Jan. 1981
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eti
ELECTRONICS TODAY INTERNATIONAL

MOSFET power amp!

LED oil temperature meter to build

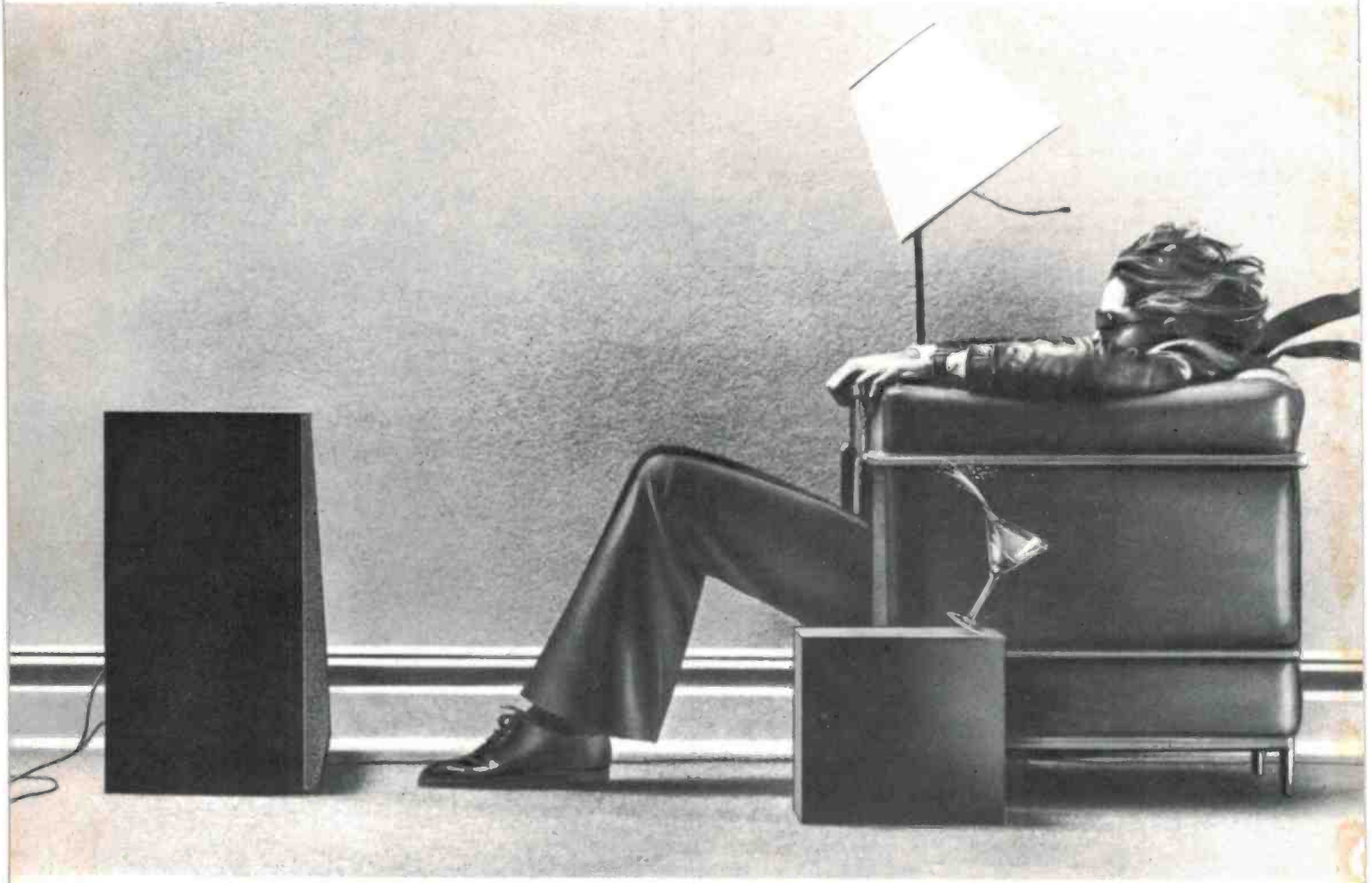
Handheld computers - they're here!

Bio-electronics - chips in the body

'Time Window' speakers reviewed

Permostat - does it really work ?

AFTER 500 PLAYS OUR HIGH FIDELITY TAPE STILL DELIVERS HIGH FIDELITY.



If your old favourites don't sound as good as they used to, the problem could be your recording tape.

Some tapes show their age more than others. And when a tape ages prematurely, the music on it does too.

What can happen is, the oxide particles that are bound onto tape loosen and fall off, taking some of your music with them.

At Maxell, we've developed a binding process that helps to prevent this. When oxide particles are bound onto our tape, they stay put. And so does your music.

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WT191/80

ELECTRONICS TODAY INTERNATIONAL

Registered for posting as a publication – Category B

QUICK INDEX

NEW DIRECTIONS

WE HAVE BECOME AWARE over the past year of an increasing demand from readers for 'high quality' projects involving 'minimum compromise' design. It was first brought home to us following publication of the Series 4000/1 Four-Way Loudspeaker project in the February 1980 issue. Reaction to that project, both in terms of kit and component sales and reader feedback, has been well beyond our expectations. We had 'inklings' of this trend in 1979 when we published the Series 4000 Stereo Amplifier, the following Series 4000 Moving Coil Cartridge Preamp and the Electromyogram. We have never ceased to be amazed at the continuing demand for these projects, and the feedback we get. That might sound a little like "blowing our own trumpet", but it's basically an honest expression of our reaction.

All this caused us to have a serious re-think about the direction and design of our projects and project planning. Too often, there's the temptation to offer a 'cost-effective' project design in the belief that that's where the maximum reader demand lies. We've come to the conclusion that that's seriously underestimating the abilities and experience of a large sector of readers. Accordingly, we've changed tack somewhat. In coming issues you'll see the result. Commencing this issue you can see the results of many months of development effort that has culminated in the ETI-477 MOSFET Power Amplifier Module. This uncompromising design is the first in a series of audio components to be described for home construction that can be assembled into a system capable of truly excellent performance. And we've got more than audio components in the pipeline.

This 'new direction' is not to say we are abandoning the popular simpler projects or beginners' projects—which represent virtually the 'backbone' of the hobby. Basically we are broadening our scope. We trust you approve.

MORE NEW DIRECTIONS

This month we say farewell to two staff members. Well, not really farewell, more bon voyage! Phil Wait has been Project Manager on the magazine since the April 1979 issue. Having 'earned his fame' he is now going to 'seek his fortune' — as a freelance designer. We all wish him success. No doubt many readers have enjoyed Phil's projects from time to time and you will have the opportunity to enjoy more as he is intending to contribute projects for publication in the magazine in the future.

