JULY 1982

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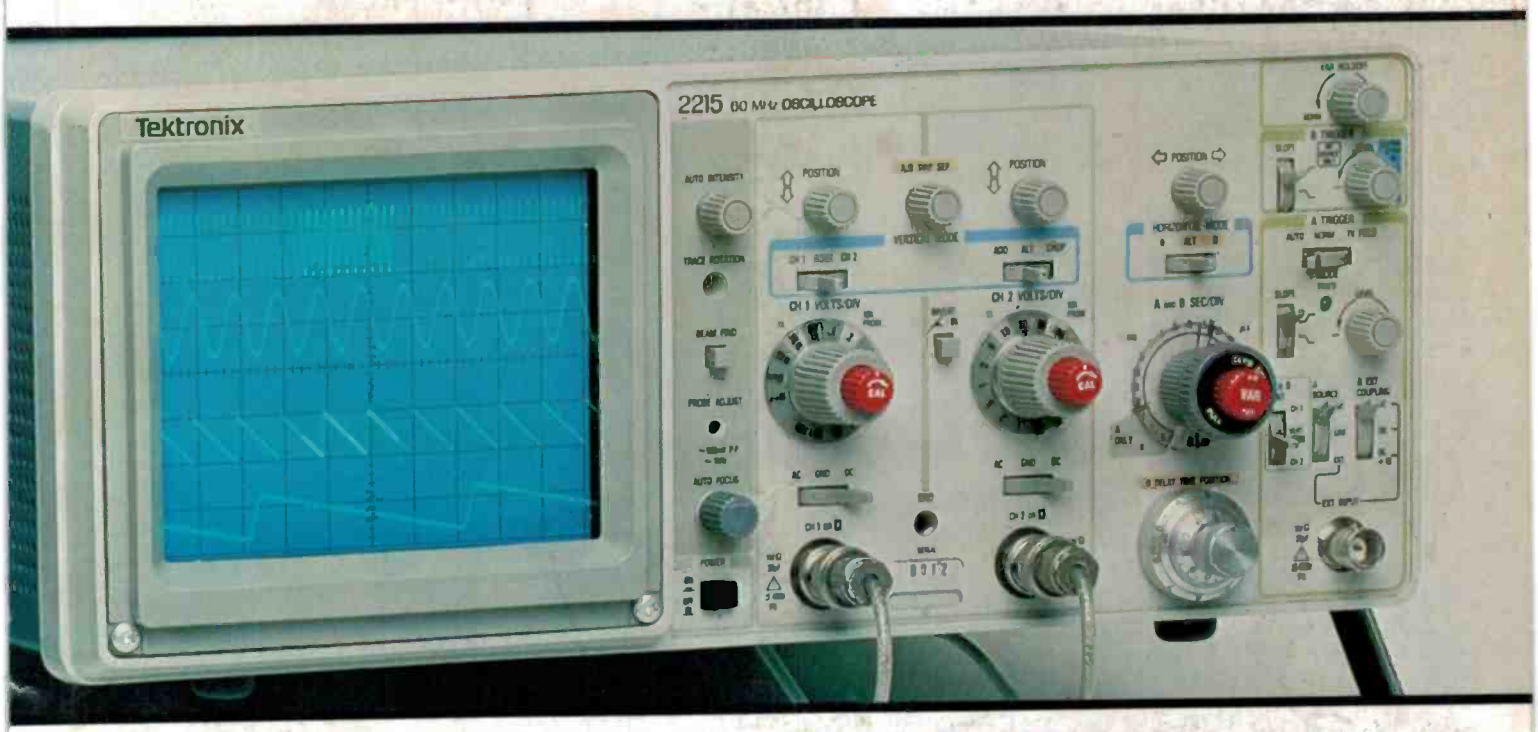
# eti
# ELECTRONICS TODAY INTERNATIONAL

# BRILLIANT NEW CROs REVIEWED




## Turtle Hand Controller

## '660 Colour Patternmaker

## Sansui AUD-33 Amp Reviewed

## 13.8V High Current Power Supply

## System 80/TRS-80 Graphics Guide

# The average hi-fi designer versus the human ear.

The human ear forms part of a sound receiving system that outperforms the best audio equipment known to science.

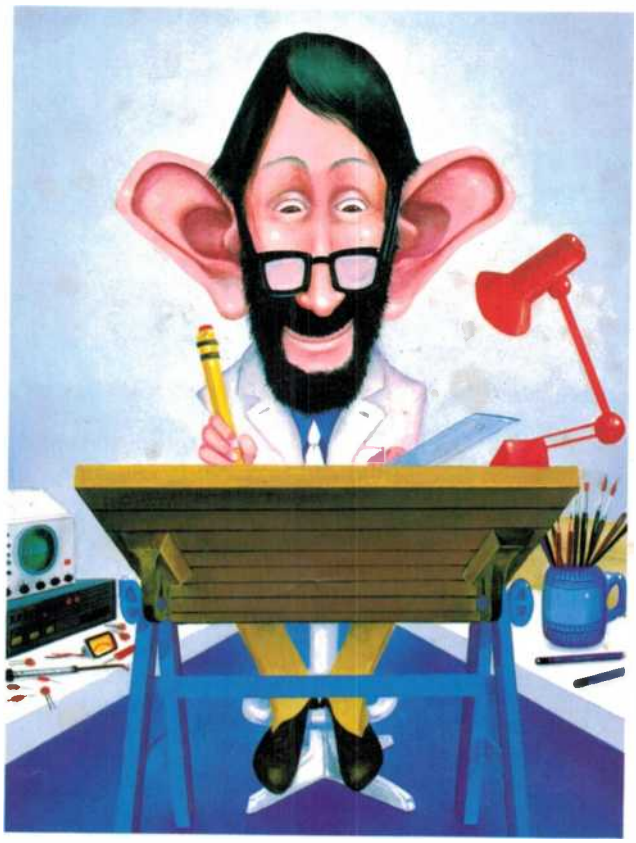
Capable of interpreting a dynamic range of 120db or 10 octaves, it has double the capability of any man made electronic equipment.

The ear can discern direction, coloration and musical within a complex detail rendition of a 50 piece orchestra in a manner no electronic equip ment is able to do.

It is, in short, a sophisticated piece of equipment that should represent the most stimulating challenge to any designer of audio equipment.

Unfortunately it's a challenge that's largely ignored. Which is why in most stereo

systems handling power and volume are substituted for subtlety and frequency response. Vector Research however is one of the few exceptions. Developed by a team of highly experienced audio engineers who



were tired of comprom ise, Vector Research represents a new standard in high fidelity excellence.

Discussing the Vector VRX 9000, *Stereo Review* states "The receiver surpassed virtually every one of its performance specific ations... it sounds as good as it looks, which is saying a lot..."

*High Fidelity* states "a receiver with such sophisticated per formance and functions demands attention."

*Popular Electronics* on the Vector VCX 600 cassette deck, "Lower Flutter readings than those of the VCX 600 are hard to find...

while not cheap, it affords excellent value." *Hi-Fi Buyer's Review* sums up.

"Vector Research is a newcomer to the audio scene, but if the VCX 600 is any guide, this company should be very successful."

If then you are an audiophile whose interest goes beyond famous names and shiny knobs then you owe it to yourself to learn more about Vector Research.

Dear V.R., In my book, beauty is in the ear of the beholder. Send me the test reports and the name of my nearest stockist.

Name _____

Address _____

_____ Postcode _____

Keio International Pty. Ltd.
198 Normanby Road, South Melbourne 3205.
Telephone: (03) 643546.

KO 404 ETI

## Vector Research. A fraction better than excellent.

eti ELECTRONICS TODAY INTERNATIONAL

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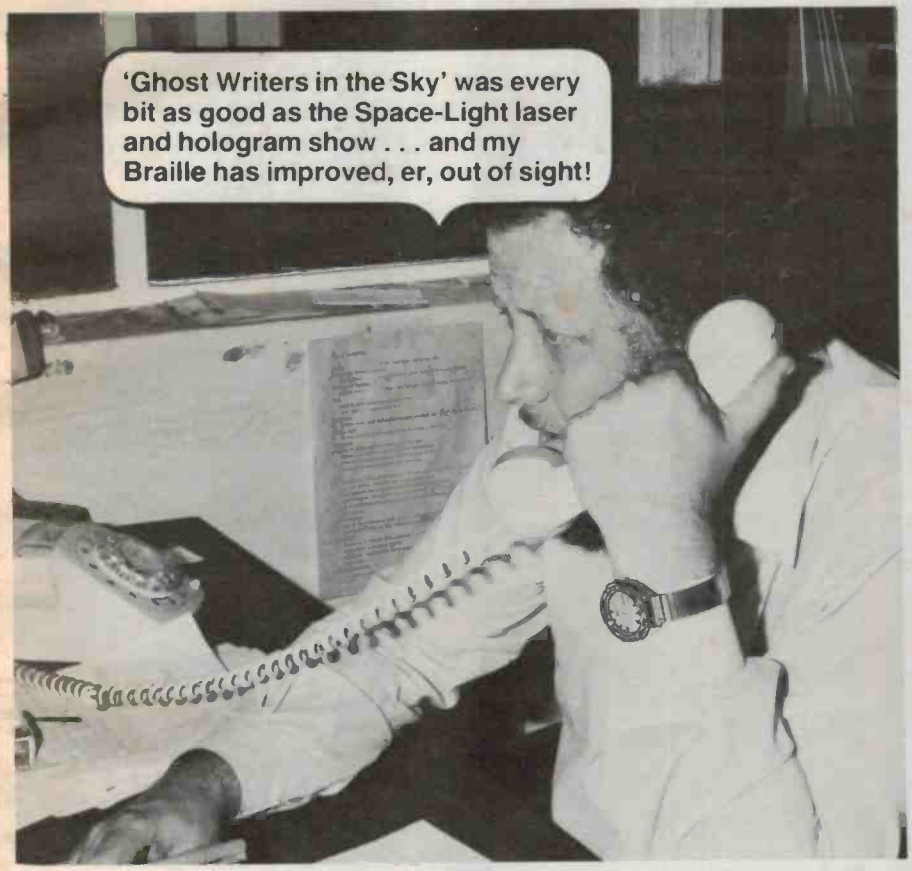


Roger Harrison
Editor

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# eti ELECTRONICS TODAY INTERNATIONAL

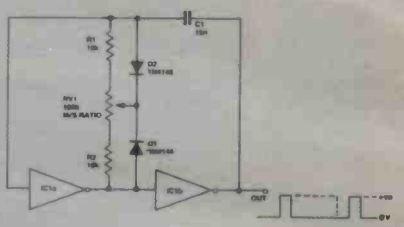
Tektronix's new low-cost, high performance, 60 MHz dual trace oscilloscopes, the 2213/2215, are reviewed in this issue. Now we know why they're so popular!

Cover design by Ali White.

# features


**REVIEW OF TEKTRONIX CROS** 16

Tektronix's new 2213 and 2215 oscilloscopes have bandwidth, functions and features never before offered on CROs costing below $2000, whilst retaining the high performance of scopes from the top end of the market.


**CIRCUIT FILE** 24

In the last issue of Circuit File, Ray Marston covered clock or square wave generators using transistors, op-amps and 555s. This time he covers the use of CMOS gates and the 4046B VCO chip.

**SPECIAL OFFER — TASMAN TURTLE KIT** 88

This kit for the 'minimum' Turtle normally retails for around $600 — our special offer price is $349. Your last chance — offer ends July 30 1982.

**GRAND HI-FI CONTEST** 110

Enter our contest and win some unbelievable hi-fi prizes — worth over $7000 altogether! The first prize alone is worth over $4900 and includes hi-fi gear from such leading names as Marantz, Shure, Audio Technica, Pioneer, Sansui, Rega, SME and more. The second prize is also stupendous, and there are another twelve consolation prizes! Enter NOW!


# news


**NEWS DIGEST** 8

LCD oscilloscope; Natural laser on Mars; Electronics correspondence course; Surplus equipment from TAB; etc.

**COMMUNICATIONS NEWS** 67

Amateur satellite first to be launched from manned spacecraft; Books; Club Call.

**PRINTOUT** 75

Even IBM boo-boos; Welcome 'The Rainbow'; Chipspeak; Club Call; and much more.

**SIGHT & SOUND NEWS** 107

First microcassette car sound system; Metro Television workshops: Perth Electronics Show; Laser-designed speakers; Carver's 16 lb amp; etc.


# projects

**1506: XENON BIKE FLASHER** 32

It's nice to feel you can be seen clearly when you're riding a pushbike at night. This bright flashing light will make quite sure of that.

### 160: 13.8 V/10 A POWER SUPPLY 38

This supply is just the thing for operating transceivers, RF power amps, etc, or anything that requires a 13.8 Vdc (nominal) supply and pulls more amps than the general run of 'CB'-type power supplies can deliver.

### 145: PROTOTYPER BREADBOARD 46

Just the thing for lashing up circuits, experimenting with circuit techniques and component values, trying out circuit ideas, attempting circuit modifications, etc.

### 646: TURTLE HAND CONTROLLER 84

This simple manual controller can be used instead of a computer and is ideal for testing and setting up the robot, trying out motional routines, keeping the kids happy while you program the computer, etc.

## computing

### COMPUTING TODAY 71

ZX Spectrum launched; Australian Beginning offer; ZX expansion; and more.

### '660 SOFTWARE 90

This month's program is a colour version of the 'Patternmaker' routine published in February 1982; it's even more fascinating than the original!

### CHIP-8 COLUMN 95

Play the CHIP-8 version of the old favourite 'Life'.

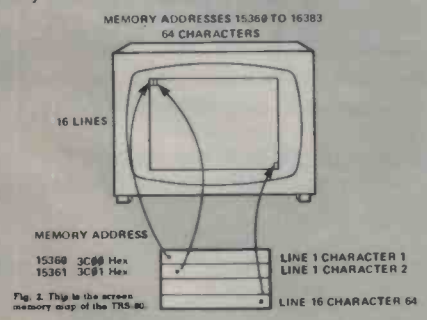
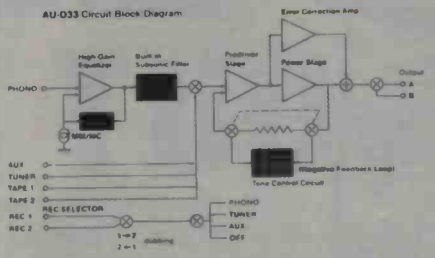


Fig. 2. This is the screen memory map of the TRS-80.

### GRAPHICS GUIDE TO THE SYSTEM 80 AND TRS80 96

Just what can you do with the rather limited character set offered by the TRS80 and System 80? Quite a lot really — as this article explains.

## sight & sound




### SANSUI AU-D33 AMPLIFIER 122

A very good amplifier, according to Louis Challis; a 'super feedforward' design produces very low distortion, but ergonomic features aren't perhaps as good as they could be.

## general

### MAIL ORDER BOOKS 20, 102

Lots and lots of fascinating books on electronics, computing, audio, etc, etc — all the information you're ever likely to want.

### ELECTRONICS BOOKS FROM ETI 54

Beginners' books, circuit books, data books, etc.

### IDEAS FOR EXPERIMENTERS 59

Resolving address contention in a microprocessor system; Idle cutout for car air conditioning; Idea of the Month contest; and more.

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## next month

### AUSTRALIAN RADIO ASTRONOMY — IN THE BALANCE

1982 is the year of decision for radio astronomy in Australia — a field in which this country's scientists have become internationally renowned. Without a major new initiative to complement Australia's fine but aging radio telescopes, one of this country's most eminent fields of scientific endeavour will die. The story of 'The Australia Telescope'.

### 12 V FLUORESCENT LIGHT INVERTER

We've had to hold this one over till the August issue owing to some component problems — now solved, so it's all systems go. This versatile unit can power one 20 W lamp, or more with additional components. A simple, low-cost, high efficiency project — and safer than candles!

### USING BIMOS & BIFET OP-AMPS

This Lab Notes from Brian Dance covers a huge variety of applications of the Texas Instruments TLOxx and the RCA CA3xxx series of op-amps featuring high impedance inputs. It's all there, from oscillators, amplifiers and filters to detectors and measuring circuits.

### TURTLE INTERFACING

The fundamentals of interfacing the Turtle Robot to a computer plus details and suggestions on attaching it to a variety of popular micros.

### 'CATCH 660' — COLOUR GAME

Another colour program for the popular ETI-660 Learner's Microcomputer plus an annotated listing of this month's 'colour patternmaker' program. And that's probably not all — we've had a stack of good programs submitted (long ones, short ones) so we'll see if space can be found to squeeze a few more in.

### BEATING THE RS232 BLUES

The ins and outs of RS232! A serial interface should be the simplest way to connect two pieces of computer gear together. Unfortunately, RS232 complicates matters. Graham Wideman explains.

### SETTING UP YOUR PA SYSTEM

You thought we were just going to dump you with the ETI-498/499 PA amp project and let you sink or swim on your own, didn't you? Here's a guide to avoiding the pitfalls and getting the best out of your PA system, covering the principles of setting up loudspeakers, mics and mic usage, gain settings, using the ALC, etc.

**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.**

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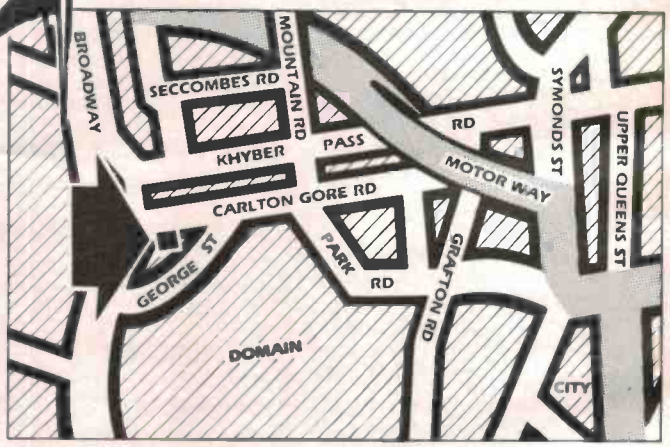


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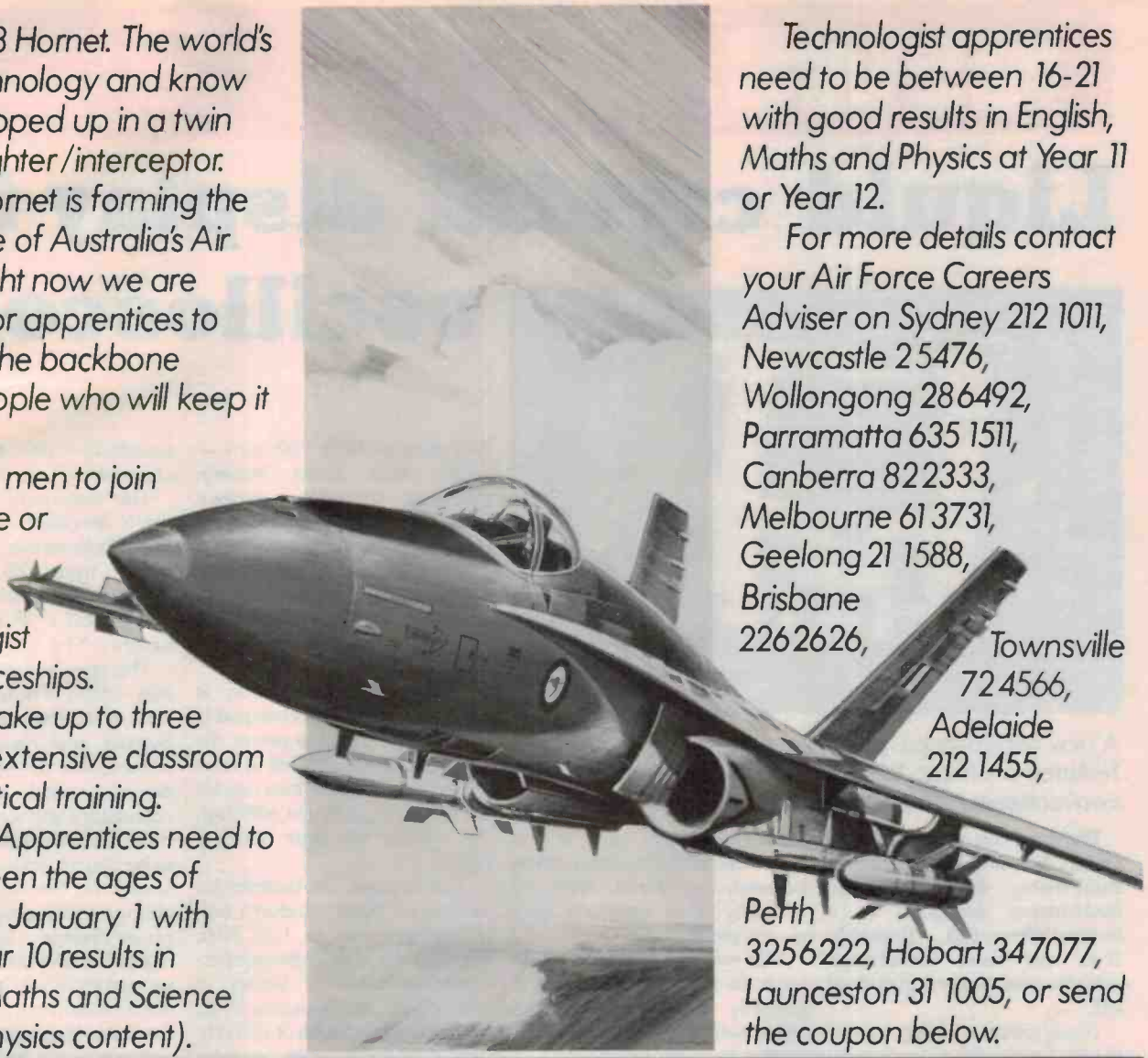

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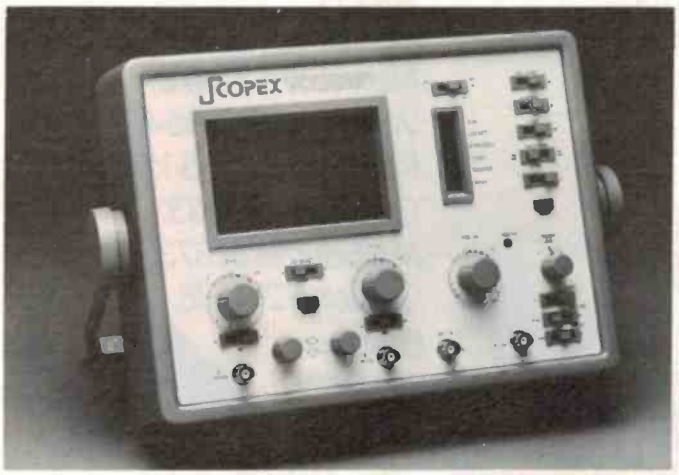
# NEWS digest

# Liquid crystal display for oscilloscope




A new oscilloscope, just released by Scopex in the UK, features a unique liquid crystal display, replacing the conventional cathode ray tube.

**Dubbed the 'Voyager', the CRO is configured as a dual-trace, digital storage instrument designed as a battery-operated portable that can store waveforms with the instrument switched off.**

Being able to store a waveform with the instrument switched off is convenient, as the portability of the instrument enables it to be taken, with stored waveform, anywhere in the world, enabling comparison between the stored waveform and any other waveform at a distant place.

The memory holds the waveform for at least 100 days, and possibly indefinitely, Scopex claim (which probably accounts for the 'Voyager' name).

The display is a dye phase-change type with a 128 x 256 matrix that gives an active display area of 64 x 102 mm — larger than most battery-operated portable 'scopes. There are over 30 000 individually addressable points on the screen, driven by a special system invented by Dr. Ian Shanks of the Royal Signals and Radar Establishment at Malvern in England.

As power consumption is very low, internal rechargeable batteries are used to power the Voyager. These provide at least five hours of continuous use for the fully-charged state, although the makers say eight hours is typical.

The Voyager has facilities for storing an input waveform with a digitising rate of 1.25 MHz, coupled to the eight-dot-per-cycle definition of fidelity in waveshape, which produces an equivalent bandwidth of 150 kHz. The dual-trace facility enables one to display and store a waveform in one channel whilst comparing it with a realtime waveform on the second channel.

The maximum sensitivity of the Y amplifier is 10 mV/cm, while the timebase sweep speeds range from 20 us/cm to 50 s/cm. The dimensions are 300 x 260 x 98 mm and the weight 2.5 kg.

The special liquid crystal display, which is only 3 mm thick, was developed at the Royal Signals and Radar Establishment. Unlike the twisted nematic displays used in electronic calculators and watches, it does not require the liquid crystal cell to be placed between polarising sheets of film for the optical change to be observable. Dye-phase-change liquid crystal displays make use of the optical properties of special dyes which are dissolved in the liquid crystal material. They operate from low voltages — the maximum voltage used in the instrument is 15 V.

**Brian Dance**

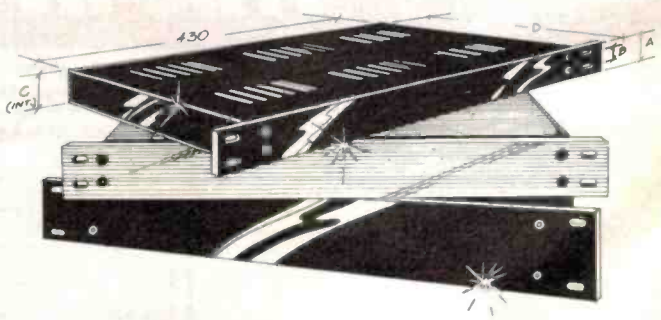
## In rack, rack in or rack off?

**Rack cabinets! Since we started racking-up projects, in particular the Series 5000 equipment, there has been much interest among readers for rack standard cabinets, and with good reason.**

Rack cabinets are convenient, come in co-ordinated, standard sizes and look good. Three years or so ago, Altronics tell us they were selling a range of professional racking boxes for which they found strong demand from the 'trade' or commercial user, and a surprising demand from the home constructor, as a lot of domestic hifi equipment, etc, was being produced in 'rack box' format and finding wide appeal.

Well, sadly, Altronics were continually faced with escalating cost increases, with the result that prices went beyond the reach of the average constructor, so the range was discontinued.

With the advent of the Series 5000 MOSFET power amp and preamp projects, the demand for quality-finish hardware revived, and to meet the challenge of high labour and handling costs Altronics have tooled up with all necessary dies, etc, to produce precision-finish racking hardware at surprisingly low prices.




Altronics produce 44, 88 and 132 mm high racking cases in both natural and black finish. Dimensions conform exactly to international racking specifications. Shop and mail customers should contact Altronics, 105 Stirling St, Perth WA 6000, and bulk users/resellers should contact Altronic Distributors, 151 York St, Subiaco WA 6008.

# Natural laser on Mars

**In spite of the importance of lasers in science and technology, the laser phenomenon has never been observed naturally until very recently — and it has actually turned up in the atmosphere of Mars!**

This process was observed between January and April 1980 in the Martian atmosphere (which is composed almost entirely of carbon dioxide) through the use of a new device known as an infrared heterodyne spectrometer (developed by the Goddard Space Centre) together with the Kitt Peak McMath Solar Telescope in Arizona.

The new spectrometer provided the scientists with the means of showing that a molecular 'population inversion' was occurring — which means that a higher energy state was more fully occupied by molecules than a lower energy state. This population inversion is necessary for lasing to occur, since the energetic molecules are then present in sufficiently large numbers for an adequate number of photons to be released as the molecules are stimulated by other photons to give up their energy.

It was found that sunlight is absorbed high in the Martian atmosphere by carbon dioxide, as a result of which the molecules of this gas are pumped into a higher energy state. This natural laser is identical in its physical principles with man-made carbon dioxide lasers, which are used for a wide variety of industrial and scientific purposes such as laser welding, laser surgical knives, etc.

The total power output of the Martian laser is quite fantastic, being at a continuous level of over one million megawatts — or over five times the total electrical power generated in the United States! Scientists hope that eventually it may be possible to extract power from this natural laser and to beam it to wherever it is needed by orbiting satellites. It is felt that this discovery may force scientists to rewrite their books on the physics of planetary atmosphere and could possibly enable new planets to be detected in other star systems by the laser radiation they are probably emitting.

The discovery indicates that there may well be a great temperature difference in the atmosphere of Mars, whereas the past theories have indicated that the atmosphere has been essentially in thermodynamic equilibrium.

**Brian Dance**

**IDEA OF THE MONTH CONTEST**

**YOU'VE GOT TO BE IN IT TO WIN IT!**

**Our 'Idea of the Month Contest', run in conjunction with Scope Laboratories, who are donating the prizes, has certainly brought forth some good ideas. If you have a good idea or two, why not submit them for a chance at a beaut prize — worth around $70 — *and* get paid $10 for the item when published! The picture shows our first winner, John Blyth of Mordialloc, Victoria, trying out his Scope Panavise board holder. See Ideas For Experimenters for details on how to enter and an entry coupon.**

# Compandor for audio, video, industry

**Philips has introduced a new dual-channel high-performance gain control integrated circuit from Signetics for dynamic analogue range compression and/or expansion. The NE572 compandor is intended for a variety of linear applications in audio, video and industrial marketplaces.**

The name compandor stems from the ability of the device to both compress and expand the dynamic range of signals, such as those found in audio systems. The NE572 offers two identical channels, making it an ideal single-chip noise reduction circuit for high-performance consumer and professional audio systems. In these applications (e.g: FM, tape, disc, microphone or Telecom) the input signal may be split into two bands with each band fed to a separate channel in the NE572. Each channel is a linearised, temperature-compensated gain cell with a full-wave rectifier and buffer amp. The buffer permits independent control of dynamic attack and recovery time with minimum external components and improved low frequency gain control ripple distortion over previous compandors. Complementary gain compression and expansion may be implemented with an external op-amp.

Typical results in an audio noise reduction application include total harmonic distortion (THD) of 0.17% at unity gain. Output noise with no input signal is only 6 uV (10 Hz-20 Hz) and dynamic range of the NE572 exceeds 110 dB. Tracking error is held to a low +/−0.5 dB (typical) at −30 dB rectifier input.

In addition to its use as a dynamic noise reduction system, the NE572 can be employed as a voltage control amplifier, stereo expander (single-ended noise reduction), automatic level controller, limiter, noise gain and variable filter. The IC allows flexibility in the design of systems that require optimised dc shift, ripple distortion, tracking accuracy and noise flow.

The NE572 operates on a wide supply voltage range (6 to 22 V) over its commercial temperature range (0° to 70°C), and dissipates 500 mW maximum from a 16-pin plastic DIP package.

For further information contact Philips Electronic Components and Materials, 67 Mars Rd, Lane Cove NSW 2066.

# NEWS digest

## Surplus equipment from TAB

**The Totalizator Agency Board has some surplus equipment — in workable condition — which they are offering for sale to ETI readers. Anything left unsold will be scrapped, so don't hang about after reading this if you want any of it.**

Up for sale are:

- Plessey keyboards incorporating a model 32 or 33 receive only Baudot teletype. RTL circuitry enables serial TX at 150 baud and serial RX at 50 baud. Power supply +4 V at 4 A, +50 V at 0.5 A, 110 V at 2 A, and 7 V at 0.5 A, including keyboard.
- Ticket printers — incorporating a hinged box approximately 10" x 12" x 24", 240 Vac Muffin fan, 1 x 240 Vac motor @ 1350 rpm, and 1 x 240 V geared motor @ 160 rpm.
- Keyboard — consisting of nine columns of 9-13 mechanically interlocked switches. A tenth column has five switches. The ten columns are matrixed via a diode pc board.
- Telecom line interface — ±50 V power supply, mercury-wetted line relays, approx. 10" x 4" x 8".
- Power supply — 240 Vac input; outputs: dc −5 V at 0.25 A, dc +5 V at 6 A, dc +40 V at 4 A. Standard 19" mount suitable for home, hobby or commercial applications.

All enquiries should go to John Watt on (03)268-2236. Sale will be on an 'as is' basis, and packing for despatch FOR Melbourne can be arranged at cost. Written enquiries should be addressed to the Assistant Manager — General Services, TAB, 1 Queens Rd, Melbourne Vic. 3004.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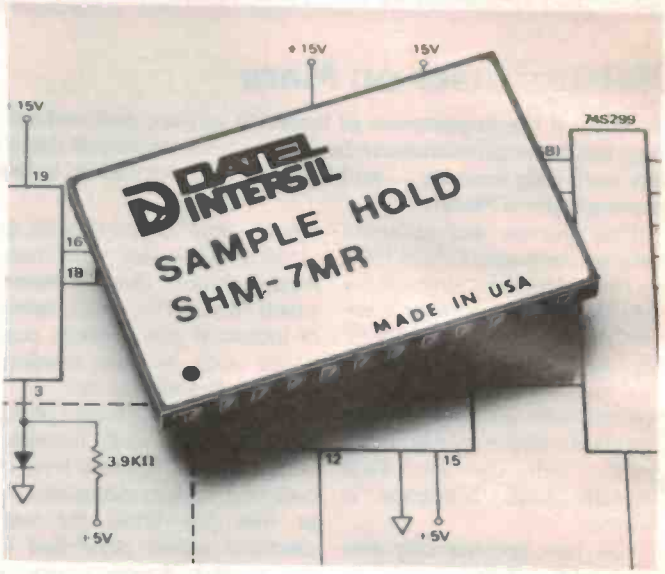


## Video speed sample & hold

**Elmeasco has released a new low cost sample/hold from Datel-Intersil, called the SH-7, designed for ultra-high speed sampling applications such as video conversion.**

The SH-7 acquires a 2 V input change to 0.1% in only 40 ns; hold-mode settling time is only 20 ns, making possible sampling rates as high as 17 MHz; and maximum aperture certainty time is 10 ps with sample-mode bandwidth of 40 MHz, according to the specs.

A unique feature of the SH-7 is its dual outputs, each with a ±5 V output range at 30 mA and an input impedance of only 13 ohms, Elmeasco say. The two buffered outputs make the device an ideal choice for applications involving two-stage conversion techniques. Output impedance can be reduced and output current increased by combining the outputs.

Other important features of the SH-7 include ±5 V input range, a fixed gain of +0.995 and a maximum hold-droop of only 100 uV/ us. Laser trimming is undertaken at the factory for offset, sample to hold offset and gain errors, making the circuit suitable for use without external adjustments.

The device is packaged in a 24-pin hermetically sealed ceramic package and is available in versions for commercial and industrial applications. Further information on the Datel-Intersil SH-7 is available from Elmeasco Instruments Pty Ltd, Box 30 Concord 2137. (02)736-2888.

## Newnes data book

**Newnes data books are world-renowned. The 11th edition of the Semiconductor Data Book, compiled by A.M. Ball, Head of Physics at the Teign School in the UK, and published by Newnes, has just been released here by Butterworths.**

The book lists basic data on around 10 000 transistors, FETs, UJTs, diodes, rectifiers, opto devices, triacs and SCRs. In addition, it lists a table of 'Transistor Comparable Types', plus seven pages of device pinouts.

The layout is clear and in alphanumeric order. The size of the book, 215 x 210 mm, makes it particularly easy to use. It contains around 190 pages (including seven blanks at the rear!), and is available from Butterworths, P.O. Box 345, North Ryde NSW 2113. (02) 887-3444.

# Practical electronics correspondence course

**The Australian School of Electronics Pty Ltd is offering a new practical correspondence course in basic electronics.**

As the course assumes no prior knowledge in the subject, it may be taken for general interest, hobby or career advancement purposes.

The average time for completion of the 'LernaKit' course is six months, although students are encouraged to learn at their own pace.

The first part of the course familiarises the student with solid-state components and circuit diagrams. Also in this part, detailed instruction and all components are supplied for the construction of a simple oscilloscope.

Practical training continues to be emphasised — by way of 40 experiments — in the second part of the course, which also introduces electronic theory. All components for the oscilloscope and experiments are supplied at no extra cost.

There is no enrolment fee, deposit or contract for the course. A student can commence for $35 with other payments as the course progresses. For further information write to the School Registrar, P.O. Box 108, Glen Iris Vic. 3146.

# Tandy's ultimate credit card

**Tandy Electronics have introduced to Australia what they call the 'Ultimate Credit Card', because there's no joining fee, no interest charge, and no statement to pay.**

The card is yours for the asking and can be used at any one of the 300 Tandy Electronics stores or participating dealers throughout Australia.

Tandy's new plastic 'Battery of the Month Club' card looks similar to a credit card, but there the similarity ends. It entitles you to a free battery to suit almost every kind of electrical appliance from transistor radios to pocket torches.

Cardholders can choose one Radio Shack 'AA-size' (penlight) cell, 'C-Cell' (cassette recorder), 'D-Cell' (large flashlight), or 9 V (transistor radio) type general-purpose red battery every month.

As each free battery is given away, that month is marked off on the card. When the 12 months have been used up a new card will be issued.

The total value given away depends on the type of battery chosen by the customer, but can add up to more than $7.00 per customer each year. Cardholders do not have to buy anything to receive their free batteries.

# Russian craft show Venus is orange, not red

**Two Soviet spacecraft that landed on Venus early in March 1982 have shown that it has a deep orange-coloured sky line. The second craft touched down on March 5 in a hilly area about 960 km (600 miles) from where another craft had landed on March 1. It measured the surrounding temperature as being 465°C.**

The first craft was dropped from the Venus 13 spacecraft and landed amongst heaps of sharp, angular stones. The second lander was dropped from the Venus 14 spacecraft and touched down upon a small hill about 490 m (1600') in height, its four-month journey having begun on November 4 for its 290 million km flight.

Perhaps the most striking result of this expedition is the convincing proof that the sky over Venus is strongly orange. Before they succumbed to the high temperatures on the surface of the planet, the two landers showed that highly alkaline potassium basalts, not found on the surface of the Earth, were the prevalent components of the Venusian soil.

The two spacecraft from which the landing vehicles were launched continued their journey into space so as to proceed with their interplanetary investigations.

**Brian Dance**

# British Satellite Television

**The British company 'Satellite Television' was scheduled to commence broadcasts in late 1981 using the European Space Agency's OTS satellite. The head of this company said that initially its aim was not to reach large numbers of viewers, but to show to Europe's cable television and satellite aerial manufacturers that satellite broadcasting can work. Satellite Television has already signed agreements with its first advertisers.**

The company is confident of reaching one million homes in Europe as soon as the broadcasts start. The spokesperson said the Teleste company of Finland had sold 40 dish antennae on the same morning that he was allocated his satellite channel.

Strangely enough the company's first transmissions will not be designed for reception in the UK, but rather for those households already connected to television dish antennae (such as the Amsterdam cable television company's system, which can supply signals to 300 000 homes).

If the first broadcasts are successful, the company plans to launch a full commercial television service in Europe and hopes to gain a large part of the estimated STG£2000 million which manufacturers are prepared to spend on their European advertising.

The cable television companies will be able to supply signals to some 30 million European homes, but when the receiving dishes become cheap enough for individuals to purchase, the audience is expected to rise to 110 million homes. During the daytime the audience will be too small for entertainment television, so it is planned that the system will transmit closed circuit television and video data at that time.

**Brian Dance**

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## TOP SELLERS

| Cat. No. | Description | 1-9 | 10 up |
|---|---|---|---|
| Z-1300 | DS547 | .14 | .12 |
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| Z-1319 | DS549 | .14 | .12 |
| Z-1329 | DS549c | .34 | .30 |
| Z-1340 | DS557 | .17 | .15 |
| Z-1348 | DS558 | .17 | .15 |
| Z-1359 | BC159 | .17 | .15 |
| Z-1443 | BD139 | .55 | .50 |
| Z-1444 | BD140 | .55 | .50 |
| Z-2145 | 2N3055 | 1.00 | .95 |
| Z-2242 | BC328 | .20 | .17 |
| Z-2252 | BC338 | .35 | .30 |
| Z-3042 | DSOA91 | .20 | .15 |
| Z-3120 | IN9141 | .08 | .06 |
| Z-3202 | IN4002 | .10 | .08 |
| Z-3204 | IN4004 | .15 | .13 |
| Z-3207 | IN4004 | .20 | .15 |
| Z-3222 | IN5404 | .45 | .35 |
| Z-3531 | 6V8 Zener diode | .40 | .30 |
| Z-3547 | 15V Zener diode | .40 | .30 |
| Z-3228 | IN5408 | .50 | .45 |
| Z-4000 | Flashing LED | .45 | .40 |
| Z-4010 | Sml Red LED | .20 | .18 |
| Z-4020 | " green LED | .28 | .25 |
| Z-4030 | Lge red LED | .20 | .10 |
| Z-4032 | " green LED | .30 | .25 |
| Z-4034 | Yellow LED | .55 | .45 |
| Z-4040 | Rect. red LED | .45 | .35 |
| Z-4042 | " green LED | .45 | .35 |
| Z-4150 | FND500 | 1.35 | 1.20 |
| Z-4510 | Triac SC141D | 1.50 | 1.25 |
| Z-4802 | Double LDR | .80 | .70 |
| Z-5601 | 4001 Norgate | .40 | .35 |
| Z-5617 | 4017 Dec. counter | 1.20 | 1.10 |
| Z-6105 | UA4136 quad amps | 2.00 | 1.80 |
| Z-6145 | DS555 timer | .40 | .35 |
| Z-6382 | LM741 op. amp. | .40 | .35 |
| Z-6545 | 7805 | 1.20 | 1.00 |
| Z-6552 | 7812 | 1.20 | 1.00 |
| Z-9310 | 4116 RAM | 3.95 | 3.50 |

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**ONLY $150**

Expand the ZX 81 to a massive 16K bytes — the maximum it can handle. Simply plug it onto the expansion edge connector at the back of your computer and away you go! Cat X-5002

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**RAINBOW CABLE**

12 colour coded strands of insulated conductor bonded together in a flat cable. Ideal for wiring looms or intercoms etc. Cat W-2045

*Minimum order 5 metres*

**90¢/m**

**100m or more 70¢/m**

## NOW A HIGH RESOLUTION MONITOR AT AN AFFORDABLE PRICE

With this monitor added to your computer system, you'll be able to use it for almost limitless applications such as accounts/statistics, medical, education, amusement etc. Features an anti-glare screen allowing for easier and sharper viewing. A must for the serious hobbyist or professional.
Cat X-1200

**$349**

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Before you buy a soldering station, check 1) is the temperature continuously variable without changing the tip? 2) Do you have a meter readout of the temperatures? Why buy an iron without these useful features?

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If you're serious about good soldering, there's only one way to do it — with a temperature controlled soldering iron. Until now, temperature controlled soldering irons have been expensive but Dick Smith has solved that problem! This superb soldering iron offers you the best quality at an unbelievably low price. Cat T-2000

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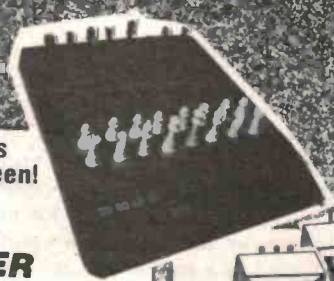
We now have in stock this superb quality antenna just right for your CB or marine radio. Comes complete with PL 259 plug. Cat. D-4074

**$14.95**

## The best Chess Game we've seen!

## 6 LEVEL CHESS COMPUTER



Become a chess grandmaster with this amazing unit. Easy to master with six graduated levels of learning to increase your skills, and it even plays against itself. Because it doesn't play two games the same way, you can never predict what moves it will make. Forward and backward keys allow you to retrace moves and grasp general patterns. Cat Y-1260

**INCLUDES CHESS MEN & POWER SUPPLY**

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0-1mA (100 ohms) Cat. Q-2010

0-50uA (2400 ohms) Cat. Q-2020

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0-20V DC (100 ohms) Cat. Q-2040

**VALUE! $8.95 each** 10 or more $7.95 each

### METRIC KNOBS

An aluminimum knob with fine vertical lines. Superb on amplifiers, etc. 40mm dia., 20mm deep. Cat. H-3846

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Satin aluminium finish with knurled body for positive grip. 25mm dia., 17mm deep. Cat. H-3843

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**ROUND TO-5**

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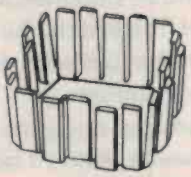

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This TO-3 heatsink gives the greatest possible heat dissipation in the smallest possible space. Unique fin design. Cat. H-3400

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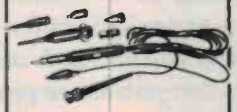
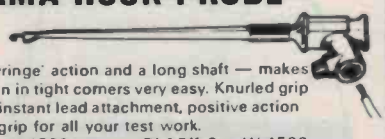
This versatile probe set will suit virtually any CRO and give you all the features of a probe set you would pay $$$ more for!
Cat. Q-1245
Working Voltage: 600V Pk (or 600V DC)
Includes: IC Adaptor tip — Spring clip — Insulating shroud — BNC Adaptor — Trimming tool — Plastic Wallet for safe keeping!



**$32.50 GREAT VALUE!**

### MIYAMA HOOK PROBE



With a 'syringe' action and a long shaft — makes connection in tight corners very easy. Knurled grip screw for instant lead attachment, positive action and sure grip for all your test work.
RED Cat. W-4589 BLACK Cat. W-4590

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SEE PAGE 19 FOR ADDRESS DETAILS

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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 $199
(excludes crystals)

M100EO $419

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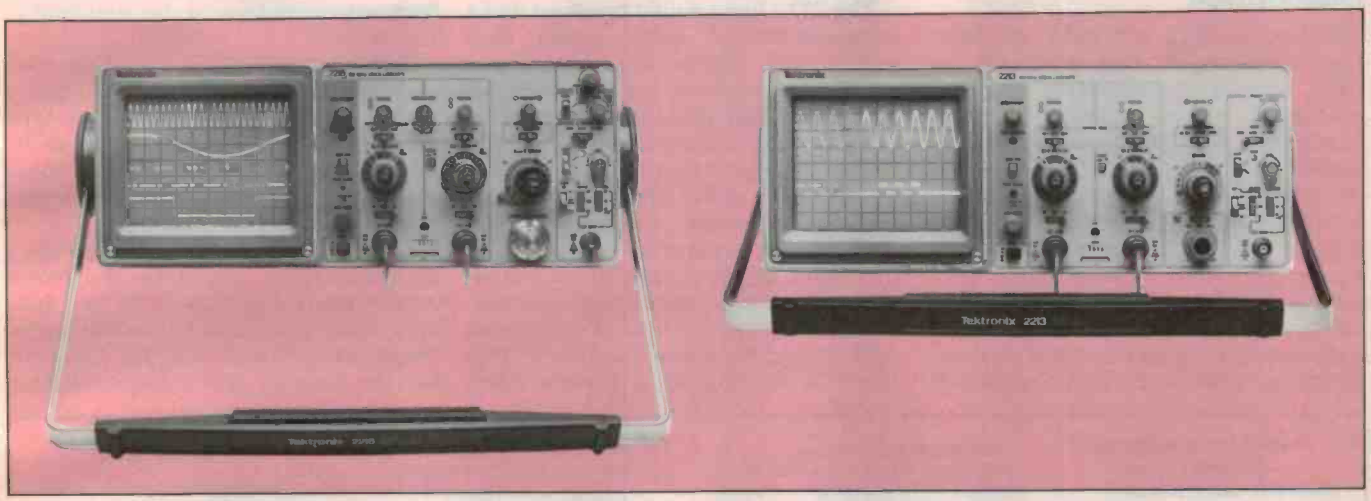
BURROWS DOBLE LAWRENCE VIC/ETI

# Tektronix' new high performance 'down market' oscilloscopes — 2213/2215




Late last year Tektronix released the models 2213 and 2215 portable oscilloscopes, with bandwidth, functions and features never before offered on oscilloscopes costing below about $2000. And they couldn't make enough; they have only just become available here in quantity. ETI has had the opportunity to review both models over the past month. Here's what we found.

**Roger Harrison**

TEKTRONIX are acknowledged as the world's leading designers and manufacturers of oscilloscopes. They have pretty well held that lead since they entered the market 35 years ago. And no wonder. Their philosophy was to "... make the world's best oscilloscope". And they did. And they still do, in all but the 'low end' market and some very specialised areas.

As electronic technology expands, becoming ever more complex and operating at higher speeds, the demand for instruments to analyse circuit operation expands. The two most important parameters of an oscilloscope, not surprisingly, are thus the vertical amplifier bandwidth and the rise time. The two are closely related, and generally the rise time can be calculated from the bandwidth:

$$\text{rise time} \approx 0.35/\text{BW}$$

Now, the vertical amplifier system of an oscilloscope should ideally have a rise time five or more times faster than the rise time of the fastest signal it is intended to examine, in order to achieve measurement errors under 2%.

It is generally important to get the highest bandwidth and fastest rise time commensurate with the measurement tasks to be undertaken. With much common digital circuitry now running at speeds of 10 MHz, a scope with a vertical amp bandwidth of 50 MHz (at −3 dB) *at least* is necessary.

Fourier analysis tells us that a square wave is made up of a series of harmonics of the fundamental frequency. If the vertical amplifier and cathode ray tube of a scope lop off the fifth and higher harmonics, the square wave will be rounded and rise time measurement virtually useless.

Glitches — those unwanted gremlins that bedevil digital circuitry — will virtually disappear on a CRO with inadequate bandwidth, rendering the instrument useless for digital circuit troubleshooting. Although you may be working with quite slow logic — 2 MHz or 3 MHz, say — a high-speed scope is pretty well mandatory.

Now that video equipment has penetrated the domestic front — beyond the family TV set — wide bandwidth oscilloscopes are increasingly necessary. Modern communications equipment now incorporates a considerable array of logic circuitry — in display, signal processing and equipment control. Microcomputers running 10 MHz clocks are becoming commonplace.

A few short years ago, a 10 MHz or 15 MHz CRO was adequate for a wide variety of applications in testing, servicing and development. A 50 or 100 MHz CRO was only required for more 'stringent' applications. That has changed. Now, a 50 MHz CRO is virtually the 'bottom line' requirement.

Dual-trace CROs have long been a 'bottom line' requirement for much routine work requiring an oscilloscope. It's no surprise then that dual-trace CROs are legion. For comparing and measuring signal parameters, there's no substitute. Modern dual-trace instruments should really also allow you to look at a 'raw' signal and at an ▶

'expanded' version of a portion of the signal. Such a facility is an important diagnostic tool.

The functions and facilities included on modern oscilloscopes are there to improve the performance and functionability of the tool and need to be assessed very carefully when deciding to buy an instrument.

## Description

The models 2213 and 2215 are dual-trace instruments with 8 and 10 cm CRT screens incorporating internal graticules with a specified vertical bandwidth of 60 MHz at 20 mV to 10 V and 50 MHz at 2, 5 and 10 mV sensitivity. Maximum sweep speed for each is 5 ns/div. (10x magnification), minimum is 0.5 s/div. Both incorporate advanced triggering systems designed for 'easy triggering', Tektronix say. The new 'vertical mode' system triggers on asynchronous signals in dual channel alternate operation, and 'enhanced' auto triggering is claimed to minimise time-consuming adjustments. TV line and field triggering permits a wide range of video measurements (a standard feature of many CROs) and 'variable hold off' gives stable triggering on complex analogue and digital signals, Tektronix claim. Waveform positioning is made easier owing to position insensitive triggering circuitry.

The 2213 has a single timebase and a *screen-calibrated delay sweep* (two modes) with claimed 3% accuracy *and* an intensified sweep facility. *Very few* single timebase scopes incorporate delayed sweep measurements.

The 2215 has a dual timebase with a quoted 1.5% delay time accuracy. It includes alternate sweep switching, A/B sweep separation control and 'B triggering after delay' functions for jitter-free delayed time measurements.

Both instruments have Z-axis input, with quoted bandwidth of 5 MHz. This input is dc-coupled, a positive-going signal decreasing intensity. A 5 V peak-to-peak signal causes noticeable modulation at normal intensity (over dc to 5 MHz quoted), i.e: it's TTL level compatible. Both models have been designed so that they are easy to set up, with the provision of **beam finder, auto intensity, auto focus** and **trace rotation** controls on the front panel.

A summary of the characteristics of both instruments is in the accompanying panel.

Two x10 probes are provided with each instrument, designed especially for the series. A conventional clip-type probe tip is provided, along with an 'IC grabber' tip, and Tektronix say these provide full bandwidth measurements at the probe tip.

Both the 2213 and 2215 incorporate a high-efficiency switch-mode power supply which operates on ac line voltages ranging from 90 Vac to 250 Vac at frequencies from 48 to 62 Hz, eliminating the need for line voltage selection

### VERTICAL DEFLECTION

(2 Identical Channels)

**Bandwidth* and Rise Time —**

(at all deflection factors from 50 Ω terminated source)

| 0°C to +40°C | +40°C to +50°C |
|---|---|
| Dc to 60 MHz, 20 mV/div to 10 V/div, 5.8 ns reduced to 50 MHz for 2 mV to 10mV/div, 7 ns | 50 MHz, 7 ns |

*Measured at −3 dB.

**Deflection Factor at BW —**
2 mV/div to 10 V/div ±3% (+20°C to +30°C) or ±4% (0°C to +50°C).

1-2-5 sequence. Uncalibrated, continuously variable between steps to at least 25 V/div.

**Vertical Display Modes —**
CH1; CH2; CH2 ADD (normal and inverted), alternate, chopped - approx 250 kHz rate, electronically switched

**CMRR —**
Common-mode rejection ratio at least 10:1 at 10 MHz for common mode signals of 6 divisions or less.

**Input R and C —**
1 MΩ ±2% paralleled by approx 30 pF.

**Max Input Voltage —**
Dc coupled 400 V (dc + peak ac)
800 V (p-p ac at 1 kHz or less)
Ac coupled 400 V (dc + peak ac)
800 V (p-p ac at 1 kHz or less)

**Delay Line —**
Permits viewing leading edge of displayed waveform.

### HORIZONTAL DEFLECTION

**Time Base A —**
(Both 2213 and 2215) — 0.05 µs/div to 0.5 s/div (1-2-5 sequence). 10X mag extends max sweep rate to 5 ns/div.

**Time Base B —**
(2215 only) — 0.05 µs/div to 50 ms/div (1-2-5 sequence). 10X mag extends max sweep rate to 5 ns/div.

**Variable Time Control —**
Time Base A (both 2213 and 2215) provides continuously variable uncalibrated sweep rates between steps to at least 1.25 s/div.

**Time Base A (both 2213 and 2215) and B (2215 only) Accuracy, center 8 divisions—**

| | +20°C to +30°C | 0°C to +50°C |
|---|---|---|
| Unmagnified | ±3% | ±4% |
| Magnified | ±5% | ±6% |

**Horizontal Display Modes (2213) —**
A, A intensified after delay, delayed.

**Horizontal Display Modes (2215 —**
A, alternate (A intensified by B and B), B. Electronic switching between intensified and delayed sweep.

### 2213 SWEEP DELAY

**Delay Times —**
Less than 0.5 µs, 10 µs, and 0.2 ms.

**Multiplier —**
Increases delay time by 20 to 1 or more.

**Jitter —**
5000 to 1 (0.02%) of maximum available delay time.

### 2215 SWEEP DELAY

**Delay Times —**
Continuously variable by means of a 10 to 1 vernier control. Delayed (B) portion is intensified on the main (A) trace.

**Delay Position Range —**
Less than 0.5 to more than 10 divisions.

**Delay Dial Accuracy —**
± 1.5% of full scale.

**A/B Sweep Separation —**
Control permits main and delayed sweep to be separated by at least 3.5 divisions.

**Jitter —**
10,000 to 1 (0.01%) of maximum available delay time.

### TRIGGERING

**2213 and 2215 A Time Base**

**Trigger Modes —**
Normal (sweep runs when triggered), automatic (sweep runs in the absence of a triggering signal and triggers automatically for signals down to 20 Hz), and tv field (with slope set for negative going transitions, and trigger level adjusted close to blanking level, sweep starts at first line of video; use NORMAL for tv line display). LED indicates when sweep is triggered.

**A Trigger Holdoff —**
Adjustable control permits a stable presentation of repetitive complex waveforms.

**Sensitivity —**
Auto and Normal Internal: Below 5 MHz, signal must be at least 0.4 divisions amplitude; requirements increase above 5 MHz; at 60 MHz, signal must be at least 1.5 divisions amplitude.

