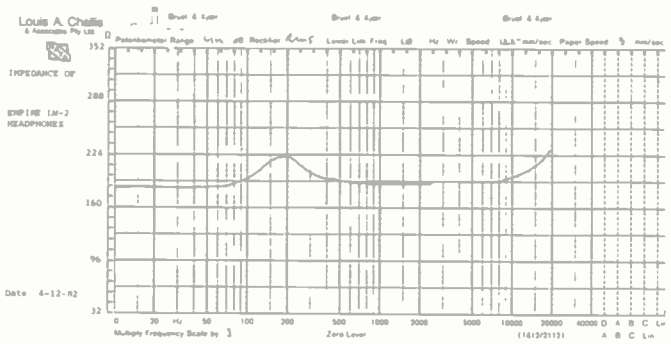
100 Hz	195 ohms
1kHz	188 ohms
6.3kHz	192 ohms

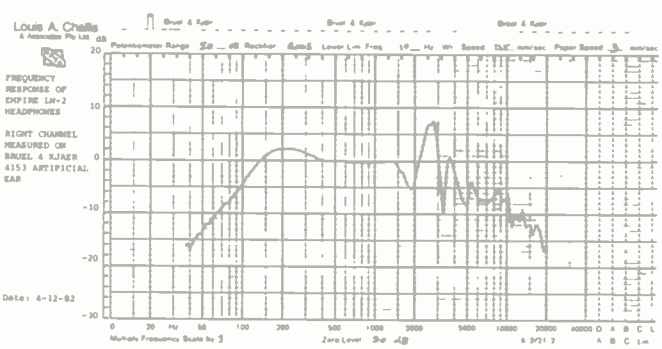
TOTAL HARMONIC DISTORTION:

	90dB	120dB
100 Hz	0.9%	12.3%
1kHz	0.06%	0.076%
6.3kHz	0.061	0.22%

REDUCTION OF EXTERNAL NOISE:

100 Hz	0 dB
1kHz	0 dB
6.3kHz	25dB





MEASURED PERFORMANCE OF NAKAMICHI SP-7

WEIGHT
(Phones & 100mm cord) 154 G

CLAMPING FORCE 3.1 Newtons

FREQUENCY RESPONSE:
(Typical) see graph

SENSITIVITY
(for 90dB SPL @ 1kHz) 114 mV (287 μW)

INPUT IMPEDANCE:

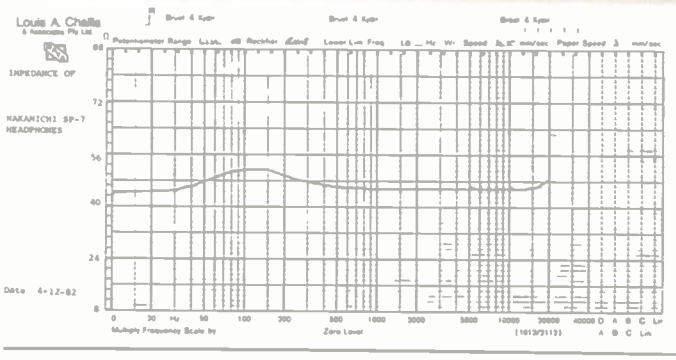
100 Hz	51.2 ohms
1kHz	45.3 ohms
6.3kHz	45.3 ohms

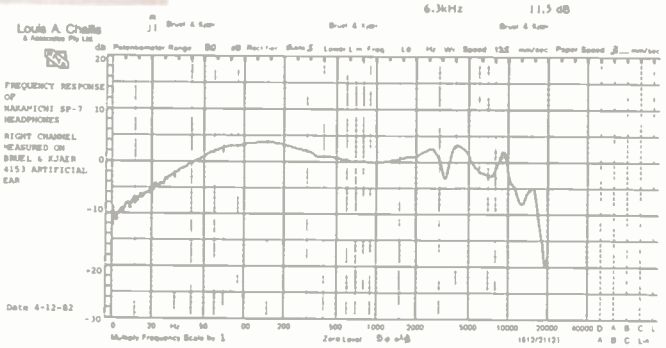
TOTAL HARMONIC DISTORTION:

	90dB	120dB
100 Hz	0.17%	1.8%
1kHz	0.06%	0.7%
6.3kHz	0.07	0.23%

REDUCTION OF EXTERNAL NOISE:

100 Hz	0 dB
1kHz	0 dB
6.3kHz	11.5 dB



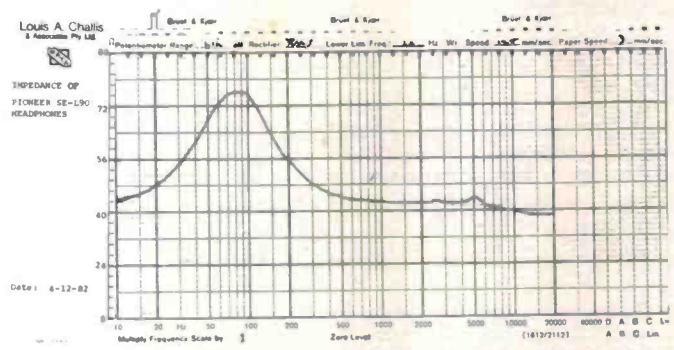


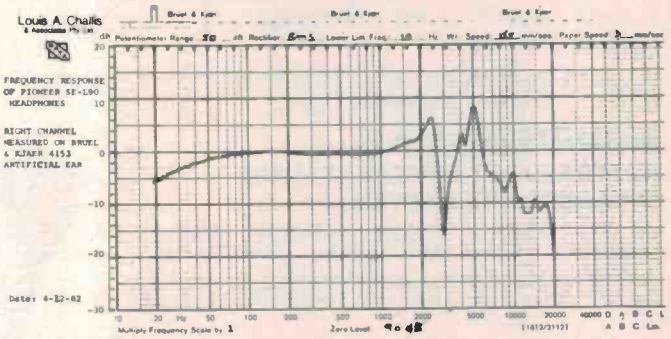
MEASURED PERFORMANCE OF PIONEER SE-L90

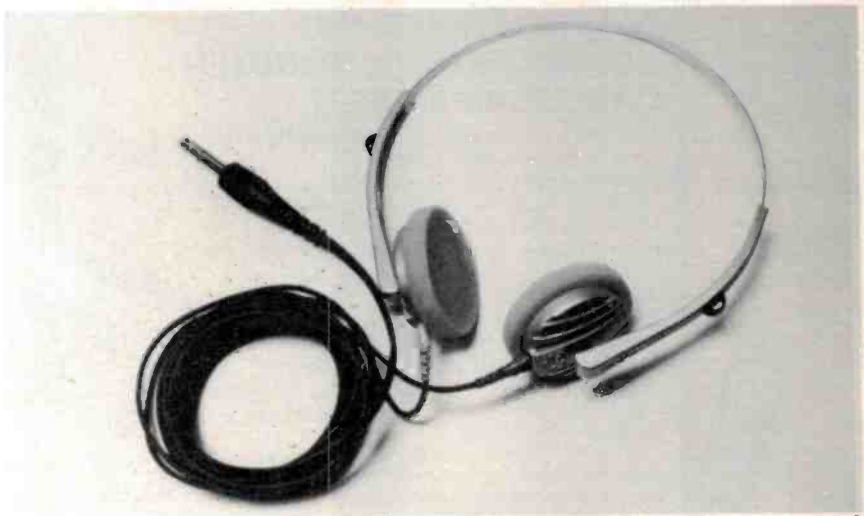
WEIGHT (Phones & 100mm cord)	70 G	
CLAMPING FORCE	2.28 Newtons	
FREQUENCY RESPONSE:		
(Typical)	see graph	
SENSITIVITY		
(for 90dB SPL @ 1kHz)	66 mV (102 µW)	
INPUT IMPEDANCE :	100 Hz	73 ohms
	1kHz	42.7 ohms
	6.3kHz	41.6 ohms