Elaine Ray commenced with us as an advertising representative early last year but we found her talents extended to more than just selling. She was pressed into editorial service from time to time with not a little success. She's leaving us to turn her hand to freelance technical writing. You'll be seeing her contributions in coming issues. All success to you, too, Elaine.

Roger Harrison
Editor

advertisers

eti ELECTRONICS TODAY INTERNATIONAL

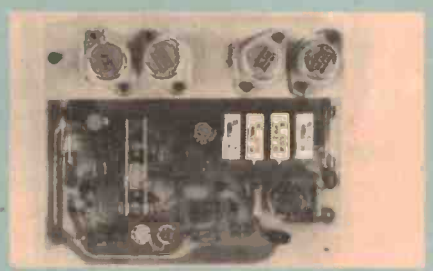
COVER

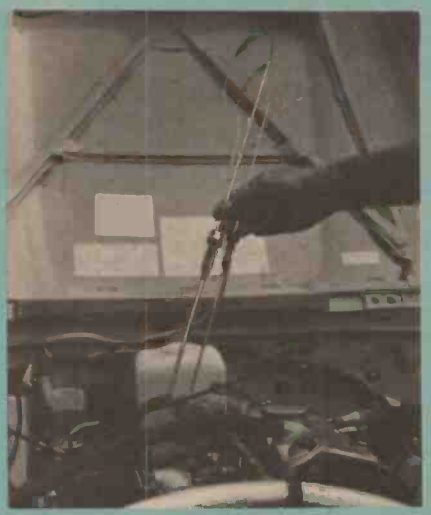
At last the wraps are off the amazing Series 5000 amplifier! Our cover shows the pc board and heat-sink for the power amp module described this month. Composition and photo by Ivy Hansen.
* Recommended retail price only.

features

news

projects





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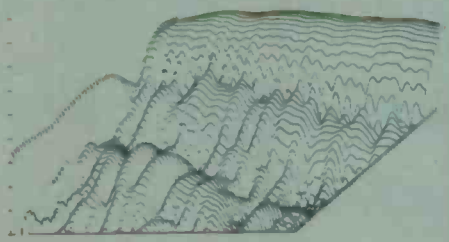


NEW TRENDS IN LOUDSPEAKER TESTING

The differences between conventional objective speaker performance tests and subjective evaluations has long been a subject of controversy. The ear-brain combination has a greater ability to detect sonic 'flaws' than most conventional 'steady state' tests, or even tone-burst tests, however sophisticated. Over the past decade, however, a technique has been developed that can truly quantify and plot the performance of a loudspeaker, by purely objective measurement, and that matches the ability of our ears. The 'cumulative decay response' technique is now available to ETI — and ETI readers — for the evaluation of loudspeakers. We are the *first magazine worldwide* to employ this technique in loudspeaker reviews. Louis Challis explains.

B & W MODEL 801 SPEAKERS REVIEWED

Our first speaker review incorporating the "cumulative decay response spectrum evaluation" technique. Louis Challis found these speakers "... should be given the accolade of a 'reference speaker system' as they come closer to the ultimate aim of faithful dynamic and transient reproduction. ... than any other speaker system I have yet heard."

MOSFET STEREO POWER AMPLIFIER

The basic MOSFET power amp module featured this month is turned into a top-class stereo power amp featuring a heatsink as the front panel! This project is *unique* and is the first in our 'Series 5000' line of top-quality audio components for the serious constructor. No cost-cutting compromises here — you can build yourself a system second to none, and be proud of it!

NAKAMICHI 1000ZXL CASSETTE DECK

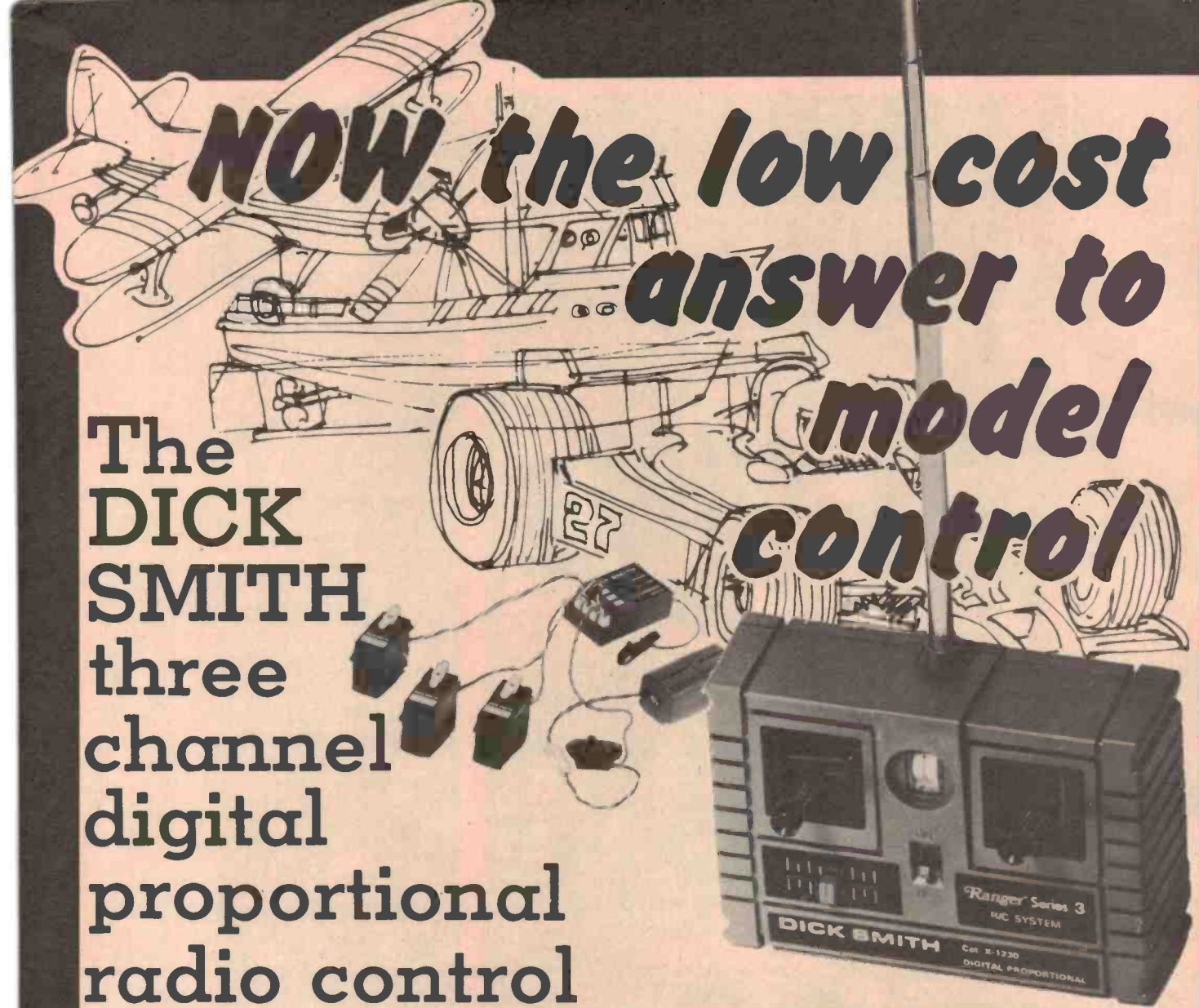
This cassette deck is 'the state of the art' to which all others aspire. Featuring microprocessor control, the 1000ZXL will automatically set itself up for the tape in use, optimising tape head azimuth, bias, recording level and equalisation to extract top performance. This is the first published review of this machine and you should not miss Louis Challis' in-depth report.