Auto and Normal External: Up to 5 MHz, trigger signal must be at least 50 mV p-p; requirements increase up to 60 MHz, where signal must be at least 250 mV p-p.

TV Field: Composite video must be at least 2 divisions amplitude.

**Level and Slope (NORM Mode) —**
Internal: Trigger level can be adjusted over the range of amplitudes displayed on the CRT. External, dc coupled: level can be adjusted over a range of at least ±2 V, or 4 V peak-to-peak. External, dc coupled and attenuated (÷ 10): level can be adjusted over a range of at least ±20 V, or 40 V peak-to-peak.

**External Inputs —**
R and C approx 1 MΩ paralleled by approx 30 pF. 400 V (dc + peak ac) or 800 Vac peak-to-peak at 1 kHz or less.

**2215 Delayed (B) Timebase**

**Level and Slope —**
Separate slope and level controls for triggering B sweep.

**Sensitivity —**
Up to 5 MHz, signal must be at least 0.4 divisions in vertical amplitude; requirements increase up to 60 MHz, where signal must be at least 2 divisions in amplitude

### X-Y OPERATION

**Full Sensitivity X-Y (CH1 Horiz, CH2 Vert)—**
2 mV/div to 10 V/div, accurate ±5%. Bandwidth is dc to at least 2 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

### DISPLAY

**CRT —**
8 x 10 cm display. Horizontal and vertical center lines further marked in 0.2 cm increments. P31 phosphor standard. 10 kV accelerating potential, mesh grid, halo suppressed.

**Graticule —**
Internal, non-parallax, not illuminated.

**Beam Finder —**
Compresses trace to within graticule area for ease in locating an off-screen signal. A pre-set intensity level provides a constant brightness.

**Z-Axis Input —**
Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 5 MHz.

### ENVIRONMENTAL CAPABILITIES

**Ambient Temperature —**
Operating: 0°C to +50°C.
Nonoperating: −55°C to +75°C.

### OTHER CHARACTERISTICS

**Probe Adjust Signal —**
Square wave, 0.5 V ±20%, 1 kHz ±20%.

**Power Requirements —**
90 to 250 V, 48 to 62 Hz without range switching. 50 watts max at 115 V and 60 Hz.

**Cabinet Dimensions —**
Height: 137 mm (5.4 in) with feet and handle
Width: 327 mm (12.9 in) without handle; 360 mm (14.2 in) with handle
Depth: 445 mm (17.5 in) with front cover, 440 mm (17.3 in) without front cover; 511 mm (20.1 in) with handle extended.
Weights: 7.6 kg (16.8 lb) with cover, accessories, and pouch
6.1 kg (13.5 lb) without cover, accessories, and pouch
8.2 kg (18 lb) domestic shipping weight

### OPTIONAL ACCESSORIES

Cover and accessory pouch (020-0672-00); viewing hood (016-0566-00); C-5C Opt 04 scope camera, Model 200C SCOPE-MOBILE® cart; Rack Adaptor Kit 016-0466-00

and providing the ability to operate almost anywhere in the world. Curiously, the rear plate of each review unit quoted the frequency range as 48-440 Hz. Presumably the latter is the true spec.

With portable oscilloscopes, weight is an important instrument parameter. Traditionally, the term 'portable' has been interpreted with considerably wide latitude. Some purportedly portable instruments I have lugged at one time or another would more realistically require an assistant with the attributes of Arnold Schwarzenegger! Not so with the 2200s. Naked, they weigh in at just over 6 kg; 7.6 kg with cover, accessories and pouch added.

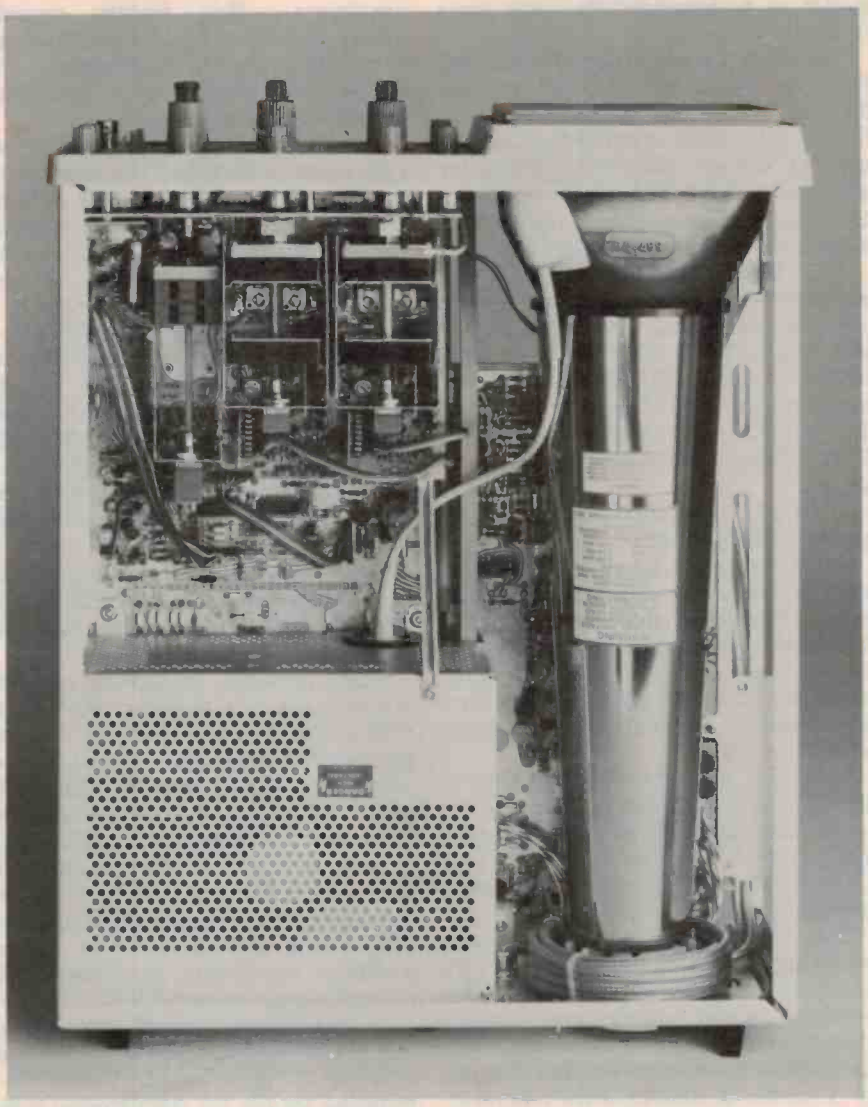
Which brings us to the 'optional extras'. Tektronix have available a front panel cover — for protection during transportation; an accessories pouch — for carrying probes, handbook etc; a viewing hood; a scope camera (takes Polaroid film) and a cart.

## Construction

First thing we looked at was construction. A portable oscilloscope needs to be *robust*. A light, strong aluminium box frame is employed. Everything is attached to this — including the front panel. A large, double-sided pc board is mounted in the bottom of the box chassis and another, smaller pc board containing the vertical input attenuator and sweep switching circuitry is mounted above this, supported from the front panel and a bracket from the power supply 'cage'. The power supply section on the main pc board is completely enclosed in this cage, the CRT accelerator cable being brought out via a special high voltage connector and lead. The cathode ray tube (CRT) is mounted between the front and rear panels, on the left hand side of the chassis, above the main pc board. The vertical amplifier delay lines — which permit viewing the leading edge of an input waveform immediately after triggering — are coiled around the base connector of the CRT. The Z-input BNC socket is located on the rear panel adjacent to the CRT base. Four plastic 'legs' are fitted to the rear panel, enabling the instrument to be stood on its end. There are four feet on the underside of the case, too.

Tektronix say the 2213 and 2215 have 65% fewer mechanical parts and 90% less cabling than the instruments they typically replace, which contributes to their light weight, serviceability and reliability. Both units have a *two-year warranty*.

The carrying handle has detents in the hinges so that it can be set in a variety of positions — to support the scope or keep it out of the way in use.



Inside the 2200 Series CRO. Power supply cage is at lower left.

Ergonomically, the controls are well-positioned and have about the best access possible to arrange on an instrument incorporating the features they do and intended for portable operation. The CRT system controls are immediately adjacent to the CRT tube, followed by the vertical system controls, then the timebase system controls and the trigger controls, moving to the right across the panel. The two photographs on page 15 show the overall arrangement.

Each model has a built-in camera bezel which mounts the Tektronix low-cost C-5C scope camera, which features a graticule-illuminating flash.

The CRT itself is basically the same as in the 'industry standard' Tek 465B. It's a halo-suppressed, 10 kV post-deflection acceleration type with P-31 phosphor and an internal non-illuminated 8 x 10 cm graticule. This is a very high-performance tube indeed.

## Operation

The CRT system controls are much the same as found on many other CROs — but the auto intensity and auto focus are a little different. The **auto intensity** control is quite cunning. Turning this knob allows you to set the trace intensity to suit the prevailing ambient light conditions. The intensity of a trace is a function of how bright you set the beam and how long the trace is on screen. As you select different sweep speeds, the beam on and off times change and the beam has more or less time to excite the CRT phosphor. Faster speeds result in dimmer traces. On most scopes you have to turn the intensity up or down to restore the initial brightness when changing sweep speeds. On the 2213 and 2215 the automatic intensity circuitry compensates for brightness ▶

changes with sweep speeds from 0.5 ms to 0.5 us, maintaining the same trace intensity initially set.

The **auto focus** performs a similar function. The scope's electron beam is focused on the CRT faceplate by a grid in the tube, with a particular voltage applied. The auto focus control circuitry adjusts the grid voltage for optimum trace focus, maintaining the focus setting over the range 0.5 ms to 0.5 us.

The **beam finder** button, when pressed, overrides the intensity setting and reduces the X and Y deflection voltages so that the trace appears somewhere on the CRT screen. From the quadrant in which it appears you can determine which way to turn the X and Y position controls to bring the trace on screen.

Good one, Tektronix! Wish we had it on the 465B in our lab.

A trace rotation control is provided, allowing levelling of the trace, which may be misaligned due to variations in the Earth's local magnetic field or other stray magnetic fields. The control is recessed and can only be adjusted with a screwdriver, preventing accidental misalignment.

Note that a **probe adjust** signal is provided at a small test point socket between the beam find button and the auto focus control. This gives a 500 mV p-p, 1 kHz square wave for probe compensation and testing.

The vertical amplifiers are provided with the usual complement of controls and each has BNC input sockets. The **vertical mode** controls are situated above the attenuator controls. There are five modes of vertical operation: display ch 1 or ch 2, display both channels, display both channels alternately (sweep ch 1 first, then ch 2 — for HF signals), chopped display (switch between ch 1 and ch 2 during sweep — for LF signals) and add both channels. The **invert** button on ch 2 allows you to *subtract* the ch 1 and ch 2 signals and display the result.

The variable control on each Y input attenuator has no indication, other than knob position, of when it is not in the **cal** position — unlike other Tektronix CROs, which include an 'uncal' LED indicator. This would have been a useful addition.

On the 2213, the **horizontal mode** switch provides three operational modes: no delay, intensified after delay and delayed. This combination permits period measurements from the CRT graticule using the intensified and delayed modes on both channels. The **delay time** switch lets you select delays of 0.5 us, 10 us or 0.2 ms, while the variable control (**multiplier**) permits a variation from x1 to about x20 (4 ms maximum). This facility provides plenty of versatility and should suit a very wide range of applications. The multiplier control is a multiturn vernier type. Very handy.

On the 2215, the dual timebases provide extra versatility. The **horizontal mode** switch has three modes: A, B and alternate. This allows **four** separate traces to be displayed — vertical channels 1 and 2 at the A sweep rate and vertical channels 1 and 2, delayed, at the B sweep rate! This sort of facility is extremely handy in multichannel analogue applications for signal comparison and multisignal timing comparison and examination in digital applications . . . etc, etc. It's the sort of facility that, once you've got it, you never know how you got along without it!

Time period and delay measurements are a 'dream' with the 2215. The **B delay time position** is a calibrated, 10-turn potentiometer on the 2215.

Very versatile triggering circuitry and controls are incorporated in both models. On the 2213, with internal triggering, you can trigger on ch 1, ch 2 or what they call 'vert mode'. The latter gives alternate channel triggering, even on asynchronous signals! This means you can have different signals in the two channels, each triggered separately, providing a stable display. The **mode** switch provides signal-seeking automatic operation plus normal triggering and TV field triggering. The **source** switch provides for internal triggering, line triggering and external trigger input. There is a coupling switch for the external input providing ac, dc and dc ÷ 10. Variable **holdoff** and **level** controls are provided, along with **slope** selection.

There is a similar range of controls on the 2215, except that **slope** selection and a **level** control are provided for the B sweep and the external input is for the A sweep.

A LED indicator showing that the sweep is triggered is provided on both the 2213 and 2215.

## In use

As one would expect from a Tektronix instrument, overall they're a delight to use. We measured the vertical input bandwidth at the −3 dB point and were *absolutely surprised* at the result:

100 MHz (0.5 V/div)!

That puts the rise time at less than 4 ns! The response was flat to 80 MHz and the sweep would *trigger on signals right up to 130 MHz!*

Performance may not be the same on all units, but as Tektronix specifications are usually conservative, our measurements are probably indicative of general performance.

All controls behave as you'd expect and you don't need an extensive 'driver's instruction course' to be able to use the instruments. A little common sense and reading the manual go a long way.

The light weight of the instruments has to be experienced to be believed! Portability now *means* something.

The 6210 probe is excellent and the IC grabber tip a welcome adjunct.

Both instruments would have been just that little extra useful if 'uncal' lights for the vertical and horizontal controls had been included, along with a 'power on' indicator. The latter is very useful when using a CRO in the 'auto' trigger mode. There is no display until an input signal triggers the sweep and a trace appears, so you can't tell at a glance whether the CRO's on or off. These points, however, are minor, and overall operation of the units is superlative.

Documentation — one of Tektronix's fortes — is up to the usual standard. The handbooks are thorough, well written, well organised, properly indexed and properly illustrated. You get an 'operator's manual' and a 'service manual'. The latter includes circuits, circuit descriptions, component lists, board overlays — the lot. The probes even have their own manual!

## Summary

At current prices of $1364 (+ tax) for the 2213 and $1692 (+ tax) for the 2215, these oscilloscopes represent *truly excellent value for money.*

Next to a good multimeter, a CRO is one of the fundamental test and measurement instruments necessary in every 'serious' electronics workshop. With the 2200 Series, Tektronix has brought the power and versatility of wide band, dual-trace, delayed sweep oscilloscope measurements within the financial realm of many technicians, freelance R&D engineers, school and college labs and well-heeled 'serious' hobbyists. They have also reduced the cost of oscilloscope equipment for those establishments which traditionally bought much higher-priced units simply because there was nothing between the 'low end' and 'high performance' instruments.

Our minor grizzles aside, these instruments should serve their owners/users well for many years and over a huge variety of applications.

Well done, Tektronix. What else can we say but . . . *we want one!* ●

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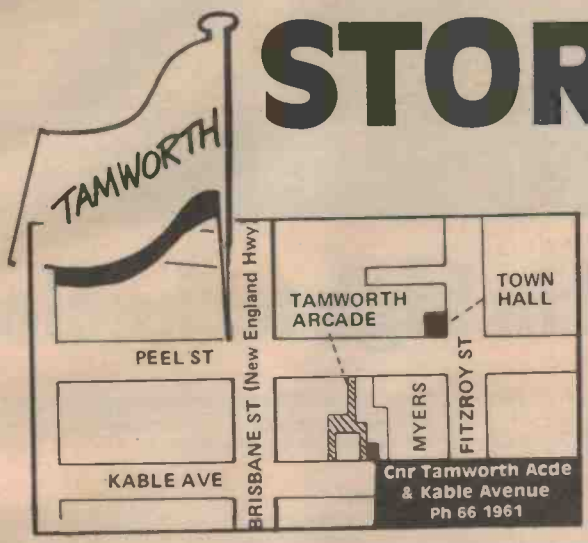


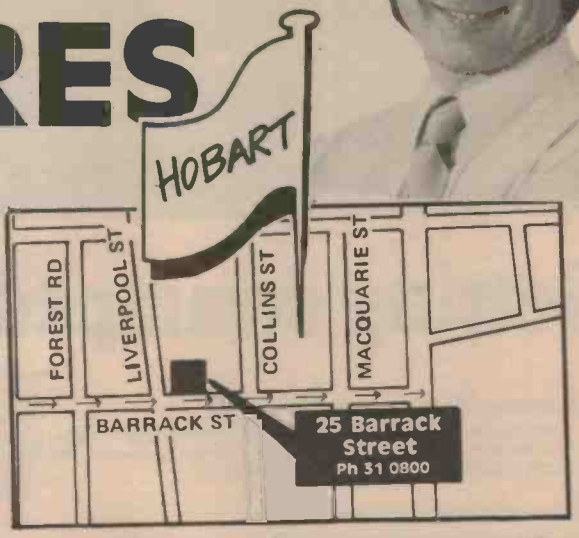


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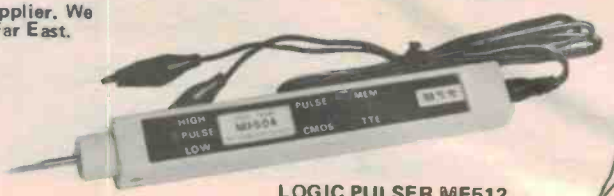


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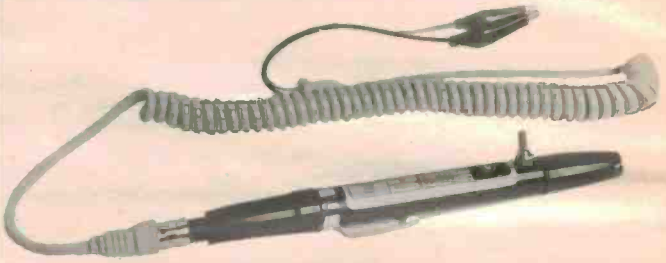

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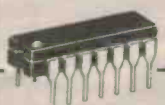

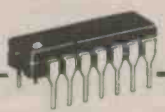

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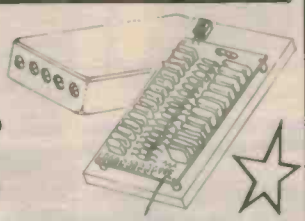

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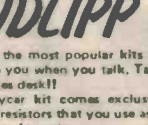

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# More clock generators

In the last edition of Circuit File, Ray covered clock or square wave generators using transistors, op-amps and 555s. This time he covers the use of CMOS gates and the 4046B VCO chip.

Ray Marston

INEXPENSIVE CMOS logic ICs such as the 4001B and the 4011B can easily be used to make very inexpensive but highly versatile square-wave or 'clock' generator circuits. They can be designed to give symmetical or non-symmetrical outputs, and can be of the free-running or the gated types; in the latter case, they can be designed to turn on with either logic 0 or logic 1 gate signals, and to give either a logic 0 or a logic 1 output when in the 'off' mode. You can even use these 'cheapo' circuits as simple voltage-controlled oscillators (VCOs) or as frequency-modulated oscillators.

If you want really good VCO operation from a square-wave generator, with excellent linearity and versatility, you can turn to the slightly more expensive 4046B CMOS IC. We'll look at some applications of this chip later, but let's start by looking at some basic two-gate CMOS square-wave generator or astable circuits.

## Basic two-gate astable circuits

The simplest way to make a CMOS astable circuit is to wire two CMOS inverter stages in series and use the C-R feedback network shown in Figure 1a. This circuit generates a decent square wave output and operates at about 1 kHz with the component values shown. The frequency is inversely proportional to the C-R time constant, so can be raised by lowering the values of either C1 or R1. C1 must be a non-polarised capacitor and can have any value from a few tens of pF to several uF, and R1 can have any value from about 4k7 to 22M; the operating frequency can vary from a frequency of 1 Hz to about 1 Mhz. For variable frequency operation, wire a fixed and a variable resistor in series in the R1 position.

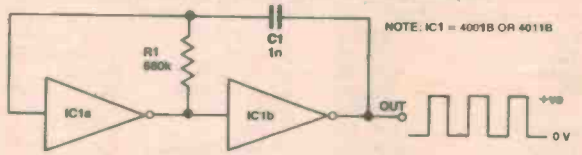


*Figure 1(a).* Circuit of the basic two-gate CMOS astable. This operates at 1 kHz with the component values shown.

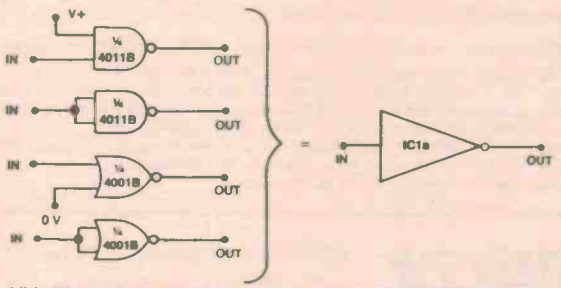


*Figure 1(b).* Ways of connecting a two-input NAND (4011B) or NOR (4001B) gate for use as an inverter.

Note at this point that each of the 'inverter' stages of the Figure 1a circuit can be made from a single gate of a 4001B quad two-input NOR gate or a 4011B quad two-input NAND gate by using the connections shown in Figure 1b. Thus each of these ICs can provide two astable circuits. Also note that the inputs to all unused gates in these ICs must be tied to one or other of the supply-line terminals; the Figure 1a astable (and all other astables shown in this feature) can be used with any supplies in the range 3 to 18 V; the 'zero volts' terminal goes to pin 7 of the 4001B or 4011B, and the '+ve' terminal goes to pin 14.

The output of the Figure 1b astable circuit switches (when lightly loaded) almost fully between the zero and positive supply rail values, but the C1-R1 junction is prevented from swinging below zero or above the positive rail levels by built-in clamping diodes at the input of IC1a. This characteristic causes the operating frequency of the circuit to be somewhat dependent on supply rail voltage. Typically, the frequency falls by about 0.8% for a 10% rise in supply voltage; if the frequency is normalised with a 10 volt supply, the frequency falls by 4% at 15 V or rises by 8% at 5 V.

Also, the operating frequency of the Figure 1a circuit is influenced by the 'transfer voltage' value of the individual IC1a gate that is used in the astable, and can be expected to vary by as much as 10% between individual ICs. The output symmetry of the waveform also depends on the 'transfer voltage' value of the IC and, in most cases, the circuit will give a non-symmetrical output. In most 'hobby' or other non-precision applications, these defects of the basic astable circuit are of little practical importance.

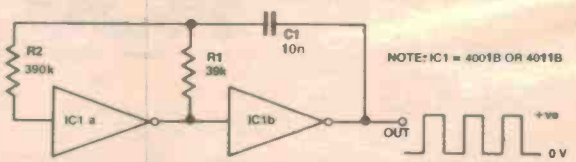


*Figure 2.* This 'compensated' version of the 1 kHz astable has excellent frequency stability with variations in supply voltage.

Some of the defects of the Figure 1a circuit can be minimised by using the 'compensated' astable of Figure 2, in which R2 is wired in series with the input of IC1a. This resistor must have a value that is large relative to R1, and its main purpose is to allow the C1-R1 junction to swing freely below the zero and above the positive supply rail voltages during circuit operation and thus improve the frequency stability of the circuit. Typically, when R2 is ten times the value of R1, the frequency varies by only 0.5% when the supply voltage is varied between 5 and 15 volts. An incidental benefit of R2 is that it gives a slight improvement in the symmetry of the output of the astable.

The basic and compensated astable circuits of Figures 1 and 2 can be built with a good number of detail variations, as shown in Figures 3 to 6. In the basic astable circuit, for example, C1 alternately charges and discharges via R1 and thus has a fixed symmetry. Figures 3 to 5 show how the basic circuit can be modified to give alternate C1 charge and discharge paths to thus allow the symmetry to be varied at will.

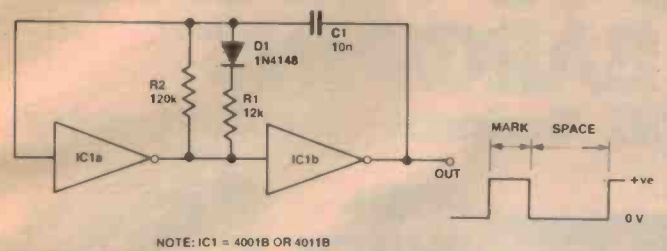


*Figure 3.* Modifying the astable to give a non-symmetrical output: MARK is controlled by the parallel values of R1 and R2; SPACE is controlled by R2 only.

The Figure 3 circuit is useful if you need a highly non-symmetrical waveform, equivalent to a fixed pluse delivered at a fixed 'timebase' rate. Here, C1 charges in one direction via R2 in parallel with the D1-R1 combination, to generate the mark or pulse part of the waveform, but discharges in the reverse direction via R2 only, to give the space between the pulses.

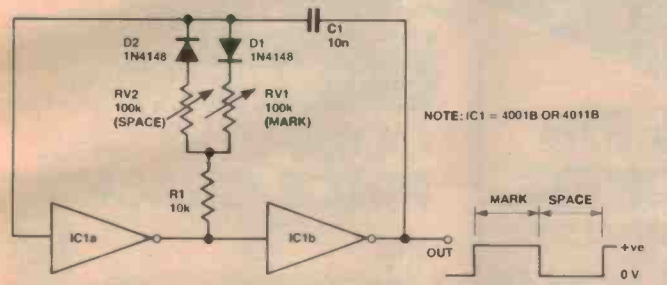


*Figure 4.* This astable has independently variable MARK and SPACE times.

Figure 4 shows the modifications for generating a waveform with independently variable mark and space times; the mark time is controlled by R1-RV1-D1, and the space time is controlled by R1-RV2-D2.

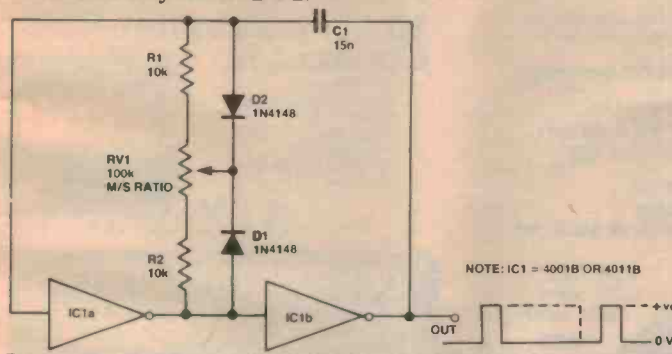


*Figure 5.* The mark/space ratio of this astable is fully variable from 1:11 to 11:1 via RV1; frequency is almost constant at about 1 kHz.

Figure 5 shows the modifications to give a variable symmetry or mark/space ratio output while maintaining a near-constant frequency. Here, C1 charges in one direction via D2 and the lower half of RV1 and R2, and in the other direction via D1 and the upper half of RV1 and R1. The M/S ratio can be varied over the range 1:11 to 11:1 via RV1.

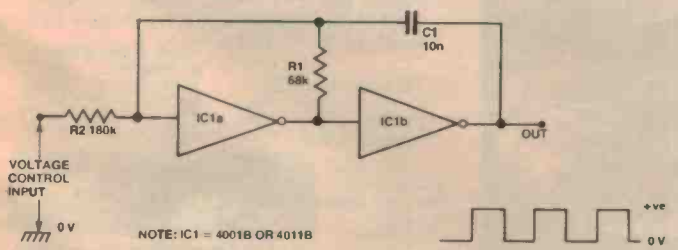


*Figure 6.* Simple voltage-controlled oscillator (VCO) circuit.

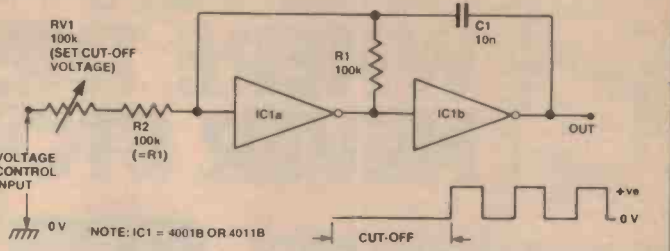


*Figure 7.* Special effects VCO which cuts off when $V_{in}$ falls below a preset value.

Finally, Figures 6 and 7 show a couple of ways of using the basic astable circuit as a very simple VCO. The Figure 6 circuit can be used to vary the operating frequency over a limited range via an external voltage. R2 must be at least twice as large as R1 for satisfactory operation, the actual value depending on the required frequency shift range; a 'low' R2 value gives a large frequency shift range, and a 'large' R2 value gives a small frequency shift range. The Figure 7 circuit acts as a special-effects VCO in which the oscillator frequency rises with input voltage, but switches off completely when the input voltage falls below a value preset by RV1.

## Gated astable circuits

All of the astable circuits of Figures 1 to 5 can be modified for gated operation, so that they can be turned on and off via an external signal, by simply using a two-input NAND (4011B) or NOR (4001B) gate in place of the inverter in the IC1a position, and by applying the input gate control signal to one of the gate input terminals. Note, however, that the 4001B and the 4011B give quite different types of gate control and output operation in these applications, as shown by the two basic versions of the gated astable in Figures 8 and 9.

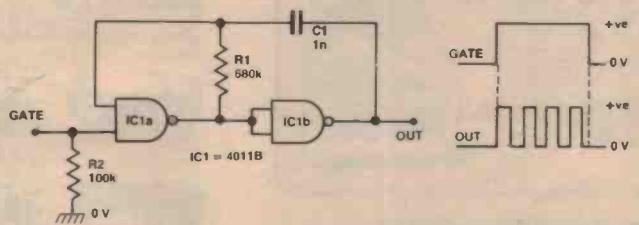


*Figure 8.* This gated astable has a normally low output and is gated on by a high (logic 1) at the input.

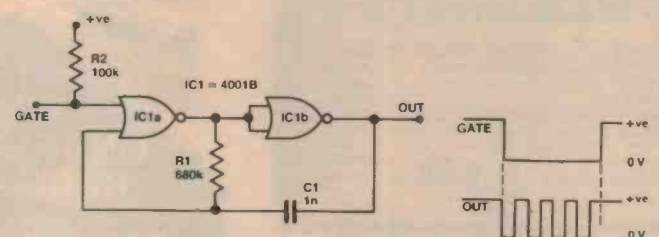


*Figure 9.* This version of the gated astable has a normally high output and is gated on by a low (logic 0) at the input.

Note specifically from these two circuits that the NAND version is gated on by a logic 1 input and has a normally low output, while the NOR version is gated on by a logic 0 input and has a normally high ouput. R2 can be eliminated from these circuits if the gate drive is direct-coupled from the ouput of a preceding CMOS logic stage, etc.

Note in the basic gated astable circuits of Figures 8 and 9 that the output signal terminates as soon as the gate drive signal is removed; consequently, any noise present at the gate terminal also appears at the outputs of these circuits. Fig-

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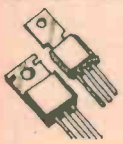

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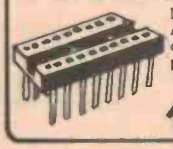

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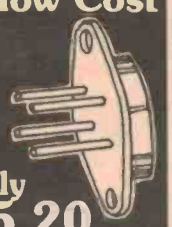

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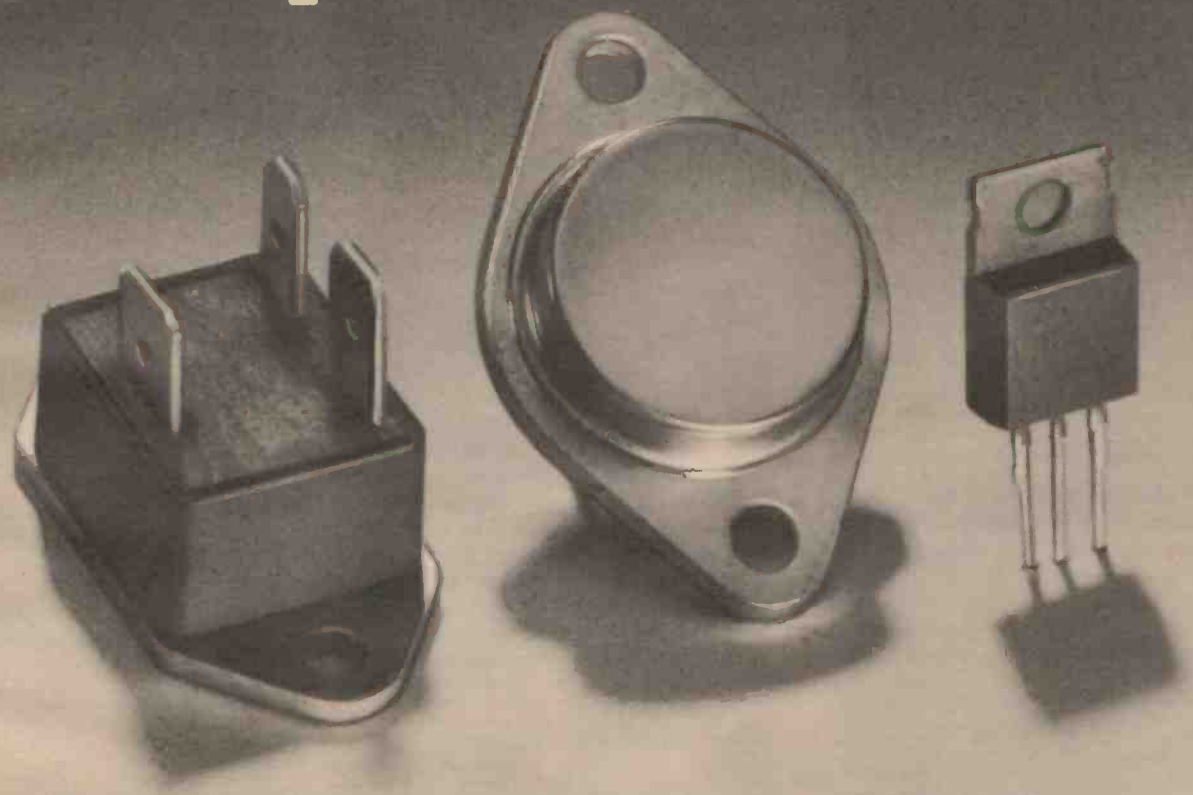

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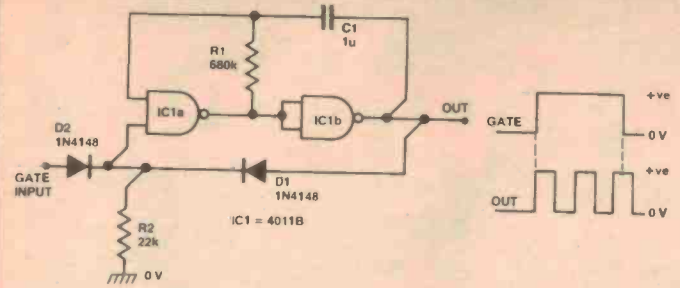


*Figure 10.* Semi-latching or 'noiseless' gated astable circuit, with logic 1 gate input and normally zero output.

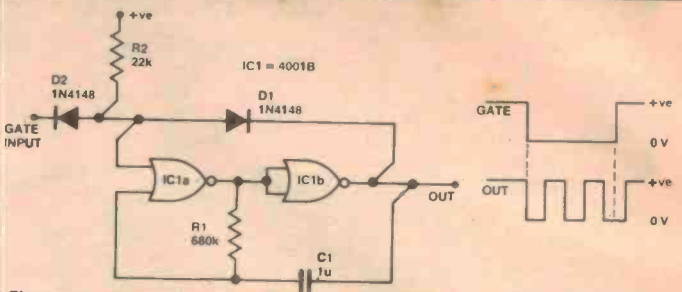


*Figure 11.* Alternative semi-latching gated astable, with logic 0 gate and normally high output.

ures 10 and 11 show how to modify the circuits to overcome this defect. Here, the gate signal of IC1a is derived from both the outside world and from the output of IC1b via diode OR gate D1-D2-R2. As soon as the circuit is gated from the outside world via D2 the output of IC1b reinforces or self-latches the gating via D1 for the duration of one half astable cycle, thus eliminating any effects of a noisy outside world gate signal. The outputs of the 'semi-latching' gated astable circuits are thus always complete numbers of half cycles.

## 'Ring of three' clock-generator circuits

The two-gate astable circuit is not generally suitable for direct use as a 'clock' generator with fast-acting counting and dividing circuits, since it tends to pick up and amplify any supply line noise during the 'transitioning' parts of its operating cycle and thus to produce square waves with 'glitchy' leading and trailing edges. A far better type of clock generator circuit is the 'ring of three' astable shown in Figure 12.

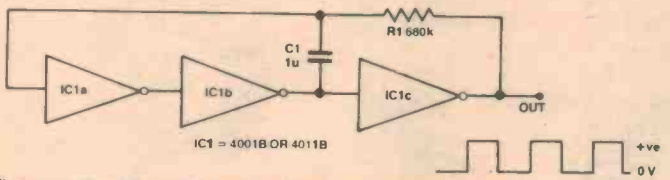


*Figure 12.* This 'ring-of-three' astable makes an excellent clock generator.

The Figure 12 'ring of three' circuit is similar to the basic two-gate astable, except that its 'input' stage (IC1a-IC1b) acts as an ultra-high gain non-inverting amplifier and its main timing components (C1-R1) are transposed (relative to the two-gate astable). Because of the very high overall gain of the circuit, it produces an excellent and glitch-free square wave output, ideal for clock-generator use.

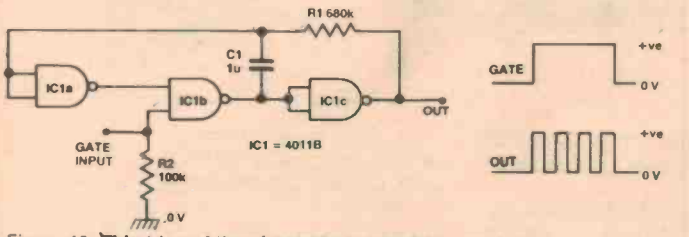


*Figure 13.* This 'ring-of-three' astable is gated by a logic 1 input and has a normally low output.

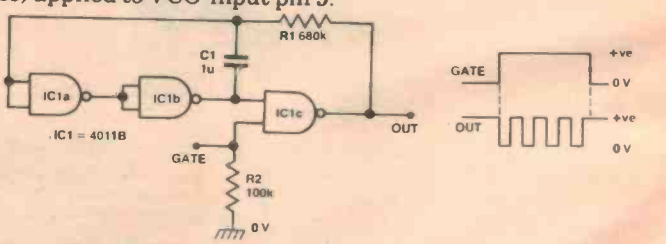


*Figure 14.* This gated 'ring-of-three' astable is gated by a logic 1 input and has a normally high output.

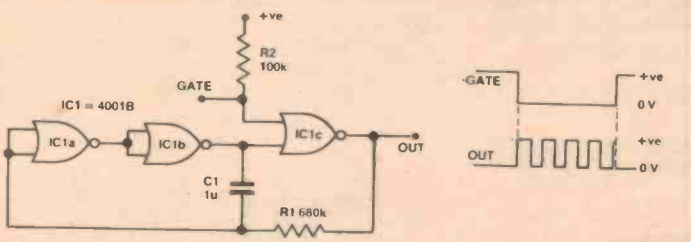


*Figure 15.* Ring-of-three gated by a logic 0 input and having a normally low output.

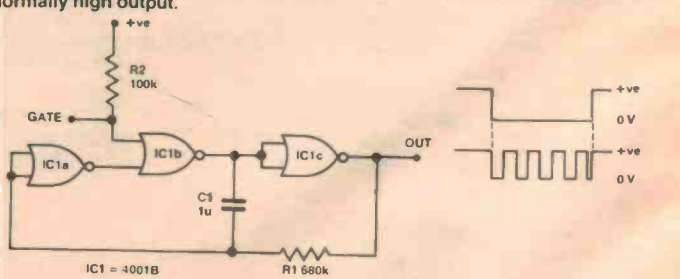


*Figure 16.* Ring-of-three with normally high output and logic 0 gating.

The basic ring-of-three astable can be subjected to all the design modifications we've already looked at for the basic two-gate astable; e.g: it can be used in either basic or compensated form and can give either a symmetrical or non-symmetrical output, etc. The most interesting variations of the circuit occur, however, when it is used in the 'gated' mode, since it can be gated via either the IC1b or IC1c stages. Figures 13 to 16 show four variations on this 'gating' theme.

Thus the Figures 13 and 14 circuits are both gated on by a logic 1 input signal, but the Figure 13 circuit has a normally low output, while that of Figure 14 is normally high. Similarly, the Figures 15 and 16 circuits are both gated on by a logic 0 signal, but the output of the Figure 15 circuit is normally low, while that of Figure 16 is normally high.

## 4046B VCO circuits

To close this look at CMOS square wave generator circuits, let's look at some practical VCO applications of the 4046B phase-locked loop (PLL) IC. Figure 17 shows the internal block diagram and pinouts of this chip, which contains a couple of phase comparators, a VCO, a zener diode and a few other bits and pieces.

For our present purpose, the most important part of the chip is the VCO section. This VCO is a highly versatile device; it produces a well-shaped symmetrical square wave output, has a top-end frequency limit in excess of 1 MHz, has a voltage-to-frequency linearity of about 1% and can easily be 'scanned' through a 1 000 000:1 range by an external voltage applied to the VCO input terminal. The frequency of the oscillator is governed by the value of a capacitor (minimum value 50p) connected between pins 6 and 7, by the value of a resistor (minimum value 10k) wired between pin 11 and ground, and by the voltage (any value from zero to the supply voltage in use) applied to VCO-input pin 9.

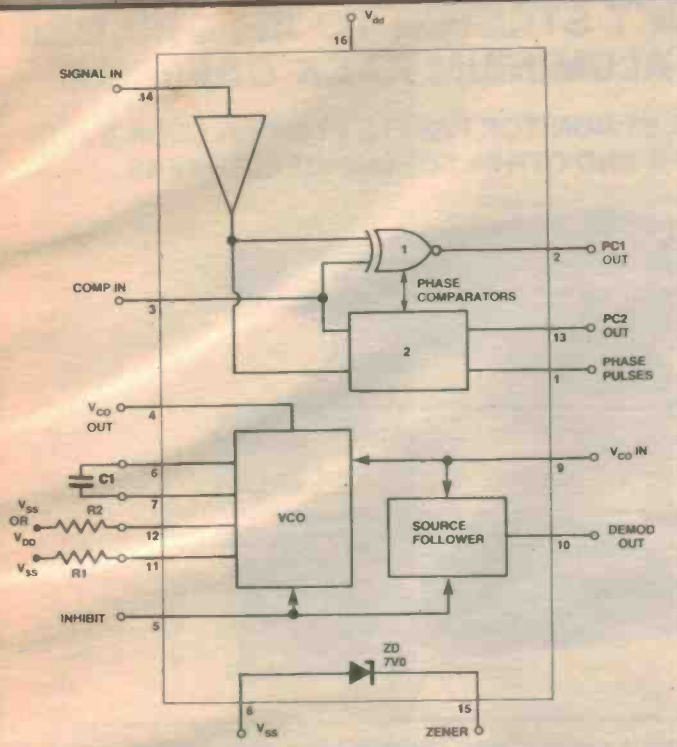


*Figure 17.* Internal block diagram and pinouts of the 4046B.

Figure 18 shows the simplest possible way of using the 4046B VCO as a voltage-controlled square wave generator. Here, C1-R1 determine the maximum frequency that can be obtained (with the pin 9 voltage at maximum) and RV1 controls the actual frequency by applying a control voltage to pin 9. The frequency falls to a very low value (a fraction of a Hz) with pin 9 at zero volts. The effective voltage-control range of pin 9 varies from roughly 1 V below the supply value to about 1 V above zero, and gives a frequency span of about 1 000 000:1. Ideally, the supply voltage to the circuit should be regulated.

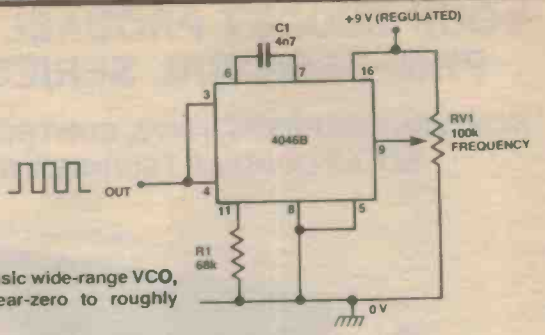


*Figure 18.* Basic wide-range VCO, spanning near-zero to roughly 5 kHz.

We've said above that the frequency of the Figure 18 circuit falls to near-zero when the input voltage is reduced to zero. Figure 19 shows how the circuit can be modified so that the frequency falls all the way to zero with zero input, by wiring a high-value resistor (R2) between pins 12 and 16. Note here that when the frequency is reduced to zero, the VCO output randomly settles in either a logic 0 or a logic 1 state.

Figure 20 shows how the pin 12 resistor can alternatively be used to determine the minimum operating frequency of a restricted-range VCO. Here, $f_{min}$ is determined by C1-R2 and $f_{max}$ is determined by C1 and the parallel resistance of R1 and R2.

Figure 21 shows an alternative version of the restricted-range VCO, in which $f_{max}$ is controlled by C1-R1 and $f_{min}$ is determined by C1 and the series combination of R1 and R2. Note that by suitable choice of the R1 and R2 values, the circuit can be made to 'span' any desired frequency range from 1:1 to near-infinity.

Finally, it should be noted that the VCO section of the 4046B can be disabled by taking pin 5 of the package high (to logic 1 level) or enabled by taking pin 5 low. This feature makes it possible to gate the VCO on and off by external signals. Thus Figure 22 shows how the basic VCO circuit can be gated via a signal applied to an external inverter stage. Alternatively, Figure 23 shows how one of the internal phase comparators of the 4046B can be used to provide gate inversion, so that the VCO can be gated via an external voltage applied to pin 3. ●

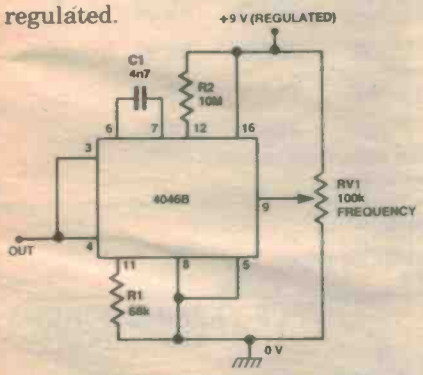


*Figure 19.* Modification of the Figure 18 circuit takes it all the way down to zero.

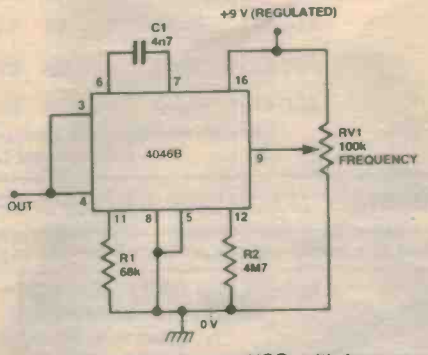


*Figure 20.* Restricted-range VCO, with frequency variable from roughly 72 Hz to 5 kHz via RV1.

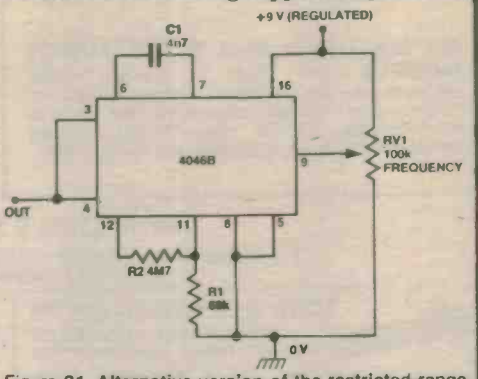


*Figure 21.* Alternative version of the restricted-range VCO. Maximum frequency is controlled by C1-R1, minimum by C1-(R1+R2).

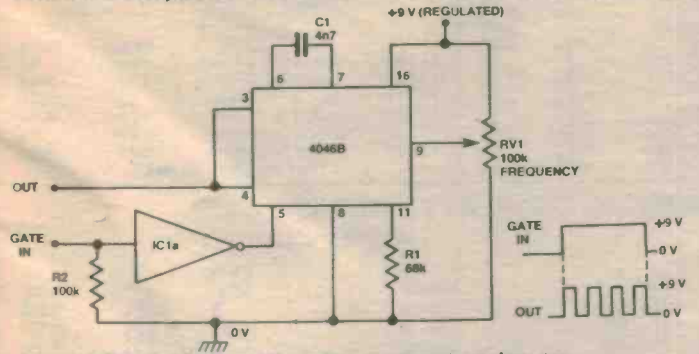


*Figure 22.* Gated wide-range VCO using an external gate inverter.

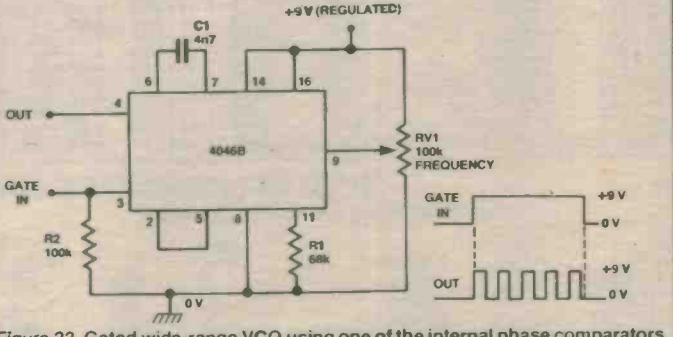


*Figure 23.* Gated wide-range VCO using one of the internal phase comparators as a gate inverter.

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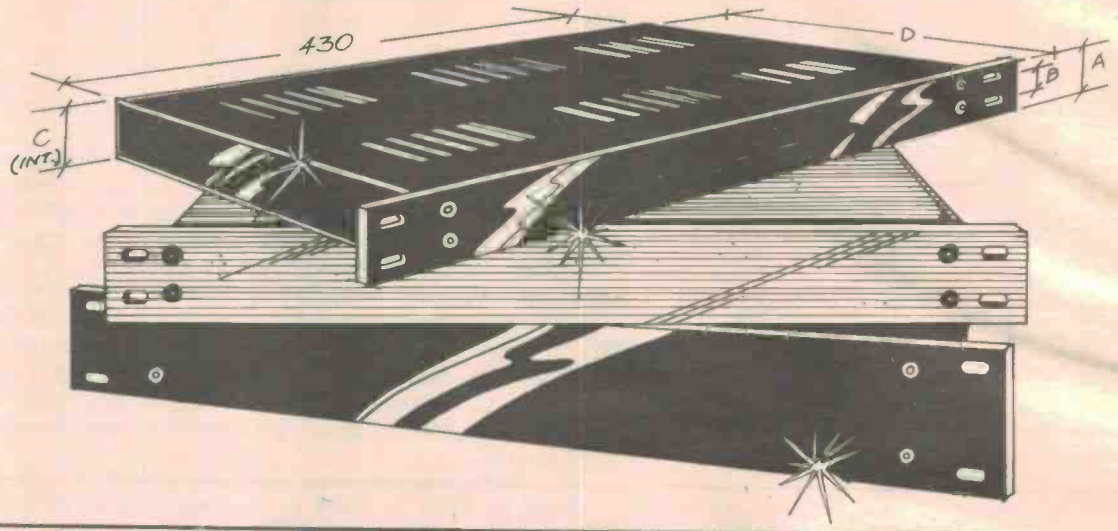


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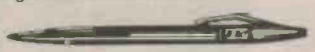

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# Xenon flasher for pushbike riders

If you go riding your pushbike on a dark night during a power blackout, you'll need this project. Even if you just ride your bike at nights, being visible to other vehicles is important for safety. A bright flashing light will see to that.

Jonathan Scott

THIS IS an idea which is only just catching on in the US (so who knows how long it will be before it gets proper commercial release here), and it's a good thing indeed. Let's face it — bicycle lights are pretty useless for seeing things, but they serve the valuable purpose of letting the rider *be seen*. It is also not a recent realisation that a xenon flash is easily seen at a distance and potentially very power economical, which is what you want if you have to purchase (and carry) the batteries.

So here it is: the low-cost, high visibility bicycle flash. It will flash for many hours on one single cell, a Nicad being best as you only have to pay about ten times the initial price for 100-500 times the life.

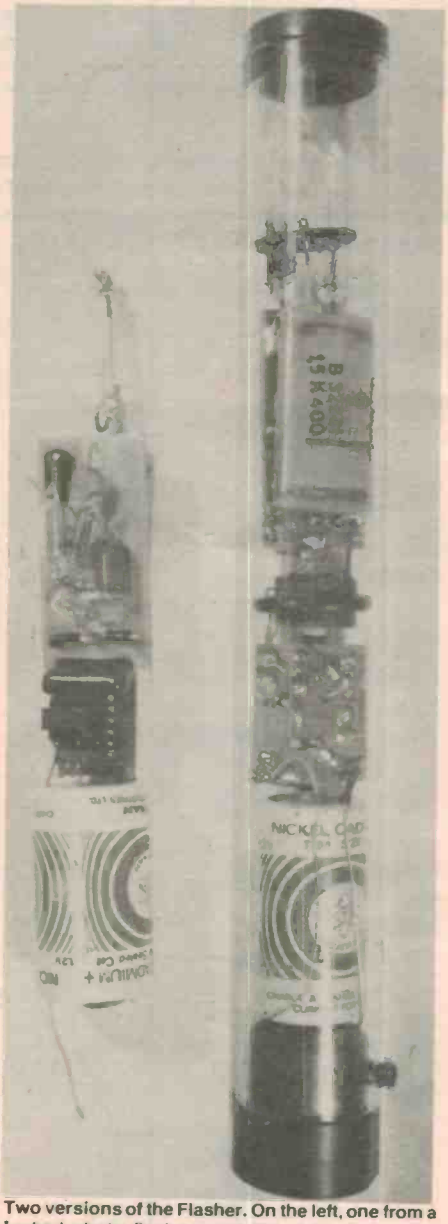
Our prototypes, one constructed using a dismantled $10 flashgun and one from commercial electronic suppliers' parts, ran for 15 hours and 8 hours at 1 Hz and 4 Hz respectively, on $7 Nicads. One quarter of this can be expected from $2 Nicads.

The unit can be recharged from any convenient source including the ETI-563 Fast Nicad Charger, a bicycle dynamo, or the charger we include in this project.

## Bits and pieces

As we mentioned before, we have built one 1506 using parts from a $10 flashgun purchased expressly for this purpose. The advantage of this is that you get the xenon tube, trigger transformer and neon lamp all customised and prepacked. You also get a prewound converter transformer, though we recommend that you wind your own, as we did, as the result is about twice as power efficient.

Alternatively the project can be made entirely from easy-to-find parts, with one small circuit modification. Perhaps at this stage you are rather confused by all the options, so let's break the project up into its two basic sections and describe how you go about each part.



Two versions of the Flasher. On the left, one from a junked photo flashgun; on the right, from over-the-counter parts.