TOTAL HARMONIC DISTORTION :	90dB	120dB
100 Hz	0.96%	12.2%
1kHz	0.065%	0.38%
6.3kHz	0.17	2.1%

REDUCTION OF EXTERNAL NOISE :	
100 Hz	0 dB
1kHz	0 dB
6.3kHz	14.5 dB





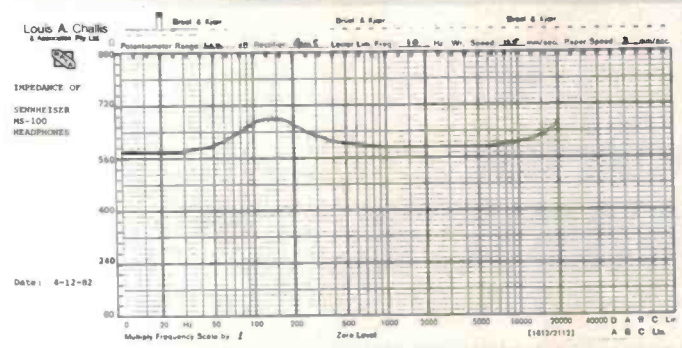


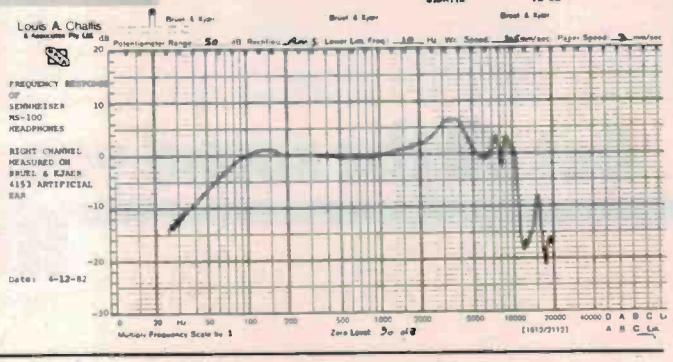
MEASURED PERFORMANCE OF SENNHEISER MS100

SERIAL NO.	3394107	
WEIGHT (Phones & 100mm cord)	48 G	
CLAMPING FORCE	2.3 Newtons	
FREQUENCY RESPONSE:		
(Typical)	see graph	
SENSITIVITY		
(for 90dB SPL @ 1kHz)	630 mV (700 µW)	
INPUT IMPEDANCE :	100 Hz	667 ohms
	1kHz	592 ohms
	6.3kHz	594 ohms

TOTAL HARMONIC DISTORTION :	90dB	120dB
100 Hz	1.2%	15.6%
1kHz	0.045%	0.16%
6.3kHz	0.06%	0.17%

REDUCTION OF EXTERNAL NOISE :	
100 Hz	0 dB
1kHz	0 dB
6.3kHz	12 dB





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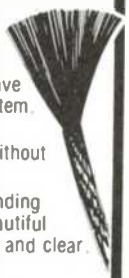

The rapid improvements in power amplifiers and loudspeakers have focused attention on a major weakness — the speaker cable system.

By eliminating the problems associated with conventional wire, Monster Cable directly couples your amplifier to your speakers without loss, without distortion.

How? More copper, finer strands, higher purity and a unique winding configuration that lets your amplifier and your speakers make beautiful music together. For sounds that are dynamic and powerful, open and clear. The way real music should be.

And more! Monster Cable provides big performance for little dollars. You can significantly improve the performance of your sound system simply by switching from your conventional speaker wire to Monster Cable — it costs you less than buying better speakers, a better amplifier, or even a better cartridge.

However . . . beware the imitators. They offer price but not quality. Only the finest materials are used in producing Monster Cable. And it is safe to use with all amplifiers, regardless of design.

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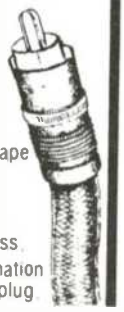
PERFORMANCE STANDARD SERIES

INTERLINK/PHONOLINK



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Interlink features a special ULTRA LITZ conductor — over 100 separately insulated strands of high purity copper. This inner core allows the most accurate signal transfer without high frequency loss.

Monster Cable has also developed and produced the perfect termination for Interlink cable — Phonolink, a precision gold-plated RCA-type plug.

Phonolink features a split centre shaft for increased contact pressure and materials that reduce interference with the audio signal to an absolute minimum.

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Interlink/Phonolink is available in pre-packaged 1 metre pairs or can be cut and terminated to the exact length you require by your Performance Standard Series dealer.

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Powerline is a four conductor, controlled impedance speaker cable that has been designed as the ultimate link in the amplifier-speaker interface.

Based on the high purity, fine copper stranding construction of Monster Cable, Powerline utilizes two conductors for each polarity. This results in extremely low resistance and a greater surface area of conductivity for maximum power transfer at all frequencies.

Sonically, Powerline brings you one step closer to the musical event. Startling clarity in the highs, tight well-articulated bass, dynamic impact and the precise localisation of instruments within the sound stage enhance your aural experience.

Powerline is available in custom cut and terminated lengths from your local stockist. He'll also be able to demonstrate the advantages provided by this new technology, which make Powerline a lifetime investment in your listening pleasure.

AND WHATEVER THE CONNECTION . . . MONSTER CABLE CAN MAKE IT

Gold Pin. The smallest and perhaps the most universal of our amplifier- to-speaker connectors.

Gold Spades. Beautiful construction with hard gold surfaces to make the ideal connection with many of today's amplifiers and speakers.

Gold Banana. An elegantly simple connector, using a crimp-on design with multiple fingers, that can significantly reduce contact distortion.

X-Terminator. An expanding solid shaft tip provides both greater contact area and high contact pressure — the ultimate banana-type connector

Cramolin. Oxidation and contamination, which attack every connection point in an audio system, can now be corrected and prevented.

Cramolin Red solution removes distortion-producing oxides and corrosions, while Cramolin Blue solution preserves and protects cleaned contacts from any further deterioration.

The Monster Cable interconnect systems and accessories are available at all leading hi-fi stores. Happy listening from all of us at Monster Cable.