EXPANDED SCALE VEHICLE AMMETER

An ammeter is a very useful instrument in a vehicle, but few carry them these days. This project can be added without disrupting the vehicle's existing wiring, features an expanded scale that clearly shows currents as low as 1 A but reads to 35 A or more and can be used with either 12 V or 24 V systems. Although the meter has a centre-zero scale, the project may employ either a conventional or a centre-zero meter.

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.

NOW the low cost answer to model control



The DICK SMITH three channel digital proportional radio control

Imagine! A fully digital proportional 3 channel radio control system for under $100.00! Compare elsewhere at $150 and more . . .
This outstanding system features three individually controlled channels, with 'trim' offset controls. Two channels are joystick controlled, the third a slider control (ideal for throttle, etc.)

- Complete with receiver, battery holder and three servos (spare battery holders and servos available so you aren't tied to just one model!)
- Ideal for models of all types: boats, planes, vehicles, etc.
- Top range transmitter and ultra-sensitive receiver
- Crystals are changeable for different operating frequencies
- Requires 10 pen light cells. Cat. S-3003: 22 cents each

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DICK SMITH Electronics

SEE OUR OTHER ADS FOR FULL ADDRESS DETAILS

No 'cottage industry' solar power

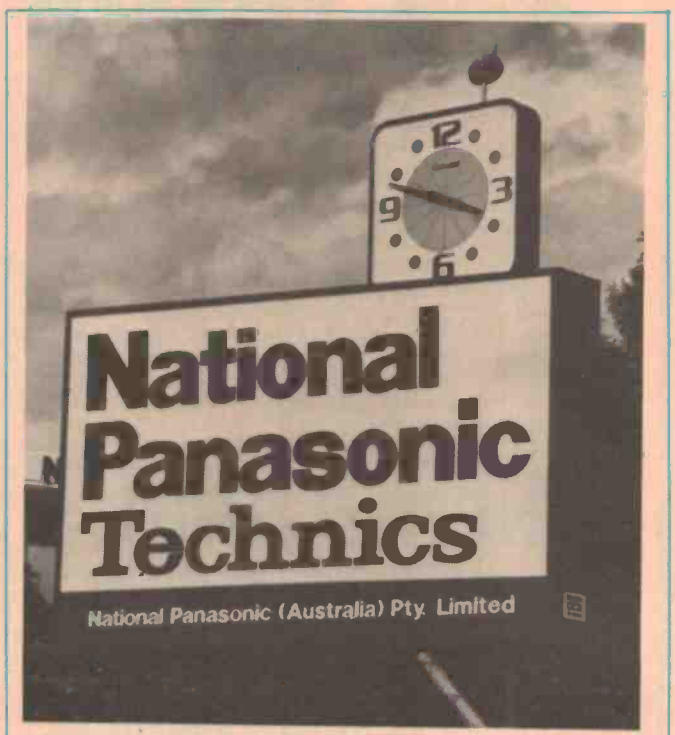
The solar power enthusiasts who believe this energy source to be the answer to the world's energy problems may be somewhat disappointed by the recent pronouncements of George F. Mechlin, Vice President, Research and Development, of the Westinghouse Electric Corporation.

Unlike the solar subculture enthusiasts who believe solar energy could thrive as a decentralised 'cottage industry', Dr. Mechlin maintains that solar power will not become a viable source of electricity until large, highly automated factories are developed for the low-cost mass production of solar photovoltaic cells.

Solar photovoltaics — the direct conversion of sunlight into electricjty — is a promising energy source. But according to Dr. Mechlin, "Technological sophistication and economies of large scale are the key to success for the solar electric industry ... industry and government must commit to intensive capital investments in new manufacturing technologies if solar-generated electricity is to see the light of day by the end of the decade.

"Highly sophisticated automation systems must first be designed and developed," he continued. "Extremely advanced manufacturing techniques must be employed, including the use of robots, to bring the cost of solar cell production down to a level that the utility market — and the consumer — can live with."

Noting that the development and application of a new technology invariably costs around a hundred times more than the research work, Mechlin said that a race was currently under way in the industry to find an efficient way to mass produce solar cells. The economical conversion of pure silicon, the key element of the photovoltaic cell, to a single crystal form has long held up the manufacturing process, but Westinghouse believes its 'dentritic web process' — the growing of pure silicon in ribbon-like strips — will ultimately win out in the marketplace because of its relative simplicity, which lends itself to automation.



NEW SLANT ON THE SUNDIAL

National Panasonic Australia has installed this new solar powered clock at its headquarters in North Ryde, Sydney. Developed by the Matsushita Electric Company in Japan (National's parent company), the clock runs from solar cells which charge NiCad batteries that keep the electronic mechanism running over 24 hours.

The main feature of the solar clock is that it can be used anywhere where the sun shines and within temperature extremes of 0° to +40°C. At night and on overcast, sunless days, the clock's NiCad batteries provide power.

The clock has two 800mm faces which can be seen and read at a long distance.

The only requirement on installation is that the clock's solar cell unit must be exposed to the sun's rays for at least four hours per day, ideally between 10 am and 2 pm.

While conventional battery clocks require regular battery changes, the solar clock needs practically no attention after installation as the solar battery will last for about 10 years, National claim. The old-fashioned sundial can't compete!

CSIRO research guide

The most comprehensive guide yet published on CSIRO's research activities throughout Australia recently became available.

The reaction to the first such guide, published four years ago, and the subsequent demand for its publication, has indicated a strong desire for information on the Organisation's research. A new-look edition published in 1979, in line with a Government directive that CSIRO should provide a comprehensive research directory, went into a second printing.