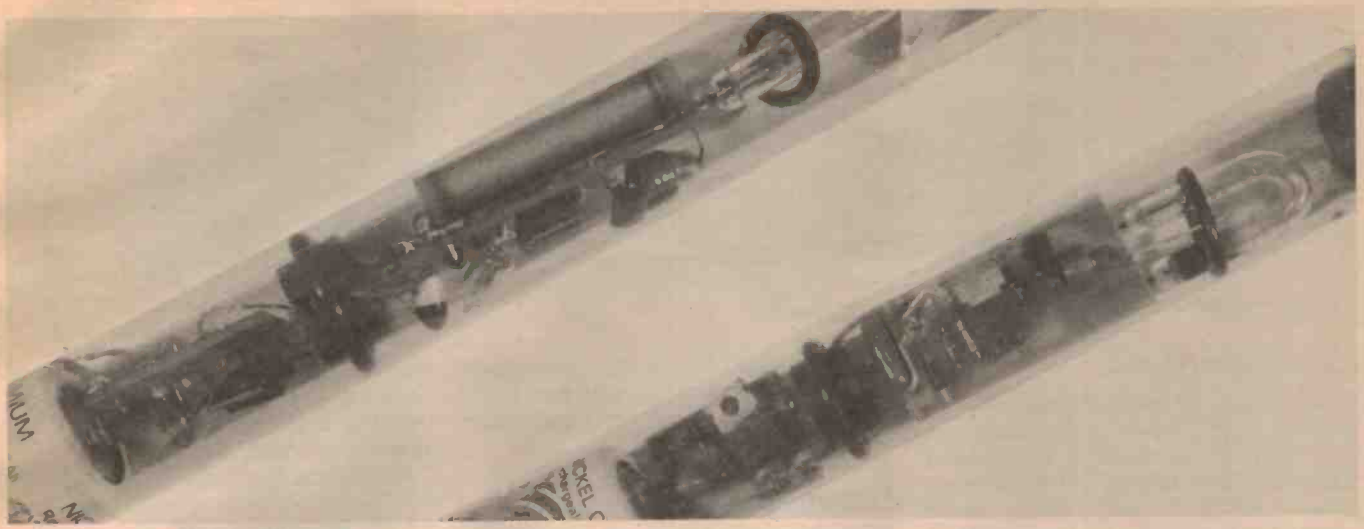
## Our preference

Referring to the circuit in Figure 1, which is our preferred and recommended circuit, you see that it is composed of a dc-ac converter board (taken directly from the ETI-575 Light Wand) and its transformer, and an ac-dc flash driver board. Starting with the latter, if you then have or purchase a cheap flashgun, you will also have the tube, trigger transformer and 220 V neon.

The small flash-type xenon tubes seem to be slightly more light-efficient than the 'U'-tube type locally sold, and are less easily broken, so we prefer them. If you don't get hold of it this way you may have difficulty getting the neon, so we have made provision on the pc board for using three of the local 70 V type (NE2) in series, in place of the single 220 V one.

An advantage of using the 220 V tube is that it delivers a non-regular flash rate, which we feel improves recognisability and reduces risk of confusing you on the bicycle with any other flashing light. We won't go into the physics of why the xenon tube does this, but suffice it to say that the 70 volt types do not have sufficiently significant erratic factors to give a visibly varying rate over short time periods.

If you use the three neons in series, you will have to cut off the SCR's heatsink tab to make the necessary room. This is quite safe, as it dissipates negligible power. See the two overlay diagrams for details of this. The tab can be removed by hacksaw, side cutters or simply by bending it until it fatigues, as it is made of thin, soft metal. This should present no problem. ▶



Inside views of the 'preferred' flash unit.

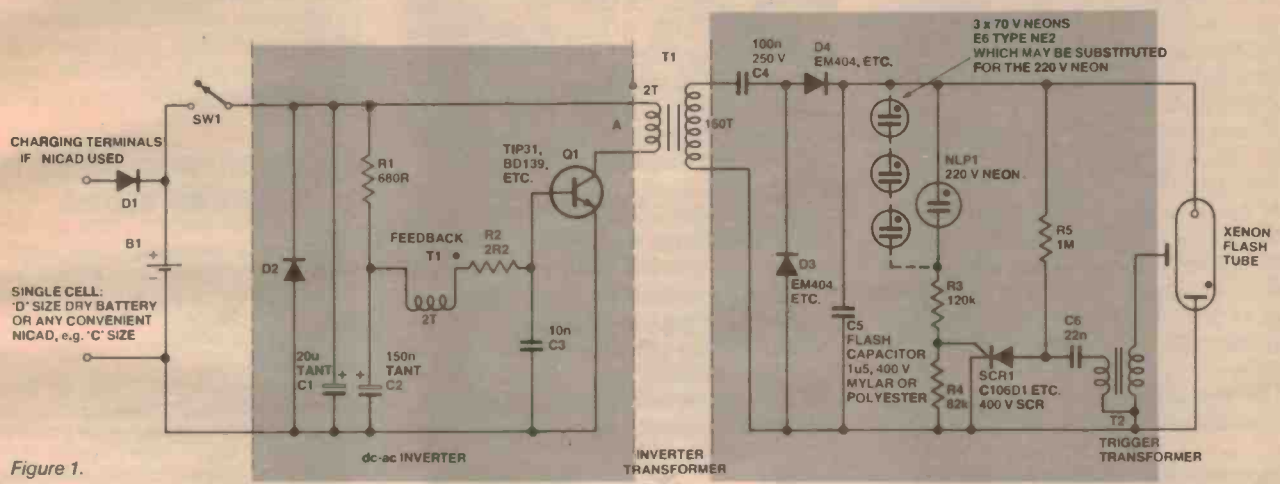



*Figure 1.*

## HOW IT WORKS — ETI 1506

There are two major sections to the circuitry: first the dc-ac inverter, followed by the xenon flasher.

### INVERTER

This employs the inverter circuit from the ETI-575 Light Wand (ETI, Aug. '79). This section of the circuit is shown on the left in Figure 1. R1, R2, C2, C3, Q1 and T1 comprise a self-oscillating dc-ac inverter.

Initially, Q1 is turned off. At switch-on, current flows through R1, charging C2. Subsequently C3 charges up via the feedback winding and R2. When C3 reaches about 0.55 volts, Q1 begins to conduct. The feedback winding then forces more current into C3 via R2 because of the phase of its connection. Q1 is then turned hard on. During this positive feedback cycle C2 is actually forced to discharge. R2 limits the maximum base current, and C3 removes fast spikes from the base circuit. These together serve to protect Q1's base.

Eventually, the magnetic field induced by the collector current of Q1 in the primary ceases to increase and the positive feedback ceases. Q1 then begins to turn off and the magnetic field in the core begins to collapse. This produces a negative voltage across the feedback winding which biases Q1 hard off. Then the cycle repeats, R1 and C2 defining the frequency and the power delivered to the tube, since a constant amount of energy (equal to $I^2$ max times L) is transferred to the load each cycle.

### XENON FLASHER

This part of the circuit is shown on the right in Figure 1. C4, C5, D3 and D4 form a 'diode pump', which rectifies the ac output from the secondary of T1 and will 'fill' C5, the 'reservoir capacitor', after a number of cycles, raising the voltage across it to the peak-to-peak input voltage. On negative excursions of the voltage from the secondary of T1, C4 charges via D3. On positive excursions, the charge in C4 is transferred via D4 to C5, and C4 is reverse charged. The period taken to charge C5 is of course dependent on its capacitance and the peak input voltage, which varies because of the inverter's output impedance. However, C5 will, after some time, exceed the 'breakover' voltage of the neon, NLP1 (or the string of three neons). This then conducts, triggering the gate of SCR1, via R3/R4. Resistor R4 prevents false triggering of the SCR by tying it to the cathode with a relatively low impedance.

Before SCR1 triggers, C6 will have charged up to the supply voltage on C5, via R5 and the primary of T1. When SCR1 fires it suddenly connects C6 directly across the primary of T1, whereupon C6 discharges rapidly, producing a large voltage spike at the secondary. This is connected to a 'trigger' electrode wrapped around the outside of the xenon flash tube, and the voltage stress produced causes the gas inside the tube to ionise. Current then flows between the anode and the cathode of the xenon tube, the gas emitting much light in the process. The current flowing in the xenon tube discharges C5. When the voltage on C5 falls far enough, the xenon tube cannot maintain ionisation and it ceases conducting, as does NLP1. The SCR1 will also return to the non-conducting state as less than the anode-cathode latching current required flows through R5. Thus C5 starts re-charging and the whole cycle repeats.

The point at which NLP1 ionises varies with the immediate electrostatic field it is experiencing and also with the ambient radiation level, as these are significant factors in the ionisation process in neon lamps of this type. Thus flashing is erratic when a 220 V neon is used.

The function of diode D1 is to prevent B1 discharging via the charging terminals if they are accidently shorted, while D2 protects Q1 in the event of reverse polarity connection of the battery. (This is particularly likely if you ever use dry batteries, as they are changed often and it's easy to slip them in a battery holder the wrong way round.)

Capacitor C1 provides a low impedance bypass for the supply rail.

Overall view of the Flasher constructed from a cannibalised flashgun.

## Converter circuit

Considering the converter circuit, we decided we would build one ourselves and 'borrow' one from a commercial flashgun. Ours turned out to be more power efficient, and quite easily adapted to using only 1.2 V of supply. It is, of course, the more effort-consuming option, as you have to wind your own transformer and make up an ETI-575 pc board, but this is the more pleasing way, electronically speaking.

If you have bought a flashgun that uses one, two or four cells, you must of course use that number if you want to use its transformer. You will have to quickly trace out their circuit to get the pin connections of the transformer before you dismantle it. It is almost certain to look like Figure 2, from which you can get a converter circuit like Figure 3.

Use the original transistor(s) as well if you like. We used a BD139 to show that it too will do the job. We suggest you only undertake this if you know what you are doing tracing around someone else's pc board.

## Housing

We elected to build our units in the same perspex tubing which we used for the Light Wand. It has 26 mm inside diameter and 32 mm outside diameter, and so just accommodates the 'C' size batteries neatly. There is no reason why you can't build it in any transparent housing, such as a plastic kitchen container, and use a battery larger or smaller as you wish. A penlight Nicad will comfortably run the unit, though not for as long as a 'C' cell, as its capacity is 0.45 Ah rather than about 1.8 Ah (if you have the high density ones).

The charger circuit supplied here is specially designed to charge a single or two 1.8 Ah batteries, and is thus suitable for the units as we have built them.

A dynamo on a bicycle may also be used, connected directly to the charging terminals. The series charging diode must be a 3 A type.

One last note. C5, the flash capacitor, can be any value from 0.5 uF to about 10 uF. We used 1.5 uF. The larger its value, the brighter the flash, but the less frequent. 1.5 uF gives about 3-4 Hz, visible for at least a kilometre of open ground. You may select the capacitor you use for its physical convenience, as we did.

### INVERTER TRANSFORMER, T1 WINDING DETAILS

**Potcore**

Phillips P26/16, 3H1 material, ue68 potcore with single section former, No. 4322-022-28250. Alternatively, a P18/11, 3H1 material, ue1750 potcore could be used. It is physically smaller, which may be an advantage.

**Secondary winding**

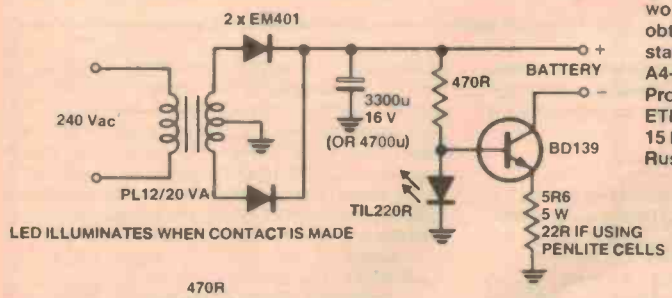
This should be wound first. Wind on 150 turns of 0.2 mm diameter enamelled copper wire (32 B&S), close-wound in layers. As you complete a layer, wrap a length of sticky tape over it before winding the next layer. You'll take about four to six layers. Put a layer of sticky tape over the completed winding.

**Primary and feedback**

These are wound *bifilar* — two lengths of wire wound side by side. Two turns are required. Use any convenient wire diameter greater than or equal to 0.5 mm (e.g: 22 B&S enamelled copper). Note: Mark the *start* leads of each winding — these correspond to those points on the circuit marked with a '•'.

If you've never done this sort of thing before, the article on the ETI-575 Light Wand (August '79) gives a detailed description of the sort of technique employed.

Charger for Nicads suitable for the Flasher




NOTE: Printed Circuit artwork for this project can be obtained by sending a stamped, self-addressed A4-sized envelope to:
Project 1506 Artwork
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011

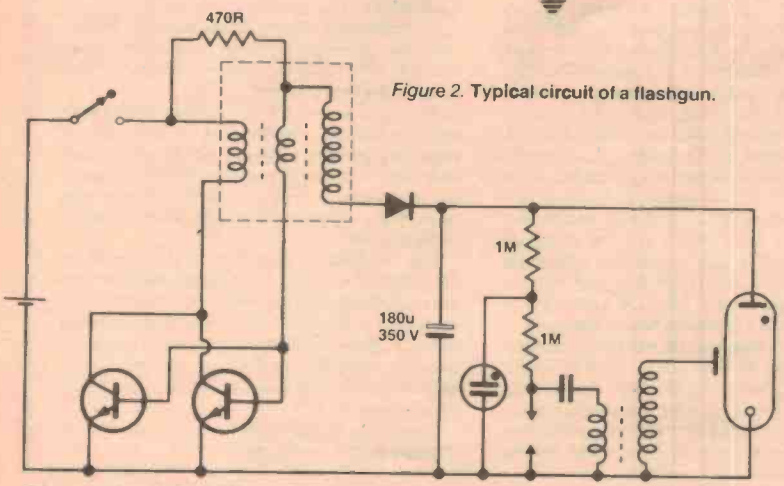
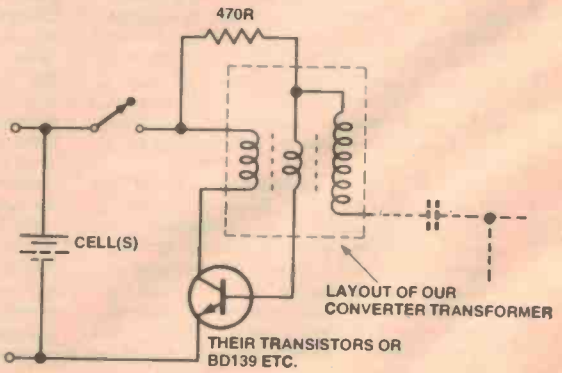
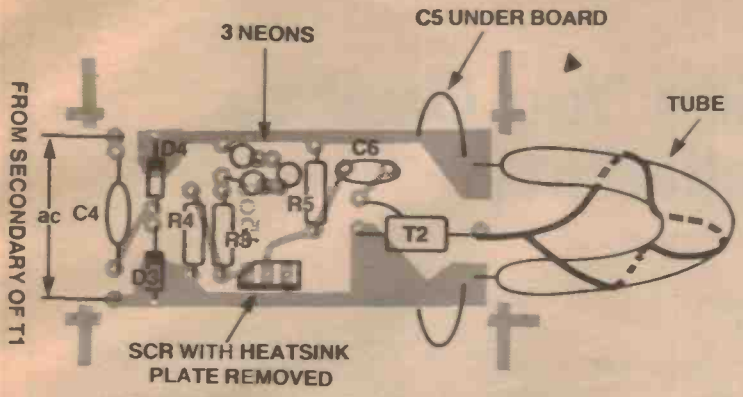


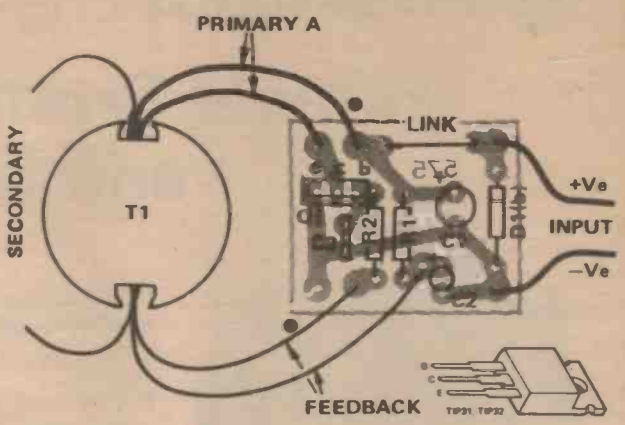

*Figure 2.* Typical circuit of a flashgun.

*Figure 3.* Converter circuit from typical flashgun.






1506 PCB OVERLAY — USING 3 NE2 NEONS




## Construction

Construction is best commenced by winding the converter transformer, T1, if you're not using one from a cannibalised flashgun. Details are given in the accompanying panel. Having wound this, carefully scrape about 10 mm of the enamel from the end of each wire and tin carefully. Make sure you have the leads clearly identified.

The inverter board should now be assembled. This employs the ETI-575 pc board, and the accompanying component overlay shows the general construction and wiring. As usual, watch component orientation with D2, Q1, C1 and C2.

The flasher board can now be assembled. The component overlay shows general assembly for the U-shaped tube, but accompanying photographs show how a straight tube from a flashgun was mounted. Note that the discharge capacitor, C5, is mounted on the 'underside' of the pc board (i.e: copper side). Again watch the orientation of semiconductors. If you've gutted a flashgun, the single 220 V neon mounts between the free end of R3 and the track to the cathode of D4.

With the U-shaped flash tube, note that a length of tinned copper wire needs to be wrapped around the tube as a trigger electrode, and connected to the secondary of the trigger transformer, T2.

Once it's all together, apply power and see that it flashes as desired. If not, check the voltage across C5. If nothing there, reverse the feedback winding connections on T1 and it should work.

The housing is left up to you as individual requirements are likely to vary widely. If you want to mount the project in a perspex tube, the technique is described in the ETI-575 Light Wand article, ETI August 1979, p.55.

Happy flashing! ●

Close-up of Flasher construction from gutted flashgun, top side.

Same unit, bottom side.

### PARTS LIST — ETI 1506

**Resistors** ..... all ½W, 5%

| | |
|---|---|
| R1* | 680R |
| R2* | 2R2 |
| R3 | 120k |
| R4 | 82k |
| R5 | 1M |

**Capacitors**

| | |
|---|---|
| C1* | 20u tant. |
| C2* | 150n tant. |
| C3* | 10n greencap |
| C4 | 100n/250 V poly. |
| C5 | 1u5/250 V poly. This could be any value from 470n to 10u, at least 250 V or greater rating. |
| C6 | 22n/250 V poly. |

**Semiconductors**

| | |
|---|---|
| D1, D2 | 1N5404, A15P; 3 A diode. (1 A type may be used if slow charging only is used) |
| D3, D4 | 400 V (PIV), 1 A diodes — EM404 or sim. |
| Q1 | TIP31 or BD139, etc. |
| SCR1 | C106D1 or similar 400 V SCR |

**Miscellaneous**

| | |
|---|---|
| T1* | see winding details or text |
| T2 | trigger transformer for xenon flash tube** (e.g: Circuit Components TR4KN) |
| NLP1 | 220 V neon or 3 x 70 V NE2 type neons. |
| B1 | single Nicad battery |
| SW1 | SPST miniature toggle switch |

Xenon flash tube** (e.g: Circuit Components type MFT1210); ETI-575 and ETI-1506 pc boards; clear case or tube to suit.

* Delete these components if using inverter components from flashgun.
** These components may come from scrapped flashgun.

**Price estimate** $25-$28

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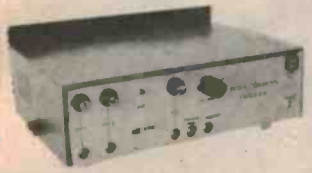

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| PF4361/1 Power transformer (or sim) | $39.50 |
| ETI 498 Module | $39.50 |
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REF: EA 11/81-1/82

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This unit has been extremely popular with audio enthusiasts right across Australia! EA have designed a special crossover/booster amp just for this unit. Now you have no excuse to build a subwoofer system to enjoy those thrilling low notes from pipe organs, synthesisers, 1812 cannons etc!!

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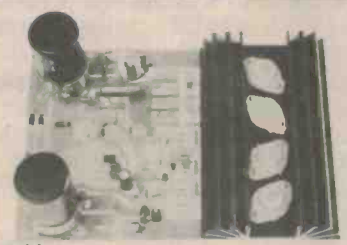

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✱ Ref: EA April 1982

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REF: EA JUNE 1982

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# 13.8 V regulated high current supply

Here's a supply that's just the thing for operating transceivers, RF power amplifiers, etc, or anything that requires a 13.8 Vdc (nominal) supply and pulls more amps than the general run of 'CB' type power supplies can deliver.

**Roger Harrison**
**Geoff Nicholls**

MANY AMATEURS operate a mobile VHF or UHF transceiver at home as well as in the vehicle — it's convenient and economical. Until a year or so ago, most of these transceivers ran about 10 W output, drawing up to 2 A from the 12 Vdc (nominal) supply. Then transceivers delivering 25-30 W and incorporating multimode operation appeared on the market. These draw about 6-7 A from the 12 Vdc supply, and owners of 10 W output transceivers often add an 'afterburner' to boost the transmitter output. The ETI-710 (April '76) and ETI-716 (Jan. '78) 2 m booster amplifier projects provided around 40-45 W output on 2 m from a drive of 10 W, drawing around 7 A from a 12.5 V supply. A number of commercial amplifiers giving similar performance is available, too.

For novices, HF band transceivers, such as the Yaesu FT-7, are popular, but operate from a 12.5 Vdc supply. The FT-7 draws about 3.3 A on transmit, and similar transceivers from other manufacturers are much the same. Trouble is, the common 'CB'-type power supplies are generally rated to deliver only 2 A continuous, and while some will deliver up to 4 A intermittent, a 3 A load is too much for them.

Marine VHF FM band transceivers require a dc supply and, as they run 25 W, CB-type supplies are unsuitable if mains operation is contemplated for a base installation.

This power supply is intended to suit all the sorts of applications mentioned above — and any others you can think of where dc-operated equipment draws more than 3-4 A.

As most dc operated equipment is specified to operate from a 13.8 V supply, that's the output voltage we have settled on. The current rating we have quoted is based on several factors. Firstly, while the transformer specified has a secondary rating of 18 V/6 A, it is capable of delivering much more before the secondary output voltage loads down seriously. In addition, transformer temperature rise needs to be taken into account. Hence we determined a current rating by experiment, taking these factors into account, and it turns out to be 7.5 A. However, as much as 10 A can be drawn from the supply intermittently. At this point the regulator circuit cannot maintain output voltage, as the input-to-output differential begins getting a little too low. Short circuit current limit was set at this point too, for convenience.

No current meter was provided as this project was not intended as a test bench supply. The only indicators are a bezel lamp to indicate the supply is on and an 'overload' LED to warn that the supply has gone into current limit should you attempt to draw too much current or have a short circuit on the output.

## Design notes

A capacitor-input bridge rectifier provides about 25 V input to the regulator circuit. This consists of a 12 V three-terminal regulator with output current being boosted by a pair of MJ15004 PNP bipolar power transistors connected in parallel. Current limiting is provided by a Darlington pair, Q1 and Q2, which senses the emitter current through the power transistors. When the current exceeds an amount determined by R2 (about 10 A), Q2 and Q1 turn on, Q1 robbing Q3 and Q4 of base current drive and preventing further increase in output current. When Q2 turns on, LED1 will turn on, providing indication of the overload condition.

The output voltage is determined by the three-terminal regulator, IC1. Its reference terminal is 'jacked up' by 1.8 V by the drop across the diode string D1 to D3, resulting in an output voltage of 13.8 V.

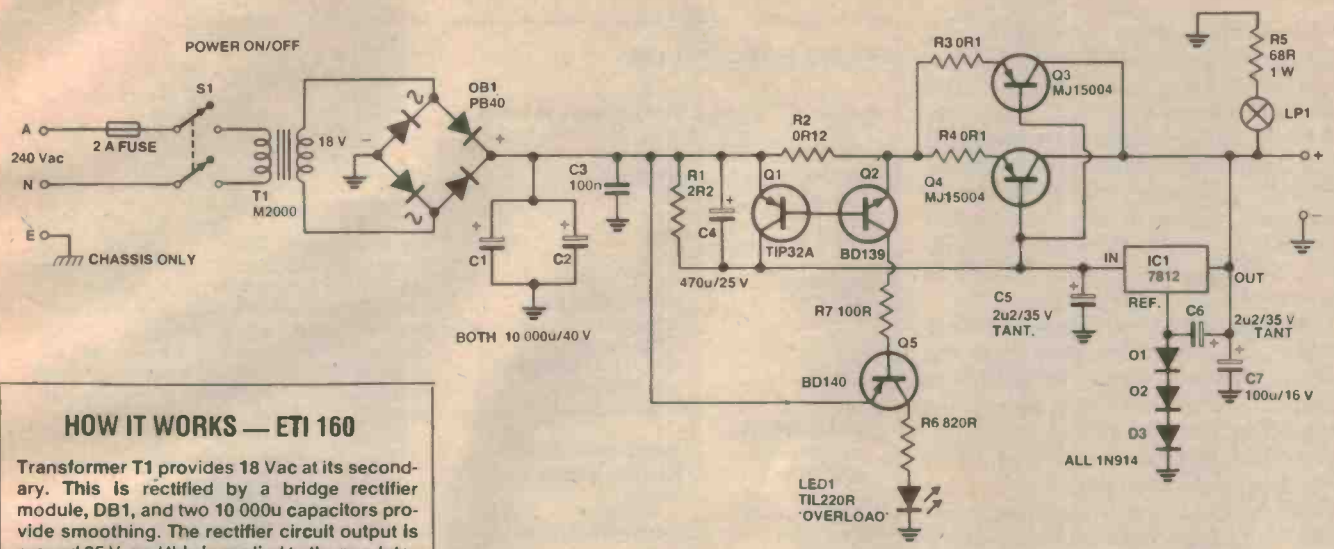
## Construction

We housed the power supply in a large K&W case, model C1064, measuring 155 x 155 x 255 mm overall. This has a U-shaped aluminium chassis with an etched front panel and four plastic feet that mount on the bottom. The case lid is steel, with ventilation slots punched in it and edges which wrap around the front and rear panels. It is secured by eight screws, four on each side panel. We made up a plastic Scotchcal stick-on label for the front panel.

Layout is generally non-critical, so components were placed in convenient positions. The heatsink carrying the major regulator components was mounted in a vertical position in the centre of the rear panel. The transformer was mounted on the bottom of the chassis, slightly to the right of centre, and the rectifier components were mounted to the rear panel. The overcurrent protection components were mounted on a small piece of matrix board on the bottom of the chassis, just to the left of centre and immediately behind the output terminals.

Unless you are purchasing this project as a kit with prepared metalwork, construction starts with the mechanical work. The heatsink should be tackled

# 13.8 V supply




## HOW IT WORKS — ETI 160

Transformer T1 provides 18 Vac at its secondary. This is rectified by a bridge rectifier module, DB1, and two 10 000u capacitors provide smoothing. The rectifier circuit output is around 25 V, and this is applied to the regulator circuit, which consists of Q1 to Q4, IC1 and associated components. Q5 drives the overload indicator LED.

IC1 is a positive 12 V three-terminal regulator, such as a 7812 or similar. A parallel pair of PNP power transistors, Q3 and Q4, are arranged to boost the output current. A portion of the input current to IC1 flows through the base-emitter junctions of Q3 and Q4. Their collectors are connected to the output and, as they are operated here as current amplifiers, the load current supplied is much greater than the three-terminal regulator can provide. Resistors R3 and R4 ensure collector-emitter currents through Q3 and Q4 are shared equally. About 300 mA of the load current is contributed by IC1.

The reference pin of IC1 ('REF.') is raised by about 1.8 volts by the three series-connected diodes, D1, D2 and D3. They are forward biased by the bias current that flows from IC1's reference pin. Thus the output voltage is nominally 12 + 1.8 = 13.8 volts.

Over-current protection is provided in the following way: when the load current passing through Q3 and Q4 exceeds about 10 amps, the voltage across R2 will be about 1.2 volts. This will forward bias the base junctions of Q1 and Q2, which will turn on. When Q1 turns on, its collector-emitter junction effectively shunts the bases of Q3-Q4, robbing them of drive current and thus limiting their collector current. When Q2 turns on, its collector current forward biases the base-emitter junction of Q5, turning it on. The collector current of Q5 flows through LED1, which lights, indicating the overload condition.

For thermal protection, IC1 is mounted on the heatsink along with Q3 and Q4. Three-terminal regulators incorporate a 'thermal shutdown' mode where, upon reaching an internal junction temperature of 150°C, circuitry on the chip shuts off the output.

Capacitor C3 is a high frequency bypass for the regulator circuit input. Capacitor C4 prevents instability of the overload protection circuit. Capacitor C5 ensures stability of IC1, while C6 improves transient response. C7 provides a low impedance ac shunt for the regulator circuit output. Lamp LP1 provides indication that the supply is on.

Note that the chassis is not connected to the regulator circuit common rail, and the whole circuit 'floats', permitting negative or positive grounded equipment to be connected without fear of possible shorts between the equipment and the power supply.

## SPECIFICATIONS
## ETI-160 POWER SUPPLY

| | |
|---|---|
| Output voltage | 13.8 Vdc |
| Output current | |
| continuous | 7.5 A |
| intermittent | 10 A |
| Regulation | |
| 0-7.5 A | 50 mV |
| 10 A | 1.3 V |

first. Mark out and drill the heatsink according to the accompanying drilling diagram. When drilling the TO3 pattern for the MJ15004 transistors, drill the lower bolt clearance holes first and then use the transistor insulating washer as a template to mark out the positions of the emitter and base pins and the other bolt hole. The emitter and base holes can be drilled to whatever clearance suits you — say 3 mm or 5 mm.

Don't forget the mounting holes on the heatsink flanges.

Using the drilled heatsink as a template, place it on the rear panel of the case as centrally as possible, flanges down and with the fins vertical. Now mark the positions of the four mounting holes and drill them to 3 mm. Draw two lines on the case rear, diagonally between the mounting holes just drilled. Where they cross, drill a 9 mm or 10 mm hole and insert a rubber grommet in it (that's a ⅜" grommet — they don't seem to have gone metric yet).

The transformer mounting holes should be drilled next. Place the transformer in the bottom of the case, orientated as shown in our internal picture, about 10 mm or so from the rear panel and about 15 mm to the right of the approximate centre line (when viewed from the front). The grommet you just inserted marks the approximate centre line. Mark and drill the transformer mounting holes to 6 BA clearance (3 mm is fine). Next mark and drill the mains cable entry hole, the fuseholder hole and holes for the mains cable clamp and terminal block. We mounted the fuseholder above the mains cable entry hole. The terminal block and cable clamp were located in a convenient position adjacent to the transformer on the bottom of the case. Drill a hole for the mains earth lug-mounting screw near the rear corner foot-mounting hole. When the mains cable is installed, the earth lead will thus be the longest, ensuring it is the last to break should the mains cable become detached.

The front panel may be marked out and drilled now, using the artwork or Scotchcal as a template. You can lay the artwork directly on the front panel and prick through it with a scriber or other sharp-pointed instrument at the hole centres. Or, you could trace the hole centres on tracing paper and mark them in the same way.

Three more holes need to be drilled in the rear panel — two to mount the clamps that secure the filter capacitors, and one for the bridge rectifier. The two 10 000 uF filter capacitors are each secured to the rear panel with a 30 mm diameter cable clamp. They are a bit larger in diameter than the caps so we used a strip of double-sided sticky tape to build out the diameter so the clamps gripped effectively. The general mounting and wiring arrangement of the caps and rectifier is shown in the accompanying diagram. Twist the positive and negative leads of the caps together. The positive leads can be brought through the +ve terminal of the bridge rectifier, as we did, if you're careful.

The Scotchcal front panel may be mounted now. We used the plastic-type ▶

Scotchcal, but these need attaching with care to avoid bubbles and ripples. The way we have found best is to first peel the backing from one edge, align the label with the edge of the case and rub it down firmly. Then, peeling off the backing as you go, smooth the label onto the panel, taking it slowly to avoid bubbles and ripples forming. If you do get a bubble, try to smooth it towards the nearest edge to remove it.

Use a sharp knife or scalpel blade to cut the Scotchcal label away over the holes in the front panel. When this is finished, all the components that mount on the front panel can be attached: the two output terminals, overload LED, bezel lamp and mains switch.

Since there are relatively few components, we have used a point-to-point wiring technique rather than assembling most components on a pc board. The regulator components are soldered on a tagstrip mounted in the heatsink 'well' and between this and the device pins. The overload protection components mount on a small piece of matrix board, as can be seen in our internal photograph.

Mount the power transistors, Q3 and

## PARTS LIST — ETI 160

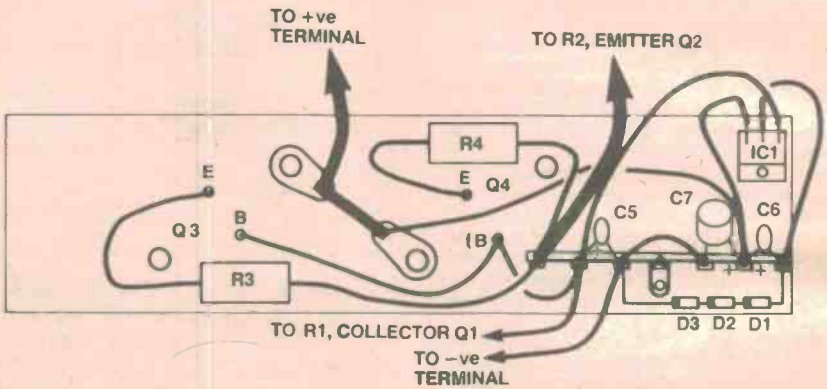
**Resistors** ..... all 5%, powers as noted
- R1 ..... 2R2, 1W
- R2 ..... 0R12, 10W
- R3, R4 ..... 0R1, 5 W
- R5 ..... 68R, 1W
- R6 ..... 820R
- R7 ..... 100R

**Capacitors**
- C1, C2 ..... 10 000u/40 V Elna RB electro.
- C3 ..... 100n greencap
- C4 ..... 470u/16 V RB electro.
- C5, C6 ..... 2u2/35 V tant.
- C7 ..... 100u/16 V electro

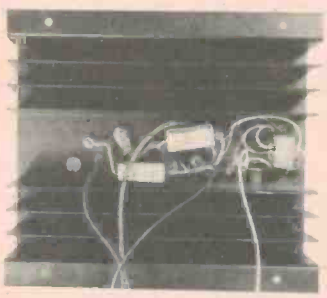
**Semiconductors**
- D1-D3 ..... 1N914, 1N4148, etc.
- DB1 ..... PB40, 40 A bridge rectifier
- IC1 ..... 7812
- Q1 ..... TIP32
- Q2 ..... BD139
- Q3, Q4 ..... MJ15004
- Q5 ..... BD140
- LED1 ..... TIL220R

**Miscellaneous**
LP1 — 6 V/100 mA E.S. lamp; S1 — DPDT 240 Vac rated paddle switch; T1 — 18 V/6 A transformer, e.g: D.S.E M2000; case — K&W C1064; bezel mount for lamp LP1; LED mounting hardware; 240 Vac cable and plug; terminal block; two grommets; cable clamp; three tag strips; Scotchcal front panel; heavy duty terminals; 150 mm length of 45D6CB heatsink; transistor insulating washers, etc; 4 x 6 mm standoff pillars; nuts, bolts, wire, etc.

**Price estimate $72-$80**

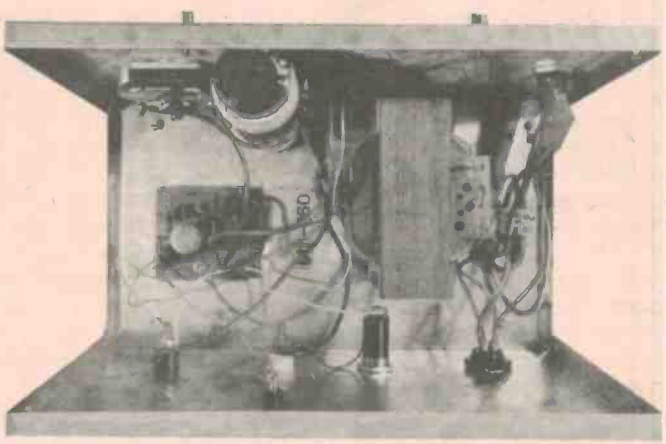



Wiring inside the heatsink.

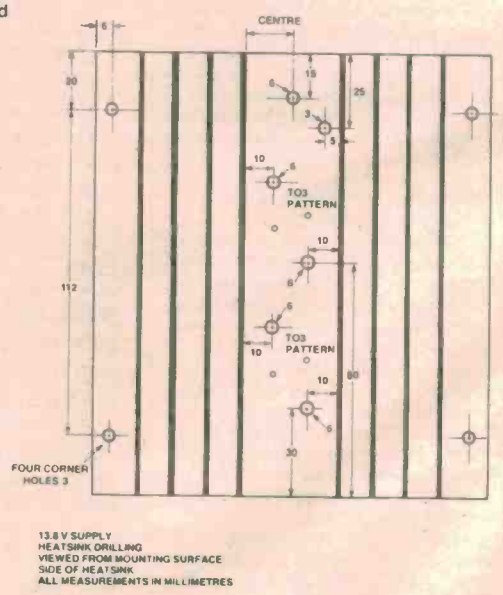


Inside the heatsink.

NOTE: Front Panel artwork for this project can be obtained by sending a stamped, self-addressed A4-sized envelope to:
Project 160 Artwork
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011



Inside the chassis, showing general component location.




Drilling the heatsink.

Q4, and the three-terminal regulator, IC1, on the heatsink, along with the tagstrip. You'll have to bend up the legs of IC1 back over its body. Carefully deburr all holes on the heatsink first and use mica washers and insulating bushes to mount them. Smear the mica washers with thermal compound beforehand. Use solder lugs under the nuts on the two mounting screws nearest to one another on Q3 and Q4 — as shown in the accompanying wiring diagram for the heatsink components. With a multimeter, check that the cases of Q3 and Q4 and the tag of IC1 are not shorted to the heatsink. If they are, disassemble the offending device and fix the problem before continuing.

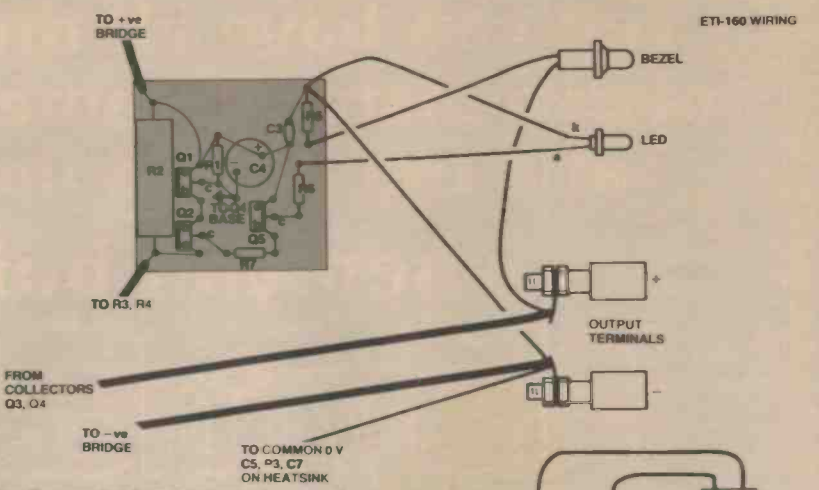
Solder the three 1N914 diodes (D1-D3) in series, with short leads between each, and solder them to the tagstrip as per the heatsink wiring diagram. Now solder C5, C6 and C7 to the tagstrip. Complete the wiring on the heatsink. Wire the collectors of Q3 and Q4 together using heavy duty hookup wire — preferably 32 x 0.2 mm. This point and the juncton of R3 and R4 should then have 250 mm lengths of heavy duty hookup wire attached, ready for wiring to the +ve output terminal and the emitter of Q2 respectively.

Two more wires run from the heatsink circuitry to inside the chassis — to the collector of Q1 and the +ve output terminal. Again, these should be 250 mm long, but only ordinary hookup wire is necessary. The heatsink assembly can now be mounted on the rear panel using 6 mm spacers.

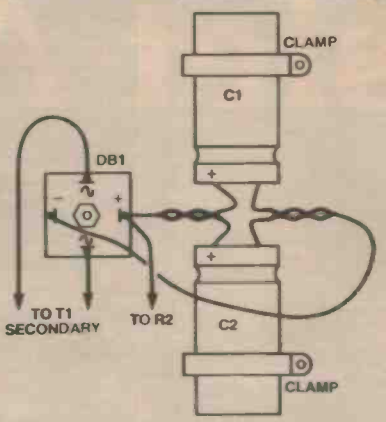
To mount the overload protection components we used a piece of matrix board about 55 mm square. General layout and component wiring is shown in the accompanying diagram. Remember to drill mounting holes in the matrix board and the bottom of the chassis. When completed, this board is mounted using 6 mm spacers.

Complete the construction by bolting in and wiring up the power transformer, the mains cable, fuse and switch, and the components mounted on the front panel. Note that it is important to use heavy duty hookup wire (at least 32 x 0.2 mm) between the filter caps' negative terminals and the −ve output terminal as well as from the rectifier's positive terminal to R2. Don't forget to bolt the four feet on the case.

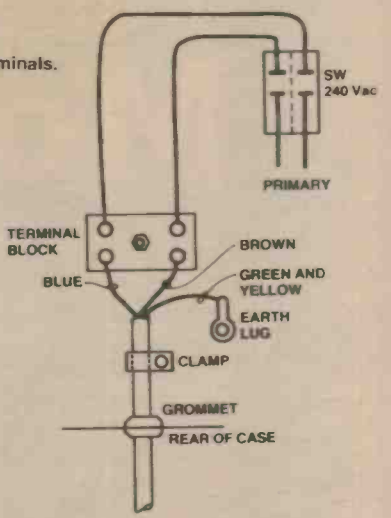
We used a 6 V/100 mA globe and a series resistor for the bezel lamp. You may have to change the value of the series resistor (R5) to accommodate globe rating. A 12 V globe could be used without a resistor, if you wish.




Wiring the overload components, bezel and output terminals.




Wiring the rectifier and filter capacitors.




Mains cable wiring. Be sure to sleeve all exposed connections for your own protection.

## Testing it

Carefully check all your wiring. If you're satisfied all is well, plug in and switch on. The bezel lamp should light immediately. Check the output with a multimeter. It should read within ±100 mV (0.1 V) of 13.8 V. If not, switch off and trace the fault. If the output is around 25 V, you have a fault in the regulator wiring. If the output is greatly lower, look for faulty rectifier wiring, or even a faulty rectifier (rare). Generally, problems will be caused by a wiring error.

If the output voltage is OK, you can apply a load and see what happens. A 100 W load consisting of a single car light, or a combination to make up that power, will draw around 7.25 amps. The output voltage should drop no more than 50 mV.

If you can make up a load to draw 10 A (you'll need two multimeters for this one), check that the output does not drop lower than 12.4-12.5 volts.

A multimeter capable of reading at least 12 A can be used to check the overload protection. Connecting the meter directly across the output terminals should result in a current of a little over 10 A (some 300-400 mA of the load current is contributed by IC1). This may vary somewhat, depending on the exact value of R2. If R2 is low, you may have to parallel another resistor across it to bring the overload current closer to 10.5 amps.

The overload LED should light when the load draws more than 10 amps.

When an overload remains on the supply for some time, the temperature of the heatsink will rise until IC1 reaches its temperature cutout point, at which stage it will turn off, turning Q3 and Q4 off, until the heatsink temperature drops. If the overload is still there when IC1 turns back on again, the process will be repeated until the overload is removed. This provides thermal protection to the unit. That's it!

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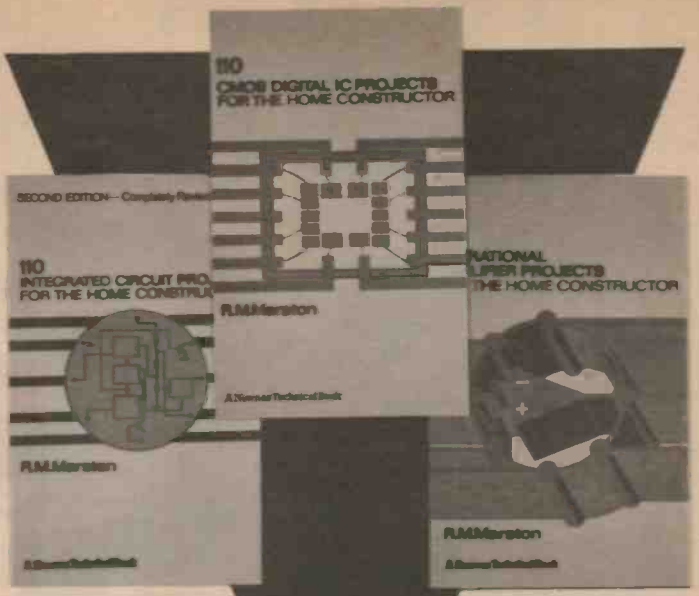


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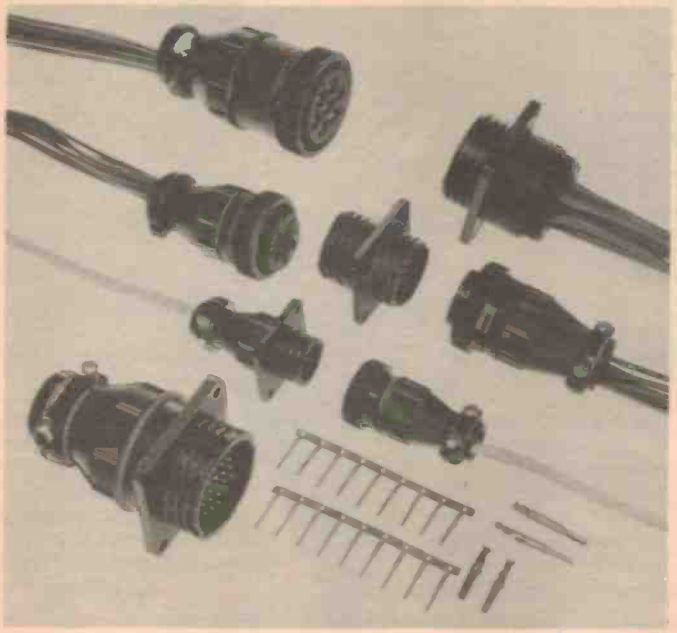

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Just the thing for lashing up circuits. There are three power supplies on board — +5 V, −5 V and variable 1.25 — 10 V. There are eight LED indicators, pulse detectors and a single generator. Uses a 'solderless breadboard'. P.O.A.

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| ET 261 | 2.90 | Fog Horn | Dec 79 | |
| ET 262 | 2.90 | Intercom | Dec 79 | |
| ET 263 | 2.90 | Simple Egg Timer | Dec 79 | |
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| ET 316 | 3.50 | Transistor Assisted Ignition | May 77 | |
| ET 317 | 3.50 | Car Rev Monitor | Jul 77 | |
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| ET 417 | 2.90 | Overload Indicator | Aug 73 | |
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| ET 452 | | Guitar Practice Amplifier | Jan 80 | |
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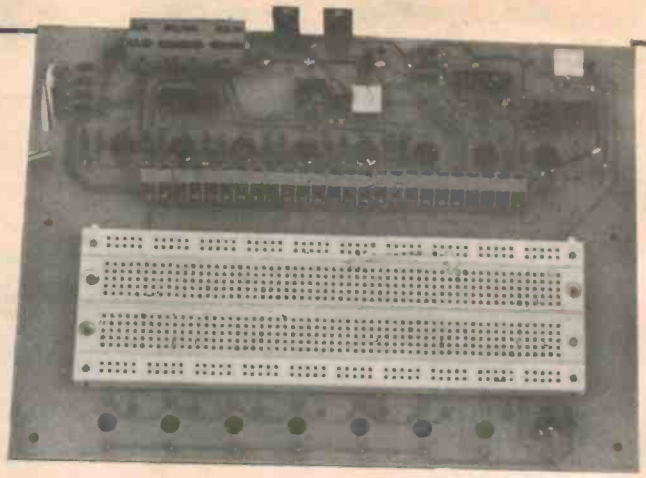
Prices spec. subject to change without notice.

Project 145



# 'Prototyper' breadboard

This is just the thing for lashing up circuits, experimenting with circuit techniques and component values, trying out circuit ideas, attempting circuit modifications, etc. If you're a dyed-in-the-wool experimenter, this project will be just your cup of tea.

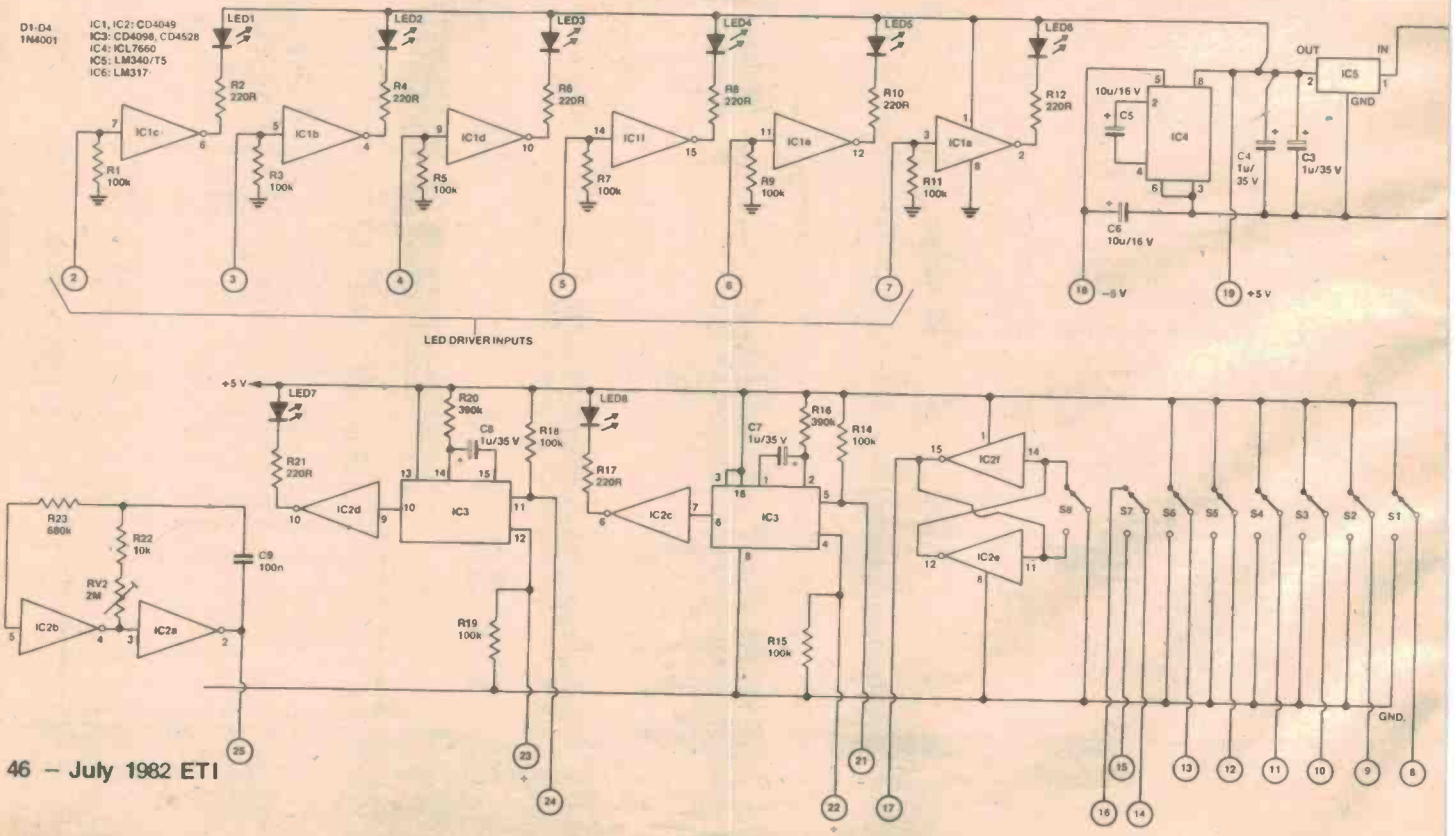
**Graeme Teesdale**

MANY HOBBYISTS have some form of 'patch board' or 'breadboard' used to mock-up circuits and make adjustments or modifications before laying out a printed circuit board. So many circuits only require a simple lash-up in order to 'prove' operation, but such lash-ups generally become monsters with power supplies, oscillators and whatever hanging off them all over the place. This project combines a number of useful pieces of test equipment on the one master printed circuit board. The unit is pretty well self-contained, with two fixed and one variable supply on-board, plus an oscillator, various indicators etc. Digital and analogue circuitry can be accommodated. It is powered from an ac plugpack — which keeps 240 Vac mains out of harm's way.

The overall size of the board is 200 x 155 mm, so it's quite compact. It fits readily into a briefcase . . . or even Roger Harrison's handbag! (— Eh? . . . Ed.).

The specifications table here lists the main features. The photograph at the head of the article shows the overall lay-out and construction. The pc board has been designed so that a 'breadboard' can be attached in the area toward the front. This consists of rows of pin sockets which accept transistors, ICs, wire and component leads, all arranged to make interconnection of components easy and logical.

Bus strips permit power supply con-nection. These are widely available and are known as 'breadboards', 'bimboard',



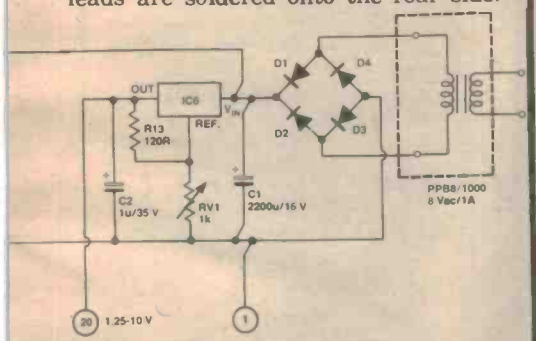
## SPECIFICATIONS

| | |
|---|---|
| Supplies | • +5 V @ 150 mA*<br>• −5 V @ 18 mA<br>• +1.25 — 10 V @ 100 mA*<br>*more with heatsink on regulators, see text |
| Signal | • Variable frequency multivibrator — 3 Hz to 600 Hz |
| Sources | • Debounced, spring-return SPDT switch (for single-shot pulses) |
| Indicators | • 6 x buffered LEDs<br>• 1 x positive-going, edge-triggered pulse indicator<br>• 1 x negative-going edge-triggered pulse indicator |
| Switches | up to seven SPDT switches, contacts available |

'breadboard socket', 'solderless breadboard', 'proto-board', etc. They are manufactured by firms such as Atek, Continental Specialities Corporation and others. You should be able to purchase one to suit this project for around $10 — $12. Make sure you get one that provides bus strips alongside the main breadboard for power supply connections.

## Construction

The unit is constructed on a double-sided printed circuit board with components mounted generally on the uppermost side. The indicator LEDs and the switches mount onto the board and their leads are soldered onto the rear side.




The Klippon screw terminal strips mount on the topside of the board, the pin connections being soldered on the rear side. Links from the top to the bottom side provide interconnection between tracks on each side of the board.

Circuitry occupies a strip along the upper portion of the board, the row of LED indicators coming between this and the Klippon screw connector strip. The switches are arranged in a row on the lower edge of the board. The terminations on the screw connector strip are marked on the upper surface of the board, etched in copper. Each of the switches and LEDs is similarly marked. Each of the first six switches connects the switch pole to 0 V (logic low) in one position ('down'), and to +5 V (logic high) in the other position. The seventh switch has all three terminals 'free', while switch eight is a spring-return type hooked up to a debouncing circuit to provide one-shot pulses for manual clocking, triggering, etc.

It is recommended you purchase a ready-made pc board if you are not experienced at making your own pc boards. For those who wish to tackle the board themselves, remember that it is double-sided as you will need to take particular care with registration to ensure board holes line up from top to bottom.

Commence assembly by carrying out a visual inspection of the pc board, looking for any shorts between adjacent tracks and (rarely) broken tracks. Check also that holes are drilled to convenient sizes for the LED mounting hardware, switches, etc. If your board is not drilled, then tackle the drilling first as it's difficult to do once you've mounted components to the board. LED mounting holes need to be drilled out to 6 mm diameter, but as switches vary we'll have to leave their hole sizes to you. ▶

## HOW IT WORKS — ETI 145

There are five sections in the Prototyper: power supplies, LED drivers, pulse indicators, square wave oscillator and switches.

### POWER SUPPLIES

There are three power supplies: +5 V and −5 V fixed supplies and a positive variable supply with a range of 1.25 to 10 V.

The Prototyper has been designed to work from an 8 Vac output plugpack, thus removing any 240 Vac mains connections from the pc board. A full-wave bridge rectifier (D1 — D4) and capacitor (C1) provide a 12.5 Vdc supply to the inputs of two three-terminal regulators, IC5 and IC6. IC5 is a positive 5 V regulator (7805, LM340/T5, etc), while IC6 is an adjustable positive three-terminal regulator (LM317, etc). R13 and RV1 provide a bias for the reference terminal ('REF.') of IC6, permitting adjustment of the output voltage over the range 1.25 V to 10 V.