Get all the sound you paid for...

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Distributed by Convoy Sydney (02) 698 7300

RG/C1594

SOUND REVIEW

MEASURED PERFORMANCE OF SONY MDR-80T

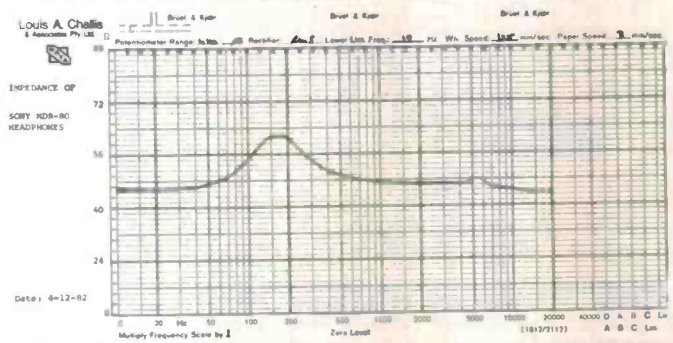
WEIGHT		
(Phones & 100mm cord)	63 G	
CLAMPING FORCE	2.39 Newtons	
FREQUENCY RESPONSE:		
(Typical)		see graph
SENSITIVITY		
(for 90dB SPL @ 1kHz)	60 mV (76 μW)	
INPUT IMPEDANCE :	100 Hz	54 ohms
	1kHz	67.2 ohms
	6.3kHz	96.4 ohms

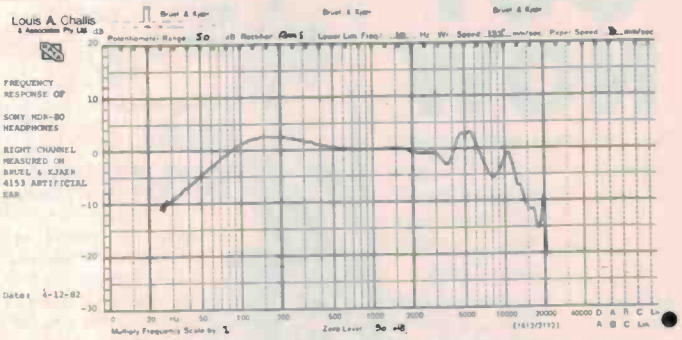
TOTAL HARMONIC DISTORTION :

	90dB	120dB
100 Hz	0.6%	6.2%
1kHz	0.07%	0.7%
6.3kHz	0.07	0.21%

REDUCTION OF EXTERNAL NOISE :

100 Hz	0 dB
1kHz	0 dB
6.3kHz	14.5 dB





YOUR COPY'S MISSING?

DICK SMITH CATALOGUE

83/84 OUT NOW

The new Dick Smith 1983 Catalogue is out. Did you find your copy in the issue? No? Alas, alack. How can you possibly last out 1983 without you Dick Smith catalogue – the data section alone is worth its weight in microprocessors. Duck into Dick's nearest store now for your copy. At 95¢ it's the years biggest bargain!

Some of the advertised lines have only limited stocks. HURRY while stocks last!

DICK SMITH

SAVE OVER $140

LIMITED STOCK!

SUPERB LITTLE

MATRIX PRINTER

We've broken the $400 barrier for a computer printer! A sprocket feed dot-matrix printer uses ordinary fan-fold paper (up to 204mm wide). Great for high resolution graphics.
At this incredible price can you afford to miss out? Cat. X-3252

WAS ~~$495~~ ONLY $349

SAVE OVER $18

AMAZING HANDHELD

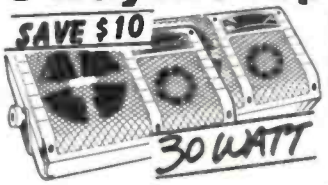
Printer Calculator

A Printer/Calculator that you can hold in the palm of your hand! This attractive calculator has a ten digit liquid crystal display as well as percentage, square root, tab (floating decimal point) key, print function etc. Outstanding value! Cat. Q-3020

WAS ~~$67~~ ONLY $49.95

3 Way Hi Fi Speakers for Cars

SAVE $10



Get the same performance in your car as you'd expect at home! 3 way, wedge type (ideal for rear parcel shelf). Complete with brackets for vetical or roof mounting if you wish. Cat. A-7082

WAS ~~$89.50~~ ONLY $79.50 pr.

DUAL CONE SPEAKERS

SAVE OVER $13

A pair of high quality dual cone speakers with extended frequency response. The most popular speaker on the market & these Dick Smith units are equal to the big names! They have 280 gram magnet and are rated at 4 ohms. Complete with superb metal mesh grille and all the hardware required to mount them, including mounting template. Cat. A-7080

ONLY $19.95 pr. WAS ~~$32.50~~

Give your Computer a voice!

SAVE $100

VOTRAX Synthesizer

ONLY

WAS ~~$549~~ $449

Yes! Your computer can actually talk. Not only talk, but in clear Intelligible English. It connects to any computer's RS-232 port. The unique Votrax Type'n Talk opens up a whole new world of computing – it comes complete with a detailed User manual & power supply. All you add is a speaker. Cat. X-3290

FRED SOUND SYNTHESIZER

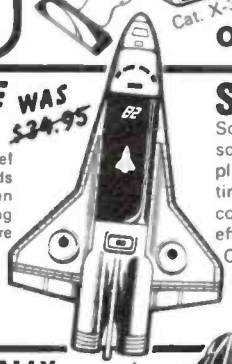
SAVE OVER $30

Give your System 80 the ability to produce music with this sound synthesizer. It plugs directly into the expansion connector with the audio output connecting directly into the AUX, TAPE or TUNER facilities of most Hi Fi amplifiers.

Cat. X-3280 ONLY $129 WAS ~~$172~~

SPACE SHUTTLE GAME

WAS ~~$34.95~~



It even looks like the space shuttle! This is one that will keep the kids (and you) amused for hours. When they're not busy playing the exciting shuttle game they can pretend they're the Shuttle pilot! Cat. Y-1145

ONLY $29.95

SONIC INVADERS

Sonic Invaders is here! Looks like something out of Star Wars and it even plays the famous Star Wars tune every time you turn it on! Features multi-coloured display with realistic sound effects – look out Darth Vader!
Cat. Y-1153

WAS ~~$49~~ ONLY $39

SAVE $10

NORMALLY $20 to $25 EA!

ONLY $15.95

RECORD YOUR FAVOURITE MOVIES

VIDEO TAPE VHS 180

The greatest value you'll find! Top quality, famous RCA brand video cassettes at a give-away price. 3 hours length. Hurry – stocks strictly limited. Limit 10 tapes per customer. Cat. C-3410

SAVE $43

MIDLAND 100M 8 CHANNEL

Marine Transceiver

A superb, compact transceiver that will complement any boat! 8 channels with digital readout, receive & transmit meter & MORE! *Why risk your life on the high seas?*
Cat. D-1407

BOAT RADIO SPECIAL PRICE

WAS ~~$142~~

NOW ONLY $99

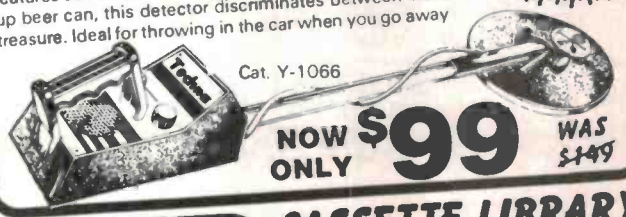
WAREHOUSE CLEARANCE

Gold Detector

SAVE $50

Actually sorts Trash from Treasure!