More than 750 copies were sold, mainly to industry, and another 800 copies went to public libraries, colleges and universities, State and Commonwealth departments, parliamentary libraries, and the Academy of Science. Thus any member of the public may now satisfy his or her curiosity about the CSIRO's research activities.

The new guide contains descriptions of each of CSIRO's over 700 research programmes and sub-programmes. In clear, non-technical language it outlines research problems being tackled by CSIRO and the implications of research findings, as well as providing details of where the research is being conducted, how many staff are involved, and how it is funded.

Copies of the publication, entitled 'CSIRO Research Programs 1980-1981', cost $12.50 (including postage) and are available from the CSIRO Editorial and Publications Service, P.O. Box 89, East Melbourne, Vic 3002; or you can contact the Media Office in Canberra on (062) 48-4484 for further information.

Harris Corp steps up operations

The high growth level in the broadcast products division over the past two years has decided the Harris Corporation to step up its operations in Australia.

The appointment of a new agent for this division was recently announced with the formation of a new company, Harris Communications (Australia) Pty Ltd. They will take over from Air Programs International Pty Ltd, who represented the broadcast products division in Australia for over 20 years.

The new company will be headed by Mr. Mario Fairlie, who was previously a senior sales engineer with Philips Vision and Sound. Harris Australia will utilise locally based field service engineers and have a complete spare parts facility for all Harris radio and television products.

Harris equipment extends over a wide and varied range, from sound studio equipment to satellite technology.

Harris (Australia) Pty Ltd will be located at 184 Blues Point Road, North Sydney 2060 NSW. (02) 92-1011.

New Sanyo video camera

Sanyo's newest colour video camera, model VCC 545P, is claimed to be suitable for both professional and domestic users.

The video/sound camera has a 6X zoom lens with standard C-mount, and is equipped with a built-in condenser microphone, electronic viewfinder and adjustable eyepiece.

According to Sanyo, the camera is "easy to operate", with a detachable shoulder rest/handgrip plus a remote pistol grip switch, and is capable of producing high quality video recordings.

The VCC 545P has a tri-electrode Vidicon colour system, with a horizontal resolution of 250 lines. The video signal to noise ratio is claimed to be 43 dB.

The retail price of around $1150 includes a 5 m extension cable and an ac power adaptor (model VCA 54).

For more information, contact Sanyo Australia Pty Ltd, 225 Miller Street, North Sydney 2060 NSW. (02) 436-1122.

Briefs

Cure-all or quackery — the negative ion generator has been called both since its rise to fame in the 1960s. Scientific evidence about the ioniser's effectiveness is uneven and inconclusive, but negative ions do cause airborne particles like pollen and smoke to settle out of the atmosphere, and studies have shown that negative ions protect mice from the flu, slow bacterial growth, and cause plants to grow more quickly.

Treating water magnetically is said to lessen mineral depositions inside pipes, hot water heaters, washing machines and industrial boilers, although the mechanism of the magnetic influence is still a mystery. In an experiment in hard (calcium salt containing) water, the amount of scale formed was reduced by a factor of 100+, and magnetism was still effective days after treatment. We have 'negative ion generators' for the air, will we have 'magnetic de-ionisers' (or somesuch) for our water?

Toshiba Corporation of Japan has developed the world's first surface acoustic wave resonator using tantalate lithium, that is suitable for VTRs. It is used especially for VHF and has improved the features of other types that are weak against shock or changing temperature.

GaAs integrated circuits will enter the market in the 1980s as silicon-based technologies prove inadequate in certain applications. High-speed applications in communications, such as satellite electronics and TV receive-only terminals; computers, both CPUs and memories; instrumentation, including IC testers; and defence, will all require GaAs devices. Silicons will continue to be used in lower cost and lower speed applications, still the majority of uses.

A cheaper technique for fabricating metal conductors and contacts on photovoltaic cells, using thick-film nickel contacts and electroplated copper conductors, has been developed by a small solar cell maker, Photowatt International Inc., in Arizona, USA. Photowatt is at present applying for funds to make the process commercially viable.

USAF's Electronic Systems Command is conducting reflecting-layer experiments centred on a US$60 million OTH radar system built by General Electric (USA) to correlate the detection capability of an experimental radar system with phenomena in the reflecting layer. One test technique beams a signal to the ionosphere, which reflects it down to the ocean. Aircraft passing through the downward beam reflect (backscatter) the radar signal back to a receiver at the system's operation centre. (See ETI feature on OTH radar, Feb. '78).

France has launched the first major test to replace phone books with alphanumeric terminals, estimated to be less costly than the annual publication of conventional telephone directories. The directory data can be updated frequently, and initial data base contains 30 000 entries. 250 000 terminals are to be distributed in the Ille et Verlaine district of France, with over 30 million scheduled to be handed out in the 1980s.

NV Philips Gloeilampenfabrieken of Eindhoven, the Netherlands, has proposed a data-buss standard for home electronics in order to simplify the operation of the proliferating consumer electronics gear. The researchers maintain that a single-wire multimaster protocol would do the trick, and the protocol, dubbed D2B (for domestic digital buss) could use wire, optical fibre or infra-red beam. As an example, if a video cassette recorder were turned on, the TV set would also be signalled on and tuned to the proper channel. How about something similar to make the coffee, cook the breakfast and give milk to the cat as soon as the alarm goes off in the morning?

Every eight minutes . . .

According to Tandy Electronics, a home is burgled in Australia every eight minutes — which indicates an extremely active population of burglars and a high demand for burglar alarm systems.

Even if your home or office is insured against theft, what you lose may be irreplaceable in monetary terms, so the obvious answer for anyone with enough to lose may be to install an alarm system.

Tandy's new microprocessor intrusion alarm, the Safehouse RF Field Disturbance Alarm System (49-320), is claimed to be a product of technology that "only a few years ago was classified 'Top Secret' ", they say. By emitting an invisible beam of energy, the RF Alarm System detects any movement within a 279 cu. m. space. If an intruder is sensed, an alarm sounds for eight minutes before the unit shuts down, resets, and waits for any further movement.

The RF Alarm System plugs into any ac outlet, and if a blackout occurs or the power supply is somehow interrupted, the unit automatically activates its built-in, rechargeable battery.

You program a four-digit code into the keyboard to arm and disarm the system, while bright red LEDs indicate the unit's mode. A time-delay function also allows you to leave and return without setting off the alarm.

The RF Alarm System requires no complicated wiring or trip wires; you simply plug it in and aim. It may also be used with window and door contact switches.