Output decoupling capacitors (C2 and C3) are provided for each regulator, mounted physically close to the devices, to improve transient response and reduce supply interaction between devices where several power supplies may be hooked up to one circuit. Both three-terminal regulators have internal short circuit and thermal overload protection.

The −5 V rail is derived by IC4, an Intersil ICL7660 voltage converter. The operation of this device is explained in the panel elsewhere in this article.

### LED DRIVERS

The LED indicators, comprising LEDs 1 to 4, are driven by CMOS inverters from a 4049 hex inverting buffer chip. LEDs may be directly driven from the output of a CMOS inverting buffer, providing the current is limited to about 15 mA, hence 220 ohm resistors are connected in series with each LED (R2, R4, R6, R8, R10, R12). The input state of each of these buffers is determined by a 100k resistor from input to 0 V. This ensures the inputs are low, and thus the LEDs off, when the buffer inputs are open circuit.

### PULSE INDICATORS

To indicate the presence of narrow digital pulses which would not light a LED long enough to be seen, two monostables are connected as 'pulse stretchers'. IC3 contains two CMOS monostable multivibrators — either a 4098 or 4528 may be used here. They can be configured to provide stable retriggerable/resettable one-shot operation. The leading edge (positive-going) and trailing edge (negative-going) inputs are brought out to the input connector strip on-board (21 and 24), each having the appropriate resistor connected to +V or 0 V so that either input is enabled (resistors R14-15 and R18-19).

Timing of the 'stretched' pulses is determined by external RC networks — R16/C7 for IC3a and R20/C8 for IC3b. With the values chosen, the period is approximately 200 ms using the 4098; a small variation occurs with the 4528. With the latter, the 'reset' input is unused and connected to +V. Its 'disabled' operation can be observed when first switching power on. LEDs 7 and 8 will come on for the delay period, after which the circuit reverts to normal operation.

The 'Q' output of each monostable drives a LED (7 and 8) via buffers from IC2 (IC2c and d).

### OSCILLATOR

A variable frequency astable multivibrator provides a signal generator or clock source. Two inverting buffers from IC2 (another 4049) are connected so that positive feedback is provided via C9. R23 aids stability, and the frequency of oscillation is principally determined by C9/R22/RV2. The time to complete one charge-discharge cycle is approximately 1.4 times the RC time constant — but this can vary quite widely due to a 3:1 ratio of the transfer voltage within the device specification.

The oscillator has been made relatively independent of supply voltage variations by using a resistor (R23) in series with the input to the first inverter (IC2b). The frequency of oscillation is adjusted by varying the RC time constant. In this circuit RV2 permits varying the frequency over about a 220:1 range — giving coverage from around 3 Hz to 600 Hz. The frequency range can be reduced by increasing the value of C9.

The oscillator output is on pin 29 of the screw terminal strip.

### SWITCHES

Eight switches are provided for on-board; all are single-pole, double-throw types. Six (S1 to S6) are wired so that the pole switches between +5 V (logic high) and 0 V (logic low). One has all terminals brought out (S7), and one is connected to a debounce circuit (S8).

The debounce circuit employs two inverting buffers from IC2 cross-connected in a flip-flop configuration. One output from the flip-flop is connected to pin 17 of the screw terminal strip. This switch can be used as a debounced manual clock. Drive capability of the output is equivalent to two DTL/TTL loads, i.e: Vcc = 5 V, Vdl ≥ 0.4 V and Vdm ≥ 3.2 mA.

# Project 145

Next, insert and solder in place all the top-to-bottom wire links. These are marked with a '•' on the component overlay.

All the resistors may now be mounted on the pc board and soldered in place. Note that some have their leads soldered on both sides of the board, the lead acting as a through-hole link. The four rectifier diodes can come next, followed by the filter capacitor and bypass capacitors C1, C2, C3, C4 and C6. Take care with the polarity of these capacitors and the diodes. Again note that some have leads soldered both sides of the board.

Mount the two voltage regulator ICs, IC5 and IC6, next. It is useful to bend their leads so that the rear of the metal tabs on these ICs is in line with the edge of the pc board. Then you can attach a heatsink to them later if more current consumption is called for on the fixed +5 V rail and/or the variable supply. A 60 mm length of 25 x 25 mm aluminium angle bracket would make a fine heatsink and permit current outputs up to two or three times the currents specified.

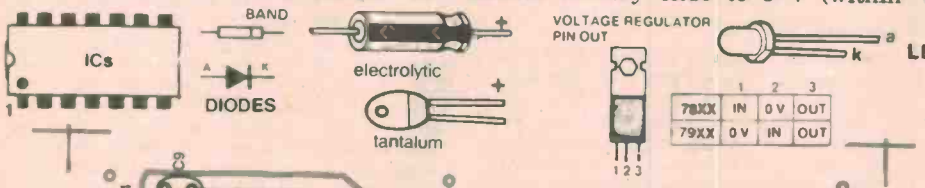
The variable supply trimpot, RV1, can be mounted now, along with the ICL7660 chip (IC4) and C5. Watch the orientation of the IC and the capacitor.

Power can now be applied for a test, if you wish. Check the supply voltages at the screw terminal strip pads. The two 5 V rails should be at 5 V ±0.1 V, and RV1 should provide an output from the variable supply that ranges between 1.25 V and 10 V. If RV1 is mounted correctly, a *clockwise* rotation will cause the variable supply output to *increase*. On no load, the voltage of the −5 V rail should be very close to 5 V (within 100 mV either way). Placing a 470 ohm resistor on its output as a load will cause the output voltage to fall to around 4.3 V, which is fine.

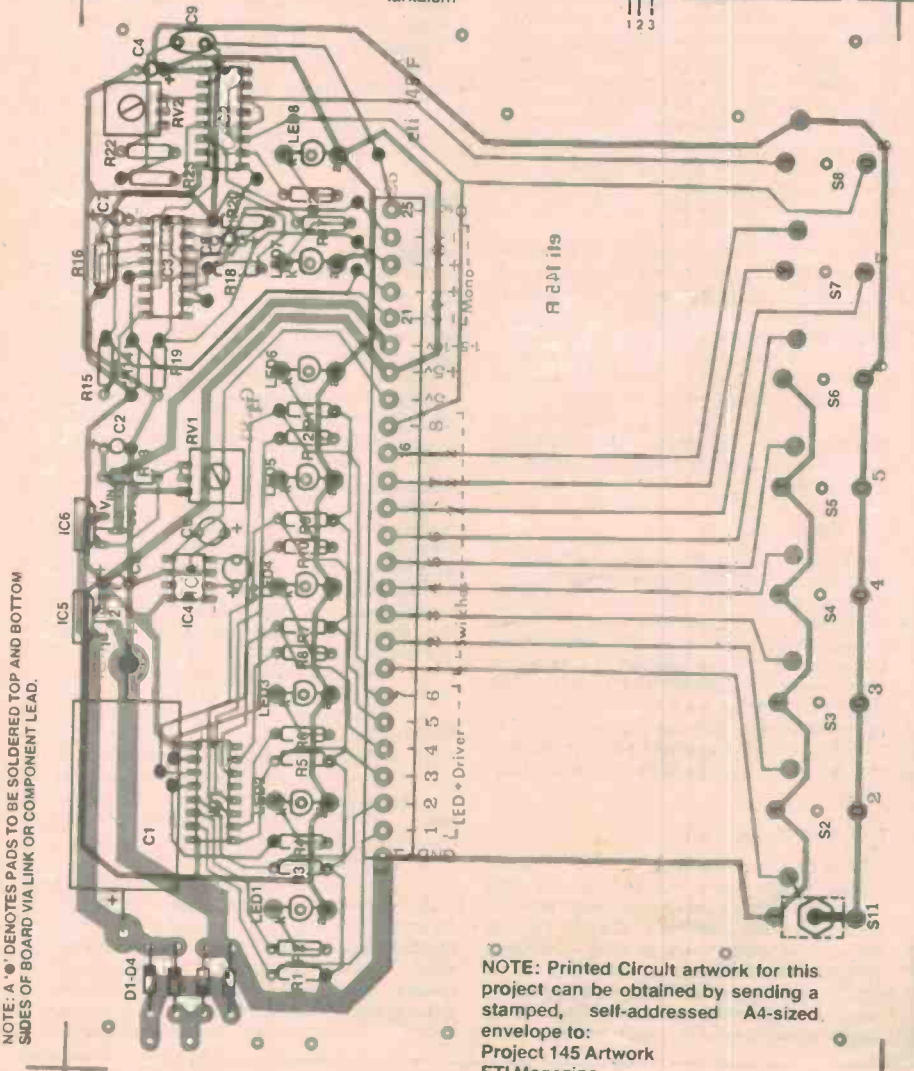
Mount the three remaining capacitors, taking care with the polarity of C7 and C8. The hardware for mounting the LEDs can be assembled to the board next. Prior to mounting the LEDs, each should have its lead formed as per the diagram here.

The cathode lead (K) should be bent and trimmed as shown, the anode lead being left longer and straight so that it provides a link to the +5 V rail when soldered on the top side of the board. When inserting the LEDs, make sure this lead protrudes through the top side of the board.

Now ICs 1, 2 and 3 can be mounted. Watch orientation and only handle them by their ends when inserting ▶




Bending the leads for LEDs 1 to 8.




NOTE: Printed Circuit artwork for this project can be obtained by sending a stamped, self-addressed A4-sized envelope to:
Project 145 Artwork
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011

## PARTS LIST — ETI 145

**Resistors** ..... all ½ W, 5%

| | |
|---|---|
| R1, 3, 5, 7, 9, 11, 14, 15, 18, 19 | 100k |
| R2, 4, 6, 8, 10, 12, 17, 21 | 220R |
| R13 | 120R |
| R16, R20 | 390k |
| R22 | 10k |
| RV1 | 1k 'Helitrim' trimpot |
| RV2 | 2M 'Helitrim' trimpot |

**Capacitors**

| | |
|---|---|
| C1 | 2200u/16 V axial electro. |
| C2, 3, 4, 7, 8 | 1u/35 V tantalum |
| C5, C6 | 10u/16 V RB electro. |
| C9 | 100n greencap |

**Semiconductors**

| | |
|---|---|
| D1-D4 | 1N4001, EM401 etc |
| IC1, IC2 | 4049 |
| IC3 | 4098, 4528 |
| IC4 | ICL7660 |
| IC5 | LM340/T5 |
| IC6 | LM317 |
| LED1-8 | TIL220R or sim. |

**Miscellaneous**

| | |
|---|---|
| S1 - S7 | up to seven SPDT toggle switches (as required) |
| S8 | SPDT spring-return toggle switch |

ETI-145 pc board; one PPB8/1000 ac plugpack; two pc board mounting strip connectors — 'Klippon' type MK 8/10 or similar; one pc board mounting strip connector — 'Klippon' type MK 8/2 or similar; one pc board mounting strip connector — 'Klippon' type MK 8/3 or similar; one length of figure-eight flex; 4 x 12 mm standoffs; 4 x rubber feet or grommets; nuts and bolts to suit; one 'breadboard' strip — such as Atek type AT-2N, Bimboard (e.g. Dick Smith Catalogue No. P-4612) or Proto-board (e.g: Dick Smith Catalogue No. P-4614).

**Price estimate** **$60-$70**

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| | | | |
|---|---|---|---|
| 2708 | $ 4.50 | BU326 | $ 1.90 |
| 2716 | $ 4.90 | Z80S10 | $18.00 |
| 2732 | $ 8.00 | 1771 | $18.00 |
| 6800 | $ 7.90 | 1791 | $59.00 |
| 6802 | $11.00 | 1795 | $59.00 |
| 6809 | $19.00 | 4116 | $ 1.95 |
| 8085 | $ 9.00 | 2114 | $ 1.95 |
| 8080 | $ 7.00 | TA7205 | $ 3.30 |
| 6821 | $ 3.50 | 100 Red Leds | $ 9.00 |
| Z80P10 | $ 5.00 | BUX80 | $ 3.90 |
| | | BU126 | $ 1.90 |

**DIP SWITCHES SPST**

| P/N | No. Switches | Price |
|---|---|---|
| SD4 | 4 | 1.70 |
| SD5 | 5 | 1.90 |
| SD6 | 6 | 2.30 |
| SD7 | 7 | 2.40 |
| SD8 | 8 | 2.50 |
| SD9 | 9 | 2.70 |
| SD10 | 10 | 3.00 |

**WIRE WRAP 3-LEVEL**

| | 1-9 | 10-25 |
|---|---|---|
| 8 Pin | 1.00 | .90 |
| 14 Pin | 1.10 | 1.00 |
| 16 Pin | 1.20 | 1.10 |
| 18 Pin | 1.50 | 1.40 |
| 20 Pin | 1.80 | 1.60 |
| 22 Pin | 1.90 | 1.70 |
| 24 Pin | 2.00 | 1.80 |
| 28 Pin | 2.20 | 2.10 |
| 36 Pin | 2.60 | 2.40 |
| 40 Pin | 2.90 | 2.70 |

**COMPUTER GRADE ELECTRO**

| | | |
|---|---|---|
| 2900uf | 40V | 6.50 |
| 6800uf | 16V | 6.40 |
| 10,000uf | 16V | 9.00 |
| 10,000uf | 25V | 9.50 |
| 10,000uf | 40V | 11.90 |
| 15,000uf | 40V | 12.80 |
| 22,000uf | 25V | 12.90 |
| 22,000uf | 40V | 23.00 |
| 27,000uf | 35V | 23.50 |
| 33,000uf | 16V | 23.50 |
| 68,000uf | 16V | 21.50 |
| 100,000uf | 10V | 20.50 |

**MULTISTRAND RIBBON CABLE**
Price per metre

| | 1-9 | 10+ |
|---|---|---|
| 10 Way | 1.00 | .90 |
| 12 Way | 1.20 | 1.10 |
| 16 Way | 1.60 | 1.40 |
| 20 Way | 2.00 | 1.80 |
| 40 Way | 4.00 | 3.50 |

### CMOS

| | |
|---|---|
| 4000 | .40 |
| 4001A | .40 |
| 4001B | .40 |
| 4002 | .50 |
| 4006 | 1.10 |
| 4007 | .50 |
| 4008 | 1.00 |
| 4009 | .80 |
| 4010 | .50 |
| 4011 | .40 |
| 4012 | .50 |
| 4013 | .80 |
| 4014 | 1.70 |
| 4015 | .90 |
| 4016 | .70 |
| 4017 | 1.10 |
| 4018 | 1.50 |
| 4019 | .60 |
| 4020 | 1.20 |
| 4021 | 1.10 |
| 4022 | 1.95 |
| 4023 | .70 |
| 4024 | 1.00 |
| 4025 | .50 |
| 4026 | 2.20 |
| 4027 | .60 |
| 4028 | .90 |
| 4029 | 1.20 |
| 4030 | .60 |
| 4031 | 2.20 |
| 4034 | 3.00 |
| 4035 | 1.30 |
| 4039 | .70 |
| 4040 | 1.70 |
| 4041 | 1.05 |
| 4042 | .70 |
| 4043 | .70 |
| 4044 | .70 |
| 4046 | 1.20 |
| 4047 | 1.20 |
| 4048 | .60 |
| 4049 | .60 |
| 4050 | .60 |
| 4051 | 1.00 |
| 4052 | .80 |
| 4053 | .80 |
| 4060 | 2.00 |
| 4066 | .80 |
| 4068 | .60 |
| 4069 | .70 |
| 4070 | .50 |
| 4071 | .60 |
| 4072 | .50 |
| 4073 | .60 |
| 4075 | .60 |
| 4076 | 1.20 |
| 4077 | .50 |
| 4078 | .60 |
| 4081 | .60 |
| 4082 | .60 |
| 4089 | 1.00 |
| 4093 | .80 |
| 4503 | .60 |
| 4510 | 1.50 |
| 4511 | 1.40 |
| 4512 | 1.10 |
| 4514 | 2.50 |
| 4516 | 1.40 |
| 4518 | 1.50 |
| 4519 | .55 |
| 4520 | 1.60 |
| 4522 | 1.25 |
| 4527 | 1.20 |
| 4528 | 1.25 |
| 4529 | 1.60 |
| 4539 | 1.60 |
| 4541 | 1.60 |
| 4543 | 2.00 |
| 4553 | 5.50 |
| 4555 | 1.00 |
| 40097 | .95 |
| 40098 | .95 |
| 40175 | 1.00 |

**74C SERIES**

| | |
|---|---|
| 74C 00 | .40 |
| 74C02 | .40 |

### 74C04 – 74C SERIES

| | |
|---|---|
| 74C04 | .40 |
| 74C08 | .40 |
| 74C10 | .40 |
| 74C14 | .90 |
| 74C20 | .40 |
| 74C30 | .40 |
| 74C32 | .40 |
| 74C42 | 1.10 |
| 74C48 | 1.55 |
| 74C73 | .75 |
| 74C74 | .70 |
| 74C76 | .75 |
| 74C83 | 1.40 |
| 74C85 | 1.20 |
| 74C86 | .80 |
| 74C90 | .80 |
| 74C93 | 1.40 |
| 74C95 | .95 |
| 74C107 | .70 |
| 74C150 | 3.40 |
| 74C151 | 1.00 |
| 74C160 | .90 |
| 74C192 | .90 |
| 74C164 | 1.10 |
| 74C173 | 1.00 |
| 74C174 | .80 |
| 74C175 | 1.00 |
| 74C192 | 1.20 |
| 74C195 | 1.00 |
| 74C221 | 1.90 |
| 74C373 | 1.80 |
| 74C374 | 2.00 |
| 74C901 | .90 |
| 74C902 | .90 |
| 74C905 | 11.20 |
| 74C906 | .90 |
| 74C907 | .80 |
| 74C915 | 1.50 |
| 74C922 | 3.80 |
| 74C923 | 5.00 |
| 74C925 | 7.80 |
| 74C926 | 7.80 |
| 74C927 | 5.90 |
| 74C932 | 5.50 |

**80C SERIES**

| | |
|---|---|
| MM80C95 | .90 |
| 80C96 | .90 |
| MM80297 | .90 |
| 80C98 | .90 |

**LINEAR**

| | |
|---|---|
| LH0002 | 9.50 |
| LH0022CD | 16.60 |
| LH0042CH | 8.60 |
| LH0070 | 12.70 |
| LH0071 | 12.70 |
| TL071 | 1.00 |
| TL072 | 1.50 |
| TL082 | 1.50 |
| SAK140 | 2.20 |
| UAA170 | 3.50 |
| UAA180 | 3.50 |
| TCA220 | 2.20 |
| LM301 | .50 |
| LM301-H | .50 |
| LM304-H | 1.70 |
| LM305-H | .80 |
| LM307-CN | .40 |
| LM307-H | .90 |
| LM308 | .70 |
| LM308-H | 1.20 |
| LM310-N | 2.20 |
| LM310-H | 2.60 |
| LM311 | .60 |
| LM311-H | 1.20 |
| LM318 | 2.80 |
| LM322 | 3.90 |
| LM324 | 1.20 |
| LM325 | 3.10 |
| LM329-DZ | 1.40 |
| LM334-Z | 1.30 |
| LM335 | 12.40 |
| LM336-Z | 3.20 |
| LM339 | .90 |
| LM348 | 1.30 |
| LM349 | 1.80 |
| LF351-N | .70 |

### LF356-AN – LINEAR

| | |
|---|---|
| LF356-AN | 1.50 |
| LF357 | 1.50 |
| LM358 | .70 |
| LM373 | 4.10 |
| LM374 | 5.40 |
| LM376 | .70 |
| LM377 | 2.90 |
| LM379S | 6.70 |
| LM308 8PIN | 1.30 |
| LM380 | |
| 14PIN | 1.50 |
| LM318A-N | 2.40 |
| LM318N | 1.80 |
| LM382N | 2.00 |
| LM383 | 2.70 |
| LM384 | 2.40 |
| LM386 | 1.00 |
| LM387 | 1.30 |
| LM391 | 1.80 |
| LM393 | .80 |
| LF398 | 5.00 |
| 8038 | 6.80 |
| NE530 | 1.10 |
| OM350 | 9.90 |
| 555 | .40 |
| 556 | 1.10 |
| LM565 | 1.30 |
| LM565CH | 2.00 |
| NE566 | 2.50 |
| LM567 | 1.50 |
| NE571 | 4.50 |
| LM709 14PIN | .70 |
| UA710CA | .60 |
| LM710-CH | .90 |
| 711 | .80 |
| UA711-H | .85 |
| UA716HC | 6.25 |
| 723 | 1.00 |
| LM723CH | 1.50 |
| LM725 | 3.90 |
| LM733 | 1.20 |
| UA739 | 2.00 |
| 741 | .40 |
| LM741-H | 1.20 |
| UA747 | 1.50 |
| UA747HC | 2.20 |
| UA748 | .50 |
| UA748HC | 1.25 |
| UA753 | 1.80 |
| UA760HC | 4.10 |
| UA777 | 2.40 |
| UA777HC | 2.65 |
| 9334 | 1.70 |
| UA743 | 1.80 |
| UA760HC | 4.10 |
| UA796HC | 1.70 |
| LM802 | 1.10 |
| LM1310N | 2.40 |
| 1408 | 4.90 |
| LM1458 | .60 |
| UA1488 | 1.50 |
| UA1489 | 1.50 |
| MC1495 | 7.30 |
| MC1496L | 11.40 |
| LM1558 | 1.50 |
| LM1596 | 1.40 |
| LM1380 | 3.10 |
| LM2902 | 1.40 |
| LM2917 | 3.90 |
| 8PIN | 2.80 |
| LM2917 | 3.10 |
| CA3028 | 1.80 |
| LM3039 | .90 |
| CA3046 | 1.70 |
| 3065 | .45 |
| LM3080 | 1.20 |
| LM3089 | 3.90 |
| CA3130T | 1.80 |
| CA3130E | 1.80 |
| CA3140 | 1.40 |
| 3401 | .70 |
| 3611 | 1.10 |
| LM3900 | .90 |
| LM3909 | 1.00 |
| LM3914N | 3.90 |
| 4136 | 1.40 |
| LM4250 | 1.75 |

### UA4558TC – LINEAR

| | |
|---|---|
| UA4558TC | 1.40 |
| MM5837 | 2.50 |
| LM7555 | 1.80 |
| Mc10116L | .95 |
| LF13741 | .60 |
| LF1374-1H | .70 |
| DS75452 | .60 |
| 76477 | 4.90 |
| 75451 | .60 |
| 75491 | 1.00 |
| 75492 | 1.40 |

**TTL (s)**

| | |
|---|---|
| 74S00 | .80 |
| 74S02 | .80 |
| 74S04 | .80 |
| 74S10 | .75 |
| 74S11 | .75 |
| 74S32 | .75 |
| 75S51 | .75 |
| 74S74 | 1.20 |
| 74S86 | 1.40 |
| 74S112 | 1.20 |
| 74S135 | 2.20 |
| 74S138 | 3.20 |
| 74S157 | 2.95 |
| 74S158 | 2.95 |
| 74S182 | 3.30 |

**7400 SERIES**

| | |
|---|---|
| 7400 | .40 |
| 7401 | .40 |
| 7402 | .40 |
| 7403 | .40 |
| 7404 | .40 |
| 7405 | .50 |
| 7406 | .50 |
| 7407 | .50 |
| 7408 | .40 |
| 7409 | .40 |
| 7410 | .40 |
| 7411 | .40 |
| 7412 | .40 |
| 7413 | .50 |
| 7414 | .70 |
| 7416 | .50 |
| 7417 | .60 |
| 7420 | .40 |
| 7421 | .40 |
| 7423 | .50 |
| 7425 | .45 |
| 7426 | .40 |
| 7427 | .40 |
| 7430 | .40 |
| 7432 | .40 |
| 7437 | .40 |
| 7438 | .50 |
| 7440 | .50 |
| 7441 | 1.00 |
| 7442 | .50 |
| 7443 | 1.40 |
| 7444 | 1.20 |
| 7445 | 1.10 |
| 7446 | 1.00 |
| 7447 | 1.00 |
| 7448 | 1.00 |
| 7450 | .50 |
| 7451 | .50 |
| 7453 | .40 |
| 8T26 | 2.20 |
| 9300 | .60 |
| 9307 | 1.80 |
| 9308 | 1.20 |
| 7454 | .60 |
| 7472 | .60 |
| 7473 | .60 |
| 7474 | .60 |
| 7475 | .60 |
| 7476 | .60 |
| 7480 | .65 |
| 7482 | 1.80 |
| 7483 | .80 |
| 7485 | .80 |
| 7486 | .60 |
| 7489 | 2.60 |
| 7490 | .70 |
| 7491 | .55 |
| 7492 | .60 |
| 7493 | .60 |

### 7494 – 7400 SERIES

| | |
|---|---|
| 7494 | .90 |
| 7495 | .45 |
| 7496 | .80 |
| 7497 | 2.50 |
| 74107 | .80 |
| 74109 | .60 |
| 74116 | 2.20 |
| 74121 | .45 |
| 74122 | .65 |
| 74123 | .60 |
| 74125 | .55 |
| 74126 | .60 |
| 74132 | .80 |
| 74141 | 1.10 |
| 74145 | .85 |
| 74147 | 2.00 |
| 74148 | 1.40 |
| 74150 | 1.20 |
| 74151 | .60 |
| 74152 | 4.90 |
| 74153 | .70 |
| 74154 | 1.20 |
| 74155 | .90 |
| 8T28 | 3.00 |
| 9310 | .65 |
| 9311 | 1.00 |
| 9312 | 1.35 |
| 74156 | 1.50 |
| 74157 | .60 |
| 74161 | 1.00 |
| 74162 | 1.00 |
| 74163 | .85 |
| 74164 | .60 |
| 74165 | .60 |
| 74174 | .50 |
| 74175 | .90 |
| 74176 | 1.10 |
| 74177 | 1.10 |
| 74180 | .90 |
| 74181 | 2.30 |
| 74182 | .90 |
| 74184 | 3.75 |
| 74185 | 1.20 |
| 74190 | 1.00 |
| 74191 | 1.20 |
| 74192 | 1.20 |
| 74193 | .80 |
| 74194 | 1.10 |
| 74195 | .65 |
| 74196 | .85 |
| 74197 | 1.10 |
| 74198 | 1.10 |
| 74199 | 1.30 |
| 74221 | .90 |
| 74290 | .90 |
| 73293 | .90 |
| 74365 | .80 |
| 74366 | .80 |
| 74367 | 1.00 |
| 74368 | 1.00 |
| 8T96 | 1.80 |
| 9314 | 1.30 |
| 9368 | 2.50 |
| 9370 | 2.80 |

**74LS SERIES**

| | |
|---|---|
| 74LS00 | .40 |
| 74LS01 | .40 |
| 74LS02 | .40 |
| 74LS03 | .40 |
| 74LS04 | .40 |
| 74LS08 | .40 |
| 74LS09 | .40 |
| 74LS10 | .40 |
| 74LS11 | .40 |
| 74LS13 | .50 |
| 74LS14 | .90 |
| 74LS15 | .40 |
| 74LS20 | .40 |
| 74LS21 | .40 |
| 74LS22 | .40 |
| 74LS26 | .40 |
| 74LS28 | .40 |
| 74LS30 | .40 |
| 74LS32 | .40 |
| 74LS33 | .40 |
| 74LS37 | .50 |
| 74LS38 | .50 |

### 74LS40 – 74LS SERIES

| | |
|---|---|
| 74LS40 | .50 |
| 74LS42 | .75 |
| 74LS47 | .85 |
| 74LS48 | 1.00 |
| 74LS49 | 1.00 |
| 74LS51 | .40 |
| 74LS54 | .50 |
| 74LS55 | .55 |
| 74LS58 | .65 |
| 74LS73 | .55 |
| 74LS74 | .60 |
| 74LS75 | .45 |
| 74LS76 | .50 |
| 74LS78 | .50 |
| 74LS83 | 1.00 |
| 74LS85 | 1.00 |
| 74LS86 | .50 |
| 74LS90 | .70 |
| 74LS92 | .90 |
| 74LS93 | .80 |
| 74LS95 | .65 |
| 74LS96 | 1.55 |
| 74LS107 | .60 |
| 74LS109 | .60 |
| 74LS112 | .60 |
| 74LS113 | .65 |
| 74LS114 | .50 |
| 74LS122 | .50 |
| 74LS123 | .75 |
| 74LS125 | .50 |
| 74LS126 | .70 |
| 74LS132 | .80 |
| 74LS133 | .50 |
| 74LS136 | .50 |
| 74LS138 | .80 |
| 74LS139 | .85 |
| 74LS151 | .75 |
| 74LS153 | .60 |
| 74LS154 | 1.50 |
| 74LS155 | 1.00 |
| 74LS156 | 1.00 |
| 74LS157 | .90 |
| 74LS158 | .70 |
| 74LS160 | .85 |
| 74LS161 | .85 |
| 74LS162 | 1.00 |
| 74LS163 | .85 |
| 74LS164 | 1.30 |
| 74LS165 | .50 |
| 74LS168 | 1.90 |
| 74LS169 | 1.90 |
| 74LS170 | 2.80 |
| 74LS173 | .90 |
| 74LS174 | .90 |
| 74LS175 | .90 |
| 74LS181 | 2.50 |
| 74LS189 | 3.00 |
| 74LS190 | 1.30 |
| 74LS191 | 1.10 |
| 74LS192 | .85 |
| 74LS193 | .85 |
| 74LS194 | .70 |
| 74LS195 | .80 |
| 74LS196 | 1.25 |
| 74LS197 | 1.00 |
| 74LS221 | 2.10 |
| 74LS245 | 2.35 |
| 74LS247 | .90 |
| 74LS249 | 1.30 |
| 74LS251 | .80 |
| 74LS253 | .90 |
| 74LS257 | .65 |
| 74LS258 | .50 |
| 74LS259 | 2.45 |
| 74LS260 | .90 |
| 74LS266 | .90 |
| 74LS273 | 1.60 |
| 74LS279 | .65 |
| 74LS283 | 1.15 |
| 74LS290 | 1.10 |
| 74LS293 | 1.15 |
| 74LS295 | 1.60 |
| 74LS298 | 1.00 |
| 74LS352 | 1.30 |
| 74LS353 | 1.30 |
| 74LS365 | .50 |
| 74LS366 | .70 |
| 74LS367 | .50 |
| 74LS368 | .50 |
| 74LS373 | 1.50 |
| 74LS374 | 1.70 |
| 74LS386 | .50 |
| 74LS670 | 2.70 |
| 81LS95 | 2.10 |
| 95H90 | 15.50 |
| 11C90 | 19.50 |
| 81LS96 | 2.10 |

### 81LS97 – TRANSISTORS

| | |
|---|---|
| 81LS97 | 2.10 |
| 2N301 | 2.20 |
| 2N657 | .60 |
| 2N930 | .60 |
| 2N1613 | 1.10 |
| 2N1711 | .50 |
| 2N1893 | 1.00 |
| 2N2219A | .60 |
| PN2222 | .30 |
| 2N2463 | .35 |
| 2N2484 | .65 |
| 2N2646 | 1.00 |
| 2N2647 | 1.10 |
| 2N2894 | .80 |
| 2N2904 | .45 |
| 2N2905 | .40 |
| 2N2906 | .45 |
| 2N2913 | 1.20 |
| PN2907 | .60 |
| 2N3053 | .60 |
| 2N3054 | 1.90 |
| 2N3055 | .90 |
| 2N3301 | .40 |
| 2N3440 | 1.10 |
| 2N3502 | .70 |
| 2N3503 | .70 |
| 2N3563 | .30 |
| 2N3564 | .30 |
| 2N3569 | .30 |
| PN3565 | .30 |
| PN3566 | .30 |
| PN3567 | .30 |
| 2N3568 | .30 |
| 2N3638 | .30 |
| 2N3639 | .30 |
| 2N3640 | .30 |
| 2N3641 | .30 |
| 2N3645 | .30 |
| PN3642 | .30 |
| PN3643 | .30 |
| PN3644 | .30 |
| 2N3646 | .30 |
| 2N3692 | .50 |
| 2N3693 | .35 |
| 2N3702 | .30 |
| PN3694 | .30 |
| 2N3704 | .30 |
| 2N3709 | .30 |
| 2N3713 | 2.20 |
| 2N3819 | .80 |
| 2N3866 | 2.00 |
| 2N3904 | .30 |
| 2N3906 | .30 |
| 2N4030 | 1.10 |
| 2N4032 | .90 |
| 2N4033 | .90 |
| 2N4036 | 1.00 |
| 2N4037 | .90 |
| PN4121 | .30 |
| 2N4233 | 1.60 |
| 2N4235 | 1.90 |
| 2N4236 | 2.20 |
| 2N4248 | .30 |
| PN4249 | .30 |
| 2N4250 | .30 |
| 2N4258 | .30 |
| 2N4292 | .70 |
| 2N4354 | .30 |
| 2N4355 | .30 |
| 2N4356 | .30 |
| 2N4398 | 5.00 |
| 2N4401 | .50 |
| 2N4402 | .50 |
| 2N4403 | .50 |
| 2N4416 | 1.00 |
| 2N4906 | 2.90 |
| PN4868 | .30 |
| 2N5088 | .30 |
| 2N5089 | .30 |
| 2N5179 | 1.90 |
| 2N5303 | 3.30 |
| 2N5320 | .80 |
| 2N5401 | .30 |
| 2N5458 | .70 |
| 2N5459 | .70 |
| 2N5461 | .70 |
| 2N5484 | .70 |
| 2N5485 | .70 |
| 2N5486 | .70 |
| 2N5769 | .30 |
| 2N5770 | .25 |
| 2N5830 | .25 |
| 2N5831 | .30 |
| 2N5856 | .30 |
| 2N5873 | 1.10 |

### 2N5874 – TRANSISTORS

| | |
|---|---|
| 2N5874 | 1.40 |
| 2N5961 | .30 |
| 2N5963 | 1.10 |
| 2N6027 | .60 |
| 3N201 | 1.50 |
| AC127 | 1.00 |
| AC128 | 1.00 |
| AC187 | 1.00 |
| AC188 | 1.00 |
| AD149 | 3.10 |
| AD161 | 2.00 |
| AD162 | 2.00 |
| BC318 | .90 |
| BC319 | .18 |
| BC327 | .15 |
| BC328 | .30 |
| BC337 | .30 |
| BC338 | .30 |
| BC547 | .15 |
| BC548 | .15 |
| BC549 | .15 |
| BC549C | .40 |
| BC557 | .16 |
| BC558 | .16 |
| BC559 | .16 |
| BC637 | .60 |
| BC638 | .60 |
| BC639 | .40 |
| BC640 | .40 |
| BCY70 | .85 |
| BCY71 | .85 |
| BD115 | 1.50 |
| BD135 | .70 |
| BD136 | .70 |
| BD137 | .70 |
| BD138 | .70 |
| BD139 | .70 |
| BD140 | .70 |
| BD235 | .65 |
| BD234 | .50 |
| BD237 | .50 |
| BD262 | 1.20 |
| BD301 | .75 |
| BD302 | .75 |
| BD263 | 1.25 |
| BD435 | .75 |
| BD646 | 1.70 |
| BD647 | 1.80 |
| BD675 | .80 |
| BDV64B | 4.50 |
| BDV65B | 4.50 |
| BF115 | .50 |
| BF173 | .70 |
| BF180 | .70 |
| BF195 | .30 |
| BF198 | .30 |
| BF199 | .30 |
| BF336 | .80 |
| BF337 | .80 |
| BF458 | .90 |
| BF494 | .40 |
| BFX85 | .75 |
| BFY50 | .90 |
| BFY90 | 1.30 |
| BSV17 | 1.00 |
| BU126 | 3.00 |
| BU208 | 3.00 |
| BUX80 | 7.90 |
| FT2955 | 1.40 |
| FT3055 | .75 |
| MEL12 | .90 |
| BU326A | 3.40 |
| MJ2955 | 1.00 |
| MJ4032 | 7.40 |
| MJ802 | 3.40 |
| MJ4035 | 6.90 |
| MJ4502 | 3.70 |
| MJE340 | 1.20 |
| MJE350 | 1.70 |
| MJE295 | 1.90 |
| MJE8055 | 1.90 |
| MJE3521 | .60 |
| MJ15003 | 5.00 |
| MJ15004 | 5.00 |
| QF102 | .60 |
| MPF131 | 1.40 |
| MPSA05 | .60 |
| MPSA06 | .60 |
| MPSA12 | .60 |
| MPSA14 | .60 |
| MPSA42 | .60 |
| MPSA56 | .80 |
| MPSA92 | .60 |
| MRF475 | 4.40 |
| TT318 | .90 |
| TI3PIC | 1.00 |
| TIP32B | .90 |

### TIP32C – TRANSISTORS

| | |
|---|---|
| TIP32C | 1.00 |
| TIP33A | 1.10 |
| TIP34A | 1.20 |
| TIP42B | 1.50 |
| TIP42B | 1.10 |
| TIP110 | 1.30 |
| TIP120 | .90 |
| TIP2955 | 1.90 |
| TIP3055 | 1.90 |
| VN88AF | 3.90 |

**MICRO CHIPS**

| | |
|---|---|
| ADCO 800 | 15.00 |
| DACO 080 | 3.90 |
| 2102 650 NS | 1.40 |
| 2111 | 8.60 |
| 2513 | 14.50 |
| 2516 | 55.00 |
| 2532 | 12.00 |
| 2650 | 23.00 |
| 2708 | 4.50 |
| 2716 | 4.90 |
| 4116 | 1.90 |
| 5101 | 9.00 |
| MM5307 | 18.00 |
| MM5309 | 6.50 |
| MM5312 | 9.00 |
| MM5369 | 2.60 |
| 5387 | 8.50 |
| MM5395 | 6.50 |
| 6502 | 10.50 |
| 6508 | 5.50 |
| 6520 | 5.50 |
| 6522 | 10.00 |
| 6532 | 17.00 |
| 6551 | 17.00 |
| MC6900P | 9.80 |
| MC6802 | 13.60 |
| MC6808 | 12.50 |
| 6810A | 4.90 |
| 6820 | 5.50 |
| 6821 | 6.00 |
| 6850 | 5.15 |
| 6852 | 6.40 |
| 7106 | 12.60 |
| 7107 | 15.00 |
| 7210 | 13.20 |
| Z80 CPU | 14.80 |
| Z80A CPU | 16.00 |
| Z80 P10 | 13.80 |
| Z80A P10 | 16.50 |
| Z80 CTC | 13.80 |
| Z80A CTC | 16.50 |
| Z80 DMA | 20.00 |
| Z80 S10 0 | 19.00 |
| Z80 S10/1 | 56.90 |
| Z80 S10/2 | 56.90 |
| Z80A S10/0 | 63.00 |
| Z80A S10/1 | 63.00 |
| Z80A S10/2 | 63.00 |
| 8035 | 27.00 |
| INS8050 | 15.00 |
| INS8080 | 8.80 |
| P8085 | 25.00 |
| 8155 | 22.00 |
| 8165 | 22.00 |
| 8205 | 5.90 |
| P8212 | 4.00 |
| 8214 | 8.00 |
| 8216 | 5.90 |
| 8224N | 5.50 |
| 8224 | 7.50 |
| 8226 | 5.90 |
| 8228 | 9.50 |
| 8238 | 8.00 |
| 8243 | 8.00 |
| 8251 | 14.00 |
| INS8251 | 6.50 |
| 8253 | 19.50 |
| 8255A | 8.60 |
| 8257 | 19.00 |
| 8259 | 15.00 |
| 8275 | 49.00 |
| 8279 | 11.00 |

| | |
|---|---|
| 8295 | 25.00 |
| Ay-5-2376 | 19.56 |
| 8748A | 29.00 |
| 8755A | 45.00 |
| MCT2 | .80 |
| MCT6 | 3.30 |
| MCT275 | 1.50 |
| MCC671 | 3.00 |
| 4N28 | .85 |
| 4N33 | 1.20 |
| 4N26 | .85 |
| MM80C95 | .90 |
| 80C96 | .90 |
| MM80C97 | .90 |
| 8098 | .90 |

**OPTOCOUPLERS**

| | |
|---|---|
| MCT2 | 1.00 |
| MCT6 | 3.30 |
| MC275 | 1.50 |
| MCC671 | 3.00 |
| 4N28 | 1.00 |
| 4N33 | 1.20 |
| 4N26 | 1.00 |

**VOLTAGE REGULATORS**

| | |
|---|---|
| 78L05 | .50 |
| LM341P-5 | .80 |
| 7805 | 1.00 |
| 7905 | 1.70 |
| LM309K | 1.95 |
| 7805K | 2.10 |
| LM323-K | 6.90 |
| 78H05KC | 8.50 |
| 78L12CP | .50 |
| 79L12 | .90 |
| LM341P12 | .75 |
| 7812 | 1.00 |
| 7912 | 1.90 |
| 7812KC | 2.15 |
| 7912KC | 2.60 |
| 79H12KC | 8.00 |
| 78L15 | .50 |
| 79L15 | .90 |
| LM341P15 | .80 |
| 7815 | 1.00 |
| 7915CT | 1.80 |
| 7915KC | 2.60 |
| 78H15KC | 8.50 |
| 78L18 | .50 |
| 7818 | 1.40 |
| 78L24 | .50 |
| 79L24 | .90 |
| 7824 | 1.10 |
| LM371T | 2.40 |
| LM337T | 3.80 |
| LM317K | 4.50 |
| LM337K | 5.90 |
| LM350K | 8.40 |
| 78HGKC | 10.50 |
| 78P05 | 16.50 |

**BRIDGES**

| | |
|---|---|
| VM48 | 1.50 |
| W02 | .60 |
| W04 | .60 |
| KHPC02 | 2.00 |
| KBP602 | 2.50 |
| KBP604 | 2.60 |
| KBP606 | 2.80 |
| KHPC1002 | 2.60 |
| KBPC1004 | 3.20 |
| KBPC1006 | 3.20 |
| MDA3501 | 4.20 |
| MDA3502 | 4.20 |
| MDA3504 | 4.50 |

**DISPLAYS**

| | |
|---|---|
| MAN2A | 6.30 |
| MAN72A | 2.20 |
| MAN74A | 2.20 |
| MAN52A | 3.40 |
| MAN82A | 3.40 |
| MAN84A | 3.40 |
| MAN6740 | 3.60 |
| MAN8610 | 3.30 |
| MAN8640 | 3.30 |
| TIL306 | 12.00 |
| DL704 | 2.20 |
| DL707 | 2.30 |
| DL747 | 3.40 |
| DL750 | 4.00 |
| FND357 | 1.80 |
| FND500 | 1.80 |
| FND507 | 1.80 |

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SEE PAGE 19 FOR ADDRESS DETAILS

them, avoiding touching the pins, as they are CMOS devices. Solder their supply pins first — pins 1 and 8 on ICs 1 and 2, pins 16 and 8 on IC3.

The only remaining components to mount are the switches, the screw connector strips and the breadboard strip. Refer to the overlay for wiring the switches. Now fix the figure-eight ac input flex to the board, looping it through the two holes near the rectifier diodes. This provides a very effective, yet simple, cable clamp.

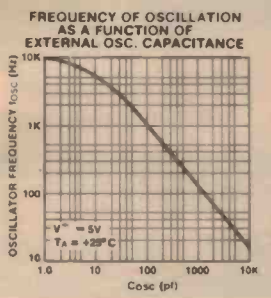
Connect the ac input cable to the PPB8/1000 plugpack and apply power. LEDs 7 and 8 should come on momentarily when you switch on. The LED driver and inputs can be tested by connecting switches 1 to 6 to the LED driver inputs 1 to 6. Putting a switch to '1' should cause the appropriate LED to come on. Switch 8 can be tested by linking it to one of the LED driver inputs. Holding SW8 on the '1' position will cause the appropriate LED to light. If anything doesn't work at this stage, make a careful wiring check, especially orientation of ICs and LEDs, and correct any faults.

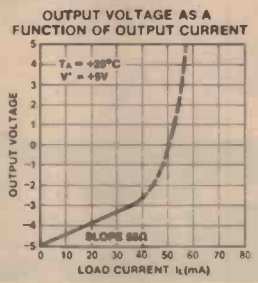
Once SW8 has been tested, it can be used to test the monostable inputs (marked 'Mono'). Link pin 17 (marked '8') to pin 21 (Mono '7', marked '-'). When SW8 is operated and released, LED7 will come on for 200 ms on the '1' to '0' transition. The reverse happens when you link SW8 to the '+' input, pin 22.

The last section to test is the square wave oscillator. Connect the 'Osc' terminal (pin 25, on the right hand end) to one of the LED driver inputs. Turn RV2 to the fully anti-clockwise position and the LED should flash at about a 3 Hz rate. To observe the maximum frequency, an oscilloscope is required, although you could couple the oscillator output to an audio amplifier (but remember the output is at quite a high level) and listen to the squeal produced. Varying the trimpot should vary the frequency.

That's it. Happy prototyping! ●

## THE INTERSIL ICL7660 VOLTAGE CONVERTER



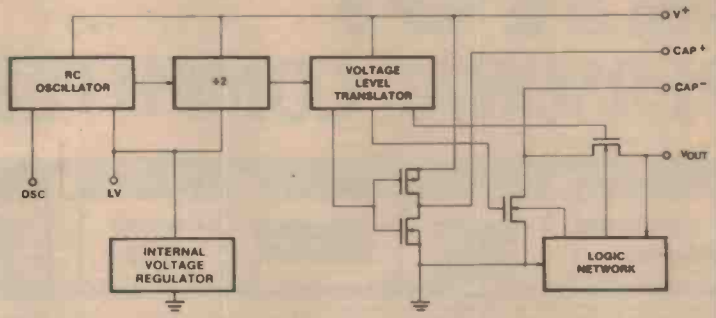




*Figure 2.* Internal block diagram of the ICL7660.

The Intersil ICL7660 is a monolithic 'MAXCMOS' power supply circuit which performs the complete supply voltage conversion from positive to negative for an input range of +1.5 V to +10.0 V, resulting in complementary output voltages of −1.5 to −10.0 V with the addition of only two non-critical external capacitors.

Contained on-chip are a series dc power supply regulator, an RC oscillator, a voltage level translator, four output power MOS switches, and a unique logic element which senses the most negative voltage in the device and ensures that the output N-channel switches are not forward biased. This assures latch-up free operation.

The oscillator, when unloaded, oscillates at a nominal frequency of 10 kHz for an input supply voltage of 5.0 volts. This frequency can be lowered by the addition of an external capacitor to the 'OSC' terminal, or the oscillator may be overdriven by an external clock.

The 'LV' terminal may be tied to ground to bypass the internal series regulator and improve low voltage (LV) operation. At medium to high voltages (+3.5 to +10.0 volts), the LV pin is left floating to prevent device latch-up.

The ICL7660 may be obtained in 8 pin DIL or TO-99 can packages, pin configurations being shown in Figure 1. The internal block diagram is shown in Figure 2.

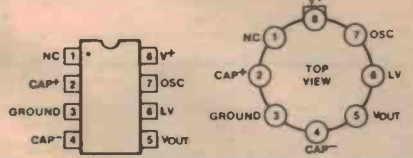



*Figure 1.* Pinouts of the DIL and TO-99 packages for the ICL7660.

### FEATURES

- Simple conversion of +5 V logic supply to ±5 V supplies.
- Simple voltage multiplication ($V_{OUT} = (-)nV_{IN}$)
- 99.9% typical open circuit voltage conversion efficiency
- 98% typical power efficiency
- Wide operating voltage range 1.5 V to 10.0 V
- Easy to use — requires only two external non-critical passive components

### APPLICATIONS

- On-board negative supply for up to 64 dynamic RAMs
- Localised μ-processor (8080 type) negative supplies
- Inexpensive negative supplies
- Data acquisition systems

### CIRCUIT DESCRIPTION

The ICL7660 contains all the necessary circuitry to complete a voltage doubler, with the exception of two external capacitors which may be inexpensive 10u polarised electrolytic capacitors. The mode of operation of the device may be best understood by considering Figure 3, which shows an idealised voltage doubler. Capacitor C1 is charged to a voltage, V+, for the half cycle when switches S1 and S3 are closed. (Note: Switches S2 and S4 are open during this half cycle.) During the second half cycle of operation, switches S2 and S4 are closed, with S1 and S3 open, thereby shifting capacitor C1 negatively by V+ volts. Charge is then transferred from C1 to C2 such that the voltage on C2 is exactly V+, assuming ideal switches and no load on C2. The ICL7660 approaches this ideal situation more closely than existing non-mechanical circuits.

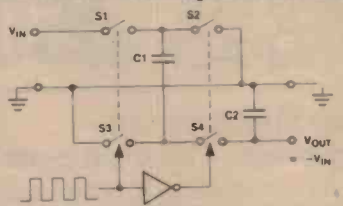



*Figure 3.* Internal representation of how the ICL7660 works.

The four switches in Figure 3 are MOS power switches; S1 is a P-channel device and S2, S3 and S4 are N-channel devices. The main difficulty with this approach is that in integrating the switches, the substrates of S3 and S4 must always remain reverse biased with respect to their sources, but not so much as to degrade their 'on' resistances. In addition, at circuit start-up and under output short circuit conditions ($V_{OUT} = V+$), the output voltage must be sensed and the substrate bias adjusted accordingly. Failure to accomplish this would result in high power losses and probable device latch-up.

This problem is eliminated in the ICL7660 by a logic network which senses the output voltage ($V_{OUT}$) together with the level translators, and switches the substrates of S3 and S4 to the correct level to maintain necessary reverse bias.

The voltage regulator portion of the ICL7660 is an integral part of the anti-latch-up circuitry; however, its inherent voltage drop can degrade operation at low voltages. Therefore, to improve low voltage operation the 'LV' pin should be connected to ground, disabling the regulator. For supply voltages greater than 3.5 V the LV terminal must be left open to insure latch-up-proof operation, and prevent device damage.

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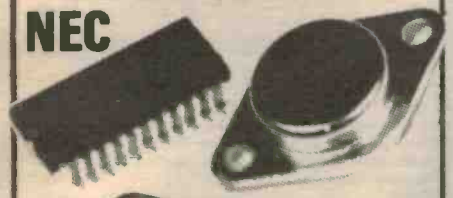

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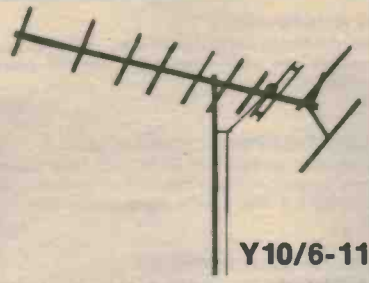

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**BP83** **$7.20**

### DIGITAL IC PROJECTS

Companion to No. 225 Practical Introduction to Digital ICs and BP61 Beginner's Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included. The more ambitious projects have been designed to be built and tested section by section to help the constructor avoid or correct any faults that may occur.

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### INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE

Companion to BP1 and BP14 equivalents books, but contains a huge amount of information on modern transistors produced by over 100 manufacturers. Wherever possible, equivalents are subdivided into European, American and Japanese types. Also shown are the material type, polarity, manufacturer and indication of use or application.

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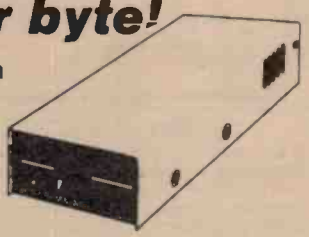

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***See page 19 for address details***

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# 5000 AMPS FURTHER REFINEMENT

5000 POWERAMP – Much has been said about the brilliant 5000 Mosfet PA by David Tillbrook. Justifiably so in our opinion. If you wish to know more send us a SAE for a descriptive leaflet. If you are well versed with the 5000 PA you may like to know that we now supply Beryllium Oxide (high thermal conductivity) TO-3 ceramic washers in place of the poor conductivity – and flimsy – mica washers, STANDARD in our kit. You may have also noticed a number of suppliers offering 'versions' of the 5000 PA and Preamp which to some could be interpreted as the same as the quality Jaycar kit. Whilst we could be smug and say that imitation is the sincerest form of flattery, we would be kidding ourselves. We still firmly believe that the Jaycar 5000 kits are the best for many reasons: Among which are: – Only the finest components go in e.g. 1% Metal film resistors. – Continuing refinement. e.g. Beryllium washers, superior export packing. – superior cosmetic appeal.

PREAMP REFINEMENTS – For quite some time now we have been using the LM194CH ultra-matched transistor array in the M.C. section of the preamp. We felt that this expensive military grade component was justified. We also used the Mil-spec MAT-01GH by Precision Monolithics Inc. of the USA. National Semiconductor now has a device called the LM394H which we now intend to use exclusively in our "Blueprint" series preamps. The H version is EVEN QUIETER than the CH versions in the past. While this component is considerably more expensive than the standard LM394 we feel that the extra investment on our part is justified. Yet another example of "Further Refinement".

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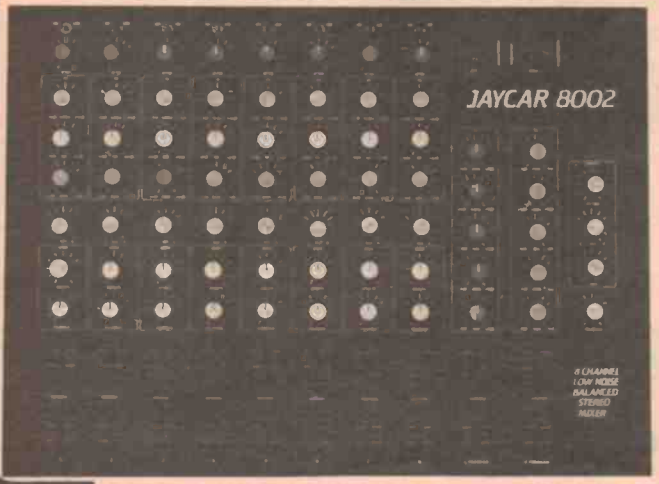


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# Ideas for Experimenters

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.

**IDEA OF THE MONTH**
**Fred Stratford**
**Arana Hills, Brisbane Qld.**

## Resolving address contention in a microprocessor system

Picture this scene. I have just added another whatever to my processor system — a new RAM, ROM or other address space consuming device. I turn it back on and the little blighter won't reset. I turn it off, remove my new whatever and it goes like a bought one.

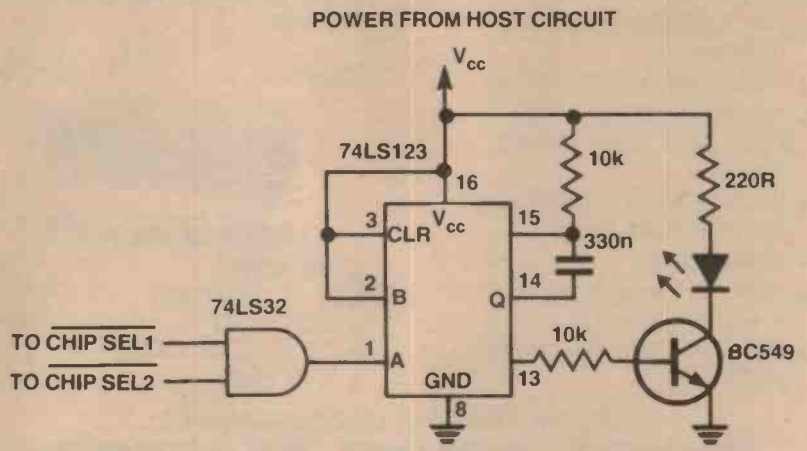
One possible reason? — address contentions!

These can be a real pain to find — especially when the system can't even struggle out of reset. An answer is to cycle the address bus (note one s!) and see if more than one chip select goes down at a given location — hard yakka using conventional approaches such as counters or DIP switches. Since processor chips are now so cheap there is an alternative. The steps are:

1. Obtain yourself a processor chip of your choice and resign yourself to stuffing (yes, I said stuffing) it.
2. Find out the processor's no-operation code. In the case of the 6800 it is hex 01, and 12 for the 6809. (No, I don't know what it is for the Z80 — why would I want to when my system is 6809-based?)
3. Put on your blue and white butcher's apron and bend all the data bus pins up! (Ouch.)
4. Now attach the data pins which should be high for a NO-OP to the $V_{cc}$ rail and those that should be low to the ground rail. Wire-wrap wire works well for this.