This superb Metal Detector is so easy to use and yet it features advanced microprocessor technology. No digging up beer can, this detector discriminates between Trash & treasure. Ideal for throwing in the car when you go away

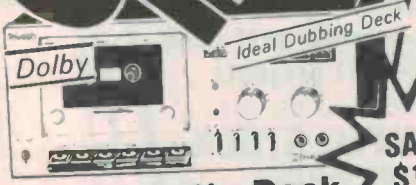


Cat. Y-1066

NOW ONLY $99 WAS $149

Triumph Metal Cassette Deck

WAS $115 ONLY $99

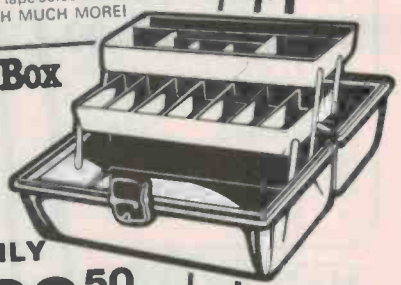


SAVE $16

This baby Metal Cassette Deck has all the features of the 'Big ones', but at such a low price! It looks good and sounds great. Has all the features of those bigger more expensive units: Dolby Noise Rdeuction, Metal Chrome and normal tape selection, Auto stop, LED VU meters, soft eject and MUCH MUCH MORE!

Cat. A-3503

Delux Tool/Work Box



Don't leave those tools scattered everywhere! Throw them all into this rugged tool box. Ideal also for

- fishing
- tradesmen
- technicians
- artists etc etc.

Lid has a carry handle fitted, and the box can be padlocked for security. Overall size (closed) 430 x 230 x 200mm. WAS $32.50 ONLY $29.50

Cat. H-2600

HITACHI TAPE TUMBLES!

Famous name Hitachi C90 low noise at a low low price!

LIMITED STOCK! ONLY $2.50

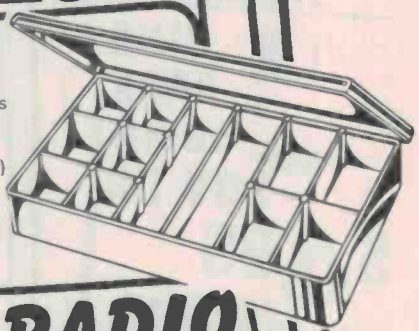
Cat. C-3065

CASSETTE LIBRARY

Cassette storage problems? Her's a way to neatly stack you cassettes. Each unit can interlock with another. Also comes with self tapping screws. There's 6 holders in each box & each one holds 5 cassettes – that's 30 cassettes! Cat. C-3800

WAS $6.50 ONLY $4.95

UTILITY BOX



Small heavy duty box with compartments for small items such as screws, resistors, capacitors etc.

Dimensions: 218(L) x 110(w) x 33(h)mm. Cat H-2590

WAS $3.95 ONLY $2.95

TECHNOLOGICAL BREAKTHROUGH AMAZING DIGILOG

Yes! Two watches in one: a superbly styled case contains a very accurate digital watch PLUS an analog type – with no moving parts! The 'face' & 'hands' are actually made up of LCD displays! Includes countdown timer, alarm & stopwatch. Cat. Y-1045

WAS $49.50 ONLY $32.50

WAS $14.95 3 WAY LANTERN

The ideal lamp for campers, on the boat, even when the car breaks down! Features: Fluorescent lamp, plus flasher and flash light.

SAVE OVER $5.00 ONLY $9.50

Cat. Y-1084

DIGITAL DIALLING & MUSIC PHONE

It's a bargain!

Looks great and has heaps of features:

- Ringer ON/OFF switch
- Stylish push button keyboard
- 20 digit redial capacity per number
- unlimited digital dialling capacity
- access pause for PABX systems

ONLY $39.95

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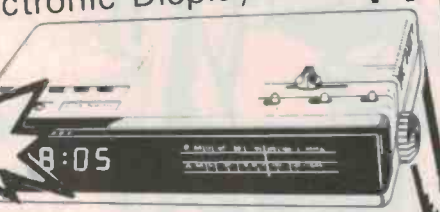
OVER 1500 SOLD

Cat. Y-1186

CLOCK RADIO

Electronic Display

SAVE OVER $20



Wake up to the sound of your favourite radio station – with the thought that you've saved $$$$ too! Features AM & superb FM radio plus an alarm buzz (if you need it) as well as a sleep timer! So don't miss this incredible bargain. Cat. A-4444

LIMITED STOCK! WAS $47.50 ONLY $25.50

Take anywhere Stereo

SOUND TRIPPER

Take your favourite radio programmes wherever you go with this amazing AM/FM radio with light weight headphones. Just think whatever you're doing, at work or play, you need never be without great stereo sound again! Powered by 4 pen light batteries (supplied).

cat. A-4330

WAS $49.50 ONLY $39

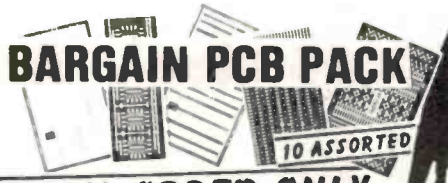
SAVE OVER $10

See page 98 for full address details

DSE/A466/JW INC IN NSW

DICK SMITH Electronics

BARGAIN PCB PACK



MAIL ORDER ONLY

~~$25~~ WORTH OF PCB'S for **$3.00** From past EA & ETI projects

Instructions included

LIMITED STOCK

BE QUICK!

Cat. H-8210

LESS THAN COST

STORE SPECIAL

PCB's For $1.00

WITH INSTRUCTIONS

FROM THESE PROJECTS — **LIMITED STOCK**

Speed Sentry	LCD Timer
Light Chaser	Low Fuel Indicator
Dual Trace Switch	Hot Canary
Stereo Booster	Car Alarm Mk1
Metal Detector	

MAIL ORDER SPECIAL!

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Cat. M-9551

$4.95

BELOW COST

Great savings on the CRAIG LANGUAGE TRANSLATOR

WERE SELLING FOR $250!

We've made a huge scoop purchase of these units at way below the manufacturers cost! Translates any language into English or the reverse! Great for overseas travellers, students, politicans etc.