The unit is 10 x 27 x 18 cm in size, and is housed in a sturdy cabinet with a simulated walnut finish. The price (siren horn extra) is $239.95, and the RF Alarm System is available from Tandy Electronics' stores and participating dealers around Australia.

20-minute battery charger

A new rapid NiCad battery charger was recently introduced by Vicom International, Australasian representatives for Redifon Telecommunications of the UK.

They claim that the new charger cuts down the time taken to recharge a battery using nickel cadmium cells from several hours to around 20 minutes, with no damage to the battery.

The disadvantage of some rapid chargers is that permanent damage can be done to the battery if the critical areas of temperature and pressure are exceeded towards the end of the charge period.

By using a pulse charging principle, Vicom's new battery charger allows a higher charge to be stored in a short space of time. At the same time, a built-in microprocessor recognises a large variation, in one specific cell parameter, of up to 600% from the partially- to the fully-charged state. This wide range means that the charger can be individually programmed to operate right up to a 95% charge level, yet to cut out safely before internal gassing can occur. Indication is given when this charged state is reached.

Vicom claims that use of its new battery charger will even improve the condition of batteries impaired by the continual use of trickle chargers, which produces a gradual degredation in performance. They can be used as part of a planned maintenance programme to recondition such deteriorated NiCad batteries.

Charging may be done irrespective of the state of charge of the cell or its operating temperature, completely avoiding critical areas of temperature and pressure.

The new charger is directed to users of portable radio equipment using rechargeable nickel cadmium cells, and has applications in the Defence Forces, Police, broadcasting organisations, fire, ambulance and emergency services together with civil aviation ground services.

Further details, prices and availability can be obtained from Vicom International Pty Ltd, 68 Eastern Road, South Melbourne Vic. (03) 699-6700.

Soanar's new mains suppression capacitor

'Mainscap', Soanar's new mains transient suppression capacitor, features self-healing construction and epoxy encapsulation for complete sealing against moisture ingression.

The new capacitors employ metallised polyethylene terephalate film dielectric and have been approved by the Energy Authority of NSW to the Australian Standards of AS.C100-1972 and AS.3145-1979 (CS1630N) for Class Y applications.

The stock range is 10 n, 22 n, 33 n, 47 n, 100 n, 220 n, and 470 n, all with 10% tolerance. Other values, flying leads and delta configurations are available on an indent basis.

For full specifications and data contact Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill, Vic 3128.

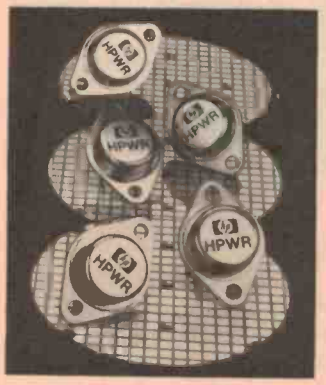
New MOSFETs from H-P

Four new power MOSFETs are the first of a line from Hewlett Packard.

Primarily designed for use in off-line switching power supplies, power inverters and converters, these new devices can also be used in ultrasonic transducer drives, audio amplifiers and general industrial high-speed power switching applications.

Called Hewlett Packard's HWPR-6501 family, they feature high breakdown voltage to allow greater design margin, and low on-resistance for low power dissipation.

Four devices presently available have the following key specifications: HPWR-6501, V_{DSS}: 450 V (min.), R_{on}: 0.85 ohm (max.); HPWR-6502, V_{DSS}: 450 V (min.), R_{on}: 0.75 ohm (max.); HPWR-6503, V_{DSS}: 450 V (min.), R_{on}: 1.0 ohm (max.); and HPWR-6504, V_{DSS}: 400 V (min.), R_{on}: 1.0 ohm (max.).



All four MOSFETs are available in the industry-standard TO-3 steel hermetic package, rated at 90 watts dc dissipation.

Chips are fabricated with planar, double-diffused ('DMOS') design. They all feature guard-ring structure for high-voltage capability, providing reliable operation in industrial applications.

The new HPWR-6501 family are available from VSI Electronics, 21 Chandos Street, St Leonards NSW. (02) 439-8622. Other branches are Melbourne (03) 877-5311; Brisbane (07) 52-4261; Adelaide (08) 51-6483; Perth (09) 328-8091; and in New Zealand at Auckland 76-1169 and Wellington 84-8922.

Rockers and toggles

Philips has just released its new 40-page catalogue detailing the expanded line of rocker, toggle and lever switches now available from Philips Elcoma.

Some of the new lines included in the catalogue are the range of Dialight three and four pole rocker and toggle switches with compatibility to the most commonly used miniature switches, and the miniature flatted toggle.

The catalogue is illustrated with photos and mounting and wiring diagrams, and describes three series of toggle switches (miniature panel mounted, PC-mounted and PC-mounted with support brackets), as well as hardware and accessories for various devices.

Complete mechanical, electrical and material specifications are provided for each series, plus an easy-to-read cross reference guide and ordering information.

To receive this free catalogue (No. 76-570-8005) contact Sales Department, Philips Electronic Components and Materials, 67 Mars Road, Lane Cove 2066 NSW. (02) 922-0181.

Electric white elephant

Massive and slow, but astonishingly powerful, this 1974 electric vehicle can be seen these days lumbering about the grounds of Sydney University.

The trouble is, nobody else really wants the poor beast. Only a research department with government funding would possibly consider maintaining a vehicle with a range of 25 kilometres, an eight to ten hour downtime for recharging at the end of that range and battery replacement costs of $3000 per year.

So the vehicle is on loan to the University's Transportation Research group, who are currently using it to deliver mail around the campus.

To be fair, the beast can manage up to 60 kilometres on suburban roads, but its lack of any regenerative braking system means that the stop-start conditions of city driving reduce its range considerably.

Its unladen weight is nearly two tonnes, which is largely accounted for by forty-six lead-acid traction batteries, each with a capacity of 154 ampere-hours at two volts. These drive a conventional series-wound 22 kilowatt dc motor, which is connected directly to the differential — no clutch, no gearbox. Speed is controlled by a ringing inductor chopper circuit, the method conventionally used in fork lift trucks.

Despite its weight, the vehicle is capable of quite surprising acceleration. At full power, the batteries are delivering 500 amps at 90 volts, or 45 kilowatts! Top speed is about 65 kilometres per hour.

In addition to the hydraulic brakes, there's an emergency braking system, which uses the full battery power to bring the vehicle to a sudden stop by snapping the motor into reverse.

Another peculiar design feature is that the 12 volt accessories circuit is powered by a separate battery, charged by an alternator driven by the motor shaft. And the recharging socket is fitted with a locking cap, perhaps to stop people stealing electricity when the driver stops for lunch!