Now when your system has an address contention or other problem, this device can be used to help locate it. The use is very simple. Just power up the system with the 'modified' processor installed. When the device resets it will read all NO-OP instructions and hence cycle the address bus through the whole address range. A logic probe or coincidence detector, like that in the accompanying circuit, can be used to detect the fault condition.

COINCIDENCE DETECTOR

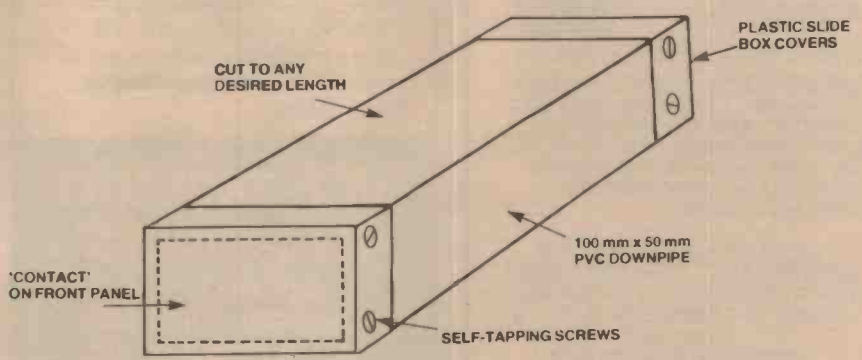



## Box your doodads

If you ever need a small box to house your latest electronic doodad but don't have one on hand, a neat and inexpensive one can be made in about one minute from a short length of 100 mm x 50 mm PVC downpipe — according to **Robert Jarvis of Epping, NSW**, that is.

Such downpipe is often discarded on building sites, and is seamless and may be cut to any desired length. Two yellow plastic lids from Kodak slide boxes make neat-fitting end pieces, which can be secured with small self-tapping screws. The whole can be sprayed any desired colour, and the front lid dressed with a piece of 'Contact' adhesive or whatever if necessary.

Care is needed when drilling the lids for pots, switches, etc, as the plastic is quite thin.



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# Ideas for Experimenters

## Idle cutout for car air conditioning

**Mr R. Lee of Beverly Hills, NSW,** found a simple and effective solution to the problem of car air conditioning loading the motor when idling.

Being the owner of a small-engined car fitted with air conditioning, I found that in city traffic, owing to the frequent stops, the extra load of the air conditioner's compressor was causing the engine to overheat and idle roughly, sometimes stalling.

Commercial units to disengage the compressor at idle are available, but expensive and none too effective. By modifying the ETI Over-rev Alarm (Project 322, Mar. '80) I have constructed an automatic idle cutout switch which disengages the air conditioner compressor's magnetic clutch during the time the vehicle is stopped, with the engine idling.

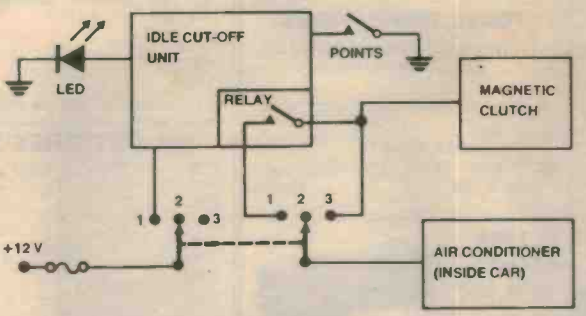
The changes necessary to the Over-rev Alarm's circuit are:

1) Increase C2 from 100n to 220n (four-cylinder car)

2) Only one adjustment is necessary, therefore only RV1 is required.

3) A Bosch automotive relay is used in lieu of the Sonalert (its contacts being wired to the compressor magnetic clutch).

4) A diode is placed around the relay to protect Q1 from voltage spikes.




SWITCH IS 3-POSITION, 2-POLE.
POSITION 1: IDLE CUT-OFF (AT IDLE COMPRESSOR DISENGAGED).
POSITION 2: MAGNETIC CLUTCH OFF (FAN MAY BE ON IF REQUIRED).
POSITION 3: NORMAL OPERATION.
N.B. MAGNETIC CLUTCH IS ALWAYS UNDER THE CONTROL OF THE THERMOSTAT.

5) A LED is mounted inside the car for visual indication of the unit's operation.

6) A three-position switch is used to allow:

(a) air conditioner to operate normally

(b) idle cutout switch in-circuit

(c) magnetic clutch circuit disconnected but with fan operating (to reduce load for steep hills, etc)

The block diagram shows how the unit is connected to the car air conditioner's and car's electrical systems.

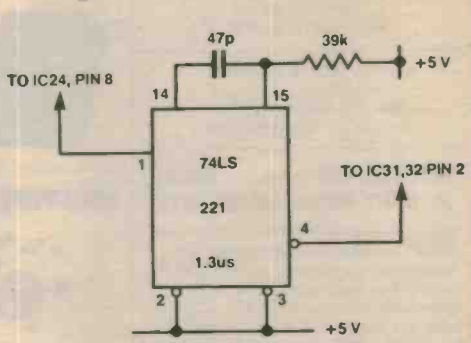
## Removing 'interlace jitter' on the ETI-640

An item by **J.J. Wilson** in this column in the **June '81 issue** detailed a method of removing 'interlace jitter' from the ETI-640 VDU. However, some owners found it didn't work for them. **N.J. Phillis and E. Clarke, in the SAMG's Newsletter,** have detailed a method which does seem to work. Here's how it goes:

(a) disconnect diode D7 from IC38, pin 9.

(b) connect a 6k8 resistor between the wiper of RV1 and IC38, pin 4.

The circuit here refers.




# ✸ 'IDEA OF THE MONTH' CONTEST ✸

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 pc board holder, model 333 — as described in News Digest, p.8, October '81 issue. Selections will be made at the sole discretion of the editorial staff of **ETI** Magazine. Apart from the prize, worth about $70, 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.

### COUPON

"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*".

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Cut out and send to: Scope/ETI 'Idea of the Month' Contest, **ETI** Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

# CLAMP METER

## MODEL YF-700

Top of the range model AC Voltage 150V 300V 600V AC Current 6A 15A 60A 150A 300A. Resistance 5kΩ (Midscole 200Ω)

was $49.99

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| ITOH 1500 SERIAL (DAISYWHEEL) | $1555 + TAX |
| ITOH 8510 PARALLEL | $910 + TAX |
| ITOH 8510 SERIAL (GRAPHIC ETC) | $1015 + TAX |

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Built and tested $99.50

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7 Slot Motherboard $90.00
Built and Tested $120.00
ACTIVELY TERMINATED

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Test these new parts for yourself with intersil's low cost prototyping kits complete with A/D converter and LCD display (for the 7106) or LED display (for the 7107). Kits provide all matrials including PC board, for a functioning panel meter ICL7106EV (LCD).

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| | |
|---|---|
| S100 gold plated wire wrap | $8.50 |
| S100 solder tail | $6.90 |
| D2 Motorola bus 43/86 solder tail | $8.50 |
| 43/86 gold plated wire wrap | $11.50 |

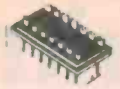
### 10 TURN POTENTIOMETERS

Stock resistance values

50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 100k

Spectrol model 534 ¼" shaft
Price 1—9 $9.50
10 + values may be mixed $8.90

### DIP PLUGS



Ideal for use with flat ribbon cable or to mount components on
14 pin $1.20
16 pin $1.40
24 pin $1.20
40 pins $5

### POWER TRANSFORMERS

SPECIALLY DESIGNED FOR MICROCOMPUTERS

- Good regulation electrostatic shield
- RI 810 8V @ 10A x 15V @ 1A $26.50
- RI 820 8V @ 20A 15V @ 1A 15V @ 3A $36.50

### 20 TURN CERMET TRIM POT

### SPECTROL 43P ACTUAL SIZE

STOCK RESISTANCE VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1M, 2M

| | |
|---|---|
| 1—9 | $1.40 |
| 10—99 | $1.30 |
| 100 | $1.20 |

Values may be mixed.

### Hexadecimal Keypad

**$28.50 each**

19-key pad includes 1-10 keys ABCDEF and 2 optional keys and a shift key

**Ideal for dream project**

### MULTIDIALS

Dials to suit 10 T Pots

| | |
|---|---|
| Model 21 1.8" dia | $16.50 |
| Model 16 9" dia | $12.50 |
| Model 18 1" x 1.75" dia | $21.50 |

### cermet single TURN TRIM POT

Spectrol model 63P ACTUAL SIZE

STOCK VALUES
10R, 20R, 50R, 100R, 200R, 500R, 1K, 2K, 5K, 10K, 20K, 50K, 200K, 500K, 1M, 2M

| | |
|---|---|
| 1—9 | $1.00 |
| 10—99 | 0.90 |
| 100 | 0.80 |

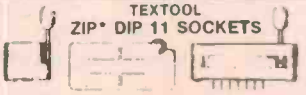
Values may be mixed.

### DIP SWITCHES SPST

| P N | No of Switches | Price |
|---|---|---|
| SD3 | 3 | $1.60 |
| SD4 | 4 | 1 70 |
| SD5 | 5 | 1 90 |
| SD6 | 6 | 2 30 |
| SD7 | 7 | 2 40 |
| SD8 | 8 | 2 50 |
| SD9 | 9 | 2 70 |
| SD10 | 10 | 3 00 |

### DIP SWITCHES SPST

### TEXTOOL ZIP* DIP 11 SOCKETS



| | |
|---|---|
| 16 Pin Zip* Dip 11 | $11.50 |
| 24 Pin Zip* Dip 11 | 12.50 |
| 40 Pin Zip* Dip 11 | 17.50 |

*Zero Insertion Pressure

### INCREDIBLE MEMORY AND DISC DRIVE PRICES

| | 1-9 | 10-25 | 25+ |
|---|---|---|---|
| 2708 | 4.90 | 4.00 | 3.90 |
| 2716 | 4.90 | 4.20 | 3.90 |
| 2732 | 8.00 | 7.50 | 7.00 |
| 4116 (200nS) | 1.95 | 1.80 | 1.75 |
| 4164 64K Dynamic | 11.00 | 10.00 | 9.50 |
| M58725P (2K x 8) Static | 10.00 | 9.00 | 8.50 |

(As used in new 64K Static $100 PCB)
ALL PRICES INCLUDE SALES TAX

### DISK DRIVES

MPI 51 $275.00 + 17.5% ST.
MPI 52 $385.00 + 17.5% ST.
MPI 91 $415.00 + 17.5% ST.
MPI 92 $515.00 + 17.5% ST.

### TANDON

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TM100-2 $385.00 + 17.5% ST.
TM100-3 $415.00 + 17.5% ST.
TM100-4 $515.00 + 17.5% ST.

### RS232 & "D" TYPE CONNECTORS

| PART NO | DESCRIPTION | 1-9 | 10-25 | 25+ |
|---|---|---|---|---|
| DE-9P | 9 PIN MALE | $3.50 | $3.50 | $3.10 |
| DE-9S | 9 PIN F/MALE | 4.50 | 4.20 | 3.90 |
| DE-9C | 9 PIN COVER | 2.20 | 2.10 | 1.90 |
| DA-15P | 15 PIN MALE | 4.50 | 4.20 | 3.90 |
| DA-15S | 15 PIN F/MALE | 5.10 | 4.90 | 4.70 |
| DA-15C | 15 PIN COVER | 2.30 | 2.10 | 2.00 |
| DB-25P | 25 PIN MALE | 5.90 | 5.60 | 5.10 |
| DB-25S | 25 PIN F/MALE | 6.90 | 6.60 | 6.10 |
| DB-25C | 1 pc Grey Hood | 2.40 | 2.20 | 2.00 |
| DB-25C2B | 2 pc Black Hood | 2.80 | 2.70 | 2.50 |
| DB-25C2G | 2 pc Grey Hood | 2.70 | 2.50 | 2.40 |
| DC-37P | 37 PIN MALE | 7.90 | 7.50 | 7.10 |
| DC-37S | 37 PIN F/MALE | 10.90 | 9.90 | 9.10 |
| DC-37C | 37 PIN COVER | 4.90 | 4.50 | 4.10 |
| DH S | Hardware set (2 Pairs) | 2.10 | 1.90 | 1.80 |

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| PART No | PRICE |
|---|---|
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| AD016101TB | $16.95 |
| AD01605-TB | $16.54 |
| AD0162-T15 | $18.78 |
| AD0162-T15 | $13.03 |
| AD0162-TB | $13.77 |
| AD0210-SQ8 | $32.70 |
| AD02160-SQ8 | $36.91 |
| AD02161-SQ8 | $33.46 |
| AD10100-W8 | $52.72 |
| AD12100-HP8 | $85.10 |
| AD12100-M15 | $79.11 |
| AD12100-M8 | $79.11 |
| AD12100-W8 | $53.99 |
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| AD12250-W8 | $90.52 |
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| AD70601-W8 | $20.40 |
| AD70620-M8 | $21.54 |
| AD7063-M8 | $20.78 |
| AD70630-M8 | $20.78 |
| AD70650-W8 | $26.96 |
| AD7066-W8 | $26.96 |
| AD80601-W8 | $20.24 |
| AD8061-W8 | $20.24 |
| AD80652-W8 | $26.20 |
| AD8066-W4 | $27.66 |
| AD8081-M8 | $9.81 |
| AD9710-M8 | $41.11 |
| ADF1600-8 | $19.44 |
| ADF500-4500-8 | $19.44 |

### DIODES

| | 10-99 | 100+ |
|---|---|---|
| IN4001 | 6c | 5c |
| IN4002 | 6c | 5c |
| IN4004 | 7c | 6c |
| IN4148 | 5c | 4c |
| IN5404 | 30c | 25c |
| IN5408 | 35c | 30c |
| IN4007 | 12c | 11c |

### HEATSINKS

**High Thermal Capacity Black Anodised**

| | 1-4 $ | 5-9 $ | 10-49 $ | 50-99 $ | 100-499 $ | 500 plus $ |
|---|---|---|---|---|---|---|
| HS1 — 38mm | 1.85 | 1.75 | 1.50 | 1.35 | 1.00 | 0.90 |
| HS2 — 75mm | 3.00 | 2.90 | 2.50 | 2.00 | 2.00 | 1.50 |
| HS3 — 150mm | 5.80 | 5.40 | 4.90 | 3.80 | 2.90 | 2.70 |
| HS4 — 225mm | 8.10 | 7.60 | 7.10 | 5.90 | 4.50 | 4.30 |
| HS5 — 300mm | 8.90 | 8.40 | 7.90 | 6.50 | 4.90 | 4.60 |

**Unanodised**

| | | | | | | |
|---|---|---|---|---|---|---|
| HS11 — 38mm | 1.40 | 1.20 | 1.00 | 0.90 | 0.80 | 0.70 |
| HS12 — 75mm | 2.50 | 2.20 | 1.90 | 1.60 | 1.25 | 1.20 |
| HS13 — 150mm | 4.90 | 4.50 | 4.00 | 3.20 | 2.45 | 2.40 |

### BLANK CASSETTES T.D.K.

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| TDK ADC60 | 1 for $3.60 | 10 for $26.00 |
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| TDK DDC60 | 1 for $3.50 | 10 for $31.00 |
| TDK SAC60 | 1 for $3.30 | 10 for $29.00 |
| TDK SAXC60 | 1 for $5.70 | 10 for $46.00 |
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| TDK ADC 90 | 1 for $3.50 | 10 for $28.00 |
| TDK SAC 90 | 1 for $4.20 | 10 for $37.00 |
| TDK DDC90 | 1 for $4.70 | 10 for $45.00 |
| TDK SAXC90 | 1 for $5.50 | 10 for $49.00 |
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# Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

## ETI-1506 Bike flasher

There are a few 'out of the ordinary' components in this one, but they shouldn't be too difficult to get. The potcores specified we obtained from Radio Despatch Service in Sydney, but All Electronic Components in Melbourne and perhaps Rod Irving Electronics could supply them. The Philips part number is given in the transformer winding details.

The xenon flash tube and trigger transformer we obtained from Circuit Components of 383 Forest Rd, Bexley NSW, (02)59-6550. The tube is type MFT1210, the tranformer type TR4KN. Dick Smith has a similar tube, cat. no. S-3882, and transformer, cat. no. M-0104. Electronic Agencies list a tube in their catalogue — no. SE3285, and a transformer — cat. no. ME0004. Tandy also list a tube and trigger transformer in their catalogue. The tube is no. 272-1145, the transformer, no. 272-1146.

All the other components are generally easy to obtain off-the-shelf from most electronic component suppliers.

## ETI-160 13.8 V supply

The only transformer we could find to do the job was the Dick Smith M-2000. Other kit suppliers may have a similar transformer specially wound for this project. It is the same transformer we used in the ETI-1503 'Intelligent' Battery Charger described in the August 1981 issue.

The K&W C1064 case is the same as used in that project, too, and should be widely available. Should you find difficulty in obtaining one of these, you might enquire about the address of your nearest supplier from the manufacturers — Ballarat Electronic Suppliers, 5 Ripon Street North, Ballarat Vic. 3350. (053)31-1947.

The 152 mm length of Philips 45D6CB heatsink we obtained from Jaycar, but it is reasonably widely stocked.

## ETI-145 'Prototyper'

This project should be widely stocked as a kit, according to feedback from kit and component suppliers. Little difficulty should be met in obtaining most of the components.

Intersil (who make the ICL7660) are represented in Australia by R&D Electronics at 133 Alexander St, Crows Nest NSW 2065, and 257 Burwood Highway, Burwood Vic. 3125. All Electronic Components in Melbourne are an official Intersil distributor and they recently advertised the ICL7660 at $4.28 plus sales tax. However, All Electronic Components should be able to supply you the ETI-145 as a complete kit.

The breadboard strip used in this kit is available in a variety of configurations from a wide range of suppliers. The Atek AT-2N is handled by Emona Enterprises, CBC Bank Building, 661 George St, Haymarket, Sydney, (02)212-4815. Radio Parts handle the Atek breadboards in Melbourne, Radio Despatch Service in Sydney. The Continental Specialities breadboard is available from a variety of suppliers. Anyhow, you should have little difficulty in getting a breadboard to suit.

## ETI-670 ASCII keyboard

Owing to an unfortunate series of circumstances — too long, boring and bitter to go into here — key components for this project have become unavailable. The overseas supplier of the low-cost keyboard let down the importer, Amtex, and this unit will not be available. Sorry, but there's nothing we can do about it. Secondly, the GIM AY-5-2376 encoder chip is now an obsolete part and will no longer be manufactured. However, the local distributors — Daneva Australia Pty Ltd — have arranged to stock several hundred devices so that the project is not completely lost. But once they're gone, that's it.

Suitable keyboards can be obtained from a variety of suppliers — Daneva can supply a low-cost Clare keyboard, for example. You can contact Daneva at 66 Bay Road, Sandringham Vic. 3191. (03)598-5622.

## Another pcb supplier

We should have mentioned in the list of pc board suppliers in the June issue that Electronic Agencies are now stocking every pc board for ETI projects published from 1975 onwards. They have two stores: 115-117 Parramatta Rd, Concord NSW 2137, and 121 York St (now on the street front), Sydney.


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| LN C90 | LOW NOISE | 12 for $28 |

TDK

| | | |
|---|---|---|
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| SA C90 | SUPER AVILYN | 10 for $39 |
| AD C90 | ACOUSTIC DYNAMIC | 10 for $30 |
| D C90 | DYNAMIC | 10 for $24 |

BASF

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|---|---|---|
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| LH C90 | LOW NOISE | 10 for $25 |

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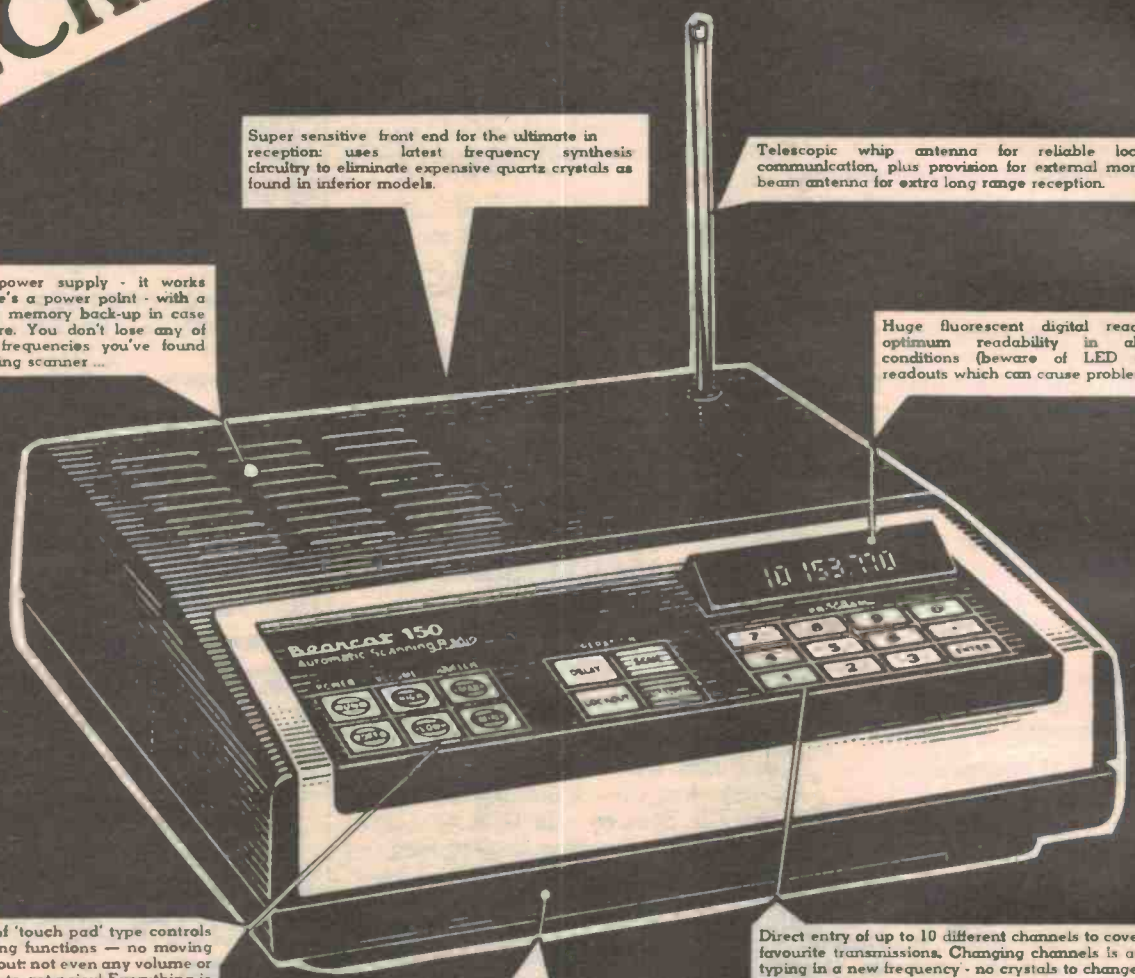


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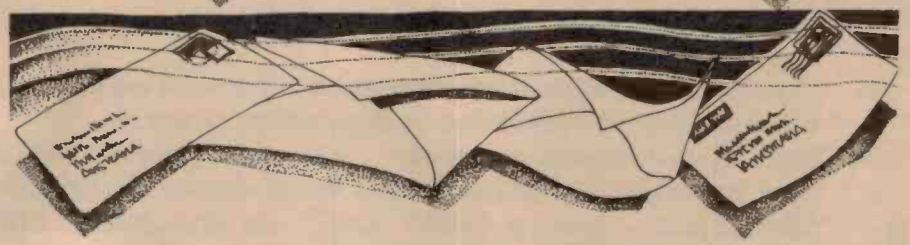
# DICK SMITH Electronics

SEE PAGE 19 FOR ADDRESS DETAILS

# LETTERS



**Dear Sir,**

As an avid hifi enthusiast I have enjoyed the 'sound' section of your magazine. However, in the past few months I have found the section dominated or squeezed out by other items. I hope this situation will not continue to get worse — or even stay as it is.

Onto other matters, I have been thinking about the model 5000 pre and power amps (and the bridging unit); however, I find the use of inferior capacitors leaves the unit to shame. When every other part of a system is scrutinised, why is the capacitor assumed to be blameless? I say you should perhaps read the articles published in the February and March issues of 'Audio' — I would regard this area of inattention the failing point of your amp system.

Perhaps you may consider a study of the factors: what higher grade units (if any) are available here, cost, size, voltage limits, characteristics, capacitance ranges available, etc.

Under no conditions would I ever use glass, mica, polyester (greencaps), mylar (or metalised), polycarbonate. And I'd start looking very hard at those electrolytics too (A1 units may be slightly better) in the audio stages; smoothing and certain other stages may not be worth worrying too much about. (And of course we *are* forgetting the ubiquitous diode too).

Well, what do you have to say?

**P. Iles**
**Sorell, Tas.**

*The 'size' of a section in ETI devoted to a particular category of the broad field of electronics is dictated, month to month, by a variety of factors. Chief among these are the interest among readers or demand for material covering a topic or area, the material available, the cost versus benefits, and the amount of advertising (the company's shareholders require that we make a profit). Whilst your specific interest may be audio, the specific interests of thousands of other readers lie in different areas — some are interested mainly in projects, some mainly in computers, etc. The situation regarding the Sound (or, rather, the Sight & Sound) section of ETI is not likely to remain 'fixed'. It is not being 'squeezed out' by other sections, but it will vary.*

*Regarding the Series 5000 power amplifier and preamplifier, your scrutiny of the circuitry clearly did not include a scrutiny of the specifications. We should point out that the published specifications are actually* **performance figures, measured on the prototype.** *Any jibe about the use of capacitors, or certain capacitors, or any other component or circuit technique employed in the Series 5000, must consider this.* **Quoted performance is not theoretical.** *Many factors were considered during the design of the Series 5000 — amongst them, capacitors and resistors. If you would never use "... glass, mica, polyester, mylar (or) polycarbonate" capacitors, and suspect electrolytics, then what would you use? Air-insulated capacitors? Ever seen a 470n air-insulated capacitor?*

*A plethora of sheer rubbish is promulgated in audio journals about the 'sound' of passive components, and capacitors seem to be out of vogue in recent years — to the point where capacitor-coupled amplifiers of any sort are frowned upon as being inherently inferior. Many writers profess a yearning for valve amplifiers — which are inferior!*

*And what about the ubiquitous diode? What do you suggest we use for ac mains to dc power supply conversion — a rotary converter?*

**Roger Harrison**
**Editor ETI**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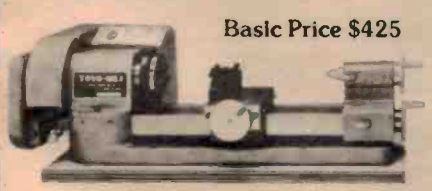

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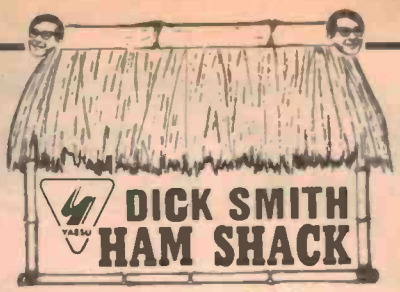


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For real amateur power! Run your station at maximum legal power - and the FL2100Z is just coasting Cat. D-2548 ~~$580~~
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| FT227RB | 2 metre with scanning *save $60* | D-2891 | $379 | $319.00 |
| FV707DM | Digital VFO for 707 | D-2896 | $299.50 | $265.00 |
| MMB2 | Mobile bracket for 707 | D-2897 | $36.00 | $25.95 |
| FT107DMS | HF WARC band, with DMS *SAVE $103* | D-2871 | | $1225 |
| FT7B | HF solid state mobile | D-2868 | $599 | $549 |
| FT901D | HF base station | D-2854 | $1075 | $950.00 |
| 901DC CONV | DC/DC Converter for FT901/902 | D-2856 | $69.00 | $49.00 |
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| 901 MEM | Memory unit for FT901/FT902 | D-2858 | $139.50 | $99.00 |

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The stores at left, stock the complete range of Dick Smith Amateur Radio equipment. All other Dick Smith stores stock some amateur equipment, but may not be able to give you the service of the 'HAM SHACK' stores listed.

A290 F1

# Amateur satellite first to be launched from manned spacecraft!

A new Russian amateur satellite was put into orbit on May 17 when two cosmonauts pushed the 28 kg (62 lb) bird 'Iskra 2' through the airlock of their Solyut 7 spacecraft.

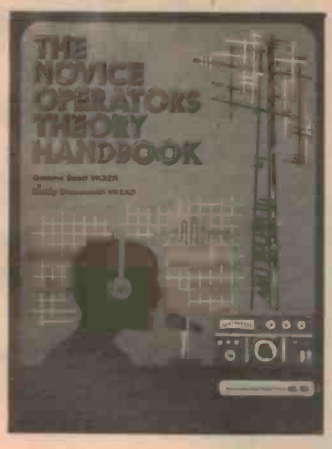
**Soviet newsagency Tass reported that the communications satellite was created with the help of "young scientists and amateur radio enthusiasts" from the USSR and several of its allies.**

Iskra 2 is believed to incorporate a translator with input on the 15 metre band (21 MHz) and output on the 10 metre band (28 MHz).

This is probably the first working satellite put into orbit from a manned spacecraft. (Westlink Report).

## Novice handbook

**What every novice or aspiring novice needs is a good Australian 'handbook'. The Novice Operators Theory Handbook, by Graeme Scott, VK3ZR, and Sandy Brucesmith, VK2AD, is an attempt to provide one.**

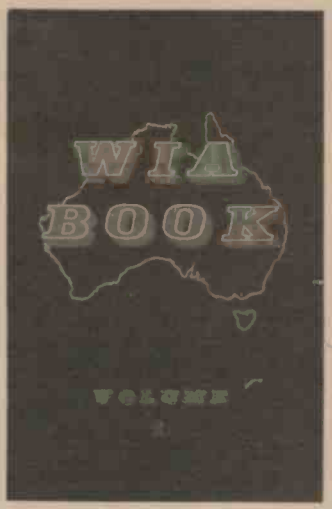



The book is set out as a 'programmed' learning manual with 16 chapters, each covering the basics of a topic followed by questions and exercises. It's a well-proven and useful study technique.

The topics covered are: electrical laws and circuits, vacuum tubes, semiconductor devices, power supplies, HF transmitters, morse transmitters, AM transmitters, SSB transmitters, receivers, propagation, transmission lines, antennas, interference, test equipment, circuit symbols, morse code. Answers to questions are also included.

The production is rough in places, particularly in the diagrams, and a little more attention to detail here would have improved the book's 'readability' immensely. The text is very limited, to the point of being 'sketchy' in places, and we recommend the book be used in conjunction with a sound basic text in electronics. It seems a 'teacher' or 'guide' is assumed — certainly, one is necessary if you're contemplating sitting for the D.O.C. Novice operator's certificate of proficiency.

The book has a strong practical 'bent' and is copiously illustrated; 205 x 280 mm, 80 pages, rrp: $6.50. A good first effort. If you can't find it in your local hobby or ham store, try Megjay Pty Ltd, 110 Rosemead Rd, Hornsby NWS 2077.




## The 'WIA Book'

**A timely and extremely useful book has been published by the Wireless Institute of Australia, simply called the WIA Book.**

Whilst it does contain a lot of information about the Institute, it is also crammed full of useful facts and articles of everyday use to Australian amateurs — something which has been hitherto totally unavailable.

The book is divided, roughly, into two sections. The front section contains much historical (fascinating!) material plus information on the WIA. It also includes items on awards, services, emergencies, the ionosphere, satellites, QSLs and call signs, etc.

The second section is almost entirely devoted to 'VHF Projects' — reprints from recent past issues of the WIA's house journal 'Amateur Radio' (which will be 50 years old next year!). All useful stuff. It even includes an article by Phil Wait and Roger Harrison — it **must** be good!

Top Stuff!

The WIA book was edited by Bruce Bathols, VK3UV, with technical assistance from Ron Cook, VK3AFW, and research by Peter Dodd, VK3CIF. Available through affiliated radio clubs and state WIA offices; 210 x 135 mm, 160 pages, cost: $3.50.

## Club Call

The **St. George Amateur Radio Society (SGARS)** has advised us that they meet on the first Wednesday of each month at 7.30 pm at Allawah Scout Hall, Cnr. Blakesley Rd and Bellevue Parade, South Hurstville NSW. SGARS's stations are: VK2LE, VK2RDX (Channel 6650, Mt. Bindo), VK2RLE (Channel 6800, Heathcote), and VK2RUH (Channel 8425, Hurstville — proposed). Novice net is on Sundays at 8 am on 3555 kHz, HF nets Tuesday at 7.30 pm on 14 120 kHz and 8 pm on 28 520 kHz, and VHF net on Thursdays on Channel 6800. Further information is available from P.O. Box 77, Penshurst NSW 2222, or by contacting Derick Sellars VK2AZS, (02)560-8644 or (02)529-8674 ah; or Jim Button VK2NPA, (02)543-3295 or (02)521-7303 ah.

---

The **Tamworth Amateur Radio Club** is holding its annual Noel Taylor Memorial Field Day on September 4 and 5 at Duri Hall. There will be a social gathering on the Saturday night, with a spit-roasted pig plus trimmings to be eaten round an old-fashioned open fire, and throughout Saturday and Sunday fox hunts, competitions, displays, etc, will be held. For further information contact E. Mogor (VK2VDQ) at the Tamworth Amateur Radio Club, Victor St, Wallabadah NSW 2343. All welcome!

DICK'S DIRECT IMPORT PRICES

# SAVE ON 40CH

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SAVE $40!

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## 40Ch AM
## STALKER VIII

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**$97.50**

Don't take chances in buying CB radio . . . buy your CB from Dick Smith, Australia's CB expert!
The superb Stalker VIII CB features the new legal 40 channels, complete with microphone and mounting bracket.
Large LED channel readout, easy to use and has maximum legal output.

***FANTASTIC VALUE!***

DOC Approval No. 249A001

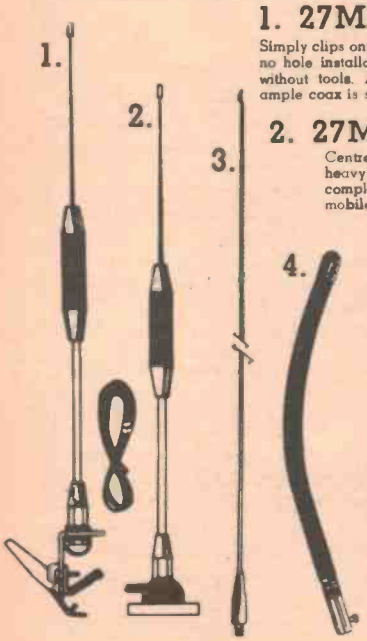
## 40Ch AM/SSB
## DICK SMITH HORNET II

This unit is the latest in 40 channel CB technology. With the massive 12 watts p.e.p. output on SSB, this set meets the high DOC standard RB249A. Frequency range is 26.965MHz to 27.405MHz and accessories include DC power cable with built-in fuse and microphone clip.

**WAS ~~$239.50~~**

DOC Approval No. 249A006

THIS MONTH ONLY $199



### 1. 27MHz Gutter Grip

Simply clips onto the rain gutter of any vehicle. Features no hole installation and can be installed or removed without tools. Antenna has centre loading coil and ample coax is supplied. Cat. D-4411 — $25.00

### 2. 27MHz Magnet Base

Centre loaded stainless steel construction with heavy magnetic base. 16 feet of coax supplied, complete with PL259 plug. Ideal for 'instant' mobile use. Cat. D-4412 — $25.00

### 3. ¼ Wave Whips

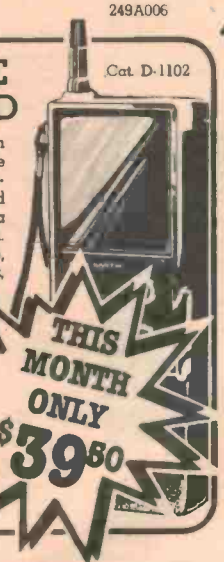
Your choice of stainless steel or fibreglass. Each is approx. 2.75m long, ideal for marine or CB use. Cat. D-4415 — $15.50 / Cat. D-4416 — $19.95

### 4. 'Rubber Duck'

Indestructable and very flexible, perfect for handheld sets. Only 300mm long, great replacement antenna! Cat. D-4629 — $8.50

## TOP VALUE HAND HELD

Cat. D-1102



For the weekend boatmen who don't want the more expensive full power transceivers, but who still need that reassurance of having a safety transceiver on board. Three channels available, one fitted with 27.620MHz, the others left blank for your own choices. Crystals are reasonably priced and easy to fit. This set takes 8 'AA' pencell batteries.

**WAS ~~$51.00~~**

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# THE MOST POWERFUL S100 CP/M BASED COMPUTER IN THE WORLD

HOW CAN AN AUSTRALIAN MANUFACTURER TRULY MAKE SUCH A CLAIM? **IT'S TRUE!**

***— ASK US WHY —***

THIS COMPUTER USES OUR UNSERIAL TERMINAL TO PROVIDE A DUEL OPERATING SYSTEM WITH CP/M ENHANCEMENTS THAT MUST BE SEEN TO BE BELIEVED.

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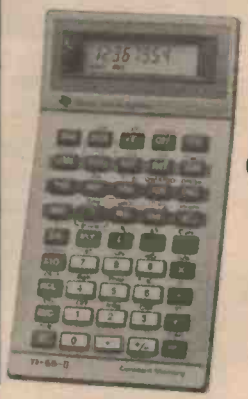

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|---|---|---|---|---|---|
| TI-1750 III | 15.62 | 17.57 | TI-35 II | 22.20 | 24.98 |
| TI-1760 DATACARD | 20.70 | 23.95 | TI-40 | 32.86 | 36.97 |
| TI-1790 DATACHRON | 35.23 | 39.95 | TI-54 | 37.00 | 41.63 |
| TI-5025 | 80.36 | 90.44 | TI-55 II | 49.29 | 55.45 |
| TI-5100 | 35.00 | 39.38 | TI-58c | 107.00 | 120.26 |
| BA II Executive | 41.12 | 46.26 | TI-59 | 224.00 | 254.73 |
| MBA | 64.55 | 72.62 | PC-100C | 205.00 | 231.60 |
| PROGRAMMER II | 61.67 | 69.38 | | | |
| TI-30 II | 17.26 | 19.42 | | | |

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**Microtrix proudly presents the entire range of MORROW DESIGNS IEEE 696 S100 products. They represent an integrated set of high performance, state-of-the-art boards and systems.**

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The Decision 1 is an attractive, versatile, IEEE 696 S100 computer utilising the advanced boards from MORROW DESIGNS. Whether you're building a single or multi-user system, the Decision 1 offers you a hardware/software combination unmatched in the field. Decision 1 is not simply an improved 8-bit microcomputer: it's a breakthrough. In both computing power and price.

**Central Processing Unit**
The CPU card, designed to function like an IBM 370* processor, features dynamic allocation of memory in 4K increments to 1 Megabyte; supervisor control of users; sophisticated trapping mechanism; and optional floating point processor.

**DMA Floppy Controller**
This controller is sheer brilliance! It implements full DMA as per IEEE 696 specifications, utilising an on-board Z-80A to supervise operations. Using MORROW's channel drive concept, operation is not unlike the channel controllers which attach to IBM 370* mainframes, enchancing system throughput. Memory and I/O mapped controllers are also available.

**DMA Hard Disk Controller**
Second to none in the world for speed, size, and cost, this controller also employs the channel drive concept and DMA transfers. The fast Signetics 8X300 microsequencer is used to control all drive functions.

**Micronix Operating System**
A multi-user, multi-tasking operating system designed to operate on the Decision 1 with hard disks. Functionally equivalent to Bell Lab's UNIX, it also provides a CP/M emulator allowing use of all CP/M programs. Up to 15 users can be supported.

**And More**
Other products include a 64K static memory board with bank select and extended addressing; I/O cards; floppy disc systems; and 5, 10, 20, or 26 Megabyte hard disk systems.

**Information?**
Please write or phone for further information and pricing on these advanced products.

Product specifications are subject to change without notice
*IBM 370 is a trademark of IBM corp.
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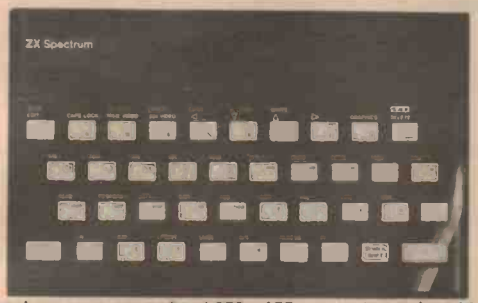
**75 Grand Boulevard, Montmorency, 3094 Vic. Phone (03) 439 5257**
**Postal: PO Box 158 Hurstbridge, Vic. 3099.**

# Sinclair does it again




**The ZX Spectrum measures about 250 x 155 mm and uses just 14 chips.**

The peripatetic Clive Sinclair has just launched the 'ZX Spectrum', the heart of a system targeted to come in under the latest rash of colour computer/home entertainment machines.

**The Spectrum features colour, sound, high resolution graphics, 16K or 48K of RAM, full ASCII character set (upper and lower case), 16K extended BASIC, pushbutton keyboard and high-speed cassette LOAD and SAVE (16K in 100 seconds!).**

As with its predecessors, the Spectrum features single keystroke entry of commands and multiple-function keys. The Spectrum will operate the existing ZX printer, and an RS232 serial interface board is in the offing.

Big news is that **microfloppies** for 'ZX Microdrives' will be available for the Spectrum. Sinclair's blurb claims each microfloppy will hold up to 100K and operate at transfer rates of 16K/sec. Up to eight microdrives can be hooked up.

On colour, you get eight colours **each** for foreground, background and border, plus flashing and brightness/intensity control. The high resolution graphics gives you 256 dots horizontally by 192 vertically, and the machine is claimed to be 'Teletext compatible'.

Sinclair is reported to be "furious" that the BBC selected Acorn to produce their 'BBC microcomputer', claiming he could offer "any facilities that the Corporation might require at a lower price than any competitor". Curiously, Sinclair and Acorn computers are represented in Australia by one firm — Barson Computers.

## Begin at the Beginning . . .

**By now anyone even marginally into electronics or computing has probably heard of the Australian Beginning — an Australian version of the successful Source system of information distribution in America.**

The Australian Beginning gives computer users access to a wide range of information at a relatively low cost, particularly if you use the system between 6 pm and 8 am or at weekends. Instructions are in everyday English, so you don't have to be a computer buff to operate it; even young children have no trouble.

The kind of information and services available on the Australian Beginning are news, weather reports, airline timetables, share prices, electronic mail, telex operation; you can also get advice on running your business and do your accounts using the on-line programs, as well as play sophisticated computer games.

The Australian Beginning and Sigma Data have now got together to offer a quality low-cost terminal and acoustic coupler, plus a printer if you need one, to get you on-line to the Australian Beginning network at a reasonable price. Along with the terminal and coupler (you need access to a phone to use this system) you get free permanent membership of the Australian Beginning, plus 60 hours of free computer time.

The terminal and coupler are available under the title of 'Executive Equipment Package' for $2395 (or terms of a weekly payment of $20 over 60 months). The printer costs $699 extra, bringing payments to $25 per week over 60 months. For further information contact the Australian Beginning, 338 Queen St, Melbourne Vic. 3000. (03) 329-7533.

## The key to your computer

**Key Computer (a franchisee of Computer Country of Melbourne) recently announced its grand opening in Adelaide.**

Key Computer will be offering a wide range of microcomputer systems which will include the Apple, the Hitachi Peach, the Osborne, the NEC PC-8000, the Atari, the Northstar, Micromation, CEC, Casio FX 9000P, Hewlett Packard and Higher Scientific — almost every major microcomputer system all in one store!

Besides having hardware and software for the previously mentioned systems, Key will also be offering software and peripherals for other systems, such as the TRS-80.

Key Computer will now act as the Computer Country franchisee with responsibility for all of South Australia. They have also been appointed the prime South Australian dealer for the Australian Beginning system. Australian Beginning is Australia's 'first microcomputer information service'. Key will have responsibility for servicing all Australian Beginning accounts in South Australia as well as holding periodical seminars for South Australian users of the Australian Beginning system.

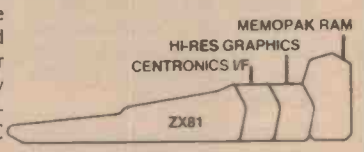
These seminars are designed to acquaint South Australian users with new services as they eventuate and also show Australian Beginning users how to get the most out of their system, Computer Country say.

Key Computer is situated at 1055 South Road, Edwardstown S.A. 5039. (08)277-8936.

## ZX expansion

**A 'memory extension' package, enabling the memory of the ZX80/ZX81/Microace to be expanded by 56K to give 64K total, is expected to be available here this month.**

From Memotech in the UK, the 'Memopak 64K' provides a claimed 'full' 64K of RAM, which is neither switched or paged, and is directly addressable. The unit is user transparent and accepts BASIC commands such as DIM A(9000).




The Memopak is designed as a series of 'piggyback' peripherals — like a Centronics interface and a hi-res graphics pack.

The Memopak 64K is being handled in Australia by Total Control Technology, P.O. Box 61, Happy Valley SA 5159, (08)381-2644; cost should be under $400.

# COMPUTER REFERENCE GUIDE

Offers a wide variety of microcomputing books for commercial, education, scientific and hobbyist users. Machine-specific books are available for the Apple, Atari, Commodore PET/CBM/VIC, TRS-80, SINCLAIR ZX 81 etc. General books covering Pascal, ADA, BASIC, Business Applications, Microprocessors and various Introductory books are also stocked.

**Computer Reference Guide is your single-source supplier for microcomputer publications from major publishers including Osborne, McGraw-Hill, Sybex, Tab, Dilithium, Wiley, Addison-Wesley, Prentice-Hall, Sams etc.**

The following titles are a brief selection of what is available. For a complete list, please call or write for our latest price list.

**APPLE II USER'S GUIDE**
*by L. Poole, M. McNiff & S. Cook*

The *Apple II User's Guide* is a true programming tool that really instructs you in using the Apple computer. This book will save both time and effort. No longer will you have to search through separate sources to find those useful tidbits of information. It's all here, properly indexed and under one cover. Includes details on the two BASICS, sound and graphics features, disk drive and the printer, as well as a chapter on controlling external appliances.

*1981; 377pp; $21.45*

**OSBORNE CP/M USER GUIDE** *by T. Hogan*

While CP/M is by far the most popular operating system, its literature has been largely aimed at the professional programmers. For end users who want to know the basics of CP/M, this User Guide bridges the gap between technical manuals and your working knowledge of microcomputers.

Beginning with the basic, practical information you beed to get started, this book details all the CP/M commands and describes compatible support programs. Use of application packages, high level languages (BASIC, Pascal, FORTRAN, Forth and COBOL), and utility programs are all covered. It includes many tables and lists which serve as operating references once you've become familiar with CP/M.

For more advanced users, the relationship between CP/M and other operating systems, such as Cromemco CDOS, is carefully examined. There is also discussion on how to modify CP/M or use CP/M for program development.

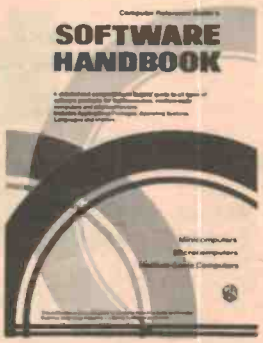
*1981; 283pp; $18.50*

**AN INTRODUCTION TO MICROCOMPUTERS VOLUME 1 - BASIC CONCEPTS Second Edition**
*by Adam Osborne*

Using concepts that are common to all microprocessor systems, *Volume 1* develops a detailed picture of what a microcomputer can do, how it does what it does, and how the particular capabilities of microcomputers can best be applied in any practical environment. Basic Concepts presents the fundamental logic framework upon which microcomputer systems are built, so that the reader can evaluate the applicability of microcomputers to any practical problem.

This second edition is the most comprehensive and up-to-date introduction to microprocessor systems available anywhere.

*1980; 320pp; $18.59*




**BENEATH APPLE DOS**
*by D. Worth & P. Lechner*

This book describes in detail the Apple Disk Operating System. Included in its eight chapters are introductory details, diskette formatting, DOS details, DOS structure, using DOS from assembly language, customizing DOS and DOS program logic. Example programs, disk protection schemes and a glossary are also included.

*1981; $29.50*

**THE SINCLAIR ZX81 - Programming For Real Applications** *by R. Hurley*

The ZX81, equipped with its 16K RAM pack, has at least as much storage as most microcomputers. It uses the same Z80A CPU that is featured in many of the best microcomputer systems and which, in other machines, can run wages, stock control and word processor systems. So why not in the ZX81? The aim of this book is to push the ZX81 a long way in the direction of serious applications, but without the use of machine code. All the programming is easy to follow and fully explained, so that the reader learns, a step at a time, how complex programs are constructed and written.

But these programs are just a beginning. Discard the belief that the ZX81 is to small and use the flexible techniques described here to fill your own special data processing needs.

*1981; 163pp; $17.95*

**SOFTWARE HANDBOOK**
*by T. Webster, L. Costelloe, E. Ray*

This *HANDBOOK* contains descriptions and listings of nearly 2000 software products for most of the major *minicomputers, medium scale computers* and *microcomputers* sold on the Australian market. It not only includes application packages broken up into many different categories (from both major manufacturers and independent suppliers) but it also describes operating systems and other systems software. As a further aid to the reader, a summary of the various hardware systems is given allowing software products to be matched to hardware capabilities. Also listed are the various high-level languages which apply to each computer.

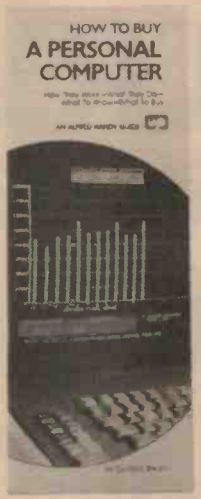
*1982; 341pp; $25.50*

## Low cost HANDY GUIDES are now available covering introductory information for a wide range of topics. Current publications include:

**Understanding BASIC:** This Handy Guide is an introduction to the BASIC language for those who have not been exposed to BASIC before. The material is designed to be used alongside a terminal, so you can run the examples before proceeding.

**Understanding Pascal:** Introduces Pascal in plain English for the non-specialist. If you have never programmed a computer this book is for you. If you already know how to program in another language, this book will provide you with a quick overview of Pascal - a "guided tour" of its highlights.

**Handy Guide Pricing:** $3.95, including postage, for each Guide. For four copies (any mix), a total of $14.95 including postage. For six copies (any mix), a total of $20.95, including postage.




**How To Buy a Personal Computer:** Discusses what is a computer, how it works, software and hardware. Includes information on choosing a personal computer, what operating systems and languages to look for, and which peripherals to select. System requirements for specific applications are discussed. Comparison tables on over 50 models of personal computers are included.

**Understanding COBOL:** In the domain of business applications, COBOL continues to be the number one choice. It is designed to have all the features necessary to conduct and record complex business transactions. This Handy Guide introduces you to some of the features of COBOL that have contributed to its universality.

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**Understanding Artificial Intelligence:** Artificial Intelligence (AI) is a process by which mechanical devices are able to perform tasks which, when they are performed by humans, require some thought. Today AI is associated with computers. Among its most important applications are: Robotics; Games; Natural Language; Image and Scene Analysis; and Computer-Aided Design.

---

**SHAKE HANDS WITH THE APPLE**
*by P. Kelly-Hartley & J. McKneil*

This book is designed to teach the operation of the Apple II Plus microcomputer. It is suitable to use as an individualised program for all age groups. Clear, easy-to-follow instructions guide the beginner to a thorough knowledge of the basic operations of the Apple II Plus. The operations are explained both with and without a diskette or cassette. The book is written and published in Australia. *1981; 91pp; $14.95*

**AUSTRALIAN MICROCOMPUTER HANDBOOK**
*by Tony Webster*

The revised 1981/82 second edition of the popular *AUSTRALIAN MICROCOMPUTER HANDBOOK* reviews in detail more than 200 microcomputer systems from over 60 major microcomputer suppliers. It is designed to aid both first-time and experienced computer users in choosing a microcomputer or microcomputer system to suit their application. Other chapters include discussions on microcomputer theory and applications, as well as descriptions of software packages from independent vendors. *1981; 400pp; $23.00*

**VIC REVEALED** *by Nick Hampshire*

This book is a collection of discoveries about the Commodore VIC 20, how and why it works, and how to use these facts to write better programs and perform more interesting functions. Includes five sections, each one covering one of the principal functional blocks into which the basic VIC can be divided.

*1981; 267pp; $17.95*

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# Big boys boo-boo

We **all** make mistakes. No one is infallible — from the lowliest to the mightiest. This includes IBM. Shock, horror! Probe report! ETI discovers boo-boo in IBM personal computer!

**A close associate of ours, and sometime correspondent, rang us all agog — he'd seen the IBM personal computer produce an error when doing double-precision calculation!**

We rang IBM. Long silence at end of line. Shortly afterwards, we extracted the following statement, dated 28 April 1982:

"In a few rare and isolated cases IBM has determined that an error may occur in the output but not the calculation of double precision number results on the personal computer. This occurs in BASIC when such a double precison number is converted from internal notation from printing display or representation and may result in the decimal point being displaced by one position.

"No IBM application programs offered for use with the IBM personal computer are affected. As an interim IBM provided an alternative way to program so as to avoid the error, but consistent with our practice we also released a corrected version of 'DOS BASIC Interpreter' which resolved the condition."

## Welcome "The RAINBOW"

**Before any computer model can be firmly fixed in the fast-paced history of computing, there has to be a printed vehicle for cross-pollination of ideas. Well, up to date, anyway. Sometimes it is a users' group newsletter, other times a specialist magazine.**

With the 80C Tandy Colour Computer, it was 'The Rainbow', a monthly that has been published in the US mid-month, without falter, fatter and fatter, since July 1981. Local TRS-80C fan, Greg Wilson, started reprinting it in Australia from February 1982. (He pretends it was earlier by printing Dec. and Jan. back issues.) It was a way to serve the news, still piping hot, without readers bearing the $33 annual air-mail surcharge. When he started, no 80Cs had been delivered by Tandy. Within two months, the Rainbow was tumed into a truly Australian edition by extending the printed page to foolscap. Presto, over fifty mini-pages for local user-group news. The TRS-80C Users' Group was started by Dianne and Ian Wotherspoon (phone: (02)629-1076). To get The Rainbow, contact Greg Wilson, P.O. Box 9, Potts Point NSW 2011.

A new monthly, 'SIXTEEN' has been announced by the US publisher of 'The Rainbow'. It will be devoted exclusively to the TRS-80 Model 16, still to be released in Australia. It is a safe bet that Greg Wilson will have an Australian edition of 'SIXTEEN' out before then.

## Commodore interface price slashed!

**Two revolutionary Commodore printer interfaces have been developed by local designer/manufacturer Micropro.**

Both units incorporate design changes and new features which supersede Micropro's existing IEEE-488/Centronix and IEEE-488/RS232 interfaces, and have the added advantage of being compatible with almost any existing standard printer.

The new models feature EPROM code-conversion tables which allow direct output to ASCII printers, and in particular feature a code table which allows the conversion of graphic characters to suit the C-ITOH 8510 graphics printer.

Other savings, including the elimination of the old cable connector, have slashed prices on both the new CBM/PET Centronix and CBM/PET RS232 to a competitive $205, recommended retail, plus sales tax.

For further information contact Micropro Design, P.O. Box 153, North Sydney NSW 2060.

## Instrumentation computer/controller features IEEE buss and BASIC commands

**Scientific Devices Australia recently released a powerful instrumentation computer/controller, designed to handle up to 14 instruments on the buss, and featuring a data rate transfer of a quarter megabyte per second for high speed measurement or data transfer applications.**

Called the SD-488, key features of the equipment include:

- 48K of useable memory (64K optional)
- one mini-floppy disk drive (second one optional)
- IEEE-488 buss plus RS232C and 8-bit parallel interfaces
- special IEEE-buss commands
- 300 mm green phosphor display
- optional CP/M operating system
- BASIC language interpreter.