Cat. Y-1340

Great range of modules available

Japanese	(Y-1342)	$19.50
German	(Y-1343)	$19.50
Italian	(Y-1344)	$19.50
Spainish	(Y-1348)	$19.50
Phonetics	(Y-1347)	$9.50
Bar & Wine Guide	(Y-1345)	$10.00
Calorie Counter	(Y-1346)	$9.50

Buy a Craig & get the Bar & Wine Guide (Y-1345) & Calorie Counter (Y-1346) FREE! WORTH $19.50

NOW ONLY $89.50

WAS ~~$36.50~~ ETI METAL DETECTOR

Build one & you could find a fortune!

WOW! An induction balance metal detector at an amazing price!

From Electronics Today International, this detector is the equivalent of many induction balance detectors in the hundreds-of-dollars bracket! All components are supplied including the meter, the box, coil wire etc, but the coil former and dowel for the shaft are left up to you (you've probably got something in the garage you could use!) Are you ready to go out & find a fortune? You could with this beauty!

Cat. K-3100

SAVE $7.00

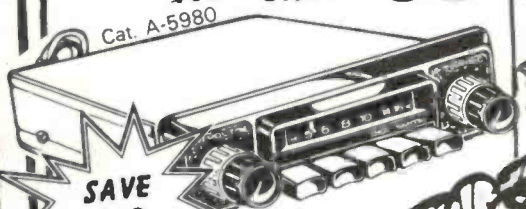
ONLY $29.50

Quality AM Car Radio

Live in a non-FM area? Why waste your money on an FM car radio? But don't be caught with an 'el cheapo' car radio either – you could be sorry. This one is great quality, easy to fit & suits all negative earth cars.

WAS ~~$52~~ NOW ONLY $39

Cat. A-5980



SAVE $13

WAS ~~$59.95~~ STEREO AM/FM CLOCK RADIO

SAVE $10

The very latest in clock radios – it's stereo! No longer will you have to put up with the 'tinny' sound that most mono AM/FM radios give you: now you can wake up to brilliant tone stereo music! It features a superb modern styling with a huge LED display. It also has another unique feature: a 'time set' lock underneath the radio, so the kids can't change your time setting.

Cat. A-4445

Battery back-up for power failure

ONLY $49.95

HOT CANARY

This great gimmick kit will keep any child, or adult amused for hours! An electrical bird noise maker that sounds just like a real bird singing!

Cat. K-3395

WAS ~~$15.50~~ ONLY $7.95

SAVE OVER $7.00

TV Antenna Clip

Strong plated springs with screw terminals and coloured plastic handles. A quicker way to connect or disconnect the antenna lead-in cable to the TV set, FM or radios, etc. Ideal when using portable sets.

Cat. L-4236

ONLY 60¢

High Impedance multimeter

10 MEG FET INPUT

For the professional who wants the lowest circuit loading . . . you want the highest input impedance. The FET input multimeter gives you a huge 10M input impedance on DC voltage, and a highly respectable 1M on AC voltage. Batteries, test leads and instructions supplied.

Cat. Q-1200

WAS ~~$72.00~~ ONLY $59

SAVE $13.00

POT PACKS

75 POTS for $9.95

Cat. R-7102

Selection includes mixed values: Dual Gang, Single Gang & Switch Pots

UNBELIEVABLE VALUE AT TODAYS PRICES!

Portable stereo Cassette

LIMITED STOCK

This fantastic go anywhere miniature cassette player is ideal for skiiers, walkers, office workers etc. Takes a full size cassette. Supplied with carry strap plus 1 set of light weight headphones with provision for one other.

INCLUDES HEADPHONES

WAS ~~$99~~ ONLY $49.50

SAVE $30

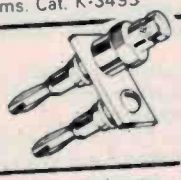
Stereo Booster Amp

WAS ~~29.50~~ ONLY $24.50

This easy to build kit can economically upgrade the power of your car's stereo system to 12.5W RMS per channel. Based on a rugged IC amp module and works with all negative earth systems. Cat. K-3493

Handy BNC Adaptor

Adapt your input terminals on the Dick Smith laboratory Oscilloscope from 'banana' socket to BNC type. Cat. Q-1281 ONLY $6.95



WORLD MAP/TIME WATCH WITH ALARM

Now you can tell the time anywhere in the world! Shows time in 20 different time zones and actually has an LCD diagram of the world! Even has a dual melody alarm! Cat. Y-1051

WAS ~~$64.95~~ ONLY $44.50

SAVE OVER $20

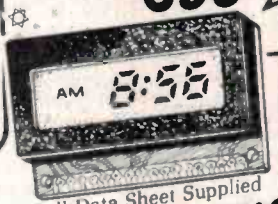
ITOH 8300P DOT MATRIX PRINTER

The Itoh 8300P features high speed, bi-directional printing (125 characters per second) with full upper & lower case character set. It accepts standard fan-fold sprocketed paper up to 240mm wide. This means you can do 80, 40 or 132 column printing. Fitted with standard centronics type parrallel port. A great seller with great features. Cat. X-3255

WAS ~~$920~~ NOW ONLY $699

SAVE OVER $200

LCD Build-in Module



The experimenter's special! Accurate quartz LCD Module ideal for building into projects. Not just a clock – also a time & controller.

Full Data Sheet Supplied Cat. Y-1050

WAS ~~$19.50~~ NOW ONLY $9.95 SAVE OVER $9.00

UNDER ½ PRICE

Digital LED Alarm Clock/Thermometer Module

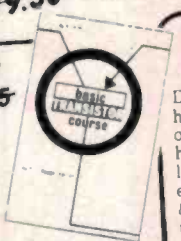
Famous NATIONAL SEMICONDUCTOR Brand

Module features huge bright red digital display, 6 display modes, time & temperature display (both °C & °F), alarm & control for clock, radio, etc. 12 or 24 hour operation. A full featured movement for use in thermometer, alarm clock, clock radio, instrument panel clock and appliance timer aplications. Complete National data sheet included. Cat. Y-1053

WAS ~~$34.95~~ NOW $12.95

AMAZING VALUE

Basic Transistor Course



Kenian 218 pages

Do you understand how the transistor works? If not, this book will explain it all – how it works and how it works with other components – resistors, capacitors, coils etc. Cat. B-1567

WAS ~~$9.95~~ ONLY $6.95

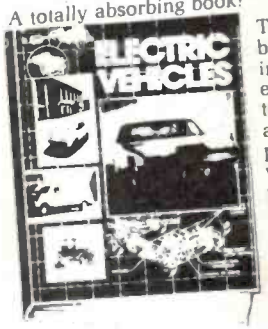
Display Electronics

Designed to introduce the hobbyist to the world of opto-electronics. Learn how injection laser diodes, liquid crystal displays, electro-luminescent displays & charge coupled devices used for image sensing in solid state TV cameras work. Special projects include a modern version of the one-armed bandit, electronic dice, games to test reaction time, and a micro-computer with binary & octal readouts. Cat B-1811

WAS ~~$7.50~~ NOW ONLY $4.95

The Complete Book of Electric Vehicles

A totally absorbing book!