Meanwhile . . . on 14 November, a Daihatsu Charade, converted to electric propulsion by engineers of the South East Queensland Electricity Board, may have driven itself into the record books by travelling 82 km non-stop from Brisbane to Surfers' Paradise. SEQEB engineers believe this to be the longest non-stop trip ever attempted with an electric car in Australia.

It took 1¼ hours to travel the distance at an average speed of 70 kph. SEQEB spokesman Jack Donkersloot, who drove the car, commented that there was still enough charge left in the batteries to complete about a further 20 km. He said cost of the electricity used was about $1, less than half the cost of fuel for a similar petrol car.

The NDK S-4000 Wordprocessing Printer

For all bulk wordprocessing applications where reliability, speed and sustained print quality are of prime importance.

Introduction

The NDK S-4000 is supplied with a heavy duty 16 wire head producing single pass high quality 17 x 16 matrix characters at 75 characters/second for wordprocessing quality and 150-200 characters/second for drafts.

Four fonts (dot matrix, wordprocessing, Super/subscript and Katakana) are supplied as standard. Typical scientific, mathematical and currency sysmbols are included as standard. The fonts can be intermixed as bold faced, enlarged (5 CPI, 17 x 23 matrix), reduced (12 CPI) or normal (10 CPI). Other fonts can be specified by the user. Each dot on the 16 x 16 matrix can be programmed by the host computer to produce special graphic effects (such as Letterheads and trade marks). Full page graphics is possible by controlling ten wires of the printer and executing half-line feeds. Patterns can be printed at the rate of 900 dot columns/second at a resolution of 4.7 dots/mm (120 dots per inch) both horizontally and vertically. A horizontal dot resolution of 240 dots per inch can be produced using half dot timing.

Superscripts and subscripts are produced by the superposition method enabling complicated mathematical formulaeto be produced quickly and easily. The subscripts and superscripts are half normal size and the printing pitch is half that of the PICA (see Specification).

The following come as standard and are included in the price shown.

A. Stand.
B. Parallel or RS232c Serial (Includes ETX/ACK and X-ON/X-OFF protocols).
C. Front or rear paper feed.
D. Adjustable tractors.
E. 2 x Form Control Loops & 2 Ribbons.
F. Sound proofed contoured casing.
G. Ease of maintenance (only 3 major sub-assemblies).
H. 6 month's warranty.

$3,190.00 plus $390.00 sales tax.

The above price is firm for all orders taken before 31/1/81

LIFELINES

LIFELINES, published by LIFEBOAT ASSOCIATES and distributed in Australia by John F. Rose Computer Services Pty Ltd Is a monthly newsletter designed to keep its readers informed of the current status of all CP/M compatible software.

Each month, a shopping list of CP/M software, a NEW VERSIONS List (detailing the latest distributed versions and updates of CP/M software), a section dealing with "BUGS" dealing with known problems and fixes, and a NEW PRODUCTS section (detailing all new LIFEBOAT products) are included in the Newsletter.

LIFELINES has articles dealing with language and application software reviews, as well as a "Letters to the Editor" section for feedback from end-users.

Subscription for 12 issues $36.00 (includes postage in Australia). Back Issues $5.00 each (includes postage In Australia).

John F. Rose Computer Services Pty Limited are the sole distributors of the NDK range of printers. The company can supply complete systems from floppy disk drive to multi-terminal hard disk installations. Send $1.00 for our new hardware Catalogue and $5.00 for our complete Software Omnibus (which describes our complete range of Lifeboat Software).

NDK S-4000

MATHEMATICS SAMPLE USING STANDARD CHARACTERS

$$F(\omega) = aT\frac{\sin \omega T/2}{\omega T/2} e^{-j\omega T/2}$$

$$e_{rms} = \sqrt{4KTR(f_2 - f_1)}$$

$$L_1 = 10 \log \frac{1}{80} \times S_\bullet \text{ (dB)}$$

$$A^2+B^2=C^2$$

$$H_2SO_4 \qquad H_2O$$

$$W_{xy}(f)=\int_{-\infty}^{\infty}\psi_{xy}(\tau)e^{-j2\pi f\tau}\,d\tau$$

$$L=\int_0^{\pi}\sqrt{\left[\frac{dx_1}{d\theta}\right]^2+\left[\frac{dy_1}{d\theta}\right]^2}\,d\theta$$

$$\psi_{xy}(f)=\tan^{-1}\left[\frac{P_{xy}(f)}{C_{xy}(f)}\right]$$

$$\left.\begin{aligned}a_1x+b_1y&=c_1\\ a_2x+b_2y&=c_2\end{aligned}\right\}$$

$$x=\begin{vmatrix}c_1 & b_1\\ c_2 & b_2\end{vmatrix}\div\begin{vmatrix}a_1 & b_1\\ a_2 & b_2\end{vmatrix}=\frac{c_1b_2-c_2b_1}{a_1b_2-a_2b_1}$$

$$S=\sum_{j=1}^{n}X_j$$

$$\Delta f_{max}\tau_{max}\leq 0.3$$

$$\left|W_{xy}(f)\right|=\sqrt{C^2_{xy}(f)+Q^2_{xy}(f)}$$

$$\Psi_{xy}(\tau)=\lim_{T\to\infty}\frac{1}{T}\int_0^T f_x(t)f_y(t+\tau)dt$$

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Bio-electronic prospects

Transistors on microelectronic chips will soon be as small as the larger molecules in living cells. So it may soon be possible to implant in a body circuits that simulate biological systems.

Dr. J.R. Barker

The idea of implanting electronic systems into living tissues is not new. Cardiac devices such as the familiar pacemaker have now progressed to the stage where they embody simple microprocessors to adapt them more closely to specific characteristics of individual hearts, and several laboratories are working on microelectronic hearing devices that bypass a defective inner ear by directly exciting a small part of the nerve bundle forming the auditory nerve. These devices use tiny electrodes, several micrometres in diameter, which are made by photolithography.

Similarly, it is possible to stimulate a precise part of the optic nerve, or visual cortex, to produce bright spots in the field of vision. By adding a microprocessor to a multi-electrode system it might be possible to pre-process and use them to build up rudimentary images of the visible world. Other work being done includes the electrical stimulation or control of defective neural units in people who are paralysed in the lower parts of their bodies or down one side. Research into the working of the nervous system, including the brain, has substantially benefited from electronic techniques for exciting and probing. But all these developments have been severely restricted by the lack of large arrays of ultra-small electrodes and miniature processing systems capable of exciting and probing in a fine mesh over a large enough portion of the neural networks, and of doing so without causing damage. So far, sensors are either too coarse or too few in number to cope with the complexity of individual cells or neural systems.