The BASIC language interpreter incorporates special commands for all commonly used IEEE buss functions, and allows complete control over loading and storing data and programs on the disk drive(s), and all necessary file manipulation functions. As an option, a number of high-level languages and application programs are available in order to meet the needs of complex and/or time critical applications.

The interfaces are supplied as standard IEEE-488, RS232 or current loop serial and 8-bit parallel. No extra options or plug-ins are required; all three are immediately available.

A large green-phospher screen with easy to read characters minimises operator strain when programming or using the unit. The keyboard is detachable, and for total comfort the unit is convection cooled to be whisper quiet, according to Scientific Devices.

The disk drive, selected because of its inherently greater reliability when compared to slower tape storage systems, is totally supported within the SD-488, and therefore does not occupy an output slot or require an external interface. A second drive can be added at any time by simply fitting the drive and connecting a cable.

An internal printer is not provided. This avoids locking the user into paper of a specific width or special expensive-coating type. With an increasing array of printers available in the under $1000 bracket, the user can select the printer that exactly suits the need, or omit the printer altogether.

For further details, contact Scientific Devices Australia Pty Ltd, 2 Jacks Rd, South Oaklelgh Vic. 3167. (03)579-3622.

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Contact Philip Lui on (03) 842-5303.

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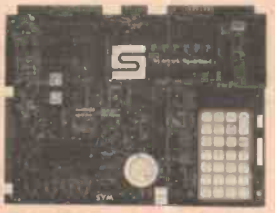

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## Western Digital Winchester Controller Board

**Western Digital's WD1000 Winchester controller is making its Australian debut after a highly successful launch in the USA.**

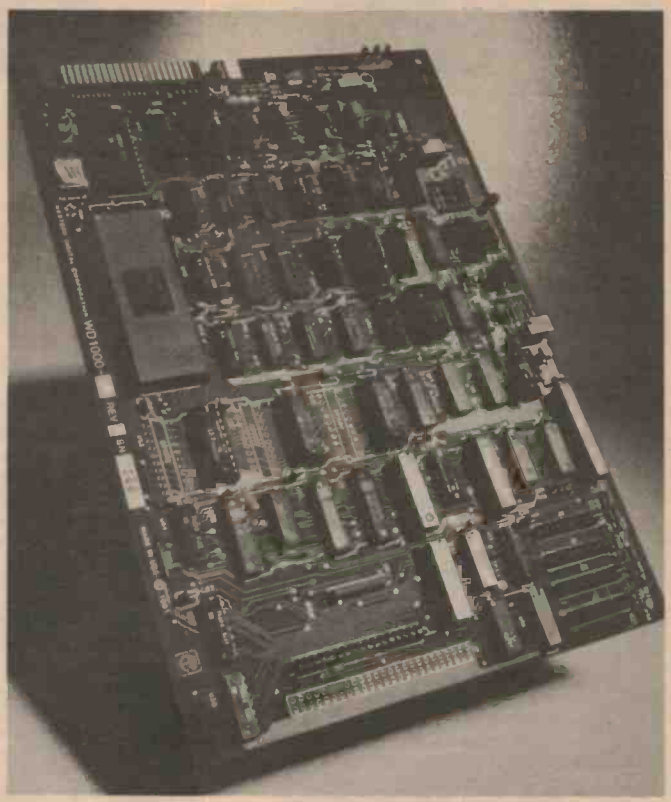
The WD1000 is a stand-alone, general purpose Winchester controller, designed to interface up to four Winchester drives to a host processor. The drive signals are based upon the floppy look-alike made popular by Shugart's SA1000, Seagate's ST506 and other drives from Quantum, Tandon and MPI.

All necessary buffers and receiver/drivers are included on the board to allow direct connection to the drive. Either a 34-pin (5¼" drive) or a 50-pin (8" drive) connector is provided, as well as four 20-pin data connectors.

Communications to and from the host computer are made via a separate computer access port. This port consists mainly of an 8-bit bi-directional buss and appropriate control signals. All data to be written to or read from the disk, status indication, and macro commands are transferred via this 8-bit buss.

An on-board sector buffer allows data transfers to the host computer independent of the actual data transfer rate of the drive.

For further information contact Daneva Australia Pty Ltd, 66 Bay Road, (PO Box 114), Sandringham Vic. 3191. (03)598-5622; telex: AA34439.



## EPROM programmers and power supplies

**An EPROM programmer is always useful to computer users, and Philitronic Components and Services are now offering a cheap programmer that operates on a stand-alone basis.**

With this programmer you can copy, verify or compare two EPROMs, as well as burn EPROMs of either 2716 or 2532/2732 types. The on-board keypad and seven-digit LED display allow you to read your EPROM data into RAM (4K on-board), step through and alter any locations, then burn your new copy. You can even read two 2716 EPROMs and burn them into one 2732, or vice versa.

The board operates with a Z80 CPU chip under a 2K program, and requires only a regulated single 5 V supply at 1.5 A max. (600 mA typical). This unit is said to be ideal for schools, industry or the hobbyist.

A compact switching power supply that gives out 5 A at +5 V, 1 A at +12 V, −12 V and −5 V, is also available. Similar to the supply found in Apple computers, it is ideal for use with the Orange computer board, Ferguson big board or other single-board computer systems. The unit is quite light in weight and very cool in operation.

Both the EPROM programmer and the power supply are available from Philitronic Components and Services of Melbourne; (03) 842-5303.

### CORRECTION — PRINTOUT, p. 70, April 1982

Our item on the PC1500 inadvertently contained an error with regard to the memory space available. We said that RAM available was 2.6K, expandable to 16K. Sharp Corporation Australia have advised us that actual RAM capacity is 3.5K, of which 0.9K is systems area, leaving user RAM of 2.6K. By the addition of 4K or 8K RAM modules, Sharp say, total RAM capacity can be expanded to 7.5K or 11.5K respectively.

## Club Call

Many users of the **TRS-80C** colour computer may feel quite an urgent need to be able to contact other users and exchange information, etc. In response to this need Ian Wotherspoon (available on (02)629-1076) has set up a network of contacts in each state, preferring this method to the forming of a somewhat cumbersome organisation requiring subscriptions, income to finance meetings, etc. The contact in each state can steer users to others with common interests, and to knowledgeable users in specialist areas. These range through 'pre-school' to 'post-secondary' 80C education; minor expansion through 88K; TRSDOS to FLEX to Cer-Comp; games to financial bases; students to engineers. Ian will provide the state contacts with user details, and Greg Wilson of the Australian Rainbow ((02)358-6491) will give them the latest news from overseas. The contacts are:

**Ian Wotherspoon: (02)629-1076 — Australian co-ordinator.**
**Brian Dougan: (07)358-9480 — Queensland.**
**Di Wotherspoon: (02)629-1076 — New South Wales.**
**Mark Carter: (03)338-9938 — Victoria.**
**Steven Eisenberg: (08)250-6214 — South Australia.**
**Robert Scott: (09)450-2007 — Western Australia.**

**The AT Microcomputer Club** has been formed for people interested in the Applied Technology DGOS Z80. Numerous programs have already been converted into Microworld BASIC, with several more in the pipeline. The date of the first official meeting has yet to be set, so interested people should contact Grant Forest on (03)879-2257 (home) or 699-2888 (bus.), and help him get the club off the ground.

**The Hunter Users' Group — All Microcomputers (HUGAM)** has been established for nearly a year, and meets on the second Wednesday of each month in Room 308, Building W, University of Newcastle, at 7.45 pm. Membership is primarily Apple II-orientated, but anyone with an active interest in micros is welcome. Members include professionals, hobbyists and students, and meetings provide the opportunity to listen to guest speakers and observe equipment demonstrations. The group has an Apple II disk library, run by a resident librarian, with about 30 disks containing games, utilities and miscellaneous software. This is available to members for a nominal fee, and the library is continually expanding. For further information visit a meeting or contact the Secretary, HUGAM, PO Box 39, Broadmeadow NSW 2298.

The Australian chapter of the **Forth Interest Group** is based in Melbourne, with 25 people on its Victorian mailing list. There are FORTH groups in Brisbane and in several hardware-based groups, but the Victorian group is the only one affiliated with the worldwide FORTH Interest Group, which has around 3500 members, about 60 of whom are in Australia. Members have their own computers, ranging from cassette-based systems to a Spectrum LSI-II system, although a typical configuration would be an Apple II with two 5" disks. FORTH is not promoted by any manufacturer, so the group provides documentation and software for interested people, and also sells any public domain FORTH software available for the popular micros. The chapter meets on the first Friday of every month, and new members and visitors are very welcome. For further information contact Lance Collins (Secretary), PO Box 103, Camberwell Vic. 3124. (03)29-2600.

# S100 CPU, VDU I/O CARDS

Whether you're a hobbyist or professional user of S100 cards and systems, you should know about Applied Technology's range of S100 products. We design and manufacture some of the world's most innovative (yet inexpensive) S100 products right here in Australia. Our 'MEGAMEMORY' static memory card and the powerful MW6545 programmable VDU card are recognized industry leaders.

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DGZ80 built and tested with DGOS in ROM **$249.00**

**MW640 Professional VDU**
This superb memory mapped VDU works under the DGOS monitor of the DGZ80 for fast easy programming. The crisp 64 characters by 16 lines display has upper/lower case, flashing characters black on white and 128x64 'chunky' graphics.
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**TCT PCG HIRes Graphics**
If you need programmable high resolution graphics, this boards gives 512x256 bit resolution. It works in with the MW640 and comes complete with two joystick ports.

TCT PCG (kit form) **$140.00**

**DG750 I/O**
This versatile I/O board has 2 programmable serial I/O lines (RS232) and 3 programmable 8 bit I/O lines, all controlled by a programmable interrupt controller. The number of serial and parallel lines can be easily doubled.
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**AT16K 16K Static Memory**
The AT16K gives you reliable static memory, inexpensively. It can be located at any 16K boundary using on-board select logic. Write protect and phantom line memory priority control are included.
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**MW864 MEGAMEMORY**
Our Megamemory card is a breakthrough in static memory performance. It's combination of high speed (6MHz), and low power (it uses only 4W fully populated) with low cost, have made it the industry leader. And we designed it here in Australia!! Available in 32K, 48K and 64K formats, Megamemory uses the popular 6116 CMOS RAMs. These RAMs are pin compatible with standard 2516 EPROMs. The board is fully IEEE compatible and features extended bank addressing, and phantom. The top 8K of memory can be deselected as 2K 'windows' to enable monitors and disc drives to be used.
32K built and tested **$325.00**
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**MW6545 Programmable VDU**
One of our newest and most powerful products, the MW6545 is built around the 6545 programmable VDU chip. So the screen format can be programmed to 64x16, 80x24, 132x40 etc. Light pen facility is built in and there's extended addressing and port controls. The display is full professional format, with upper/lower case, built in programmable graphics and transparent screen refresh.
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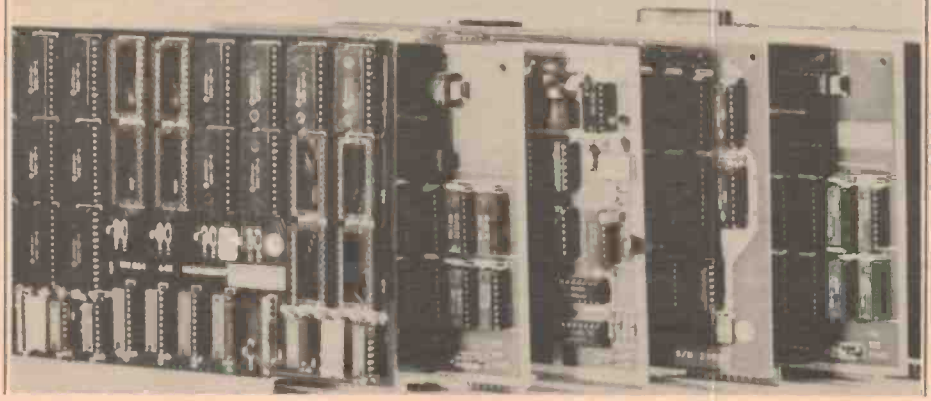
MW6545 built and tested **$325.00**

**MW ROMBLASTER**
This memory mapped EPROM programmer suits 2516, 2716, 2532 and 2732 single voltage EPROMS. Programming supply is on-board. The RomBlaster can be located anywhere in memory and ROMs can be verified under DGOS. Programming is very easy, just make a single block move under DGOS.
MW ROMBLASTER **$195.00**



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**SCVT, 2650 Cards**
We still have stocks of these cards, (see article in EA and ETI for details). Please write for details.

**MW1550 Mother board**
This 10 slot mother board now comes with S100 sockets soldered in ready for use. The board can be connected to the MW800 power supply. It fits the MW600 card frame.
MW1550 ready for use **$100.00**

**MW600 Card Frame**
This card frame accepts the MW1550 mother board and has provision for internal power supply, cooling fan and I/O connectors. The frame takes standard 19" rack mount hardware.
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**Euro Case**
This professional desk top case is the best we've seen. Moulded from high impact plastic, it features adjustable mounting feet, ventilation, carrying handles and comes with an anodized front panel and reset button. The card frame slides into the Eurocase, providing superb protection and appearance.
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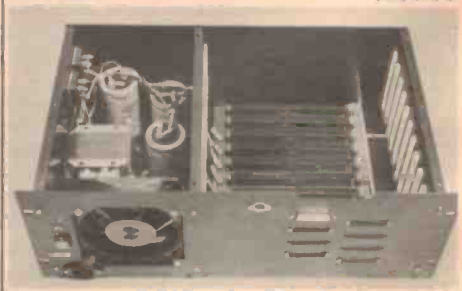

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# PRINTERS EPSON MX100

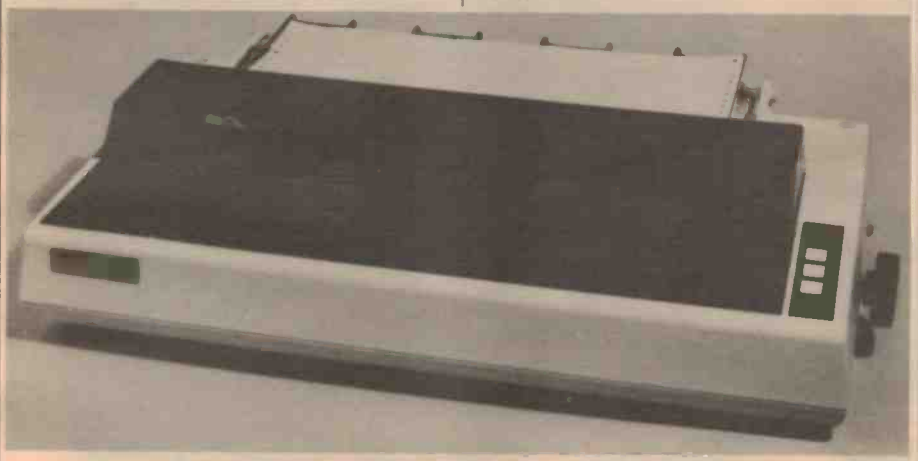
We are delighted to be selling Epson's new range of dot matrix printers. Examine the constructional quality and print output of these machines and you'll quickly appreciate why they are by far the best value dot matrix printer you can buy.
The print output of both the MX80 and MX100 is a full 9x9 matrix with true descenders. Condensed, enlarged and emphasized printing is selectable. The resulting performance is more in keeping with a machine in the $3,000 bracket. Now you can have a correspondence quality machine without paying out a fortune. Not surprisingly, Epson have been selling over 50,000 of these printers per month to the American market. There's simply nothing else like them.

## Epson MX100

Epson's newest model, the MX100, is the most powerful printer in its class.
First class mechanicals have been combined with an incredible range of features. The full 96 character ASCII set has true descenders. And there's 8 international character sets with switch selection for font variation. The printer also offers ultra high resolution bit image printing up to 1632x8 dots per line. Normal, condensed and enlarged printing is available and is further programmable. Form feeding is programmable up to 127 lines and 12 horizontal and 8 vertical tabs are available.
The MX100 has a full 15 inch carriage and will handle single sheets or continuous stationary. Paper feed is by adjustable sprocket feed or by friction feed, with a normal typewriter style platten. The MX100 has a standard Centronics 8 bit parallel port. Both the MX100 and the MX80 share a versatile range of interfacing options. Printing rate of the MX100 and the MX80 is a fast 80cps in text mode. Printing is bidirectional with logic seeking.

# PRINTERS EPSON MX80

The MX80 is currently the world's top selling printer. It differs from the MX100 only in it's paper handling size and the range of paper handling formats. The base MX80 Model I is straight tractor feed. The slightly more expensive MX80 II FT is both friction and tractor feed and incorporates the incredible graphics capability of the MX100. Both MX80 machines take up to 9.5 inch paper (tractor feed). Both come standard with Centronics parallel interface. They accept all the interface options with the MX100.
The MX80 provides up to 80 column (132 column condensed) printing. We currently have an MX80 on demonstation with the MicroBee and we recommend them as a really superb combination.



| Model | |
|---|---|
| MX80 Model I (tractor feed) | $795.00 |
| MX80 Model II FT (plus graphics) | $915.00 |
| MX100 FT (with graphics) | $1195.00 |
| **Options** | |
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| MicroBee Cable | $55.00 |
| TRS80/System 80 | $110.00 |
| IEE488 PET | $135.00 |
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| Apple II (Model II) | $170.00 |

All prices include user manuals and 90 day warranty.

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This low cost 12" white phosphor monitor provides an excellent video display for hobbyist use. It is suitable for use with the MicroBee or any other Personal Micro.
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This book has over 50 separate versatile commands. Features arithmetic and integer functions, user-defined functions, machine language routines, text editing, string operations. Also contains 25 error codes to assist you in programming.

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| Lower Case Generator Option (K-3607) | $49.00 |
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| S-100 Expansion Unit (K-3606) | $19.50 |
| Metal Case (H-3200) | $39.50 |

**DICK SMITH ELECTRONICS**

SEE PAGE 19 FOR ADDRESS DETAILS

DSE/A163M/

# Printout

## Serial/parallel data test system

**The HF Design 'Multidata' is a portable microprocessor-based test system capable of full duplex communication with computer peripherals and data communications equipment fitted with V24/RS232, 20 mA current loop or 60 mA current loop interfaces.**

The unit is also fitted with Centronics-compatible and Data-products-compatible parallel ports to facilitate testing of printers with these interfaces.

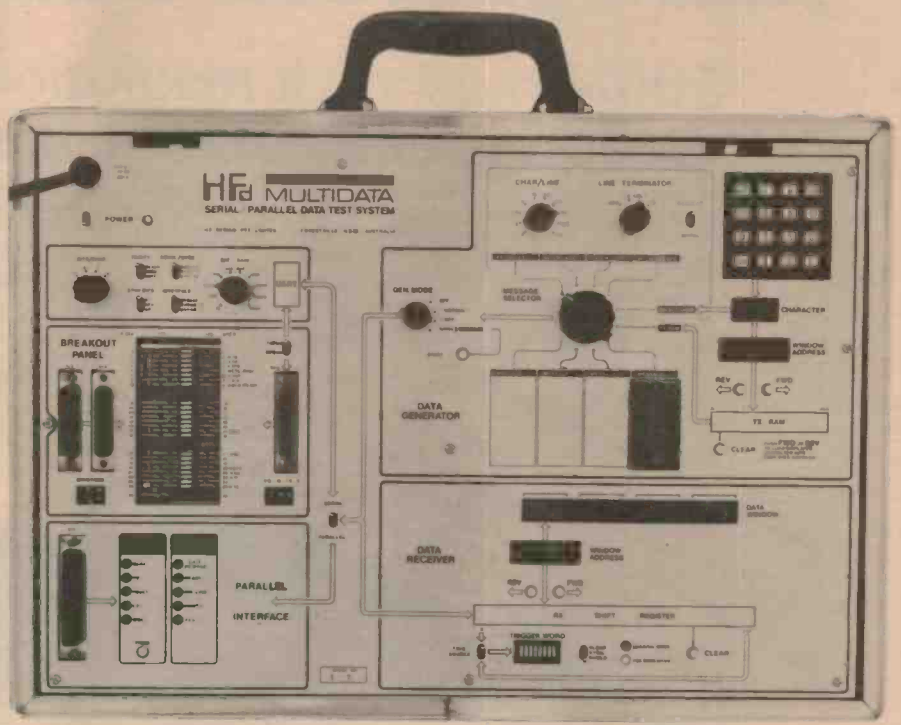
Applications include location of faults in printers, CRT terminals and data communications equipment, checkout of devices during the commissioning of systems, and laboratory testing during system design.

As a data generator the unit will output single or repeated messages, single or repeated characters, pre-programmed alphabet patterns (64, 96, 128-character ASCII and 96-character EBCDIC), messages in EPROMs (internal and front panel sockets), or sequences entered via the hexadecimal keyboard into a 256-byte RAM.

The received data enters a 256-byte shift register and may be viewed by means of a movable four-byte wide 'window'. In TRIG mode data received before or after a selected eight-bit trigger word in a received sequence may be examined.

Serial interface facilities include control of data format, parity, asynchronous or synchronous mode, and ten bit rates (75 to 9600 bps) by means of front panel switches.

Multidata is available from HF Designs Pty Ltd, 55 Lady Davidson Circuit, Forestville NSW 2087. (02)452-2411.




## Chipspeak!

**Local manufacturer Hypercom Pty Ltd and its distributing company, the TCG Group, have announced the release of a voice output system (VOS 2200) developed in Australia by Hypercom and claimed to be the first fully operational system released in Australia.**

The system replaces by voice the output a computer would normally display or print, and was developed originally for the Hypercom-manufactured dataphone used to transmit information to a host computer via a standard telephone line.

The basic VOS 2200 was developed from the Ohio Scientific standard voice output package, the Votrax unit, and can be programmed to provide three types, or levels, of voice.

The standard package sounds natural and has a restricted vocabulary. The sound can be programmed on request to provide specific responses, depending upon the application. Appropriate words are selected from a vocabulary of 500 standard words, and are programmed according to user requirements. The sound is humanoid and neutral without the metallic tones usually attributable to electronic voices.

Custom-designed, personalised programs can also be created using a specially requested voice, such as a well-known personality or someone easily identifiable with a product or service. The chosen voice is recorded onto high-quality audio tape in an audio lab, and the tape is then flown to California, where for a one-time charge of $5000 and $128 per word, TCG's associate Californian company will fly back a program with realistic and near perfect reproduction of the selected voice. TCG will then develop a computer interface which will relay the distinctive and recognisable voice.

Hardware costs are around $4500 for a single channel interface.

Full details from TCG, (02)439-6477.

## 'Special K' for the TRS-80C

**Nobody can agree on the ideal amount of memory to stuff into the 80C's gullet. Nobody should! The amount depends upon the particular needs of each user.**

There are plenty of options. What do you want: 4K, 16K, 32K, 64K, or 256K? Just because Motorola Development Labs have thrown 256K into the 80C, it doesn't mean it will be easy for you. Otherwise, it's all up to you!

You can only buy the 4K, 16K and 32K models off-the-shelf, but Tandy will be pleased to upgrade a 4K to either of the others. In fact, you may climb up all by yourself using cheap 4116 chips. To go to 64K, you will need MCM 6664 chips from Motorola. These must be faster than 300 nanoseconds, but on last checking, they were a mere $72 a set. The catch with these is that you will need disk software to switch the 6883 SAM chip.

What about ROM? If you will be working mainly with assembly language, or steering clear of fancy graphics and text manipulation, there is no reason why you can't get by with the 8K BASIC ROM that comes with the 4K machine. Otherwise, you will need an extra Extended Colour BASIC ROM.

That's not the end, of course. It's easy to put 16K into a ROM-PAC. At the expense of BASIC, 32K will fit in. (How many FORTH screens could that give you?)

Tandy can provide you with up to 600K of disk storage, but never fear . . . disk operating systems are available, right now, to go to 4.8 Megabytes from eight-inch disks. Greedy, aren't you! All right, you can access hard disk drives, but do you really want to, with the mega-mega-byte accessing TRS-80 Model 16 on the horizon?

Details of upgrades to the 80C are in 'The Rainbow' (Australian edition) a monthly magazine for TRS-80 Colour Computer owners (P.O. Box 9, Potts Point NSW 2011).

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Based on Electronics Australia design DEC. 81 issue.

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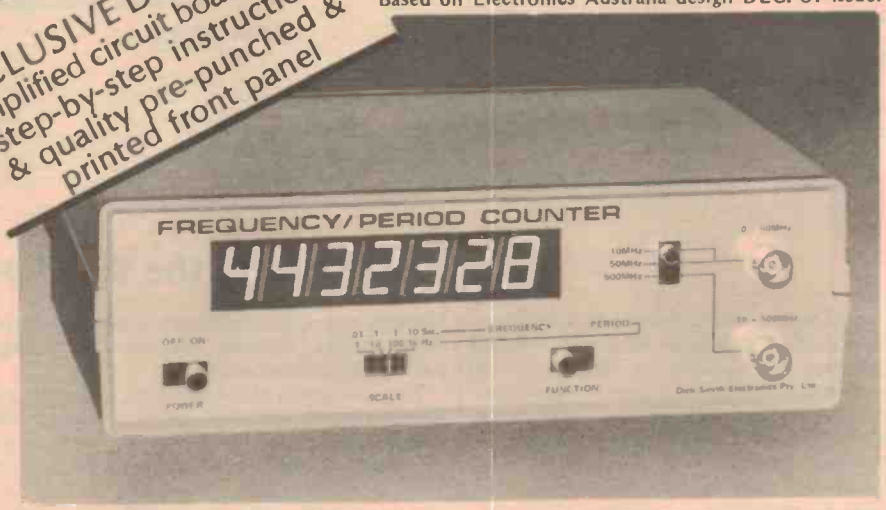


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DSE A144RB

# SBC 800

## THE NEW Z80 S100 SINGLE BOARD COMPUTER

**The SBC-800 is a S100 Z80 Single Board Computer with dual serial ports, Real time clock, on board Ram & Eprom, for use as the main CPU card in a Microcomputer.**

**The SBC-800, a very powerful Single Board Computer, provides all of the necessary facilities needed for a standalone processor.**

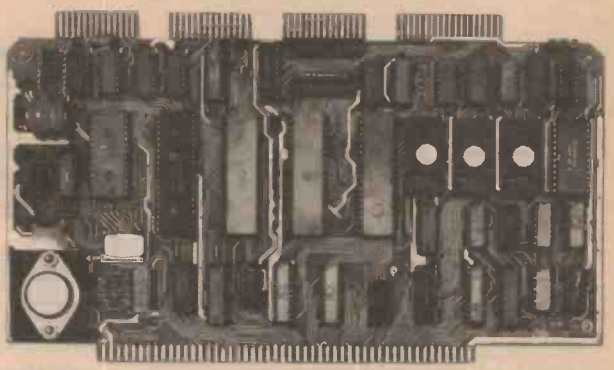
The heart of the board is a Z-80 Microprocessor. Running at 4 Mhz, the processor communicates with all of the SME Systems range of boards. The board includes a CTC counter timer, for generating the baud rates for the 2 serial ports on board, as well as 2 vector interrupt driven channels for off board interrupt processing, or on board timing functions.

Serial I/O consists of a DART which provides 2 serial ports which may be modems, terminals or printers. Each one of these serial ports operates independently of the other.

Parallel I/O consists of a pair of 8255, Programmable Perip-heral Interfaces. The first of these devices provides all the I/O lines necessary to talk with the Centronics Port, as well as the on board Real Time Clock. The second device, provides up to 22 general purpose I/O lines which can be programmed in a number of different modes of operation.

The board also provides four 24 pin sockets for installing up to 16 Kbytes of Eprom, using 2732 devices, or 8 Kbytes of Eprom, using 2716 devices. The sockets have provision for installing 2 Kbytes of ram in up to 3 sockets, to provide 6 Kbytes of Static Ram in lieu of Eprom.

An on board, rechargeable battery, provides power for the Real Time Clock, as well as the CMOS static memory which has been fitted to the board.



**FEATURES**

- S100 Bus Compatible (IEEE 696)
- Z-80 Microprocessor running at 4 Mhz.
- Two Serial RS232 Communication Ports.
- Software programmable Baud rate generator.
- Parallel Centronics Printer Port.
- 22 Programmable, General Purpose I/O Lines.
- Real Time Clock, Battery backed.
- 2K CMOS ram standard, 6K option.
- Provision for up to 12K EPROM on board.
- Standby Rechargeable Battery on card.
- Power on Reset/Power Fail detect.
- Power on Jump to Monitor/Bios.
- On board memory disable.

# SBC 400

The SBC-400 is a low cost CPU card for use in a system where the power of the SME Systems SBC-800 Single Board Computer is not required.

SBC-400 price reduced from $465 to **$395.**

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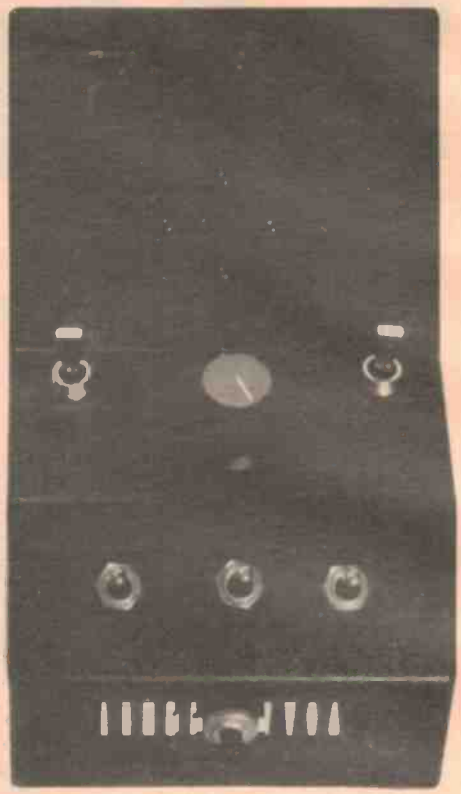
PEN 190/3622

# A hand controller for the Turtle robot

Here's a simple manual controller for the Turtle that can be used in lieu of a computer and is ideal for testing and setting up the robot, trying out motional routines, keeping the kids happy while you program the computer, etc.

**Allan Branch**

Flexible Systems, Hobart, Tasmania



Our hand controller is housed in an Arlec PC4 case.

A HAND controller to operate the Turtle is simple to construct and useful in setting up and adjusting the robot, amongst other things — such as proving test signals for a remote control unit. Three common CMOS ICs are employed and a set of switches provides control of motion and the functions — pen, horn, etc. An oscillator provides pulses for the stepper motors; varying the frequency of the oscillator permits varying the speed of motion.

## Construction

This is quite straightforward. Flexible Systems have made up a pc board for the hand controller, to suit mounting in a small jiffy box, while ETI have made a version on matrix board, mounted in a low-cost Arlec instrument case. Suit yourself. Kits or built-up units are available from Flexible Systems.

Layout is non-critical and specific details are left to the individual constructor. When laying out controls on whatever case you use, make sure they are grouped logically and frequently used controls are within easy reach — such as the LEFT and RIGHT motion switches. The latter should be wired so that the direction of operation of the switch represents the direction of movement of the particular motor; e.g: pushing the switch forward makes the motor go forward. Thus if you set the LEFT switch forward and the RIGHT switch backward, the Turtle will execute a right hand, on-the-spot turn. Setting just one switch forward will cause the Turtle to pivot about the opposite wheel.

Note that LMS must go high (+12 V) and RMS must go low (0 V) to set the Turtle moving forward, so wire SW1 and SW2 accordingly.

A pushbutton has been used for the HORN ON/OFF function so that the HORN TONE can be set high or low, and pressing the pushbutton allows you to 'toot' the horn.

The sensor switches are 'reflected' in the hand controller so that you can see where the Turtle has run into something when you can't see the Turtle.

When installing the ribbon cable that runs between the controller and the Turtle, ensure it is secured inside the hand controller case to prevent joints breaking or other damage occurring should the cable be accidentally pulled. The maximum length of cable we've used is 3½ metres, although we don't know what the limit is.

Take care when wiring up the unit and check for wrong connections, incorrect orientation, etc. Check which way switches are 'on' before wiring them up — otherwise they'll operate the reverse to what you expect! Note that when wiring the speed potentiometer minimum resistance gives maximum speed.

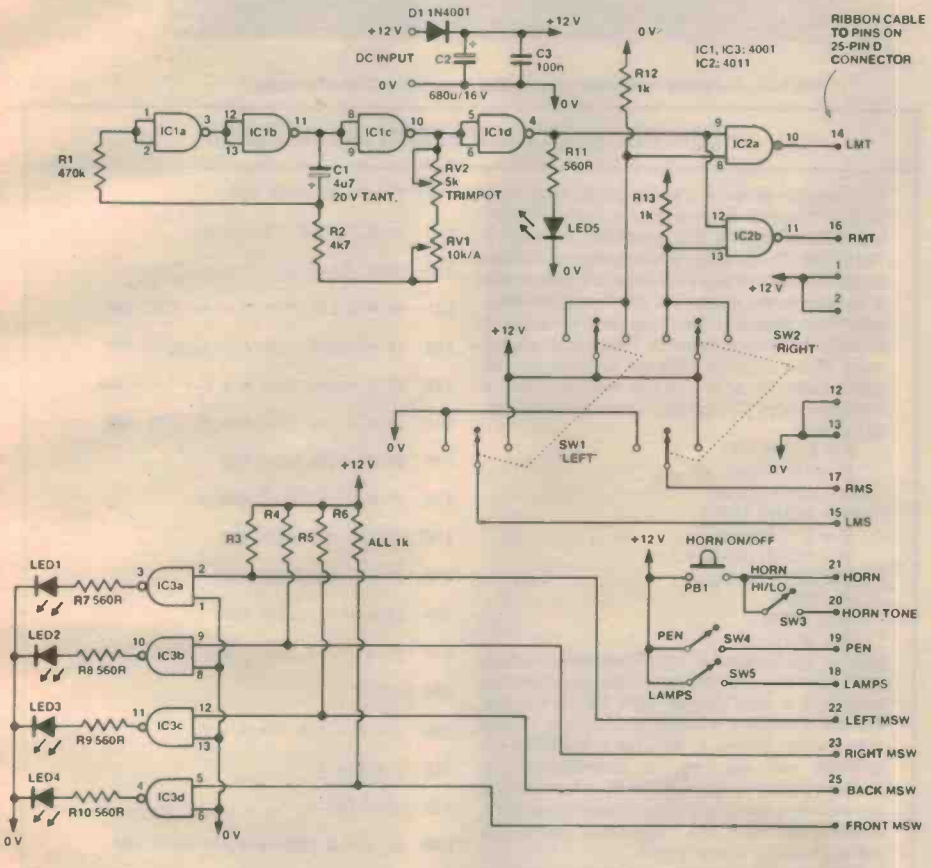
Take care you get diode D1 the right way round. While D1 is rated at 1 A, the Turtle can draw up to 1.4 A. The diode survives OK, but if you're worried use a 1N5404 or A14P.

## Setting it up

First, apply power (12 Vdc) to the controller, but don't plug it into the Turtle. Check that supply is on each IC (pin 14 — +12 V, pin 7 — 0 V). Now set RV2 to about mid-position and RV1 to maximum resistance (slowest speed). LED5 should flash at a slow rate. Using a multimeter, check that the supply is on pins 1-2 (+12 V) and 12-13 (0 V) of the 25-pin plug.

It's a simple matter to check the functions work correctly. Take your multimeter, set the LEFT switch *forward* and the RIGHT switch *backward,* and look at pins 15 and 17 of the 25-pin plug. There should be +12 V on each (with respect to 0 V). With the switches in the centre position, there should be nothing on these pins and no connection to 0 V. With the LEFT switch *backwards* and the RIGHT switch *forward,* pins 15 and 17 should be connected to 0 V — check with the ohmmeter.

The HORN, TONE, PEN and LAMPS can be checked with the multimeter also. Operate each switch and see that +12 V appears on the appropriate pins of the 25-pin plug.




The sensor indicators can be checked by shorting each pin (22, 23, 24, 25) to ground in turn and seeing that the appropriate LED lights.

Correct any errors, and when all is well plug the controller into the Turtle and . . . you can't quite take it for a walk yet. The maximum speed needs to be set. This is simple. With the controller plugged into the Turtle and the LEFT and RIGHT switches in the centre position, set RV1 at minimum resistance (maximum speed). Set RV2 at maximum resistance and then set the LEFT and RIGHT switches forward. The Turtle will set off at some speed. Adjust RV2 so that it is moving fast but not so fast that the motors vibrate or chatter. Check that the Turtle will execute turns and changes of direction without the motors chattering. If they do, back off RV2 a little and it should behave perfectly. Refrain from trying to make your Turtle a BMX model!

If you're using the hand controller to get your Turtle up and running, you may not be able to complete the above adjustments, but you should be able to get the motors running smoothly and adjust the wheel assemblies so that the gears do not bind or mis-cog. Then you can adjust the controller for maximum speed.

Have fun!

*NOTE: Flexible Systems can supply handheld controllers constructed and tested for $79, or a complete kit for $55. Their pc board for the hand controller (part No. HCB) is available for $13, with component overlay. Contact Flexible Systems, 219 Liverpool St, Hobart Tas. 7000. (002)34-3064.*

## HOW IT WORKS — ETI 646

The circuit is straightforward, using only three CMOS gate ICs. A 4011 quad NAND gate, IC1, is configured as an oscillator, generating square waves to supply the 'toggle' pulses for the Turtle stepper motors. The oscillator is a simple astable multivibrator using gates a, b and c from IC1. The charge/discharge time constant of the oscillator feedback can be varied continuously by RV1 to provide motor speed control. A trimpot, RV2, allows setting the range of the speed control. The output is buffered and inverted by IC1d.

A LED on the output of the oscillator, LED5, indicates that the oscillator is in operation by flashing, although at the higher speeds it seems to be on continuously due to the persistence of vision.

Two DPDT centre-off toggle switches control the direction and toggling of the Turtle stepper motors. SW1 controls the left motor, SW2 the right. Two gates from another 4022, IC2, gate the pulses from the output of the oscillator to the toggle inputs for the Turtle motors. No toggle pulses are sent to a motor when the control switch (SW1 or SW2) is in the centre-off position.

When SW1 is operated, say to the right here, +12 V (logic high) is applied to pin 8 of IC2a and the pulses on pin 9 are then inverted and appear on the output of the gate, providing motor toggle pulses for the LMT input. At the same time, +12 V (logic high) is applied to the LMS input of the Turtle, setting the left motor in forward motion. When SW1 is operated to the left (as per the diagram), the pulses are again gated through to LMT while the LMS input to the Turtle is held at 0 V (logic low), setting the left motor in backwards motion. SW2 operates in a similar way.

The other four Turtle functions: HORN, HORN TONE, PEN and LAMPS, are controlled by PB1, SW3, SW4 and SW5 respectively. These apply +12 V (logic high) to the Turtle function inputs when operated. Note that a pushbutton is used for the HORN ON/OFF function, which allows simple 'tooting'.

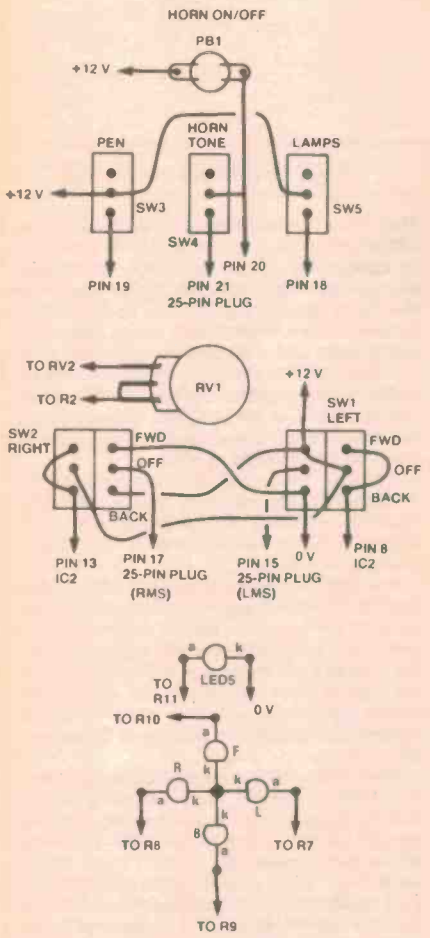
The four LED indicators on the Turtle's inner disc, at the front, are represented on the hand controller so the operator can see if a sensor has been activated. (Useful if the Turtle is being controlled from a cable running under the door — a great party trick.)

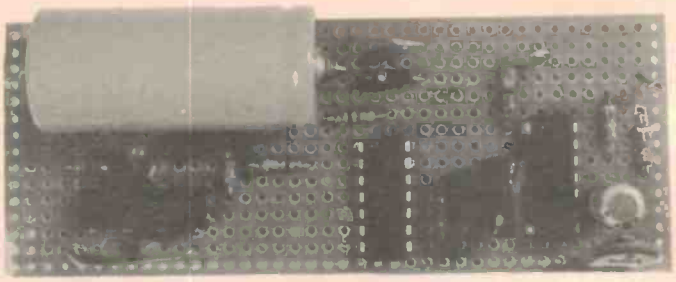
The four sensor input lines drive inputs of the four gates from IC3, a 4001 quad NOR gate. The gate inputs are held high by pull-up resistors — R3 to R6. This ensures the gate outputs are low unless a sensor is operated — which grounds the input, causing the gate output to go high and lighting the LED connected to the output (LEDs 1 to 4). Resistors R7 to R10 limit the current LED and gate output to a safe value.

An 'idiot' diode is connected in series with the power supply input to protect the controller and Turtle against possible disastrous damage if the supply were to be connected in reverse. Capacitors C2 and C3 bypass the supply rail.

# Project 646 — turtle hand controller

ETI-646 TURTLE HAND CONTROLLER
WIRING THE OFF-BOARD COMPONENTS



We built our hand controller electronics on a piece of matrix board.

## PARTS LIST — ETI-646

**Resistors** ..... all 5%, ½W
- R1 ..... 470k
- R2 ..... 4k7
- R3, 4, 5, 6, 12, 13 .. 1k
- R7, 8, 9, 10, 11 .... 560R
- RV1 ..... 10k/A pot.
- RV2 ..... 5k trimpot

**Capacitors**
- C1 ..... 4u7/20 V tant.
- C2 ..... 680u/16 V axial electro.
- C3 ..... 100n greencap

**Semiconductors**
- D1 ..... 1N4001
- IC1, IC3 ..... 4001
- IC2 ..... 4011
- LED1-5 ..... TIL220R or sim. (LED5 could be TIL220G)

**Miscellaneous**
- SW1, SW2 ..... DPDT 'centre off' toggle switch (C&K 7203P or 72035)
- SW3, SW4 ..... SPST toggle switches
- PB1 ..... push-on pushbutton

Matrix board 40 x 100 mm minimum size; case (e.g: Arlec PC4); LED mounts; ribbon cable; 25-pin D plug; figure-eight cable, wire etc.

## CONTROL YOUR TURTLE FROM THE KEYBOARD

This program allows you to use simple single-key strokes to command the minimum Turtle — like 'F' for FORWARD, 'B' for BACKWARDS, 'L' for LEFT TURN, etc. The program scans the keyboard looking for the value of the key pressed and then writes a number to the address of the Turtle interface, which then generates the correct binary number to activate the function required. The sensors are not 'read' in this program, although suitable routines could easily be added as the 'read' address is initialised (lines 530 to 560). Your commands are as follows:

F = FORWARD
B = BACKWARDS
L = LEFT TURN
R = RIGHT TURN
E = EYES (lamps)
H = HORN ON/OFF
T = TONE HI/LO
P = PEN
W = WAIT
S = STOP

Most of the commands are self-explanatory. You don't have to press (W) wait when going from one command to another; the Turtle will just execute the last command pressed. If you press W and then another command later, like P, the Turtle will continue with the motional command it was executing before you pressed wait — for example, say you were doing a right turn (R) and pressed W, followed later by P, the Turtle would operate the pen and continue turning right.

Consider this program as a starting point for developing something more complex and grandiose.

Note that when you have the program debugged, the screen clears immediately you type RUN. You could insert a PRINT statement following line 15, listing the commands. This will then provide the instructions on-screen following RUN.

```
1     REM "REALTIME" ALAN BRANCH
      1982 APPLE II
5     K= -16384: REM  KEYBOARD ENTRY
10    W= -16224: REM TURTLE ADDRESS, SLOT 2
12    GOSUB 500: REM INITIALISE PIA
15    CALL -936:REM CLEAR SCREEN
20    POKE W,C
30    GOSUB 100
40    POKE W,B
50    GOSUB 100
60    GOTO 20
100   M = PEEK(K)
110   IF M = 87 THEN 100
115   IF M-127 < 0 THEN RETURN
120   POKE -16368,0
125   IF M = 198 THEN A = 8: GOTO 300
130   IF M = 194 THEN A = 2: GOTO 300
140   IF M = 204 THEN A = 10: GOTO 300
145   IF M = 210 THEN A = 0: GOTO 300
150   IF M = 211 THEN END
160   IF M = 197 THEN 400
170   IF M = 208 THEN 420
180   IF M = 200 THEN 440
190   IF M = 212 THEN 460
195   IF M = 215 THEN 100
200   RETURN
300   B = A + E + P + H + T
310   C = B + 5
320   GOTO 100
400   IF E = 0 THEN E = 16: GOTO 300
410   E = 0: GOTO 300
420   IF P = 0 THEN P = 32: GOTO 300
430   P = 0: GOTO 300
440   IF H = 0 THEN H = 64: GOTO 300
450   H = 0: GOTO 300
460   IF T = 0 THEN T = 128: GOTO 300
470   T = 0: GOTO 300
500   POKE (W+1),0
510   POKE W,255
520   POKE (W+1),52
530   R = W+2
540   POKE (R+1),0
550   POKE R,0
560   POKE (R+1),60
570   RETURN
```

Roger Harrison

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DSE928

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# TASMAN TURTLE ROBOT KIT

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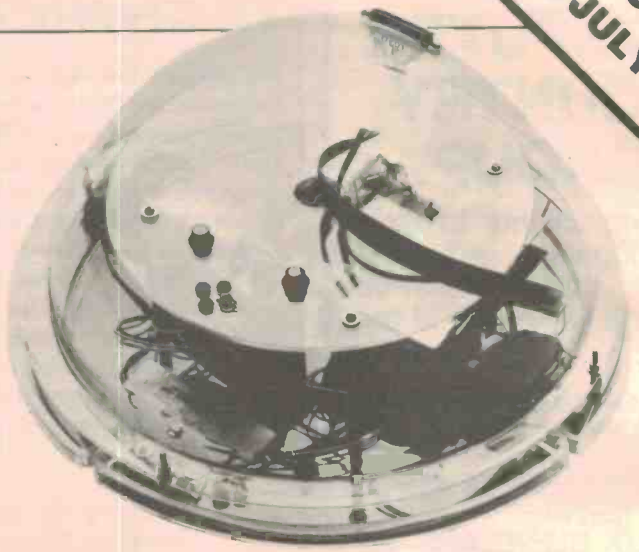
**(tax exempt: $297.00)**
**plus $6 post and handling (inc. registration).**

This product has never previously been offered as a kit and would normally retail for around $600.



## OFFER CLOSES 30 JULY 1982

Here is a not-to-be-missed opportunity to get started in robotics. For minimum cost this kit will provide you with the basic equipment to construct a robot which can be driven by remote control, electronic hand control or under computer control. Called the 'Minimum Turtle Kit', it has been put together by Flexible Systems of Hobart, Tasmania, manufacturers of the Tasman Turtle (see Printout, page 82, February ETI). Using this kit as a start you can develop a sophisticated robot capable of a huge variety of tasks.

The complete Minimum Turtle Kit comes ready for assembly according to the construction description published in ETI, packed in a box which has been designed so that the Turtle may be housed or stored in it after assembly.

### HOW TO PURCHASE A MINIMUM TURTLE KIT

Fill out the coupon here and include a cheque or money order for a total of $355. Make out the cheque or money order to 'Flexible Systems, Turtle Kit Offer', and post it, together with the coupon, to:

**ETI/Turtle Robot Kit Offer**
**ETI Magazine**
**15 Boundary St**
**Rushcutters Bay NSW 2011**

The orders will be processed by ETI and, on clearance of the cheque or money order by Flexible Systems, the kit will be despatched directly to you by ETI via registered post.

**Alternatively:** You may call in to ETI's Sydney or Melbourne offices at the addresses given below and purchase a Minimum Turtle Kit for $349. A demonstration kit and/or model will be available for inspection during this offer.

**Sydney:** ETI, 4th Floor
15 Boundary St
Rushcutters Bay

**Melbourne:** Murray Publishers, 22nd Floor
150 Lonsdale St
Melbourne

**Tax exemption:** For schools, TAFEs, etc. this kit can be purchased at the tax exempt price only if the coupon is accompanied by a signed order and a tax exemption declaration.

**NOTE: This offer is made by Flexible Systems in co-operation with ETI Magazine. ETI is acting as a clearing and despatch agent for orders. All mail orders will be despatched by registered post. Please allow four to six weeks for delivery.**
**Note that the offer expires 30 July 1982.**

### DEMONSTRATIONS: see the Turtle — live!

**Sydney:** at ETI's office, 4:30 — 6:00 pm, Monday to Thursday.
Apple II computer supplied for demonstrations courtesy Imagineering Pty Ltd.

**Melbourne:** at city office, by appointment
Apple II computer supplied for demonstrations courtesy Computer Country Pty Ltd.

### WHAT YOU CAN DO WITH IT

You can use your Minimum Turtle to experiment with many aspects of robotics by interfacing it with a computer: draw figures under program command, solve mazes, make measurements, identify objects, etc, etc. It can be driven via a cable or a remote control. The Minimum Turtle has been designed so that a wide variety of add-on projects may be included to increase the sophistication as you desire.

### THE MINIMUM TURTLE KIT CONTAINS:

- **All hardware (base, nuts and bolts, perspex dome, 'touch' ring, pen solenoid, speaker, etc)**
- **All mechanical parts (wheels, gears, axles, two stepper motors, etc)**
- **'Standard Turtle' electronic control pc board and components**
- **All wire and cable for internal wiring**
- **A 25-pin plug for bidirectional data buss, control lines and power supply connections**
- **Comprehensive instruction manual**

*Tasman Turtle is a registered trademark of Flexible Systems.

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I enclose $ ..... plus $6 each postage (inc. registration).

TOTAL $ .....

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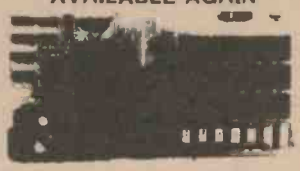

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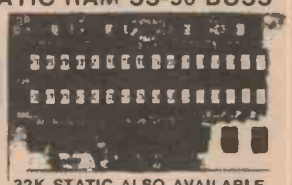

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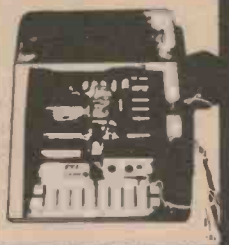

FEATURES INCLUDE
Colour capability, operates from optional 9 V plugpack. 1K memory expandable to 3K on-board. single-board construction. cassette interface. audio output. simple to program (uses Chip-8). Expansion projects coming up include ASCII keyboard, light pen, games software, etc.
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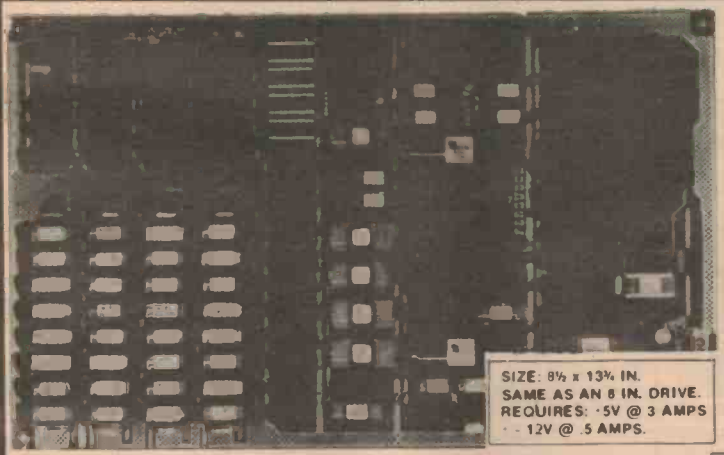

SIZE: 8½ x 13¾ IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
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### FEATURES: (Remember, all this on one board!)

#### 64K RAM

Uses industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

#### Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software

#### 24 x 80 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true.

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Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232! For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: $65

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Uses WD1771 controller chip with a TTL Data Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the SA800 or SA801. Drives can be configured for remote AC off-on. Runs CP/M® 2.2.

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Consists of a separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

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The real power of the Big Board lies in its PFM 3.0 on board monitor. PFM commands include: Dump Memory, Boot CP/M®, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search. PFM occupies one of the four 2716 EPROM locations provided. It does not occupy any of the 64K of system RAM!

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**PLEASE WRITE OR RING FOR THE BEST POSSIBLE PRICES ON DISC DRIVES, PRINTERS AND OTHER COMPUTER COMPONENTS.**

## COLOUR PATTERNMAKER

**Anyone who has loaded the Patternmaker program (ETI Feb '82, p.117) into their '660 will have found it a very fascinating program. The program described here gives it new dimensions by allowing any combination of background and foreground colours to be chosen.**

This program asks you first to 'SELECT BACKGROUND', displaying the four possible background colours along with their appropriate keys across the screen. In the same way it then prompts for one (or two) of the eight possible foreground colours.

If key 8 is pressed before selecting a foreground colour, two colours can be chosen. The next key pressed will set the outside colour, while the last key will set the centre colour. Unfortunately this feature is not supported by prompting, as it was a late addition to the program.

In this program I have made considerable use of the 'DO' subroutine instruction, and the mainline (0700 to 0736) contains mostly calls to subroutines which in themselves call further subroutines. This method of structuring makes for easier writing and debugging, as the program flow is more easily followed.

Some of the routines used in this program may be useful in other programs. For example, the colour routine at 0788 could be used, as is, to colour any area of the screen, large or small. Simply load the following variables with the appropriate values before calling it:

V9: y start
VA: width
VB: height
VD: colour (0-7)
VE: x start

To load the program, put in the Patternmaker program between 0600 and 06FF, the ETI colour routines (April, p.89) between 07A2 and 07FF, and then key in this program between 0700 and 07A0 and between 0800 and 08F2. Change the first instruction (0600) of the Patternmaker program to 1700.