The most complete & fact filled book available today, describing in detail commercially built electric cars, trucks, cycles, trains and buses. The information supplied is supported with photographs & a history of each vehicle. Speed data, home built vehicles, state-of-the-art & what the future holds are all covered. Cat. B-2400

ONLY $9.95

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DSE/A466/JW

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WAREHOUSE CLEARANCE

LIMITED STORE STOCK
PLEASE PHONE BEFORE MAKING A SPECIAL TRIP

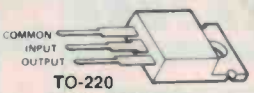
index 1982

NOTES AND ERRATA 1982

January '82, Short Circuits, Autostart & etc for ETI-730 RTTY Decoder: the author, Ralph Youie, writes "I draw your attention to an error indicated to me by Ken, VK3ALC, on page 64 of January 1982 ETI. All references to Q1 in the article should refer to Q2, BF338, as there is no way that the circuit will work as shown. If there are difficulties in obtaining the correct waveform at the output of IC7, it may be necessary to change the 56k resistors to 68k, and the 8k2 resistor to 10k. Also note that pin 1 and pin 16 of the CMOS hex inverter should go to +12 V and pin 8 to 0 V."

February '82, Ideas for Experimenters: On the bottom of page 57 the 'Double Density Computer Cassette Storage' idea will only work with decks that have a split erase head. Otherwise, when recording on one track, any recording on the other track will be erased.

April '82, Circuit File: Power supplies and voltage regulators, page 20. The pinout of the TO-220 79xx voltage regulator shows the common and output reversed. The correct pinout is shown here.



TO-220
79xx –ve voltage reg.

May '82, Video Drawing p.117: This program has the last four lines missing! Following 06A4 (00 EE), enter:

81 04
82 74
16 32
00 00

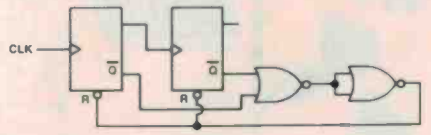
In addition, addresses 0664 to 0672 contain a data file and do not call subroutines, as the disassembled listing indicates.

August '82, Beating the RS232 Blues: Figure 3 on page 85 shows the STOP and PARITY bits transposed. The parity bit comes before the stop bit. The associated text is correct.

September '82, Inertial Navigation Systems: Pages 16-17 have been transposed with pages 18-19. From page 14, the article reads on to page 18, from page 19 it reads on to page 16, from page 17 it reads on to page 20.

October '82, Ideas for Experimenters, Three-Channel Light Chaser: Colin Burns of Mawson ACT wrote in to advise us of an error in this circuit. Both flip-flops should be cleared (reset) when their Q outputs (B and C) are high simultaneously. This is to produce a high output (A) from the NOR gate IC3a. The modification required to achieve this is shown below.

Only when both Q outputs are low will the flip-flops be cleared. This arrangement also uses one less NOR gate.



October '82, Traditional Space Invaders, p.95: There is an error in this program at address 06C0. Instead of 4501, this should read 4F01. Thanks to Peter Easdown for the correction.

November '82 Audio Amplifiers Using Nested Differentiating Feedback Loops, Part 2: Equation (10) on the bottom of page 123 is missing the 'tau'. It should read $\tau_F = \mu_1\beta\tau_x$. In Figure 11, the pictures for (a) and (c) have been swapped inadvertently.

Project 162, Bench Supply, December '82: Capacitor C4 was omitted from the Parts List, but appears on the circuit (150n greencap). Resistors R8 and R9 were transposed on the overlay, but as they're in parallel, it doesn't matter a whit.

Project 459, Series 5000 Graphic Equaliser, November '82: In the circuit diagram on page 32, power supply section, diodes D2 and D3 are shown back to front. The pc board overlay is correct. In the parts list, R5 and R6 are shown as 15k, but 10k on the circuit, 10k is the correct value, though not critical.

Project 469, Percussion synthesiser, April '82: Diodes D1 to D6 were omitted from the Parts List on page 43. They are all 1N914s or 1N4148s.

Project 499, Mosfet amp, March '82: Some people have had trouble with the output offset voltage adjustment, being unable to reduce it to 10 mV or less. This can be fixed by changing R2 from 100k to 33k. The input high-pass pole only rises to just under 20 Hz, which is OK.

Project 644, Direct-connect modem, October '82: Note that R93 should be rated at 1 W or 1.6 W (e.g: Philips PR37 resistor). Capacitor C5 (in reference channel flip-flop, IC5) can be reduced to 680p to provide a better variation range for RV1 ('adjust output symmetry pot'). Also note that C18 connects to pin 3 of IC12a on the pc board, not pin 2 as shown in the circuit. R48 goes to 0 V, not −6 V.

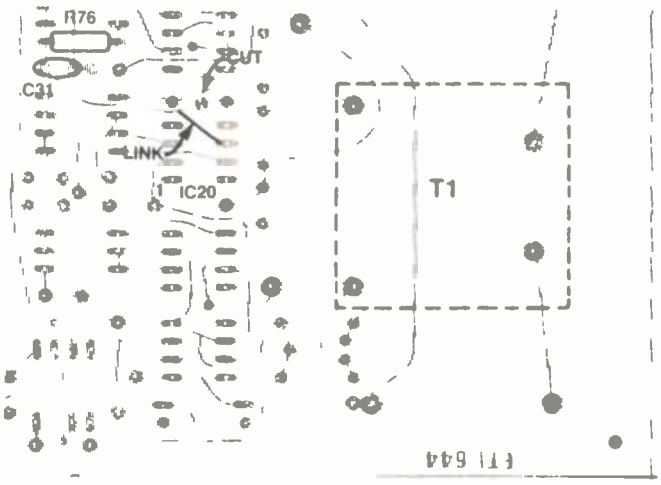
In the Parts List, transistors Q4, 6, 8 & 10 were cut off — they are all BC549s. C4 is shown as 1n, but 1n2 on the circuit — it can be either. C19 should be a 2n2 and C21 a 330p. R48 should be 6k8, not 68k. Resistors R53 to R64 are given as 10k in the Parts List and 47k on the circuit. Either is correct. Note that the programming diodes were not mentioned in the Parts List. A total of 85 are required.

Experience has shown there can be wide variation in the characteristics of the 4528B, IC4. At the extreme, it is found that RV1 (ADJUST OUTPUT SYMMETRY pot) does not have enough range. There are two cures for this: Capacitor C5 can be reduced to 680p or you can swap R2 and R16.

If 75 baud operation proves 'touchy' increase the value of C18 to 220n or greater.

There are two discrepancies between the circuit diagram and the pc board. Trevor Marshall advised a number of modifications at a late date which were made on the pc board but the circuit has not been corrected in two places. Firstly, C18 goes to pin 3 of IC12a, not pin 2 as shown on the circuit diagram. Secondly, the junction of C31 and R76 goes to the junction of D14 and D4, not to pin 6 of IC20.

Experience indicates an improvement in performance under weak signal conditions can be obtained by making the pc board conform to the circuit here (output of IC20). This requires simply cutting one track and adding a link as shown in the accompanying diagram.