These problems could, in theory, be overcome by borrowing from the microfabrication techniques used in making silicon chips. But there still remains the problem of transmitting the information from, say, a 100 000 electrode array to the experimeter. Extensive sorting and pre-processing is obviously necessary, which means incorporating a versatile, high-density microprocessor. Such an 'intelligent' implantable sensor for monitoring and controlling might be termed a *biochip*.

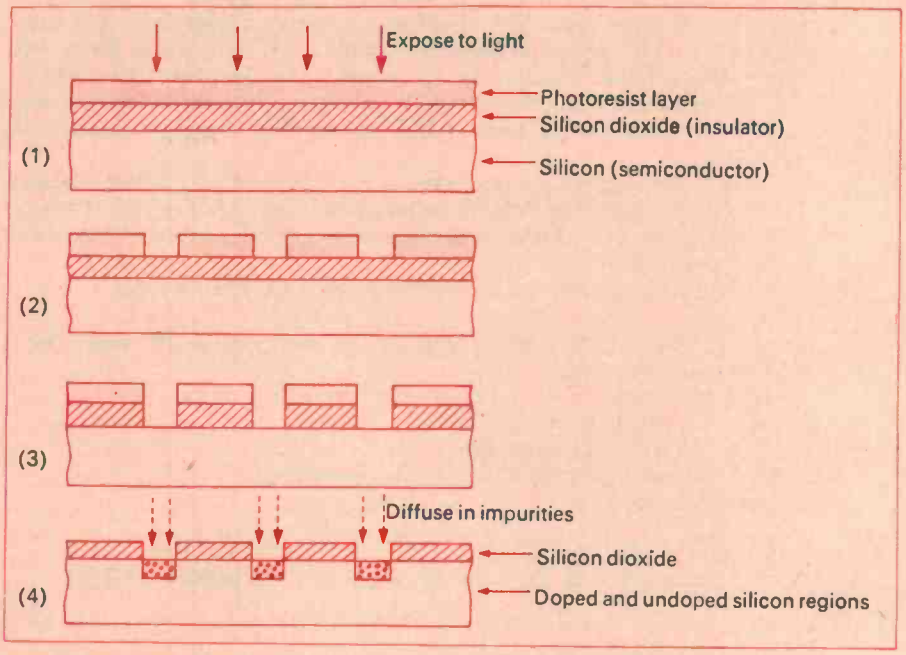


Figure 1. Photo-lithographic process for making integrated circuits: (1) An oxide layer is grown on the silicon wafer, followed by a photosensitive layer; (2) The photoresist is exposed and the pattern etched; (3) The exposed oxide layer is etched away; (4) The photoresist is stripped away and impurity atoms are diffused into the silicon layer. The final structure is equivalent to an array of planar transistors.

If advanced medical instrumentation were to be developed along biochip lines it could significantly improve our knowledge of the electrical signals (and chemical ones, if chemically-sensitive ultra-small devices were used) that govern learning, memory and behaviour. From this knowledge, and by reversing the job of a sensing biochip to that of control, it would become a real, if still distant, possibility that neural tissue might be at least partly repaired.

Fabrication

Industry is now getting to the end of the era of large scale integrated circuits (LSI), in which, typically, a microprocessor is manufactured as an array of some 64 000 transistors interconnected on a silicon chip about four square millimetres in area and sizes of the smallest features are about two to four micrometres. Biochip developments will mean very large scale integrated (VLSI) circuits comprising many millions of components packed on to a single chip. Individual circuit elements as small as 20 nanometres will be used. This is about the size of large molecules in cellular matter. Many of the ideas and techniques of bulk solid state physics which have held for the last three decades of electronics will no longer work on this ultra-small scale.

Solid state microcircuits are built by a process known as photolithography. First, a wafer of silicon several centimetres in diameter is cut from a single crystal. Next, a thin insulating layer of silicon dioxide is grown on its surface and coated with a photo-sensitive film, known as the photoresist. A pattern of the intended circuit is then projected onto the photoresist using a beam of ultraviolet light or, in advanced lithography, some other radiation. The

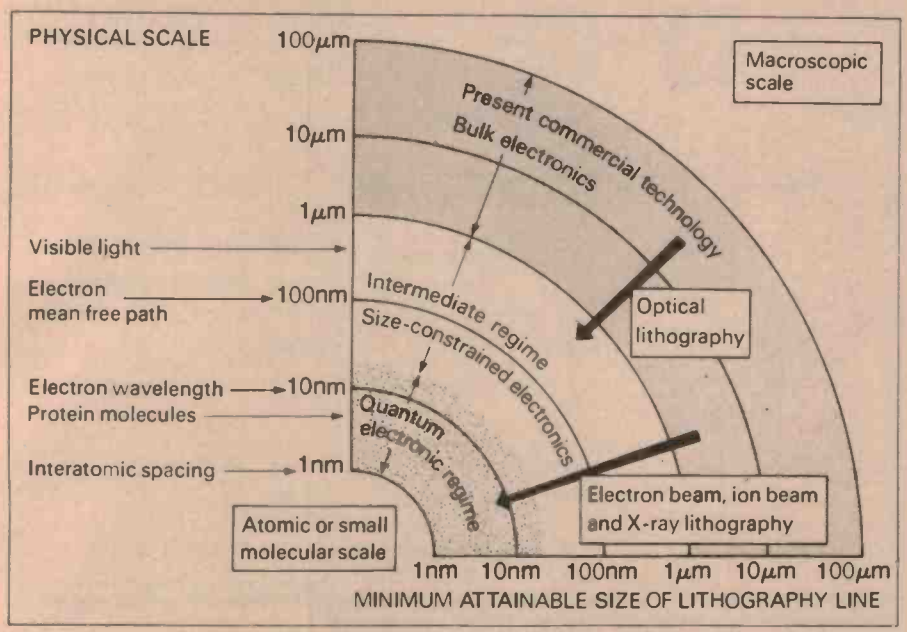


Figure 2. **Orders of size for features in silicon-chip devices, showing sizes of lithography lines required.**

exposed film is then developed by dissolving away the exposed areas, leaving a pattern of open insulator regions. These are in turn removed by etching, usually by acids, to reveal the underlying silicon surface. Very small amounts of impurity atoms may then be diffused into the open silicon regions by placing the wafer in a controlled, hot furnace containing the impurity gas. In this way, the pattern of exposed silicon is given the electrical properties that are wanted. The result is an array of planar transistors or other circuit elements. Figure 1 illustrates the process. A similar procedure is used to lay down metallic electrodes and to make inter-connecting pathways to link the circuits.