**Noel Plummer**

**Editor's Note**

*Next month we'll present an annotated listing of this program so you can see its workings in detail. Meanwhile — sit back and play with it in sheer fascination.*

```
0600  17 00
0602  }  KEY IN
      }  PATTERNMAKER
0679  }  (FEB. P.117)
0700  00 FF
      07 C1
      6D 06
      27 38
      28 18
      28 00
      28 18
      6D 05
0710  27 46
      28 18
      28 48
      27 54
      00 E0
      00 FF
      6D 05
      27 38
0720  28 20
      28 00
      28 20
      6D 06
      27 46
      28 20
      28 78
      27 62
0730  00 E0
      6D 00
      16 02
      00 FF
      69 00
      6A 06
      6B 08
      6E 00
0740  27 88
      00 EE
      00 FF
      69 0B
      6A 08
      6B 03
      6E 00
      27 88
0750  00 EE
      00 FF
      F5 0A
      45 00
      00 EE
      75 FF
      07 A2
      17 56
0760  00 FF
      69 00
      6A 08
      6B 10
      FD 0A
      6E 00
      4D 08
      17 74
0770  27 88
      00 EE
      FD 0A
      27 88
      69 04
      6A 04
      6B 08
      FD 0A
0780  6E 02
      27 88
      00 EE
      00 FF
      88 A0
      8C B0
      8F 90
      27 AB
0790  7C FF
      7F 01
      3C 00
      17 8E
      78 FF
      7E 01
      38 00
      17 8A
07A0  00 EE
07A2  }  KEY IN
      }  COLOUR
07FF  }  ROUTINES
      }  (APRIL,P.89)
0800  A8 C0
      60 03
      61 03
      63 03
      28 38
      60 13
      61 0A
      63 03
      28 38
0810  00 EE
      00 FF
      00 FF
      A8 DE
      28 28
      00 EE
      00 FF
8020  A8 E8
      28 28
      00 EE
      00 FF
      60 03
      61 0A
      63 02
      28 38
0830  00 EE
      00 FF
      00 FF
      00 FF
      67 05
      D0 15
```


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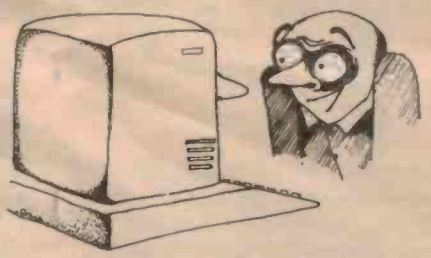
```
      70 08          61 17          18 AA
      F7 1E          62 08          84 24
0840  73 FF          63 00          75 10
      33 00    0880  64 00          00 EE
      18 3A          6A 01          00 FF
      00 EE          6B 08    08C0  EE 88
      60 07          6D 00          EE 28
      61 17          69 10          EE 8E
      62 10          8E D0          88 8E
      63 00          27 88          88 EE
0850  64 00          7D 01          EE 84
      65 08    0890  28 98          84 84
      69 10          3D 08          E4 EE
      6A 02          18 88    08D0  8A 88
      6B 08          00 EE          A8 E8
      6D 02          F3 29          EA AA
      6E 00          D0 15          AA AA
      27 88          28 A8          EE EC
0860  28 98          80 24          AA AA
      6D 00    08A0  73 01          AA AC
      27 88          00 EE    08DE  EE AA
      28 98          00 FF    08E0  EE AA
      6D 04          00 FF          EA E8
      27 88          66 1F          8A 8C
      28 98          76 01          8A EA
      6D 01          A8 F2          EE 8A
0870  27 88          D4 61          EA 8A
      28 98    08B0  32 08          8E EE
      00 EE          D5 61          A8 8E
      00 FF          36 37    08F0  88 8E
      60 03                   08F2  FF
```



## BAD BYTE IN THE CHIP-8 MONITOR EPROM (IC11)

Hugh Anderson has discovered an error in one byte of the EPROM program listing published on page 33 of the Nov. '81 issue and page 51 of Computers & Computing — Yearbook 1982. It turns out the actual listed printout is in error — the original PROM, and the one currently installed in the '660 here at ETI, are OK. Glitches catch you in the most awkward places! The error is at location 03B5. In our listing it shows **9E**. The correct instruction is **9F**.

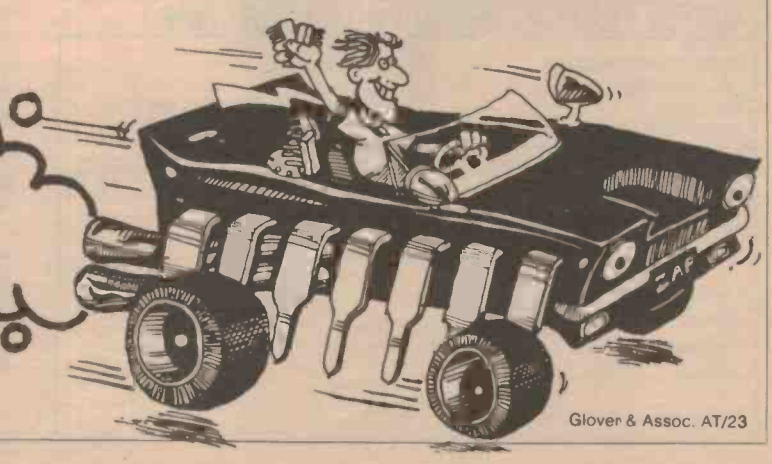
You can see if your EPROM contains the bad byte by examining that location: press '0', then '03B5' and look at the data on the screen. If it shows **9F**, you're OK. If it shows **9E**, then you'll need to have it corrected.

As Murphy's law would have it, you can't just have this location erased and reprogrammed; the whole EPROM has to be erased first and then reprogrammed in its entirety. We have already notified suppliers of the ETI-660 project and they have taken, or are taking, steps to correct existing stocks. For those of you who have already built the project and find the EPROM contains the bad byte, we can arrange to reprogram it for you. What you do is this: extract your EPROM and stick it in a small piece of foam. Obtain a 'jiffy' bag from the Post Office, 200 x 125 mm size, together with a $1 postal note (to cover return post and handling) and include your name and address. We will return it correctly reprogrammed.

Send it to:
ETI-660 BOMB PROM PROGRAM!
ETI Magazine,
15 Boundary St,
Rushcutters Bay NSW 2011.

Note: if you are having trouble getting your ETI-660 going, this bad byte is not likely to be the source of the trouble. The error only affects the '5XY0' instruction, causing it to skip the next two instructions, instead of the next one.


**Drive in Semiconductor Centre, 1500 lines and instant pickup**



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NEW

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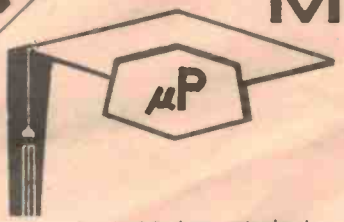


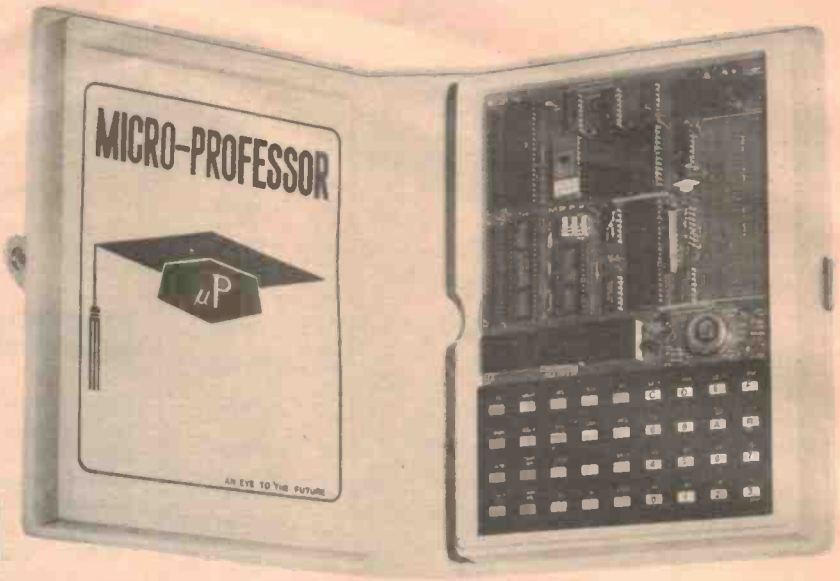


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**RAM** - 2K bytes expandable to 4K bytes.
**ROM** - 2K bytes of sophisticated monitor expandable to 8K bytes.
**INPUT/OUTPUT** - 24 system I/O lines.
**MONITOR** - 2K bytes of sophisticated monitor. It scans the keyboard and executes the command entered immediately after the power is turned on. The monitor includes: system initialisation, keyboard scan, display scan, tape write and tape read.
**DISPLAY** - 6 digit 0.5" red LED display.
**AUDIO CASSETTE INTERFACE** - 165 bit per second average rate for data transfer between memory and cassette tape.
**EXTENSION CONNECTORS** - Provides all buses of CPU channel signals of CTC and I/O port bus of PIO for user's expansion.
**COUNTER TIMER CIRCUITS** - Circuits are provided.
**PARALLEL I/O CIRCUITS** - Circuits are provided.
**SPEAKER** - A 2.25"-diameter speaker is provided for user's applications.
**USER AREA** - Provides a 3.5" x 1.36" wire wrapping area for user's expansion.
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| | |
|---|---|
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| ADDR- | Set memory address and display memory content. |
| DATA- | Input data to memory or register. |
| PC- | Recall program counter. |
| REG- | Select register and display contents of register. |
| +- | Display content of next memory address or register. |
| —- | Display content of last memory address or register. |
| STEP- | Single step execution of user's program. |
| SBR- | Set break point of user's program. |
| CBR- | Clear break point of user's program. |
| MONI- | User's program break and return to monitor. |
| GO- | Execute the user's program. |
| INS- | Insert data of the address followed by the current display address. |
| DEL- | Delete data of the current display address. |
| MOVE- | Move memory block in the RAM. |
| RELA- | Relative address calculation, calculates and stores relative address. |
| TAPE WR- | Store data to the cassette tape. |
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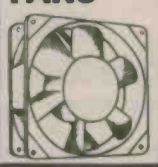

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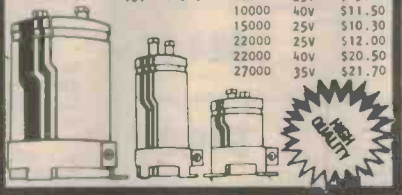

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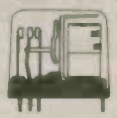

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# THE CHIP-8 COLUMN

**This month, we have another contribution from J.L. Elkhorne of Chigwell in Tasmania. This time it's the game of 'Life' on the VIP machine, but note that you'll need more than 1K of memory.**

Contributions for this column are welcome. We'd like to see programming hints and tips as well as your own programs. Commented listings are preferred and MUST BE TYPED: you must prove them by loading the program from your typed submission. All contributions will be paid for.

## COSMAC LIFE

With CHIP-8 loaded, the following program is keyed in. On 'RUN', a cursor appears at the left side of screen. Cells are written into memory at your discretion. Load keys are:

1: Write cell and advance cursor
0: Erase cell
A: Reverse cursor movement
F: Terminate loading and proceed to machine code

Subsequent generations follow the John Conway rules of 'Life' as described in Scientific American.

Generations appear approximately two per second! Should this be too quick, one can always put a CHIP-8 delay loop in. However, the 'F' key can be used to freeze the display. Any subsequent key press will start automatic mode again.

The cell test matrix is set up in the following fashion:

```
A    B      C
D   CELL    E
F    G      H
```

The display is eight cells wide by 32 lines deep.

As I work with a 4K machine, the display page is 0F. To utilise this program on a smaller memory size, change 0309 to the appropriate page number. Obviously, as it stands, this program will not fit into a 1K machine.

```
LOADER:
0200    6A00  6B08  6C08  60FF
0208    A2FF  F055  A2FF  6D08
0210    DAB1  DAB1  6301  E3A1
0218    223C  630C  E3A1  223E
0220    6300  E3A1  DAB1  630A
0228    E3A1  2248  630F  E3A1
0230    1258  FD15  F007  3D00
0238    1234  120E  DAB1  7A08
0240    7CFF  4C00  1270  00EE
0248    7AF8  7C01  4C09  2252
0250    00EE  7BFF  6C01  00EE
0258    630F  0300  E3A1  1262
0260    1258  F318  F315  F307
0268    3300  1264  F30A  1258
0270    7B01  6C08  00EE

0300  INITL   F8 00    LDI
0302           AC      PLO C
0303           A7      PLO 7
0304           AD      PHI D
0305           BD      PHI D
0306           F8 04   LDI
0308           B7      PHI 7     BUFFER STORE POINTER
0309           F8 0F   LDI
030B           BC      PHI C     DISPLAY POINTER
030C           EC      SEX C
030D           30 20   BR  GETADR

0320  GETADR   8C      GLO C
0321           FA 07   ANI
0323           BD      PHI D     L/R TEST. L=00, R=07
0324           8C      GLO C
0325  TOPTST   FD 07   SDI
0327           33 4F   BPZ DTST
0329  BTST     8C      GLO C
032A           FF 08   SMI
032C           AC      PLO C
032D           F0      LDX
032E           FB FF   XRI
0330           3A 33   BNZ ATST
0332           1D      INC D

0333  ATST     9D      GHI D
0334           32 40   BZ  CTST
0336           87      GLO 7
0337           FF 09   SMI
0339           AC      PLO C
033A           F0      LDX
033B           FB FF   XRI
033D           3A 40   BNZ CTST
033F           1D      INC D
0340  CTST     9D      GHI D
0341           FB 07   XRI
0343           32 4F   BZ  DTST

0345           87      GLO 7
0346           FF 07   SMI
0348           AC      PLO C
0349           F0      LDX
034A           FB FF   XRI
034C           3A 4F   BNZ DTST
034E           1D      INC D

034F  DTST     9D      GHI D
0350           32 5C   BZ  ETST
0352           87      GLO 7
0353           FF 01   SMI
0355           AC      PLO C
0356           F0      LDX
0357           FB FF   XRI
0359           3A 5C   BNZ ETST
035B           1D      INC D

035C  ETST     9D      GHI D
035D           FB 07   XRI
035F           32 68   BZ  BTMTST
0361           87      GLO 7
0362           FC 01   ADI
0364           AC      PLO C
0365           F0      LDX
0366           FB FF   XRI
0368           3A 68   BNZ BTMTST
036A           1D      INC D

0368  BTMTST   87      GLO 7
036C           FF F8   SMI
036E           33 96   BPZ RESULT
0370  GTST     87      GLO 7
0371           FC 08   ADI
0373           AC      PLO C
0374           F0      LDX
0375           FB FF   XRI
0377           3A 7A   BNZ FTST
0379           1D      INC D

037A  FTST     9D      GHI D
037B           32 87   BZ  HTST
037D           87      GLO 7
037E           FC 07   ADI
0380           AC      PLO C
0381           F0      LDX
0382           FB FF   XRI
0384           3A 87   BNZ HTST
0386           1D      INC D

0387  HTST     9D      GHI D
0388           FB 07   XRI
038A           32 96   BZ  RESULT
038C           87      GLO 7

038D           FC 09   ADI
038F           AC      PLO C
0390           F0      LDX
0391           FB FF   XRI
0393           3A 96   BNZ RESULT
0395           1D      INC D

0396  RESULT   87      GLO 7     READJUST ADDRESS
0397           AC      PLO C
0398           F0      LDX       GET CELL
0399           32 9D   BZ  STORE
039B           F8 10   LDI
039D  STORE    57      STR
039E           E7      SEX 7
039F           8D      GLO D
03A0           FA      ADD
03A1           57      STR

03A2  ENDTST   87      GLO 7
03A3           FB FF   XRI
03A5           32 AF   BZ  REFILL
03A7           EC      SEX C
03A8           17      INC 7
03A9           1C      INC C
03AA           F8 00   LDI
03AC           AD      PLO D
03AD           30 20   BR  GETADR

03AF  REFILL   E7      SEX 7
03B0           F8 00   LDI       READJUST ADDRESS
03B2           A7      PLO 7
03B3           AC      PLO C
03B4  DISFIL   72      LDXA
03B5           AD      PLO D
03B6           FB 12   XRI       TEST LIVE WITH 2
03B8           32 C8   BZ  SETCEL NEIGHBORS
03BA           8D      GLO D
03BB           FB 13   XRI       TEST LIVE WITH 3
03BD           32 C8   BZ  SETCEL NEIGHBORS
03BF           8D      GLO D
03C0           FB 03   XRI       TEST EMPTY WITH 3
03C2           32 C8   BZ  SETCEL NEIGHBORS
03C4  CLRCEL   F8 00   LDI
03C6           30 CA   BR  PUT
03C8  SETCEL   F8 FF   LDI
03CA  PUT      5C      STR
03CB           1C      INC C
03CC           87      GLO 7
03CD           FB 00   XRI
03CF           32 D3   BZ  RETURN
03D1           30 B4   BR  DISFIL
03D3  RETURN   D4      SEP 4     BACK TO CHIP-8

END LISTING
```


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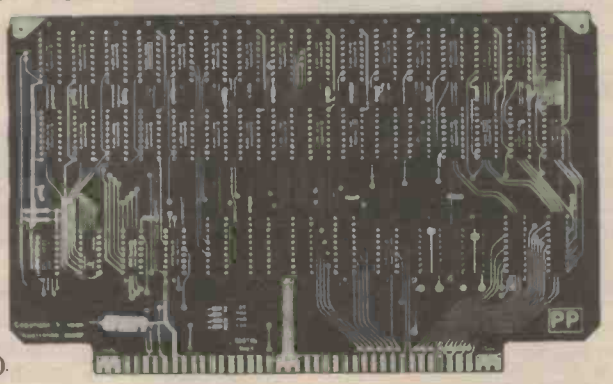

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MICROCOMPUTER EQUIPMENT

# Graphics guide to the System 80 and TRS-80

Just what can you do with the rather limited character set offered by the TRS-80 and System 80? Quite a lot really — as this article explains.

**Tony Edwards**

THIS ARTICLE is intended to be an overview of graphics programming on the System 80 and TRS-80 computers and, as such, programmers of all standards should find some parts of it of interest to them. Beginners can start at the beginning and the advanced programmers can skip until they come to more interesting parts. Owners of different models of computers will not find the detailed presentation of great interest, due to the vast differences in the methods of producing graphics displays in different types of computers. Nevertheless, the basic techniques should prove of general interest to all, as similar techniques can usually be employed on other machines and experimentation with all systems is to be encouraged.

The theme of the programs presented here is simple. We shall attempt (not always successfully) to switch on the whole screen: a kind of inverse CLS. This will be attempted using a number of different techniques, and a program is supplied for each method. The programs are consequently very simple, but once the technique has been understood the programs can be varied to produce the required graphics. Finally a more useful program is presented which shows an offbeat use of graphics (especially if you can smuggle it into someone else's machine).

## SET and RESET

The simplest and most straightforward way of producing graphics is to use the SET(n,m) statement. After all, that is what the thing is provided for. To use this statement to switch on the whole screen, two simple loops are all that are required.

```
10  CLS
20  FOR X%=0 TO 47
30    FOR Y%=0 TO 127
40      SET(Y%,X%)
50    NEXT Y%
60  NEXT X%
70  GOTO 70
```

Tried it? Not difficult, but it did take a long time — about 40 seconds. For the beginner a few points are relevant which will be applicable to all programs presented here.

The variables are all integer variables (indicated by the % sign). This is good practice when all the values are to be integers (whole numbers) as it saves space and running time. The leading blanks are to give the program a structure, thus making it easier to read, and for the same reason I insist on scattering spaces liberally throughout the program. If space is really at a premium (and usually this is not the case) a space deleting program can be used later to remove all unnecessary spaces (and make the program unreadable).

The loop in line 70 simply holds things so the READY prompt does not spoil your nice white (green) screen. The SET command and its inverse, the RESET command, are so simple that little more can be said, but before leaving the subject some comment should be made with regard to the 32-character mode. Here the System 80 and TRS-80 differ considerably — more so than many people expect. Consider:

```
10  CLS
20  PRINT CHR$(23)
30  FOR N%=0 TO 20
50    SET(N%,N%)
60  NEXT N%
70  PRINT@832,"":REM**THIS MOVES
    CURSOR
80  GOTO 80
```

You may be forgiven if you think this would produce a diagonal line — not so. It does on the System 80 but not on the TRS-80. The System 80 screens all bytes of screen memory at double width if the video cut is set, but the TRS-80 only screens even-numbered bytes. Remember there are two pixels per byte when working out which will and will not be screened. The patch for the TRS-80, if you must have that diagonal line, is to insert:

```
40  X%=N%+2*FIX(N%/2)
50    SET(X%,N%)
```

Before leaving the subject of CHR$(23), all those System 80 owners who cheated by entering the last program first and have not yet found out how to immobilise it should press BREAK to see what a mess CHR$(23) makes to the graphics on a System 80. A space is inserted after every symbol printed. To fix this enter CLS, which clears the CHR$(23), as well as the screen.

## The PRINT@ statement

Another simple approach is to use the PRINT@ statement.

```
10  CLS
20  FOR N%=0 TO 1023
30    PRINT@N%,CHR$(191)
40  NEXT N%
50  GOTO 50
```

This sets the screen more speedily than SET, but it still takes a long time (about 10 seconds) and raises a troublesome point. Did you notice the screen jump at the end of the run, and the fact that the screen is not full? Can you understand why? This system control of the cursor can cause trouble in graphics. Consider now that the above does not just produce a set screen but is your masterpiece of graphics (second only to the Mona Lisa) and you want some screened instructions. Add the following:

```
50  PRINT@10,"ARE YOU FINISHED"
60  INPUT A$
70  IF LEFT$(A$,1)="Y" THEN END
    ELSE GOTO 50
```

Now RUN the whole program answering 'NO' to the question as you still want to gaze at your masterpiece. What a mess! The computer never liked your artwork anyway, but all is not lost, everything is possible; the fix is:

```
52  B$="":REM**NULL STRING
53  CLEAR 200
54  FOR N%=64 TO 127
55    B$=B$+CHR$(PEEK(15360+N%))
56  NEXT N%
65  PRINT@64,B$
```

All is now fine and your masterpiece is safe from the cursor.

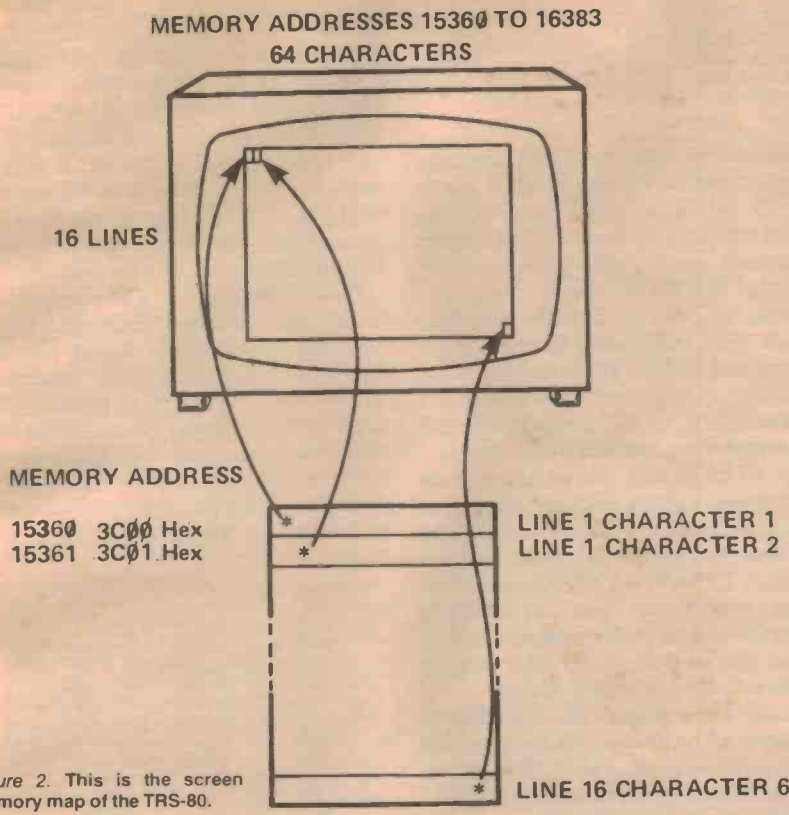


*Figure 2.* This is the screen memory map of the TRS-80.

The previous program also contains a number of points worth explaining before we go on. Line 30 contains the statement CHR$(191). This is a full six-pixel graphic block and is one of a series of numbers from 1 to 255 which can be used to produce various characters, graphics or cursor movements (not all are active). To see the full set run the program:

```
10  FOR A%=1 TO 256
20    PRINT A%,CHR$(A%)
30      FOR B%=0 TO 500
40      NEXT B%
50    PRINT:PRINT
60  NEXT A%
```

This program produces a list of all CHR$ codes, and an ERROR which shows what happens if a code higher than 255 is used. The graphic block codes can be calculated as shown in Figure 1.

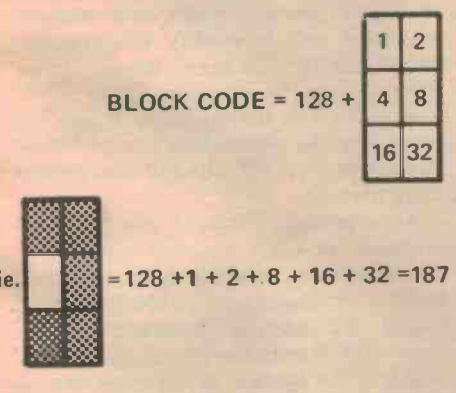


*Figure 1.* How to calculate the values of the graphics blocks. Regular readers will spot that this is somewhat similar to our standard for pixel codes.

The next point of interest is in line 70, where the symbol ',' is used in place of the THEN. A simple abbreviation, but do not expect a renumbering program to notice it. The lines 54 to 56 and 65 are the key to the fix and need some explanation. The symbol on each piece of the screen is held in the memory in locations 15360 to 16383. Consider these as 1024 (2 to the power of 10) little boxes, each containing what is on their own little section of the screen. See Figure 2.

To return to the previous program: when it gets to line 50 most of the boxes contain the solid graphics code 191, and in line 50 some are changed to hold the characters 'ARE YOU FINISHED' and some other things. In line 60, if we are not careful, some more will be changed to 32 (the code for a space). To avoid this, in lines 52 to 56 we collect a copy of the second line, spaces 64 to 127, from their memory locations (15360 + 64) to (15360 + 127) and save them as B$. After line 60 they are reprinted on the screen by line 65, and all the damage is repaired.

## Fast and faster still

Back now to setting the screen, but faster. The TRS-80 Level II manual suggests:

```
10  CLS
20  FOR X%=15360 TO 16383
30    POKE X%,191
40  NEXT X%
50  GOTO 50
```

Not bad, the time taken is about seven seconds. The program uses the screen address as mentioned above and POKEs the graphic block 191 into each memory cell. The POKE instruction places some numbers in a particular location and its reverse PEEK copies the numbers in some particular location, but leaves them undisturbed. This program is quite fast but even faster, and still in BASIC, is:

```
10  CLS
20  CLEAR 259
30  X$=STRING$(255,191)
40  FOR X%=1 TO 4
50    PRINT X$;
60    PRINT CHR$(191);
70  NEXT X%
80  GOTO 80
```

At about one second this is the fastest BASIC program I know to set the screen, and is quite fast enough for most purposes. In either of the two previous examples you can use some other graphic code if you would like a nice pattern.

## Machine code methods

To produce even faster results we must use machine code. Beginners need not be hesitant to join in, as no damage can be done to your computer by POKEing machine code about. All the essential code is in ROM, which you cannot POKE anyway (that is why it is called 'Read Only Memory'). Some vital lines of operation from ROM routines spread into RAM and can be fouled up by POKEing, but all 'damage' can be rectified by switching off and on again after 15 seconds.

It is not my intention to give instruction on machine coding here, so you must accept that the following code, in decimal, sets the screen. (After all, it is easily proved and contains our old friend, the graphic block 191.) 1,16,64,33,0, 60, 62, 191, 119, 35, 16, 252, 6, 64, 13, 32, 247,201. This could be used by putting it directly into the memory, but as many readers will not have the necessary program to do this we shall use a BASIC program to put it in a suitable part of the memory.

```
10  CLS
20  X$=CHR$(1)+CHR$(16)+CHR$(64)+..
    ..+CHR$(247)+CHR$(201)
30  X1=PEEK(VARPTR(X$)+1)
40  X2=PEEK(VARPTR(X$)+2)
50  POKE 16526,X1
60  POKE 16527,X2
70  X=USR(0)
80  GOTO 80
```

This program is a little more complex than the earlier ones, but should still be easily understood. Line 20 assigns the machine language string to the variable X$. When the program is RUN the computer stores this string in the memory as we wanted, but where in the memory? The variable pointer (VARPTR(X$)) identifies the address in the RAM where the variable type is stored, and the whereabouts of the actual contents of the string is given by the address stored in the next two memory cells, VARPTR(X$)+1 and VARPTR(X$)+2. These two parts of the address (the address is too big to fit in one memory cell) are PEEKed and assigned to X1 and X2 by lines 30 and 40. The address is then POKEd into memory cells 16526 and 16527.

Now the program proceeds to the dreaded USR command. The form must be X = USR(0), but the X and 0 are (in this case) meaningless symbols. When this statement is reached in the program the computer looks at the address in 16526 and 7 (we just POKEd the X$ address there), jumps to the address stored there and reads the contents as a machine code program. The characters in X$ say 'set the screen' and USR does this very quickly, in significantly less than a second — for most purposes instantaneously.

## Something for nothing

Typing in line 20 was hard work so let's try another way, and just to show I know more than one machine language program we will use another, but it still only sets the screen. The new machine code is:

33,0,48,17,0,60,1,0,4,237,176,201

We will put this into a data statement and POKE it away somewhere with the program below, but first we will enter ?MEM to see how much memory is available, and make a note of it:

```
10  CLS
20  FOR N%=16512 TO 16523
30    READ A%
40    POKE N%,A%
50  NEXT N%
60  DATA 33,0,48,17,0,60,1,0,4,
    237,176,201
70  NEW
```

Before RUNning the program CSAVE it for later because line 70 will destroy it. After RUNing enter ?MEM again to see how much memory has been used. How much? Yes, that's right, none at all — the machine code program is safely tucked away in protected memory. Something for nothing at last! Now type in and run the following program to use the machine code to set the screen again almost instantaneously:

```
10  CLS
20  POKE 16525,128
30  POKE 16527,64
40  X=USR(0)
50  GOTO 50
```

For the adventurous the USR statement can be replaced by the NAME statement. A bit of a fiddle, this, but an interesting area to explore. As a start you should modify the last program, using the EDIT command. I hope you CSAVEd the one before as we now need it again. Two extra machine code steps are required, so line 20 should end with 16525 not 16523, and line 60 should have two extra DATA values put in, 229 at the beginning and 225 at the end

Now RUN it and retype the second program, but use the memory addresses 16783 and 16784 in lines 20 and 30, and make line 40 NAME. No, this does not produce a SYNTAX ERROR, although you may expect it to. Now you can RUN and set the screen. Your machine locked up, but the screen *is* set! The NAME 'statement' does strange things — it alters the HL register for one (that is why two extra machine code instructions are required to POP and PUSH the HL register value). It can be mastered, but I leave this to you as an exercise.

## String packing

As a final screen setting manoeuvre we will try POKEing machine code from a DATA statement direct to a string statement. This is done by:

```
10  CLS
20  A$="XXXXXXXXXXXX"
30  X1=PEEK(VARPTR(A$)+1)
40  X2=PEEK(VARPTR(A$)+2)
50  X3=X2*256+X1
60  POKE 16526,X1
70  POKE 16527,X2
80  FOR N%=0 TO 11
90    READ D%
100   POKE X3+N%,D%
110 NEXT N%
120 X=USR(0)
130 GOTO 130
140 DATA 33,0,48,17,0,60,1,0,4,
    237,176,201
```

If you have followed the previous examples, the workings of this program should be clear — at least if you only RUN it once. RUN it twice and you are in trouble — a syntax error in a non-existent line, of all things. All will be revealed if you list line 20. This program changes itself and to RUN it again we must re-assign 12 Xs to A$.

Does the above program give you some ideas? If not, how about adding to your graphics masterpiece the lines:

```
1000  A$="GRAPHICS BY NO ONE IN
      PARTICULAR"
1010  PRINT A$
```

Then, before reaching line 1000, POKE your name in place of 'NO ONE IN PARTICULAR'. Then after line 1010 POKE 'NO ONE IN PARTICULAR' back. If you also immobilise the BREAK key (with POKE 16396,23) it will give some worries to those who wish to claim authorship for your graphics. This is not as easy as it seems, but worth the effort. I again leave it as an exercise.

Now that you have worked so hard to set the screen, and have had your appetite whetted for some fun, type in the sequence of commands 'SYSTEM';'10';'32688' to protect a little high memory, then type in and RUN the following program (CSAVE it first because of line 190). That READY prompt is gone for ever; TRS-80 owners may change the program if it upsets them.

```
10  CLEAR 500
20  A$=CHR$(128)+CHR$(157)+
    CHR$(156)+CHR$(149)+CHR$(13)+
    CHR$(176)+CHR$(179)+CHR$(183)+
    CHR$(177)+CHR$(144)+CHR$(13)+
    CHR$(133)+CHR$(191)+CHR$(175)+
    CHR$(149)+CHR$(133)+CHR$(13)+
    CHR$(180)+CHR$(191)+CHR$(170)+
    CHR$(181)+CHR$(148)
30  B$=CHR$(13)
40  C$="GENIE IS AT YOUR SERVICE-
    WAITING"
50  A$=A$+B$+C$:REM**LEN(A$)<63
60  FOR K=32688 TO 32703
70    READ D
80    POKE K,D
90  NEXT K
100 DATA 205,248,1,205,249,32,33,
    192,127,205,167,265,167,40,225,
    195,43,26
110 K=32704
120 FOR J=1 TO LEN(A$)
130   POKE K,ASC(MID$(CA$,J,1))
140   K=K+1
150 NEXT J
160 POKE K,13:POKE K+1,0
170 K=16812
180 POKE K,195:POKE K+1,176:POKE
    K+2,127
190 NEW
```

Next time you're demonstrating a program on a friend's machine, add the above (remember to protect some memory for it) and he will be stuck with a new 'READY' prompt until he switches off. If you have no friends, only enemies, you may like to modify the program before forcing it on them. It's easy to do. A$ contains the graphics, B$ is a line feed and C$ is the message. If you use more than 62 characters you will have to change lines 60 and 110 and protect more memory.

As a parting 'shot', if you have the program in high memory and get so frustrated with the machine you could kill it, just shoot graphics blocks (our old friend 191) into the 'protected' memory above 32688 with the POKE instruction and kill the System 80, because that is where it lives. It won't help you to be a better programmer, but it may make you feel better. ●

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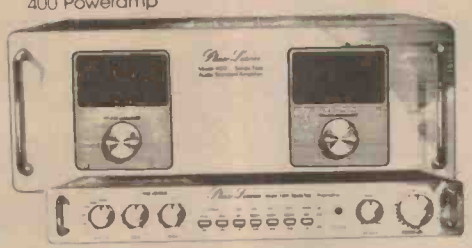

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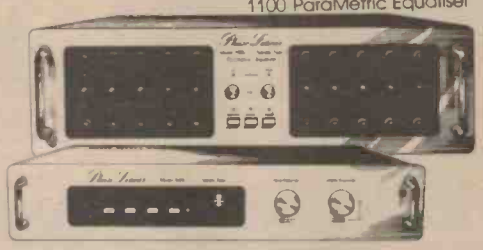

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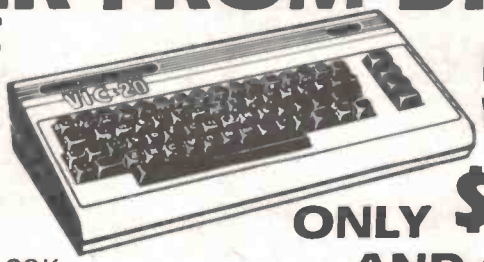


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# Not Just Speaker Wire

Conventional speaker wire limits the performance of your sound system by decreasing power output, restricting dynamic range, and reducing clarity and definition. You can significantly improve the performance of your audio system by switching from your present speaker wire to Monster Cable.

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Don't be deceived by imitations. If it doesn't say Monster Cable you're not getting all the performance you paid for.

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# The audio experts are raving about the Magnetic Field Amplifier

M-400 Magnetic Field Amplifier

"Its distortion and noise levels are entirely negligible . . . it's hardly conceivable that a small, inexpensive lightweight cube such as this could deliver as much clean power as any but a few of the largest conventional amplifiers on the market."

That's what Julian Hirsch reported in Stereo Review about the Carver M-400—the unique magnetic field power amplifier. It's a cube that weighs around 4 kgs and delivers 200 watts per channel. And costs a lot less than you think.

Equally startling, the M-400 can safely drive speaker-load impedance as low as 2 ohms. And in mono it can deliver more than 500 watts into an 8-ohm load, with peaks to 900 watts! (Bring on digital audio!)

To hear for yourself why all the audio experts have flipped over Carver, ask for a demonstration and descriptive literature. It will be a totally new experience for you.

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# SIGHT & SOUND

# First microcassette car sound system

Matsushita Electric Industrial Co Ltd of Osaka, Japan, has developed the first microcassette audio system for cars, to meet the increasing consumer demand for compact, lightweight car systems.

**The new system features**

- **microcassette (MC) car stereo system with FM/AM tuner (RW-7100XZ)**
- **the world's smallest MC car stereo deck (FW-7110XZ)**
- **MC audio centre with FM tuner and recording function (RW-7120XZ).**

In addition to in-car use, the MC audio centre can be used with home systems, allowing consumers to produce their own MC software.

The company will start marketing the new system with the introduction of the RW-7100XZ first. The marketing of the other two models will follow. Export of the models is slated for after the introduction in Japan.

The RW-7100XZ system is designed to fit into the dashboard opening for conventional compact cassette or radios. The saving of depth and weight allows dashboards to be designed more compactly and efficiently, Matsushita say.

The world's smallest microcassette deck (the RW-7110XZ) is almost half the size of conventional compact cassette car stereo decks. The microcassette audio centre with FM tuner and recording function (RW-7120XZ) provides for MC audio enjoyment both in the car and at home. The audio centre can work in the home as a component of a stereo system and can then be transferred to a car and easily installed. The

recording function and the built-in FM tuner allow people to make their own MC tapes at home. For expanded home or outdoor enjoyment an optional amplifier and speaker systems will be available.

## Perth Electronics Show

**Perth's 'mecca' for the person interested in hifi, video and consumer electronics is the Claremont Showgrounds, from the 22nd to the 25th of this month.**

Show manager Chris Gulland says there has been such a flood of bookings from distributors that the Jubilee and Robinson pavilions at Claremont Showgrounds may not be big enough to hold them, and more space has been tentatively booked.

Last year's show, which was held at the Ascot racecourse, had about 50 exhibitors with about 2000 square metres of space. A similar number of exhibitors have booked this year, but the trend so far has been for them to take much larger amounts of space.

The exhibition has become Australia's biggest electronics show — a fact that forced organisers to move the venue to the much larger Claremont Showgrounds.

Last year more than 60 000 people passed through the gates, a figure which organisers are confident of exceeding this year. Looks like a 'not-to-be-missed' event.

## World standard plug-in cartridge?

**Noting the popularity of Technics' linear tracking turntables, the world's leading cartridge manufacturers have gone ahead to produce cartridges to fit the plug-in connector system developed by Technics.**

Under technical guidance from Technics, Shure, Ortofon and Audio-Technica already have cartridges on the market, while other manufacturers are taking steps in this direction, Technics claim.

## Video workshops at Metro Television

**Metro Television, Sydney's only public television centre, is running a series of public workshops covering a whole range of aspects of video production.**

Facilities and experience are available in all aspects of production, Metro's aim being to make video media more accessible to the public.

Metro Television Ltd is a non-profit company, incorporated in June 1981, which is funded with assistance from the Australian Film Commission and the NSW Premier's Cultural Activities Division, as well as from its earned income.

In providing video training to the Sydney public, Metro hopes to establish public broadcasting there — the third tier of television broadcasting. Video facilities are offered to community and commercial organisations at a low cost, and individuals and community groups can be trained to produce programmes for non-broadcast use and later for public TV broadcast.

Metro has a full colour studio, colour camera, editing suites, vision and sound mixing facilities, telecine transfer facilities and a full range of special effects. These facilities are in Paddington Town Hall.

Portapaks, cameras, U-matic videotape playback decks, monitors and portable lights may also be hired from Metro.

The video workshops began in April, and no previous experience is necessary to enrol in most of them. They include:

- Colour portapak
- Location and field production
- Studio techniques
- Studio production
- Advanced studio production
- Colour editing
- Vision mixing and special effects
- Colour camera operation
- Sound techniques for editing
- Video art
- Acting/directing workshop
- Scriptwriting for video
- Alternative drama for TV
- Children's TV workshop
- Planning a rock clip
- Shooting a rock clip
- Choreography for camera
- Video and education

For further information contact Metro Television at Paddington Town Hall, or PO Box 299, Paddington NSW 2021. (02)33-5318.

# GRAND HI-FI CONTEST!

***Here's an unbeatable opportunity to win some fabulous hi-fi gear***

We've assembled ***over $7000 worth*** of 'top-shelf' equipment and accessories from some of the world's best-known audio equipment manufacturers to be presented as prizes in the Grand Hi-Fi Contest. We've equipment from Allsop, Audio-Technica, KEF, Marantz, Monster Cable, National Technic, Pioneer, Rega, Sansui, Sennheiser, SME, Sharp, Shure, and TDK.

**YOU COULD WIN A COMPLETE SYSTEM, PLUS ACCESSORIES, WORTH NEARLY $5000! — that's some first prize!**

**OR — YOU COULD WIN A COMPLETE PORTABLE SYSTEM AND ACCESSORIES WORTH MORE THAN $1100!**

**AND THERE ARE 12 CONSOLATION PRIZES! — ranging in value from about $220 to about $15. ALL IN OUR UNBEATABLE**

# $7000 GRAND HI-FI CONTEST!

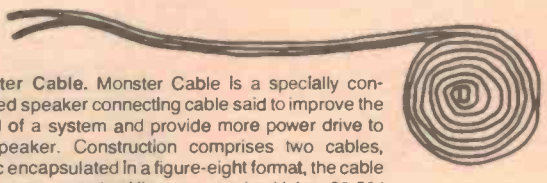
## JUST LOOK AT THE PRIZE LIST:

**Audio-Technica.** One **Audio-Technica ATH8 stereo headphones set.** This superb set of electret headphones — complete with adaptor — offers superb performance. Reviewing them in ETI, September '81, our audio consultant Louis Challis said these headphones ". . . offer a rare example of . . . the sort of quality now regarded as the norm from the best loudspeakers." Value: $353.50. Six **Audio-Technica AT125LC cartridges.** Audio-Technica's new 'para-toroidal' 100-series range of moving-magnet cartridges feature special toroidal-wound coils and dual magnets. AT claim this provides them with outstanding linearity, efficiency and frequency response. Value: $65.

**KEF.** A pair of **KEF 104AB loudspeakers** are included in the first prize. KEF's constant research — in particular, their pioneering of the 'cumulative delay response' test technique — has earned them a deserved reputation as being amongst the world's top loudspeaker manufacturers. The KEF 104ABs have an almost unrivalled reputation for linearity and sound quality. Value: $890.

**Allsop.** Twenty **Allsop 3, Model 70300 cassette deck cleaners.** These unique cleaners, housed in a cassette case, are driven by the cassette drive mechanism and clean the heads, capstan and pinch roller with non-abrasive felt pads. Value: $8.50 each. Six **Allsop 3, Model 58000 Orbitrac record cleaning systems.** Another unique Allsop product; the soft bristles of the special cleaning pad, together with the special cleaning solution sprayed on the pad, remove dust and grit from the grooves. Cleaning is not done on the turntable, which can upset drive mechanisms. Value $37.95 each.

**Marantz.** Marantz have offered their superb **ST-8 FM/AM tuner.** This tuner features an oscilloscope tuning display, 'quartz-lock' tuning, low distortion detection and very high signal-to-noise ratio. On FM stereo, Marantz quote an 80 dB S/N ratio, 55 dB on AM. THD on FM stereo is quoted as 0.06% and frequency response as 30 Hz-15 kHz, +0.2, −1 dB. Value $713.



**Monster Cable.** Monster Cable is a specially constructed speaker connecting cable said to improve the sound of a system and provide more power drive to the speaker. Construction comprises two cables, plastic encapsulated in a figure-eight format, the cable being many strands of fine copper wire. Value: $3.58/metre (length to suit).

**National Technics.** One of their latest **microprocessor controlled, dbx cassette decks** is offered — **the RS-M255.** This is a three-head, two-motor machine with colour-coded fluorescent bargraph level display, soft touch controls and metal capability. It has both Dolby and dbx noise reduction systems. This deck is included in the first prize.

**Pioneer.** Pioneer have provided **an A8 amplifier.** Reviewed in ETI only last month, this 90 W/channel amp features extremely low distortion — with a THD of 0.0036% at 1 kHz — superb transient response and excellent signal-to-noise ratios. Louis Challis used words like 'superlative' and 'exemplary'. Value $759.

**Rega.** The **Rega Planar 3 two-speed turntable** has been offered by Concept Audio. Noted for their superb engineering and simple design, Rega turntables have a deservedly good reputation among hi-fi buffs. Value: $445. (This will be fitted with the SME arm and Shure cartridge mentioned later).

**Sansui.** Sansui have provided their **SE-8 stereo graphic equaliser/analyser,** featuring a 10-band equaliser in each channel and a plasma spectrum analyser display. In reviewing the SE-8 in ETI's December '81 issue, Louis Challis said the unit "... comes closer to the amateur's expectation of a panacea than anything else ... yet seen ..." Value: $499.

**Sennheiser.** Six **Sennheiser Model HD40** headphones. These super-light headphones feature a frequency response of 22 Hz-18 kHz and the finest reproduction, the manufacturers say. They have nominal impedance of 600 ohms and are supplied with three metres of cable. Value $29.75 each.

**SME.** Audio Engineers have provided an **SME tonearm** — to be fitted to the Rega turntable. Whenever tonearms are mentioned in conversation, SME is always mentioned. Their reputation is unrivalled. Value: $280.

**Shure.** With the SME tonearm, Audio Engineers have thrown in the fabulous new **Shure moving magnet cartridge — the V15 Mk V.** This cartridge has received critical acclaim from reviewers all over the world. Its predecessor, the V15 Mk IV, virtually set a 'standard'; the Mk V looks like establishing a new standard. Value: $375.

**Sharp. The Sharp VZ2000 portable hi-fi system** was only recently released here. It features a vertical, bilateral, linear tracking disc player that can play both sides of a record without having to turn it over! The system includes a cassette deck with Dolby noise reduction, metal tape capability and an 'auto program search system'. There's a stereo FM/AM tuner too, and the two-way loudspeaker system has separate amplifiers for the woofers and tweeters, providing a total 10 W/ channel output. The VZ2000 can be powered from mains, internal batteries or 12 Vdc. Value: $995.

**TDK. 50 TDK SA-C90 cassettes.** TDK tapes need no introduction. The SA on these cassettes stands for 'Super Avilyn', which is TDK's designation for TDK's cobalt-enriched ferric oxide formulation medium. SA tapes are used on high bias/eq setting on a cassette and offer better MOL and frequency response than top-ranked chrome tapes, according to TDK. Value: $6.38

## Prizes have been kindly donated by the following firms:

**Audio Engineers (SME, Shure)**
342 Kent St, Sydney NSW 2000

**Pioneer Electronics (Australia)**
178-184 Boundary Rd, Braeside Vic. 3195

**Concept Audio (Rega)**
22 Wattle Rd, Brookvale NSW 2100

**R.H. Cunningham (Sennheiser)**
146 Roden St, West Melbourne Vic. 3003

**Convoy International (Monster Cable)**
4 Dowling St, Woolloomooloo NSW 2011

**Marantz Australia**
32 Cross St, Brookvale NSW 2100

**National Panasonic (Aust.)**
95-99 Epping Rd, North Ryde NSW 2113

**Vanfi Australia (Sansui)**
198 Normanby Rd, South Melbourne Vic. 3205

**Maurice Chapman Aust. (Audio-Technica)**
44 Dickson Ave, Artarmon NSW 2064

**Communication Power Inc. (Allsop)**
P.O. Box 246, Double Bay NSW 2028

**TDK Australia**
Unit 5, Level B South, 100 Harris St, Pyrmont NSW 2009

**Audioson (KEF)**
64 Winbourne Rd, Brookvale NSW 2100

**Sharp Corporation of Australia**
64-72 Seville St, Fairfield NSW 2165

***NOW TURN THE PAGE FOR YOUR CHANCE TO WIN THESE GREAT PRIZES!***

# GRAND HI-FI CONTEST!

## WE'RE LOOKING FOR FOURTEEN LUCKY WINNERS FOR THESE FOURTEEN SUPER PRIZES — YOU COULD BE AMONG THEM!

### HOW TO ENTER

All you have to do is answer the questions on the entry form on the opposite page, fill out the coupon and send your entry to:
**ETI, GRAND HI-FI CONTEST,**
**15 Boundary St,**
**Rushcutters Bay NSW 2011.**

Please read the rules carefully.
Multiple entries will be accepted. You must enter your name and address on each entry submitted. Photostats or clearly written copies of the entry form will be accepted, but if sending copies you must cut out and include with each entry form the month and page number from the bottom of the page of the contest. When sending multiple entries, then, you will need extra copies of the magazine so that you send an original page number with each entry.

**CONTEST CLOSES 31 AUGUST 1982**

### FIRST PRIZE

**Complete hi-fi system, comprising:**
- Shure V15 Mk V cartridge
- SME tonearm
- Rega Planar 3 turntable
- Allsop 3 Orbitrac record cleaner
- Technics RSM255 cassette deck
- 10 TDK SA-C90 cassette tapes
- Two Allsop 3 cassette deck cleaners
- Marantz ST8 FM/AM stereo tuner with oscilloscope
- Pioneer A8 stereo amplifier
- Sansui SE8 equaliser
- KEF 104AB loudspeakers
- Pair of speaker wires by Monster Cable
- Audio-Technica ATH8 headphone set

**TOTAL : OVER $4900!**

### SECOND PRIZE

**Complete portable hi-fi system, comprising:**
- Sharp VZ2000 portable hi-fi system
- Two Allsop 3 cassette deck cleaners
- Allsop 3 Orbitrac record cleaning system
- 10 TDK SA-C90 cassette tapes
- Sennheiser model HD40 headphones

**TOTAL: OVER $1100!**

## PLUS THESE SIX OTHER GREAT PRIZES!

### 1ST CONSOLATION
- One Audio-Technica AT125LC cartridge
- Two Sennheiser HD40 headphones
- Two Allsop 3 cassette deck cleaners
- One Allsop 3 Orbitrac record cleaning system
- Eight TDK SA-C90 cassette tapes

**TOTAL: OVER $220!**

### 2ND CONSOLATION
- One Audio-Technica AT125LC cartridge
- One Sennheiser HD40 headphones
- One Allsop 3 Orbitrac record cleaning system
- Two Allsop 3 cassette deck cleaners
- Six TDK SA-C90 cassette tapes

**TOTAL: OVER $185!**

### 3RD CONSOLATION
- One Audio-Technica AT125LC cartridge
- One Sennheiser HD40 headphones
- One Allsop 3 Orbitrac record cleaning system
- Two Allsop 3 cassette deck cleaners
- Four TDK C-90 cassette tapes

**TOTAL: OVER $170!**

### 4TH CONSOLATION
- One Audio-Technica AT125LC cartridge
- One Sennheiser HD40 headphones
- One Allsop 3 Orbitrac record cleaning system
- Two Allsop 3 cassette deck cleaners
- Two TDK SA-C90 cassette tapes

**TOTAL: OVER $150!**

### 5TH CONSOLATION
- One Audio-Technica AT125LC cartridge
- One Sennheiser HD40 headphones
- One Allsop 3 cassette deck cleaner
- One TDK SA-C90 cassette tape

**TOTAL: OVER $115!**

### 6TH CONSOLATION
- One Audio-Technica AT125LC cartridge
- One Allsop 3 cassette deck cleaner
- Two TDK SA-C90 cassette tapes

**TOTAL: OVER $85!**

**PLUS — SIX RUNNERS-UP,** each receiving:
- One Allsop 3 cassette deck cleaner worth $8.50
- One TDK SA-C90 cassette tape, worth $6.38.

### RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Audio Engineers Pty Ltd, Pioneer Electronics (Australia) Pty Ltd, Concept Audio Pty Ltd, R.H. Cunningham Pty Ltd, Convoy International Pty Ltd, Marantz Australia Pty Ltd, National Panasonic (Aust.) Pty Ltd, Vanfi (Australia) Pty Ltd, Maurice Chapman Aust. Pty Ltd, Communications Power Inc. (Aust.) Pty Ltd, TDK (Australia) Pty Ltd, Audioson Pty Ltd, Sharp Corporation of Australia Pty Ltd, Murray Publishers, Offset Alpine, Australian Consolidated Press and/or associated companies.

**Closing date for the contest is 31 August 1982.**

Entries received within seven days of the closing date will be accepted if postmarked prior to and including 31 August 1982.

The winning entries will be drawn by the Editor of ETI, whose decision will be final. No correspondence can be entered into regarding that decision.

Following closing of the contest, all entries will be put into a box and thoroughly mixed. Entries will then be drawn from the box at random and the first fourteen correct entries drawn will be declared winners in the order drawn.

Winners will be advised by telegram the same day the result is declared. The name of the winners, together with the winning answers, will be published in the next possible issue of ETI.

Contestants must enter their name 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, accompanying this contest, that they have read the above rules and agree to abide by their conditions.

**You may enter as many times as you wish but you must use a separate entry form for each entry and include the month and page number cut from the bottom right hand portion of the page containing the entry form. You must put your name and address on the entry form and sign it where indicated.**

# ENTRY FORM

TC.82-801

**QUESTION 1**
It can be established without any shadow of doubt that one and only one of the following statements is true. In each instance the statement relates to whether or not significant scientific discoveries were made in Britain between September 3rd and September 13th 1752.

- ☐ Many significant discoveries were made
- ☐ A few significant discoveries were made
- ☐ No significant discoveries were made
- ☐ The question is impossible to answer

**QUESTION 2**
On February 14th 1876 Alexander Graham Bell filed his now-famous patent for a telephonic apparatus. Just three hours later (and hence three hours too late) someone filed a caveat with the Patent Office regarding a basically similar device. What was that person's surname?

- ☐ White
- ☐ Brown
- ☐ Gray
- ☐ Siemens
- ☐ Edison

**QUESTION 3**
Who utilised a diaphragm and hog bristle to develop what? And (roughly) when?

Who? .....

What? ..... When? .....

**QUESTION 4**
What were the physical dimensions of Hollerith's first punched cards? What influenced him to use that specific size?

.....

.....

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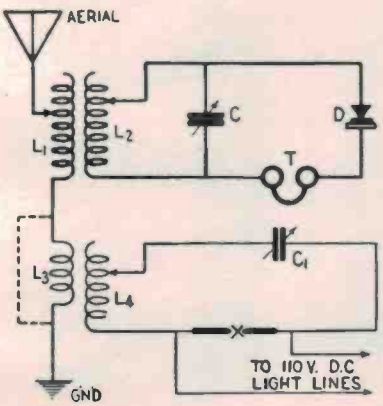



**QUESTION 5**
What is this device — please explain in less than 25 words. (note — the caption 110 V.DC is not an error)

.....

.....

**QUESTION 6**
What is/was a 'Rheotome'?

- ☐ Early wave-form plotter
- ☐ Book of resistor terminology
- ☐ Type of rheostat
- ☐ Early 'Variac'
- ☐ Transformer with variable primary/secondary ratio

**QUESTION 7**
Who wrote "Is it a fact — or have I dreamt it — that, by means of electricity, the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time?"
Clue: the year was 1851.

- ☐ Nathaniel Hawthorne
- ☐ Neville Williams
- ☐ Joseph Joubert
- ☐ Charles Lamb
- ☐ William Hazlitt
- ☐ Dennis Lingane

**QUESTION 8**
Decimal time was actually introduced by one European country and retained for two years.

Which country? .....

Approximately when? .....

**QUESTION 9**
Who is this man (born 1806) and how did he have great influence on computing? Limit answer to 25 words maximum please.

.....

.....

**QUESTION 10**
The discovery of thermoelectricity is usually attributed to T.J. Seebeck. There is evidence that his discovery was anticipated by someone else. Further to this, the effect was also discovered quite independently by yet another. Who were these two people? (Tick two names.)

- ☐ Peltier
- ☐ Cummings
- ☐ Dessaignes
- ☐ Nobilli
- ☐ Faraday
- ☐ Melloni

**QUESTION 11**
Taking facsimile transmission to mean 'a method by which printed, handwritten and graphic data may be transmitted via communication channels and recreated as hard copy', when was the concept first patented?

- ☐ 1843
- ☐ 1877
- ☐ 1905
- ☐ 1923
- ☐ 1931

**QUESTION 12**
Babbage is best known for his work with calculating machines. Nevertheless, his genius extended beyond this. One of his inventions was used by the Russians in the Crimean War. Which?

- ☐ Mirror for indirect sighting of artillery
- ☐ Rocket for boosting projectiles
- ☐ Signalling lamp
- ☐ Railway dynamometer car

Name .....