Project 686, PPI-based EPROM programmer, October '82: In the power supply circuit at the bottom of page 72 the A-E-N on the 240 Vac input should be A-N-E. Q1 is missing from the Parts List. It is a BC547.

Project 723, 'Selectacall' for ham/CB transceivers, February '82, Page 44: For some totally unfathomable reason, the introduction to this project does not actually refer to this project but to commercial 'selcall' systems. Ggaahh! The last two lines of the intro should read: "... then this simple accessory allows you to turn down the volume, notifying you when that 'certain party' calls — no tones or funny noises required".

OOPS! More books!

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amateur radio, DX, communications

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FOR SALE: OSI Superboard II plus 610 board, 32K RAM, disk drive, full documentation, software plus extras. $1300 ono. (08)264-3461.

FOR SALE: DGZ80, DG640, PCG, 12K ROM BASIC, 16K RAM, monitor, cassette recorder and interface, clare keyboard, software. Featured in Computers and Computing. $1300. (02)597-3828.

FOR SALE: S100 computer. DG680 CPU, DG640 VDU, two 16K RAM cards, BASIC in PROM motherboard, TV, GP-80 printer and manuals, $1200. (03)232-6300.

COMPUTER CLUB (Aust): TRS-80 and System-80 Users Group. Australia wide club via modems etc. For details phone (03)397-6972.

FOR SALE: One Super 80 assembled W/PSU, S100 manuals ROM BASIC 48K, cost $512, sell $150. Contact Jeff (047)39-5366. Free delivery.

SELL: Exorciser buss compatible Pennywise EDC-58 disk controller. Suit ss/ds 5/8 inch floppies. Presently working, $200. R. Hansberry, 5/41 Paxton St, E. Malvern Vic. 3145. (03)25-8940 or (03)606-5541.

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DISK DRIVES for sale. Two as new MPI52 double sided, double density, 500K drives. $850 ono. Phone Tony Saul (07)356-9134 (after 6 pm).

FOR SALE: System 80 with built-in sound, manuals, loads of software, Micro-80 magazines with tapes. Everything $645. Phone (03)580-1668 after 5pm. Parkdale.

MICROBEE OWNERS interested in forming users group in Bendigo (Vic.) area contact Bruce Wilson, 38 Nolan St, Bendigo. (054)43-0311 bh or (054) 42-3046 ah.

TO SELL: ZX81 1K — adaptor, tapes, leads, manual. $225 or price negotiable. Write to Poseidon Software, 72 May St, Preston Vic. 3072.

MODEM FOR SALE, 1200 BPS, half duplex, tested OK, full RS232 interface, Telecom approved, $50. (02)406-5338 ah.

BUSINESS COMPUTER: WANG 2200T, VDU, cassette, EPROM programmer (with software), disk/printer controllers, many spares, $800. Centronix 701 matrix printer, $750. Phone Denny (02)651-2143.

SOLAR SYSTEM: moving graphics model for ZX81/16K. View any year. Variable speed and viewpoint. All planets and asteroids. $15 (P+P) Incl. tape. P.M. Connor, P.O. Box 1, Kuranda Qld. 4872.

COPY16: Backup 16K programs using 16K TRS-80, System-80. SAE for info. $13.50 for tape. Ray Peverill, P.O. Box 78, Sale Vic. 3850.

WANTED: ZX80/81S for wrecking. Write, quoting asking price and condition to Helge Nome, c/o P.O. Ravenshoe N. Qld 4872.

S100 BOARDS: 16K static RAM, new $185. 16K ROM with Z80 BASIC, new $160. MW640 VDU, $130. ONO on each. Dean (058)21-4141.

WANTED: Fairchild type 4710 CMOS 64-bit RAMs. Price and number to P.O. Box 211, Caulfield East Vic. 3145 or phone (03)568-2224 ah or (03)573-2463 bh.

FOR SALE: SBC2650 with SCVT100, 32K. Also 2650, KT1500 8K RAM. Lots of software on tape including RTTY receive and transmit. VK2MJ Ken (0649)51624 QTHR.

MISCELLANEOUS

FOR SALE: 19 inch STANDARD RACK console. Walls steel, dk. green, sides and rear locking hinged panels. Height 75 inches, depth 19 inches, $100. (03)870-2842.

WANTED: PROPORTIONAL model radio control, one to three channels with servo(s) and/or similar circuit diagram, one to six channels. Nathan Spence, 'Coolawong' Acland Qld 4352.

HEAPS OF MAGS to sell. ETI, EA, PE, PW, Radioelectronics, etc. Send SSAE for complete listing and prices. Frank Rees, 27 King St, Boort Vic. 3537.

SELL: TEKTRONIX 2213 oscilloscope, mint condition. Cost $1916 duty and tax paid, sell $1500. (02)759-8927.

FOR SALE: One CRO BWD 1956 valve type in working condition with X and Y diff amps and handbook, $100. (03)743-5975 ah.

FOR SALE: One Bellco mini A/4/60 min T66 17, 240 Vac, four cam motorised switch. Cost $195, sell $100. (03)743-5975 ah.

FOR SALE: Modules for 'Speak and Spell'. All new in boxes. Grades 1-3, 4-5, 7-8. $15 each. (03)870-2842.

SELL: 10 channel light chaser with 32 programmed patterns, TTL output, details supplied on 240 Vac drivers, $250. J. Williams, P.O. Box 5366, Toowoomba Qld. 4350. (076)34-3243.

— *from page 103.*

Readers of Tom Moffat's article on 'Roehn Functions' in the MicroBee column should be advised that the whole thing is pure claptrap, written in celebration of the beginning of April!

The Gutenberg Transform program turns the MicroBee's entire character set into a mirror image of itself. Anyone who has already tried it out then attempted to put it back right by running the program a second time will have sent the MicroBee into a *monumental crash*, with recovery possible only by conducting a cold start (Escape and Reset Keys together).

As Tom says, "GOT YA THAT TIME!...(HO-HO-HE-HE-HAR-HAR-HAR...).

DREGS

WHAT WITH this month's feature project being a robot and all, the dreaded Dregs Design Draughting Team decided to dedicate some delirious doodling to the problem of designing a *truly Australian* robot.

Now, robot creatures of all sorts are positively *legion*. Every modern body of greater than bineuronal, monosynaptic intelligence has heard of R2D2. Sorry to disappoint you folks, but our pangalactic, auriculotonic little friend is not really a robot (See ETI, December '78, Inside Star Wars). No matter, Heathkit have their HERO (Heath Educational RObot), a strolling, talking, singing beast with one arm.

Way back, there was the 'mouse' genus — dull creatures that could barely find their way around a maze, and 'turtles'/'terrapins' — so-called because of their resemblance to the real creatures (especially their ambulatory velocity). These had the unique ability to draw.

Latterly, one of ETI's UK associates, Hobby Electronics, featured the 'HEBOT', a turtle-like creature, but with racier habits.