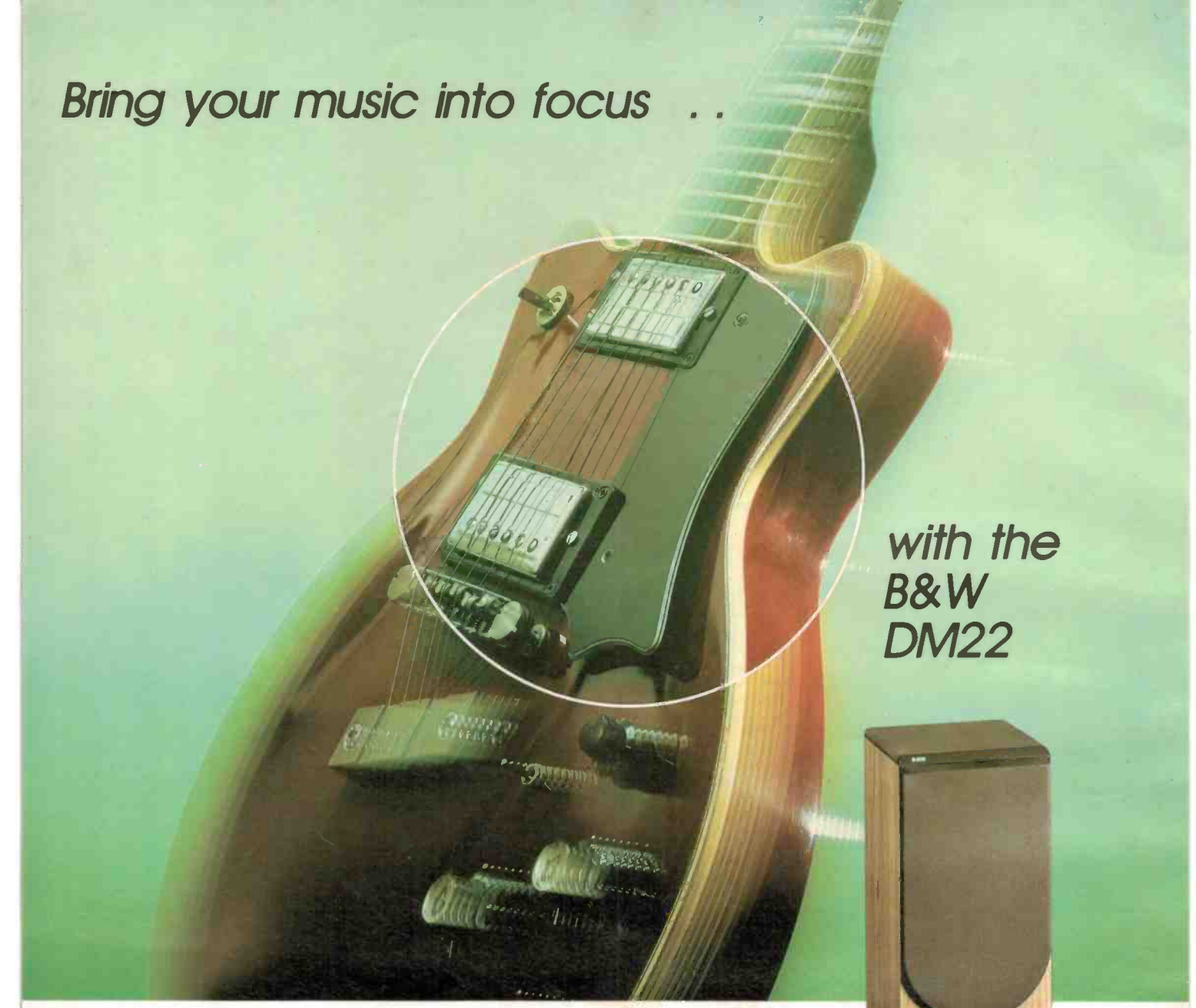
Address .....

..... Postcode .....

Send to: ETI, Grand Hi-Fi Contest, 15 Boundary St, Rushcutters Bay NSW 2011.
I have read the contest rules and agree to abide by their conditions.

Signature .....

# *Bring your music into focus . .*



## *with the B&W DM22*

*Like a photograph that is out of focus, a loudspeaker that presents a hazy, clouded image will never make music sound real.*

*In a camera, exact optical focus, is achieved by the combination of advanced design and exacting constructional standards. B&W Loudspeakers achieve musical focus by adhering to the same strict standards. Their advanced technology includes crossover designs optimized by computer and cone inspection performed by laser interferometry. B&W's flawless construction is evidenced throughout — from massive cast-alloy frames to exquisite wood veneer finishes.*

*B&W Loudspeakers reproduce much more than just the notes and overtones of a performance. By revealing the subtlest details of the music, they add a sense of depth and clarity that brings one much closer to the experience of listening to a live performance. Serious music listeners use a variety of terms to describe this elusive quality. We at B&W call it focus.*

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B&W

**DM22**
The DM22 benefits from B&W's most important technological innovations, including the use of polymer driver materials and laser interferometry design procedures. Yet the DM22 is not a 'utility' model but rather is a handsomely crafted wood veneer, high performance loudspeaker. The DM22 achieves a new level of value and is truly the least expensive loudspeaker worthy of the B&W name.

B&W DM is a registered trade mark of B&W Loudspeakers Ltd.

## Four heads are better than one?

**The recently released V8700A VCR from Toshiba features four heads, claimed to provide a wide choice of tape speeds including a 'vari-speed' (from one thirtieth to one third of normal).**

Double speed and 'cue-and-review' functions allow operation 7 and 25 times faster than normal. The optional fast speeds greatly accelerate scene locations.

The extremely slow speeds afford a revealing study of 'action' locations which, if necessary, can be frozen or advanced frame by frame, free from noise bar distortion. All these functions can be controlled from an infrared remote handpiece.

Recording time on the V8700A with various cassettes extends to 3¼ hours. The machine will record the programme whilst the viewer watches, record one programme whilst the viewer watches another, or record up to three separate programmes over a one-week period — even though they're coming in from different channels!

The V8700A also allows you to edit out unwanted sections of a programme, and will automatically dovetail the unedited content together without 'jittering' the picture.

Other features include an audio dub control for adding a soundtrack to previously recorded material, and a counter-memory function to return the tape automatically to any pre-selected spot.

For more information contact Roger Porter on (02)922-6877.

## Craig car sound equipment in Australia

**One of America's three top-selling car stereo equipment ranges is now available in Australia through a national network of exclusive specialist car sound dealers.**

A Sydney company, Sonic International, has the Australian distribution rights for Craig.

The Craig range in Australia will initially comprise seven radio/cassette combination units, nine alternative speaker selections and a choice of power amplifiers with outputs of up to 30 watts per channel. Also available is the 'Road Rated' component cassette player.

A key model in the line-up is the Craig T619, a manual tune radio/cassette unit which offers a high level of specification including metal tape compatibility, Dolby, auto reverse, locking fast forward and rewind, the Craig 'electronic search and play' track selection system in the cassette mode, separate controls for balance, fader, bass and treble, and an inbuilt output of 12 watts per channel.

All front ends are compatible with any of the Craig power amplifier and speaker systems.

Craig's 'flagship' model — the T693 — is a fully electronic unit with electronic scanning and tuning, 12 station electronic presets (six AM and six FM), digital readout for time and station frequency, plus all the features of the T619.

The Craig 'Road Rated' car sound range is available from dealers in all capital cities, and selected country areas. For further information contact: Sonic International, 4 Clarendon Street, Artarmon NSW 2064. (02)439-8900.

## Sansui turntable features 'silent synchrotor' system

**Sansui's new XR-Q7 turntable is a direct-drive motor system that employs a special motor assembly said to eliminate fluctuations in torque that cause the turntable cabinet to vibrate, inducing pitch waver and unstable stereo imaging.**

The 'silent synchrotor' system utilises a second rotor, essentially the same design as the drive motor, located directly underneath the drive motor. This second rotor is synchronised with the main drive motor, but rotates back and forth in either direction in response to speed change commands sent by the servo to the drive motor, thereby cancelling any vibration that the torque variations may transmit to the cabinet, Sansui say.

The drive motor is a newly developed coreless linear-drive type. Wow and flutter performance is quoted as an amazing 0.009%, signal-to-noise ratio as 80 dB (DIN B)!

Not only that, but Sansui have equipped the XR-Q7 with their 'dyna-optimum balanced' (DOB) tonearm, used on previous turntables and received with wide acclaim.

Operation is microcomputer controlled and features fully automatic control.

Further details are available from Sansui agents, Vanfi (Aust.) Pty Ltd, 297 City Rd, South Melbourne Vic. 3205. (03)690-6200.

### CARVER'S '16-POUNDER'

**As we mentioned in this column last month, Carver has released a 600 W/channel magnetic field amp, designated Model M-1.5, weighing just 16 pounds.**

**This picture arrived just as we went to press and we thought you'd like a glimpse of the monster. Well, not so much a monster — more like a mouse that roars!**

**Carver Corporation say the M-1.5 is a completely new and "totally unique" amplifier design. Employing 'demand responsive magnetic field circuitry', the M-1.5 is claimed to be the world's lightest and most efficient 600 watt-per-channel high fidelity power amplifier.**

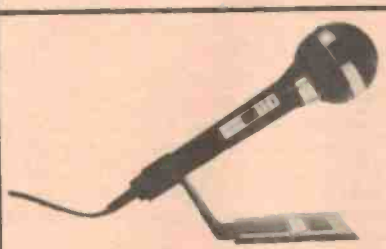
# REACH FOR RALMAR . . .

# MICROPHONES GALORE !

DMS200

## STEREO SET

Twin metal mesh ball dynamic microphones from your own stereo recordings. Low (300 ohm) impedance with omni-directional pattern. Frequency response 50-10000 Hz. Suitable for most hifi systems and other general voice applications.



**DM301L**
Low Impedance Dynamic.

## BUDGET OMNI

This is our most popular seller. Metal mesh ball, on/off switch and stand. Low impedance 500 ohms to suit most cassette decks and music centres up to 1000 ohms. Frequency response; 50-14000Hz. Complete with 1 metre cord.

**DM25D**

## DUAL IMPEDANCE DYNAMIC

Ideal for PA and band work. Also suitable for home recording. Cardioid pattern. Heavy mesh ball. On/off switch. Low 300 ohms/high 30k ohms. Frequency response 50-14000Hz. Supplied with 3 metres cord and stand adaptor.

## RALMAR FOR MICROPHONES

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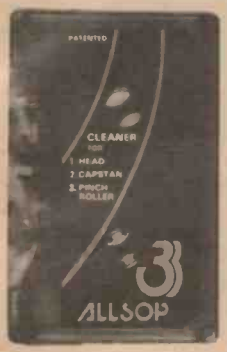
# What do . . . Sanyo, Marantz, Yamaha, Clarion, Mitsubishi and Alpine . . . all have in common?*




They all want you to keep it clean with the Allsop 3 cassette deck cleaner. Their state of the art cassette deck units are virtually maintenance free but the heads, capstan and pinch-roller need to be kept free of dust, pollutants and tape oxides.

The Allsop 3 audio cassette deck cleaner is just about the fastest and easiest way to keep your cassette deck operating at its peak. Simply moisten the Allsop 3 with Allsop's specially formulated solution and insert into the deck like a standard cassette.

In seconds, the Allsop's virgin wool felt pads gently clean, leaving your deck ready to produce sounds that will make your ears tingle. The Allsop 3 cleans quickly and safely, which is why it is recommended by leading makers of high quality audio products. In fact the Allsop 3 is also the only cleaner that has been endorsed by leading audio manufacturers for use in their cassette decks.

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Telex: 23381 "COMPOW"

ALLSOP 3
WE KEEP IT CLEAN ™

* Sanyo Electric Inc., Yamaha Electronics Corporation USA, Marantz-Superscope USA, Clarion Corporation of America, Mitsubishi Electric Sales America Inc, Alpine Electronics of America Inc.

# Don't get caught in the backseat committing the original sin.

Unfortunately, when you enter the maze of car stereo products, it's easy to get stuck in all of the "facts and figures". And there are so many products out there, you'll never get to see them all. But there's an easier way to choose that system for your car. No matter what car stereo machine you decide to buy, ask to listen to it punched with a Rockford Fosgate power amp. Insist on it. The clarity and punch of Rockford Fosgate will open your ears to real music quality. Listen just once, and you'll never settle for less. Other power amps simply make your car stereo play louder . . . The Punch makes it louder and makes it sound real.

We have something to suit everyone. Amplifiers from 40 watts to 200 watts RMS plus a world first, units incorporating dbx which will give you the ability to play dbx-encoded cassettes on virtually any car stereo. Prices start at around $200.

"The performance of the amplifier section with the array of loudspeakers connected was devastating, and for the first time in a car I could reproduce the type of sound levels that I can achieve in my home with my 2 x 200 watt amplifier and various monitoring loudspeakers" — ETI November 1981 Review of Model PR252

Rockford Fosgate

***A car stereo without the Punch is the original sin***

Trade inquiries invited
Communications Power Inc (Aust) Pty Ltd
P.O. Box 246 Double Bay NSW 2028 Phone (02) 357 2022. Telex 23381 "COMPOW"

# SIGHT & SOUND news

## VCL Video — splash release!

**VCL Video, one of Europe's leading independent video movie companies, made a big splash in Sydney when they recently released an initial range of 40 new video movies in VHS and Beta format.**

The company distributes video movies through Video Classics, Australia's leading independent video movie distributor.

Programmes available include 'Aloha Bobby and Rose', 'Elton John — Live In Central Park', 'The Passage' and 'E.L.O'. 'An Evening With Charles Aznavour' is a world premiere feature-packed cassette to delight Charles Aznavour fans; under an exclusive arrangement with London's Capital Radio, 'An Evening With Charles Aznavour' was recorded by VCL at the Duke of York's Theatre in January this year.

Charles Aznavour was guest of honour at a cocktail party hosted by VCL in Sydney during his recent Australian tour.

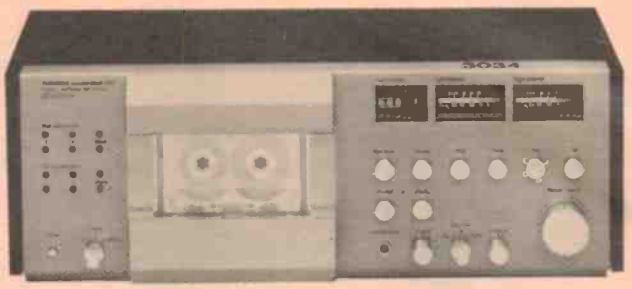
Pam Ayres, pommy poet and story-teller, hosts 'Pam's Party', a video cassette loaded with great children's entertainment. In an interview with Pam during her recent Australian tour, she said, "It's a programme which we thought would be an alternative to the interminable cartoons on television. If parents want a variety programme to entertain their children on a rainy day, or for a party, then this programme is for them."

VCL are one of the few video movie distributors who produce many of their own programmes, and the company has extensive facilities for sub-titling in its Scandinavian plant.

A twenty-page full-colour catalogue is available on request or through video movie outlets to make selection of programmes easy.

VCL's video movies became available in May, for sale or rental, from video specialists, electrical retailers, department stores and anywhere video is sold. Prices range from $49.95 to $69.95, recommended retail. The cost of a one night rental is about $9.

For further information on VCL please contact Peter Sweeney or Jill Francis, VCL Video Pty Ltd, PO Box N284, Sydney 2000. (02)221-3422.



## New Tandberg stereo cassette deck

**The new TCD3034 two-head cassette deck was recently released by Tandberg. It joins the very high-performance TCD3004 and is directed towards the medium price market.**

This cassette deck includes three special features: 'Dyneq' — a dynamic recording equalisation system; 'Actilinear' — a special recording system, and a multicore senalloy record/playback head for use with metal tapes.

The Dyneq amplifier is a self-regulating circuit where the input signal level determines the record gain at high frequencies. This is claimed to give drastic reduction in intermodulation distortion and optimum recordings for almost all types of music, even if the programme contains loud, complex, high frequency passages.

The second Tandberg design feature — the Actilinear recording system — offers a number of advantages, Tandberg claim, including lower intermodulation distortion and improved isolation between the recording amplifier and the bias oscillator. With a 15 dB overload margin, it is very suitable for recording on high coercivity tapes including any metal tape.

Tandberg has chosen a diamond-cut multicore senalloy record/playback head, which has a high saturation limit and extended head lifetime.

Optional side walls, rack handles, dust cover for the cassette compartment and rack-mounting kit are available for the TCD3034.

For further information, contact Rank Electronics, Sydney, Melbourne, Brisbane, Adelaide and Perth.

## New laser-designed speaker

**Celestion recently introduced a new loudspeaker designed with the aid of their new measurement device, a Scanning Doppler Laser Interferometer, invented by the company (see March issue, p. 117).**

This instrument, when interfaced with a computer of Celestion's own design, has enabled designers to see for the first time the microscopic movements of loudspeakers in the form of a three-dimensional animation.

The company claim that with the detailed and specific information made available by this technique, the imperfections of physical and mechanical motions have been removed, together with the limitations of performance.

Celestion claim their new SL-6 loudspeaker is the first created with a complete understanding of the vibrational behaviour of all its drive units, and a level of control of design which has not been possible previously.

In the past designers have often mainly aimed at obtaining a flat frequency response, although it is accepted that good sound may be obtained without a particularly flat response. Designers have taken great trouble to achieve this objective, adding complex crossover and equalisation networks, in an attempt to eliminate problems of physical and mechanical motion which were not fully understood. These designs have been accepted over the past half century, since it has been impossible to see (and therefore to understand) the mechanical movement of loudspeakers.

The SL-6 has completely new types of drive units designed to operate together with overall controlled behaviour when mounted in a cabinet as part of a complete system. The overall control of their behaviour means that no storage of energy occurs, leading to delayed resonances which can confuse the stereo image, colour the sound quality and limit the dynamic range.

The design of the tweeter unit is especially interesting, since it consists of a metal dome without any coil former. The metal dome itself acts as the coil and also acts as its own heatsink. It is 37 mm in diameter with a 20 kHz resonance.

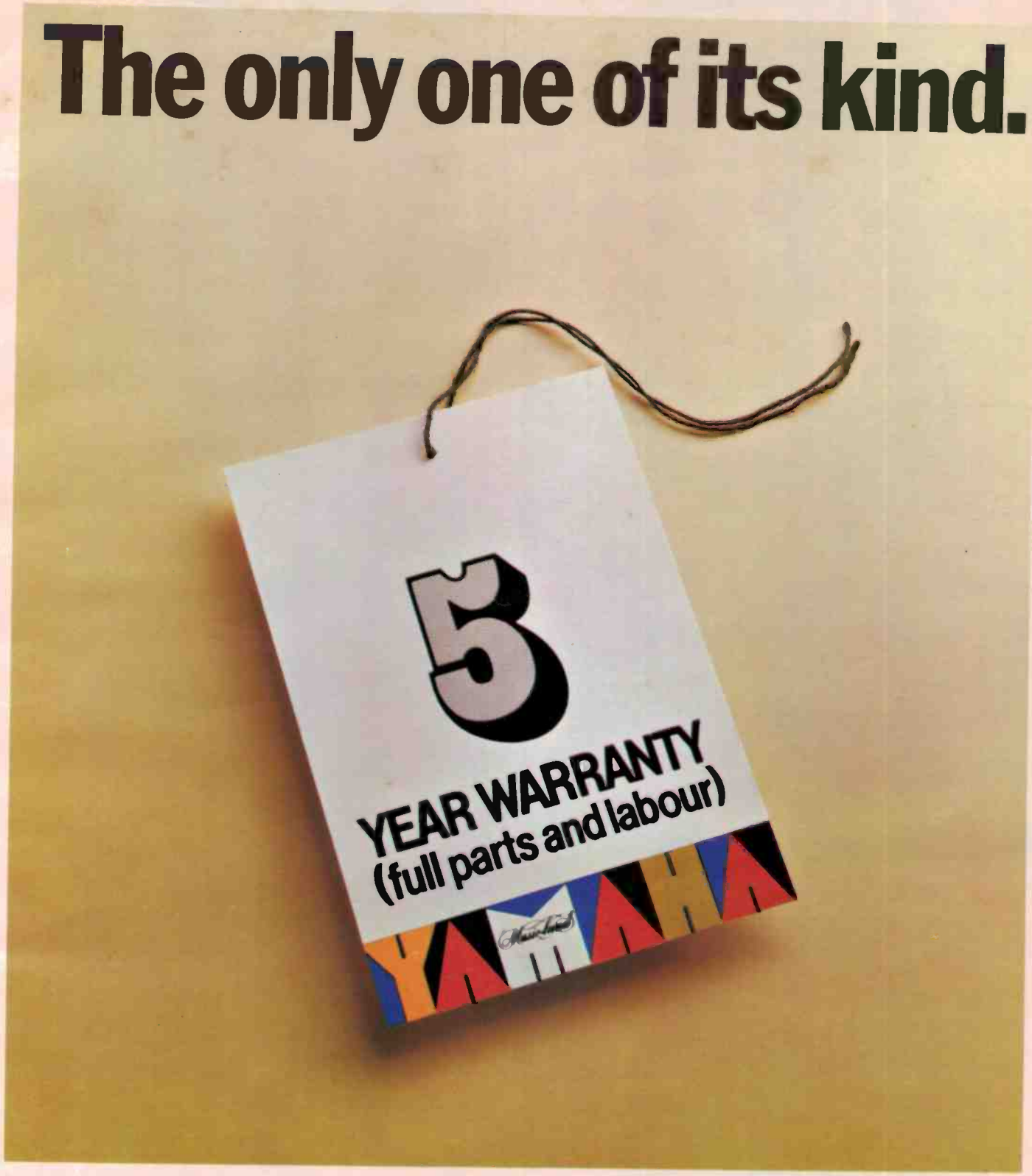
The mid-frequency/bass unit is 140 mm in diameter, with the coil former, the suspension and lead-out wires from the coil all attached in one plane so as to reduce the number of adhesive joints and the effects they would produce on the sound. This main drive unit is vacuum-formed polyvinyl chloride with suitable properties, but it is interesting to note that there is no centre cutout for the cone.

The relatively large crossover network employs four components and has a crossover frequency of 2.3 kHz with a 12 dB per octave response.

The SL-6 is housed in a 12-litre cabinet (370 x 200 x 255 mm), has a nominal 8 ohm impedance and a programme power rating of 100 W. The sensitivity is quoted as 82 dB/W at 1 m, and the low frequency performance falls to −3 dB at 75 Hz and −6 dB at 60 Hz.

Manufactured in Ipswich, England, the SL-6 is available from M & G Hoskins (Pty) Ltd, 268 Princes Highway, Arncliffe NSW 2025.

# The only one of its kind.




You'll only see this tag on one brand of Hi-Fi equipment: Yamaha.

It means that for five long years, any malfunction or any part covered by the warranty, will be fixed, free of charge.

We often wonder why we're one of a few manufacturers with this much confidence in our own product.

It's one thing to offer instant listening satisfaction.

Quite another to promise five years of it.

MCR/RM3829

**Put some high powered entertainment into your day with these swingers from Sanyo.**

Whether you're having fun, playing your favourite sport, or simply relaxing with your kind of music, Sanyo's super-compact personal radio/tape players deliver high powered performance wherever you go.

**M-G10 Compact Personal Tape Player** – ☐ normal and metal tape facility ☐ Hi-Lo tone switch ☐ lightweight headphones ☐ convenient thumbwheel volume control ☐ Auto-Stop tape system ☐ cue and review ☐ carry case with shoulder strap.

Clean, compact styling and every feature you need for your listening pleasure – All this, plus the rugged reliability you expect from Sanyo – one of the world's most respected brands in audio equipment.

**SANYO** *That's Life!*

**M-G30 Combination AM/FM Radio and Tape player –** ☐ headphones ☐ metal tape facility ☐ tone switch ☐ metal/normal tape selector ☐ FM stereo/mono mode selector ☐ cue and review ☐ Auto-Stop tape mechanism ☐ carry case.

# Now two new magnificent

PLAYMASTER

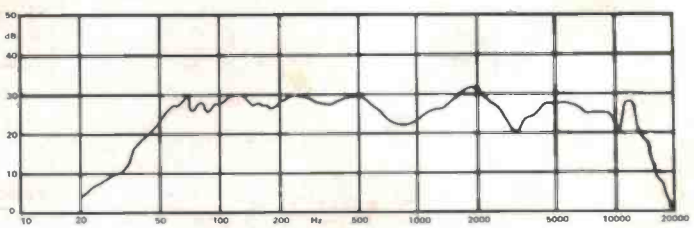
# build-it-yourself hi fi speaker systems

Dick Smith brings you these superbly styled speaker systems to suit your room, your decor ... and your pocket!

Acoustically designed by Neville Williams, MIREE (Aust.), Editor-In-Chief of Electronics Australia magazine, they feature a **completely new format and style,** starting with the strikingly **handsome new grilles** with the **new 'Playmaster' logo** - and ending with a **performance you'd be amazed at!**

You'll **save a fortune** over comparable commercial speakers - because you build them yourself. And all it takes is a couple of hours construction time, a tube of glue and a screwdriver.

They look so good, and sound so great, your friends will never believe you built them!




Measured response of Playmaster 300mm speaker system. Compare this performance with speaker systems you'd pay 3 or 4 times as much for.

**Measurements performed by Dick Smith Electronics Technical staff**

look how easy

The boxes simply fold together - no woodworking knowledge needed. All panels are pre-cut, pre-rebated and pre-drilled. We've even heard of schoolchildren building their own Playmasters: they're that simple!

no special tools needed

**What the experts say:**

*"... the end result represents outstanding value for money. Whether you buy it in kit form or fully assembled, we are sure you will be pleased with sound quality."*

*"... the new Playmaster 3-70L has generous power handling capacity so that it can give a good account of itself on virtually any type of music."*

*Neville Williams & Leo Simpson (EA, March 1982)*

All you need is a tube of glue and a screwdriver - everything else is supplied for you. The wiring loom for the speakers is pre-assembled — the connectors just push on. And the speakers drop into position in the holes provided. If you can read simple instructions, you can build your own commercial quality speakers.

**Look at these new features:**

★All new design in simulated woodgrain finish to complement decor ★Separate level control for high and mid ranges* - tailor the sound to suit your listening environment ★Special speaker sealant material supplied to ensure absolute air tightness ★New design ribbed woofer with massive 30cm cone for accurate bass reproduction ★Built-in plinth to raise speaker off floor level for minimum audio colouration ★Manufactured to the exacting standards of the original design published in Electronics Australia magazine ★Acoustically transparent silk-like grille cloth heat welded to support frame.

*300mm system only

And now you're finished. Settle back with a drink, play your favourite record or tape. The sound quality will make you more than happy and your friends will never believe you built them!

| 300mm SYSTEM | 250mm SYSTEM* |
|---|---|
| **Speaker kit, crossovers & faders**<br>This kit includes 300mm woofers, high and mid range faders, and 3 way crossover with high power handling capacity.<br>Cat C-2042 ..... **$175.00** | **Speaker kit, and crossovers**<br>This kit includes 250mm woofers and 3 way crossover with medium power handling capacity.<br>Cat C-2044 ..... **$149.00** |
| **Enclosure kits**<br>A pair of large 70 litre cabinets for the ultimate in sound reproduction.<br>Cat C-2632 ..... **$159.10** | **Enclosure kits**<br>A pair of large 53 litre cabinets to give great sound reproduction.<br>Cat C-2634 ..... **$143.10** |
| **Deluxe speaker grilles**<br>Handsome new design featuring the new 'Playmaster' logo.<br>Cat C-2612 ..... **$39.90** | **Deluxe speaker grilles**<br>Handsome new design to fit 53 litre cabinets, featuring the new 'Playmaster' logo.<br>Cat C-2610 ..... **$35.90** |
| Note: All prices are per pair. | |
| **TOTAL SYSTEM ONLY $374 per pair!** | **TOTAL SYSTEM ONLY $328 per pair!** |

*250mm System available early July. Phone your nearest store for full details of availability.

and look at the superb finish

# DICK SMITH Electronics

SEE PAGE 19 FOR ADDRESS DETAILS

DSE/A285/PAI.LM

# Sansui AU-D33 amplifier

A 'super feedforward' design produces very low distortion, but ergonomic features seem to lack the same attention to detail. A very good amplifier; "... it would only take a little refinement to make it better."

**Louis Challis**

MOST OF MY REVIEWS over the past twelve years have been straightforward, generally innocuous and devoid of incidents or unusual features. The review of the AU-D33 looked like starting off to be that way, but changed into what can only be described as an unusual set of circumstances.

The trouble was that the equipment arrived late in 1981 for review, and early units from the production line were shipped prior to the printing of the operating instructions, which normally accompany the equipment which we review. Whilst in the case of the TU-S33 (reviewed in the April issue), which arrived at the same time, this presented no problems, in the case of the AU-D33 it created quite a number, not the least of which was the evaluation of the correct power output.

We rang the importers, who could not answer the question, so we took a guess as to what we thought the power output ought to be. Our guess was based on the size of the unit, and most particularly the size of the heatsink. Needless to say, Murphy's Law prevailed once again, and we were grossly in error in our evaluation of the amplifiers we were rating. I estimated 80 watts per channel, when in fact the manufacturer only claims 50. The review that follows takes into account the imprecision of my guess, as much of the technical data derived on the amplifier was initially biased by that incorrect assessment, yet even so the amplifier comes through testing and assessment remarkably well.

**SANSUI AU-D33 AMPLIFIER**

| | |
|---|---|
| *Dimensions:* | *430 mm wide x 112 mm high x 334 mm deep* |
| *Weight:* | *7.3 kg* |
| *Price:* | *$399 rrp* |
| *Manufacturer:* | *Sansui Electric Co, Tokyo* |
| *Distributor:* | *Vanfi, 198 Normanby Rd, South Melbourne Vic. 3205.* |

## Back and forward

The AU-D33 amplifier incorporates a number of new technical features which the manufacturers claim improve the distortion characteristics of this amplifier to exceed the performance of most other amplifiers currently available. The most important claim for the 'Super Feedforward System' is its ability to minimise high frequency distortion, which 'normal' negative feedback does not greatly improve. The forward feed signal is based on feeding an amplified error signal around the main output stage of the amplifier, providing a completely separate loop from the primary negative feedback loop, which is fed around the whole of the amplifier. By this means, it is claimed, the overall distortion levels are significantly reduced to the point where distortion is no longer a problem.

## Appearance

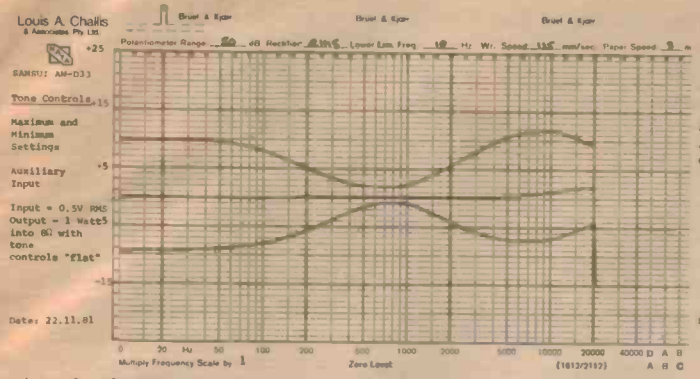
The amplifier is relatively conventional in appearance, featuring a black front fascia with the controls laid out in two rows separated by a red horizontal line right across the front surface of the fascia. At the top left hand end of the panel is a power switch, surmounted by a rectangular red LED, which is part of the protection circuit. When a fault develops, this light flashes to warn the user of the problem. Two similar LEDs are provided to indicate that speaker system A and/or B is selected. Above the tone controls a rectangular yellow LED is also provided to indicate whether the controls are functioning or not.

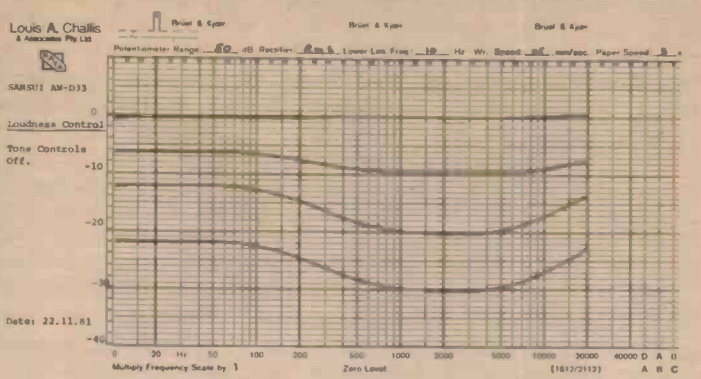
In the central top section of the fascia are five large rocker switches, each interlocked with its own large LEDs above. These make it possible to select either of the two tape recorders, auxiliary input, tuner or phono for the main amplifier output.

On the right hand side of the panel are two small buttons for selecting a moving magnet or moving coil cartridge inut. A red LED is provided above the moving magnet switch and a green LED above the moving coil cartridge input.

A large volume control is provided on the right of the panel, which is flanked by another small pushbutton, with a bright yellow LED indicator to provide 20 dB of muting.

The bottom row of controls incorporates a headphone socket, two switches for speaker systems A and/or B, bass and treble tone controls, and a small tone defeat switch. On the right hand side of the lower section of the front panel is a rotary selector. This allows the user to record from auxiliary, tuner, phono or to dub from tape 1 to tape 2, or tape 2 to tape 1. All of these can be performed whilst the major controls above are separately feeding the normal




signals through to the main amplifier output.

On the right is a high filter switch, which should preferably have been a rumble filter. Immediately below the volume control is a balance control and to the right of this a loudness switch.

The rear of the amplifier is straightforward, with a sensible layout of coaxial sockets. The four inputs and outputs for the tape recorders 1 and 2 are grouped on the left hand side. A single pair of phono sockets is provided to connect either the moving magnet or a moving coil output directly from the record player, using the control switch on the front panel for correct selection. Below this is located a pair of sockets for tuner and another pair for auxiliary inputs, with a well-placed ground socket adjacent to the phono inputs. The speaker connections are provided by means of four pairs of rotary action sockets, designed to accept bare speaker leads. The only other control provided is a 220 V/240 V selector switch adjacent to the two-core mains lead.

The inside of the amplifier is neatly arranged and sensibly designed, with four major groupings of printed circuits laid out in the strong steel chassis. The first thing one notices is that this amplifier looks different from the majority of other amplifiers. The heatsink assembly is an unusual finned aluminium structure designed to achieve more effective cooling than conventional heatsinks. Using this heatsink, the designers have achieved a simple electrostatic screen between the main output stage and the low-level input and tone control stages at the front of the amplifier. A separate electrostatic screen on the side of the output stage separates it from the input circuitry of the tape recorders, phono and auxiliary inputs, which are in close proximity to the output amplifier.

The individual printed circuits in the amplifier make use of a number of piggy-back boards, mounted one above the other, and this is exemplified by the power supply connection to the main amplifier stage, the tone control's section interconnected with the main preamplifier stage and the pre-preamplifier connections with the input stages. All of these are neatly coupled by ribbon cables to the adjacent printed circuit boards.

The main power transformer is encapsulated and neatly screened to minimise leakage of spurious magnetic fields.

Both the base and the lid are effectively ventilated, but it is interesting to note that the lid incorporates two large vented plastic panels in lieu of the more common slotted metal perforations, and so plastics are slowly displacing more and more functions that were always the domain of steel.

## On test

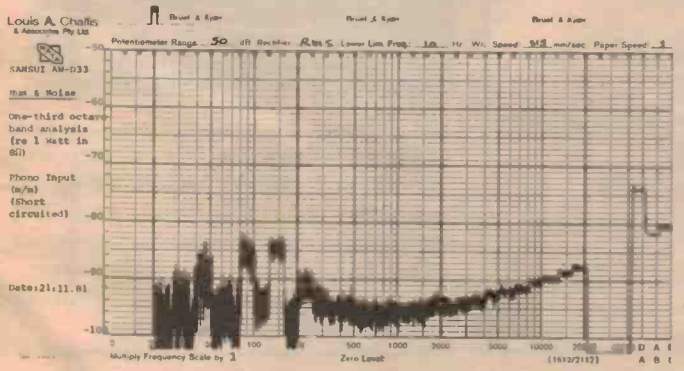
Having started our objective testing on the wrong foot with a supposition that the power rating was approximately 80 watts, it is to be expected that some of the figures that we derived were slightly at variance with the manufacturer's.

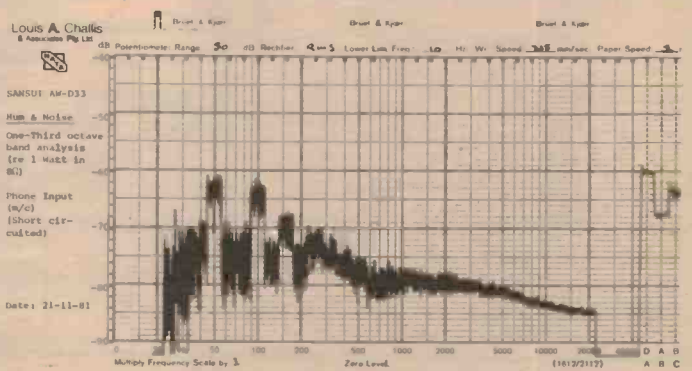
The measured frequency response, with tone controls defeated, is 3 Hz to 92 kHz, whilst with the tone controls operative and centred, is better than 3 Hz to 100 kHz. The left channel has a slight rise of 2.5 dB in its response at 40 kHz, whilst the right channel has a somewhat shallower rise of 1.2 dB at 100 kHz. At 80 watts output into 8 ohms, the distortions measured at 100 Hz, 1 kHz and 6.3 kHz were respectively 0.0076%, 0.0075% and 0.014%. Obviously these are somewhat higher than the manufacturers claim (0.004%), but not all that much considering that we were extracting 60% more power than the manufacturer had intended!

At one watt into 8 ohms the figures are not all that different, being 0.0067%, 0.0072% and 0.012%. These are still excellent performance figures.

The moving coil cartridge has a 68 dB(A) signal-to-noise ratio, which is slightly better than that claimed by the manufacturer. The transient intermodulation distortion is also extremely low and virtually immeasurable, whilst the hum and noise levels were 78 dB unweighted and 82.5 dB(A) weighted re one watt.

The maximum output power at the clipping point, in accordance with IHF-A-202, is 100 watts, and based on the manufacturer's 50 watt rating this ▶



means that the unit has 3 dB dynamic headroom. The transient overload recovery test proved that the amplifier had almost perfect recovery characteristics, with no trace of jitter, and full recovery within the first half cycle.

Two of the test results did not agree particularly well with the manufacturer's claims. The first of these relates to channel separation. Whilst the manufacturer claims 72 dB separation at 1 kHz, we could only measure 62 dB. This separation level dropped down to as low as 37 dB at 20 kHz, which is not exactly what one would expect from the claims made for improved separation between the power supply channels in the manufacturer's blurb. The treble tone control at maximum cut provides only 8 dB of attenuation at 10 kHz, which falls a little short of the manufacturer's claim and the preferred 10 to 15 dB that we would have chosen.

The 'high filter' switch provides a miniscule 4 dB drop at 20 kHz, which hardly warrants the provision of the switch. I feel a better functional choice would have been a rumble filter, from which most users would derive much more use than from the function the designers have selected.

## At home

In practical use at home, the amplifier shows that it can provide exceptional performance with *a clarity and definition which are almost unrivalled in its power and price class.* The equipment I use at home does not warrant the rumble filter, and to be honest I seldom use tone controls when listening to music, so two of the criticisms I have raised did not prove to be a problem for me, but could be in other situations.

The channel separation, although less than stated, did not prove troublesome, as none of the records I play (or own) have channel separations of better than 30 dB at 20 kHz, and so the 40 dB figure that we measured is of academic interest. What does show up, however, is the clarity and definition on reproduction, and particularly on one new record I have just received. This is a half-speed mastered CBS record, Neil Diamond's 'You Don't Bring Me Flowers'. Using the AU-D33 with an Audio Technica AT25 cartridge, Technics SL120 turntable and a set of B & W 801 loudspeakers, *I was unable to detect any trace of amplifier colouration.* One track on the record is the 'Dancing Bumblebee and Bumble Boogie', and this constitutes an excellent selection of test material for assessing not only the amplifier's performance but that of the rest of the system as well.

The amplifier is readily capable of putting out peak signals from the speakers of over 110 dB, at which point my ears start hurting (and the family starts complaining). The beauty of the AU-D33 is that it handles peaks like this that are obviously well in excess of the 50 watt rating without any sign of complaint. More significantly, the distortion figures under these conditions are insignificant until you reach the onset of clipping.

## Summary

Now that Sansui have solved the obvious electronic design problems, they should give a little more time and thought to the less obvious ergonomic features of their amplifier, like rumble filters instead of useless high pass filters. They will then have what could well be one of the finest amplifiers in its price and class in the marketplace. This amplifier is already very good, and it would only take a little refinement to make it even better. ●

MEASURED PERFORMANCE OF SANSUI AU-D33 S.N. 831090010

**FREQUENCY RESPONSE:** (-3dB re 1 Watt, 0.5V Input to Aux)

Tone Controls Defeated
Left <3Hz to 102kHz
Right< 3Hz to 92kHz

Tone Controls Centred
Left < 3Hz to >100kHz
Right< 3Hz to > 100kHz

Maximum
+2.5dB @ 40kHz
+1.2dB @ 100kHz

**SENSITIVITY:**

| (for 1 Watt in 8Ω) | Left | Right |
|---|---|---|
| AUX | 29.0mV | 29.0 mV |
| TUNER | 29.0mV | 29.0mV |
| TAPE | 29.0mV | 29.0mV |
| PHONO M/M | 380 | 380 µv |
| PHONO M/C | 3.6 | 3.9 µv |
| OVERLOAD M/M | 152 | 155 mV |
| OVERLOAD M/C | 16.7 | 17.2 mV |

**INPUT IMPEDANCE:**

| | Left | Right |
|---|---|---|
| AUX | 50 k | 50 kΩ |
| TUNER | 50 k | 50 kΩ |
| TAPE | 50 k | 50 kΩ |
| PHONO M/M | 39 k | 39 kΩ |
| PHONO M/M | 120 | 120 Ω |

**OUTPUT IMPEDANCE:**
148 milliohms (@ 1kHz)

**HARMONIC DISTORTION:**

(A) (At Rated power of 80 Watts into 8Ω = 25Volts)

| | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|
| 2nd | -83.4 | -82.7 | -77.3dB |
| 3rd | -89.9 | -94.9 | -88.0dB |
| 4th | -96.4 | - | -90.8dB |
| 5th | - | - | -dB |
| THD. | 0.0076 | 0.0075 | 0.014% |

(B) (At 1 Watt into 8 Ω)

| | 100Hz | 1kHz | 6.3kHz |
|---|---|---|---|
| 2nd | -84.5 | -83.1 | -79.6dB |
| 3rd | -90.3 | -95.0 | -85.7dB |
| 4th | -99.7 | - | -91.0dB |
| 5th | - | - | -dB |
| THD | 0.0067 | 0.0072 | 0.012% |

**TRANSIENT INTERMODULATION DISTORTION:**
Very low, less than 0.1%
(3.15kHz square wave and 15kHz sine wave mixed 4:1)

**NOISE & HUM LEVELS:**

re 1 Watt into 8 Ω) AUX -78 dB (Lin) -82.5 dB(A)

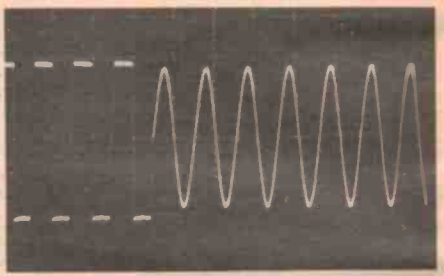
(with volume control set for 1 Watt output with, PHONO M/M -76.5dB (Lin) -81.5 db(A)

0.5V Input (Aux)
5mV input (Phono M/M)
0.5mV Input (Phono M/C)

**MAXIMUM OUTPUT POWER AT CLIPPING POINT:**

(IHF-A-202)
(20mS burst repeated at 500mS intervals) 80 V P-P
= 100 Watts

Transient overload recovery test (IHF-A-202). 10 dB overload re rated power into 8 ohms, both channels driven. Overload duration: 20 ms; repetition rate: 512 ms.



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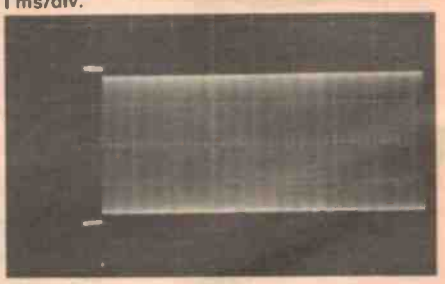

50 ms/div.

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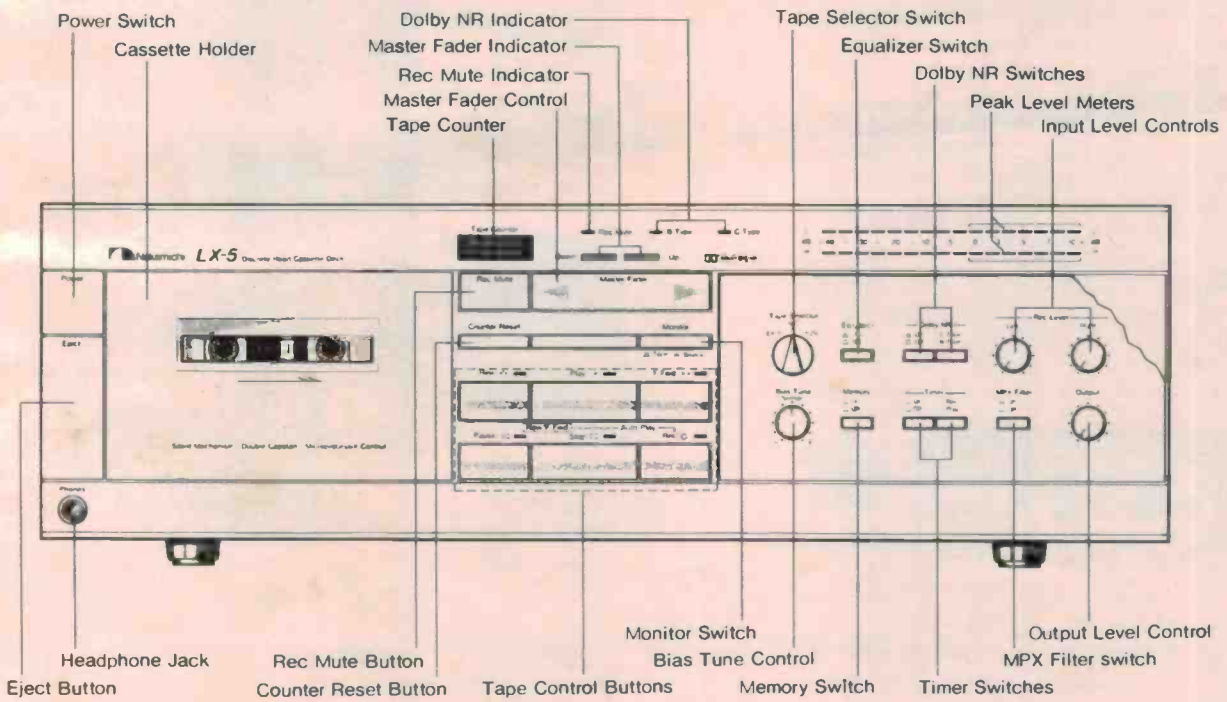
# LX-5/LX-3

## News Release

Nakamichi Corporation

The LX-5 and LX-3 follow the same elegant design trend initiated by the Nakamichi 700ZXL and 700ZXE. A wide central belt of silver holds the cassette door, main transport controls, and a hinged panel which swings down to reveal additional controls. Above and below it are black bands, the upper one containing an array of LEDs: the meters, tape counter, and other indicators. Both models also incorporate advanced Nakamichi features found in our top-line decks: the Asymmetrical, Diffused Resonance, Dual Capstan Transport, the Discrete Three Head system (LX-5), and Dolby C-type noise reduction.

By offering increased transport control flexibility in combination with elegant styling and excellent all-around performance, the LX-5 and LX-3 are impressive additions to the Nakamichi line.




**LX-5 Front Panel (showing controls behind the hinged panel)**

Nakamichi Products are distributed exclusively in Australia by Convoy International, 4 Dowling St, Woolloomooloo Sydney NSW 2011. Telephone 02 3582088

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SUPER 80: $250, complete and running with case, manuals, extra RAM, etc. Phone Michael Wise, bh (02)662-3789, ah (02)51-2335.

SELL: DGZ80 S100 CPU, DG640 VDU, DGOS SD Expando RAM with 32K, motherboard, power supply, keyboard, monitor, 12K BASIC plus software. $850. Gordon, (02)587-3449.

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ST8

SM1000

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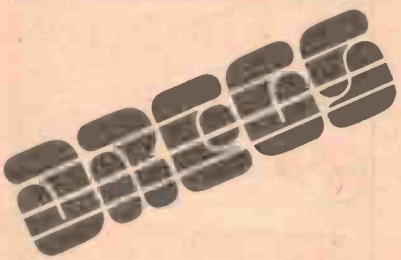

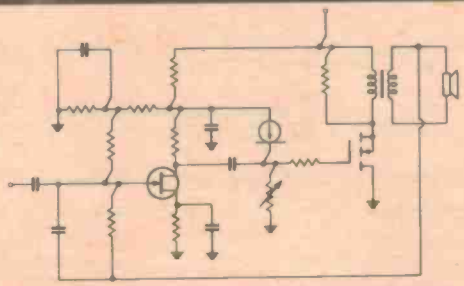

IT'S NOT OFTEN one finds fun material for Dregs amongst applications notes, but we recently saw a real doozey!

The accompanying circuit shows a 20 W, class A audio amplifier. Nothing funny about that, you say. Audio buffs will immediately appreciate the attributes of class A amplifiers — 'pure' sound, low distortion, etc, etc. And followers of the state of the art will appreciate the attributes of VMOS devices. All this spun through this Dregs hack's brain when the application note was sighted — then he read the blurb that went with the circuit. Here, I shall quote it — verbatim (well, almost. The device type has been removed to protect the innocent), and without further comment:

"Linear transconductance characteristics and low drive power requirements make VMOS ideal in low-distortion audio amplifiers. VMOS transconductance becomes linear at higher operating currents. This is in direct contrast to bi-polar transistors which exhibit gain that changes significantly with changes in collector current.

"The Class A amplifier shown delivers 20 watts into an eight ohm load using a single xxxxx driving a transformer-coupled output stage. This circuit is similar to the audio output stage used in many inexpensive radios and phonographs. Distortion is less than 5 per cent at 10 watts using very little feedback (3%) with the xxxxx biased at 3 amperes." !!!!

## Words, words, words . . .

And you thought word processors had problems? In the publishing game, where you are dealing all the time with words and their meanings, you often come across some strange anomalies. In computing (. . . **now** do you get the link with word processing?), you often find processes need to be repeated. A loop in the program will do this for you. Such a process, or rather, executing such, is called an 'iterative' process. It comes from the word 'iterate', which our Concise Oxford, Sixth Edition, page 575, says means ". . . repeat; . . . make repeatedly". Big deal. Now look up **reiterate** on page 944. It says, ". . . say or do again repeatedly". Nested loops, or simple tautology?!

Famous wits have played havoc with the language, by exploiting such anomalies, for many years. Now who was it said, "Tautology? Mere repetition!" Probably some editor. On the subject of tautology, heard a couple of good ones recently — maybe they'll appear on T-shirts:

"The status quo is in a continual state of flux"

and

"I think the status quo should be left where it is"

Put those on the front and back of a T-shirt respectively and you're bound to cause a stir!

TC-FX6C

# Deep C.

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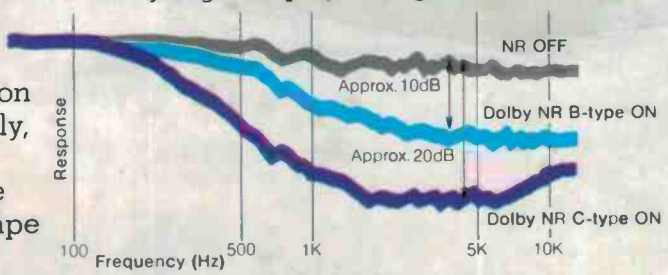


In conjunction with conventional Dolby (B type), Sony's new "C" decks do not simply cover up unwanted sound debris. They take it all the way down to clean silence.

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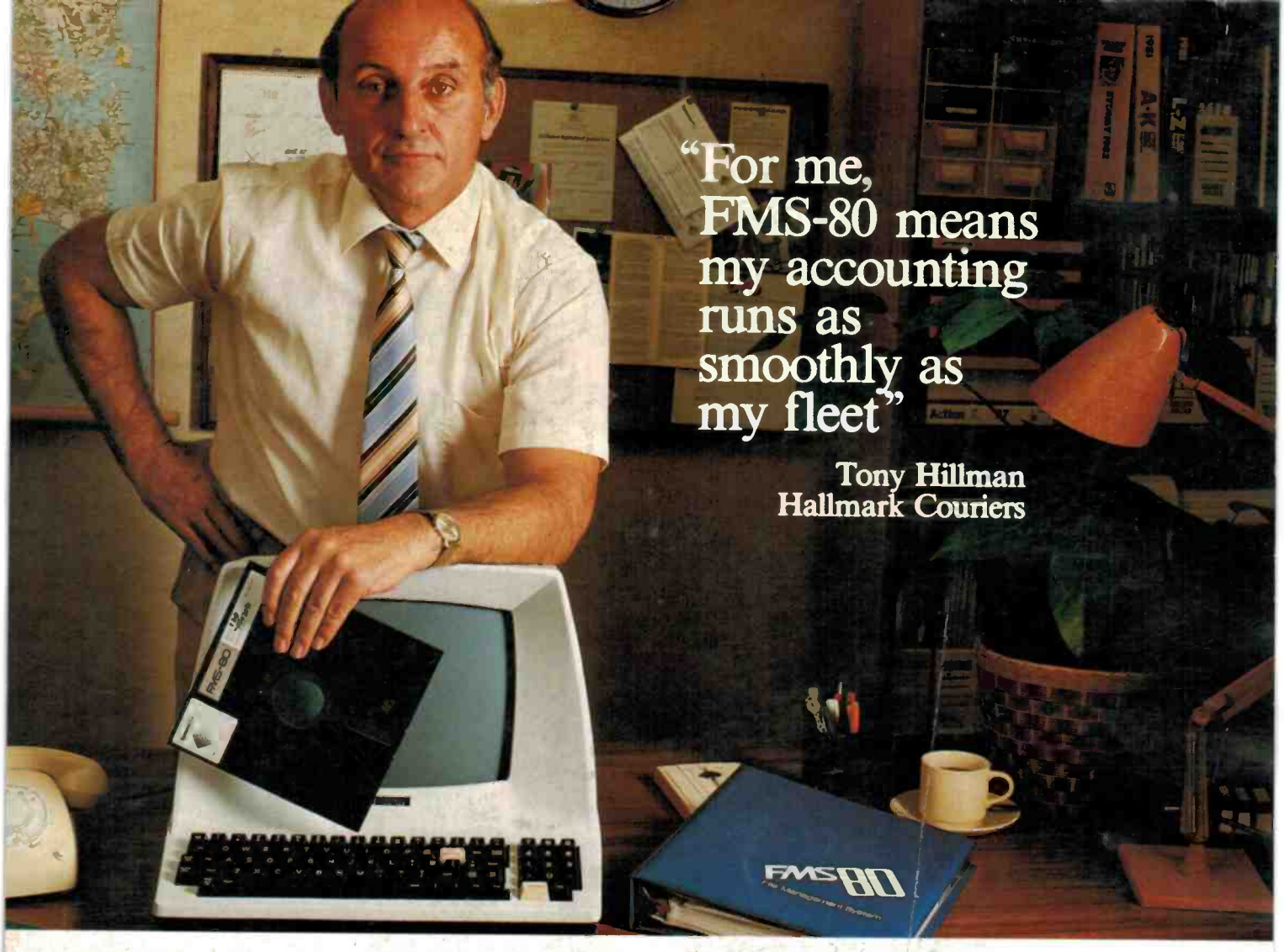


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