No doubt to ride the wave of R2D2 popularity, RB Robot Corp. in the US produced the RB5X. It's very reminiscent of our little pangalactic movie hero, but a whole lot smarter. For a start, it comes with 'tactile' sensors and can respond to objects in its path, learning how to get around its own environment. RB5X can seek out its battery charger and charge itself. What's more, you can add an ultrasonic rangefinder and pulsating lights. Wow!

While all credit should go to Flexible Systems for their Tasman Turtle, a *turtle* is not a creature folks the world over can *really* associate with Australia. Kangaroos, yes. Koalas, yes. Turtles, no.

Now, a kangaroo robot was carefully considered by the Dregs Design team. We came to the conclusion that a kangaroo, while a fine creature in itself, was really a grasshopper designed by a public service committee. i.e: spent too much money and made it bigger than necessary for the job. While bounding robots may one day make their appearance, we felt the world was not yet ready (let alone technology).

Koalas are cute, but that's where it ends.

Then, a recent news item came to our notice. Wombats were in great demand by zoos of the world. It struck us that *here* was a creature, wholly recognisably Australian, suitable for robotic emulation.

So, the Dregs Design team produced . . . **The Wollongong Wombat!**

Made with a rolled steel chassis and clad in corrugated iron (after all, he comes from Wollongong!), this little fellow has many unique features.

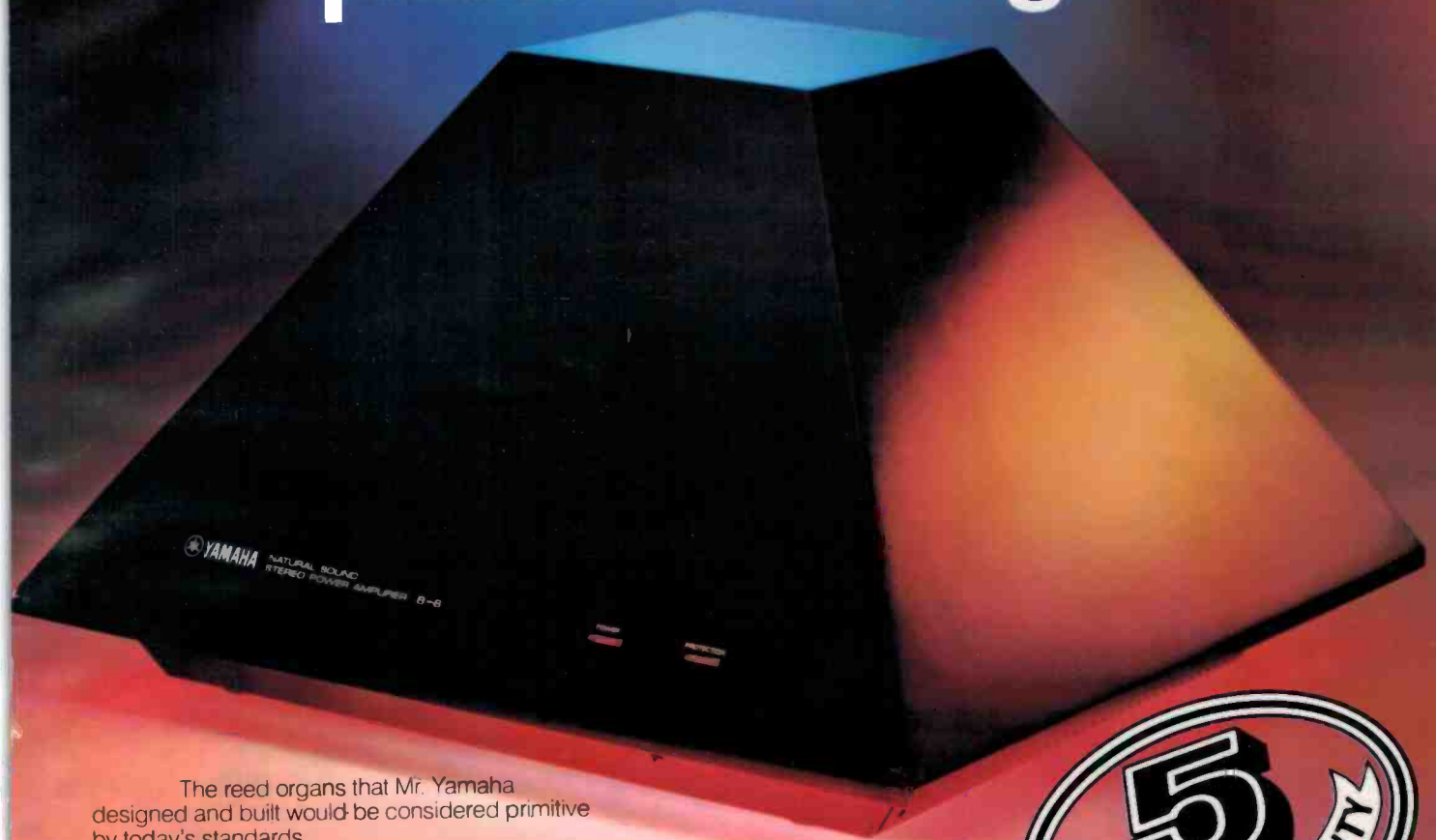
His two forward sensors (eyes) are coupled to the internal microprocessor via a special filter so that he ignores (a) fences, and (b) cars — just like the real thing! Hence the rolled steel chassis. A special drawing attachment (a la the turtle robot species) was added, but has not yet been perfected. Rather than drawing a line where he's been, he leaves big brown stains.

Frontal probes (whiskers) seek objects in his path and the internal microprocessor assesses whether to pass around them (i.e: it might be a lump of granite) or see if said objects are suitable for consumption.

You guessed it, the Wollongong Wombat has the same *disgusting* masticatory habits as his animate namesake — he eats roots, shoots and leaves!

(At this point, we leave it to readers to *imagine* what other wombat habits the Dregs Design Team included . . . Ed.)

This remarkable amplifier was developed over 95 years from a primitive reed organ.



The reed organs that Mr. Yamaha designed and built would be considered primitive by today's standards.

But in 1887 they were hailed as the world's finest.

Since then, Yamaha has become the world's largest maker of high quality musical instruments; from flutes to flügal horns, from clarinets to concert grands.

But our audio equipment is perhaps our proudest achievement.

The pyramid-shaped B-6 amplifier illustrated above for instance, is just as much 'state-of-the-art' now as Mr. Yamaha's reed organs were 95 years ago. And though technology has changed, the Yamaha principle hasn't.

All of our audio equipment, just like our fine musical instruments, is designed, crafted and ruthlessly tested by musicians. Just like our reed organs almost a century ago.

Indeed, the trained ear rather than a computer will always be the final arbiter of perfection.

And naturally the perfection that our musicians require and that our heritage demands, cannot be achieved by cutting corners or trimming costs.

Which may explain Yamaha's premium pricing and the full five year warranty we give all our audio equipment.

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Wow and Flutter	immeasurable

The CDP-101 will be generally available May 1 thoughout Australia but for a demonstration now, 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) 715777.

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