Photolithography is very economical because a large number of identical circuits can be made on one wafer before it is cut into separate integrated circuit chips. By making the circuit components smaller, more components can be built into each chip, making it more versatile. There are additional advantages in that smaller transistors use lower power and operate faster. Because the cost per component is related to the area it occupies on the chip, higher component density means greater economy. The number of components per chip has about doubled each year since 1960, so we might expect a million-component chip to be attained in the early 1980s.

In a move towards VLSI, recent advances in optical projection systems and the use of light in the far ultra-violet part of the spectrum show that circuit features as small as 0.5μm can be inserted into the pattern by photolithography. The smallest limits are fixed in the end by diffraction effects, which can be overcome only by using shorter wavelength radiation. Advanced lithography techniques now being developed for VLSI use soft X-rays and electron and ion beams to give a resolution of features down to the order of 10 nanometres. New high-precision techniques are being worked on for the etching and diffusion stages to complement the fine pattern generation and transfer; in particular, plasma etching and ion implantation are promising. Figure 2 shows the sizes of circuit features that are possible with different lithography techniques.

Conventional computer systems will be difficult to incorporate on VLSI chips because of the very high proportion of interconnect paths, which take up a lot of space. This 'wiring' problem is brought about because so-called sequential processing architectures are in use, in which computations are carried out as a long chain of logic operations. Parallel or concurrent architectures, in which computers can perform a large number of operations simultaneously, offer better space-filling pathways but are not as well developed. Choosing the computer architecture to use in VLSI chips will mean considerable rethinking of basic computer science; constraints imposed by the economies of design and fabrication of the equivalent electrical circuits will not be the least of the problems to be solved.

Small scale effects

A great deal of our research effort is devoted to exploring and exploiting novel electronic processes which become available in sizes somewhere between solid-state LSI and the true atomic scale. In a conventional bulk semiconductor device, electrons or 'holes', which are vacancies in energy bands normally filled by electrons, are swept from one electrode to another through the application of a control voltage. The time this takes is called the transit time. A steady average drift velocity is reached when the rate at which the electrons gain momentum from the accelerating electric field is balanced by the rate of loss of momentum through collisions with impurities and vibrating atoms in the host semiconductor. Ohm's law is obeyed if the fields are weak and there are many completed collisions within the transit time. But in very small devices the accelerating electric fields can be very large because the control voltages cannot be scaled down below the thermal noise level, that is, the small ▶

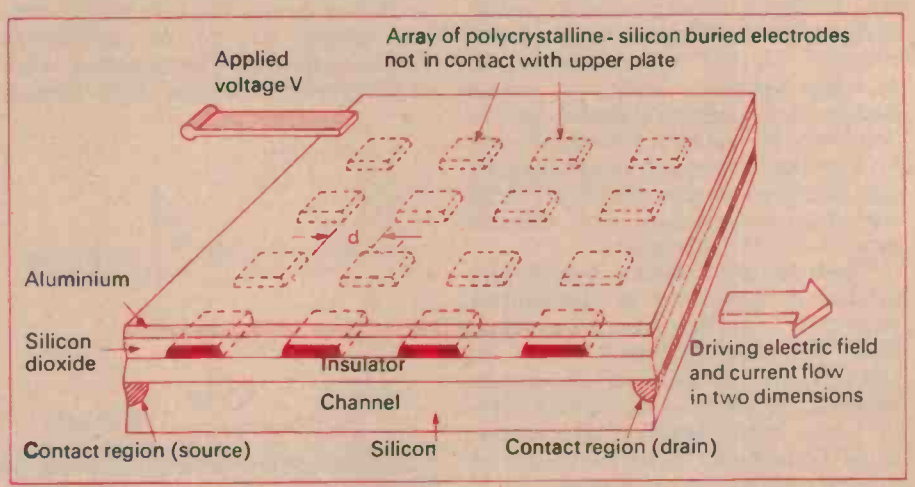


Figure 3. **A two-dimensional superlattice. The atomic-like potential barriers and wells are electrically controllable by a voltage applied to the aluminium 'gate' electrode. By means of the control voltage V and the superlattice spacing *d*, the implanted superlattice may be used to over-ride the dynamical effect of the natural silicon lattice.**

voltages arising from the temperature-dependent, random motion of electrons. Non-ohmic conduction happens easily and the very short transit times may make it impossible to achieve a steady drift velocity. This condition is called the 'transient regime'.

At smaller scales, the transit time eventually becomes less than the mean free time between collisions. The conduction becomes ballistic: electrons no longer see the scattering mechanisms within the device volume, and free acceleration should take place. However, the electrons can still interact with the encroaching environment of the device, that is, with the imperfections and atomic vibrations in the contacts, interfaces and surrounding insulator regions. In this regime, conduction is constrained by size.

In the extreme, when the device is small enough, Heisenberg's uncertainty relation indicates that it becomes more and more difficult to confine the electrons to the device. Quantum effects become strong, and the available energy states for the electrons become discrete rather than continuous. The wave nature of the electron becomes a dominant factor when the size of the silicon approaches the 10 nanometre region, for the electron waves can then escape from the device and may overlap into adjacent devices; this is known as the tunnelling phenomenon. Conduction still goes on, but to understand what is happening requires the full theory of quantum mechanics.

Superlattices give us a good example of the sort of quantum effects which can be exploited in ultra-small systems. In a perfect crystal, the electronic properties of the material are fixed by a periodic array of atomic potentials, which diffract the electron waves as they propagate trhough the crystal lattice. An artificial one-dimensional lattice, known as a superlattice, can be superimposed on the crystal lattice by growing alternate layers of various materials on a semiconductor substrate, separated by less than 100 nanometres. By varying the composition and separation of the layers it is possible to control the electron dynamics in a direction perpendicular to the layers.

Superlattice effects have been demonstrated by a number of laboratories, particularly Dr Ray Dingle's group at Bell Telephone Laboratories in the USA. Figure 3 shows a two-dimensional superlattice proposed by Dr R.T. Bate, of Texas Instruments. This structure could be made by using one of the advanced lithography techniques.

Applying a voltage V to the upper aluminium electrode induces a periodic electrical potential at the silicon/silicon-dioxide interface in the vicinity of the buried periodic array of polycrystalline-silicon electrodes. If the electrode spacing d is made comparable to the average electron wavelength at the interface, these electrons will see an artificial, periodic lattice superposed on the natural, silicon lattice. By altering V and d, the dynamical properties of electrons flowing between the source and drain electrodes could be drastically altered. Generalisations of this type of VLSI structure, in which various voltages are applied over different regions of the buried superlattice, are of considerable interest in our investigation of co-operative electronic phenomena to do with biochip design.

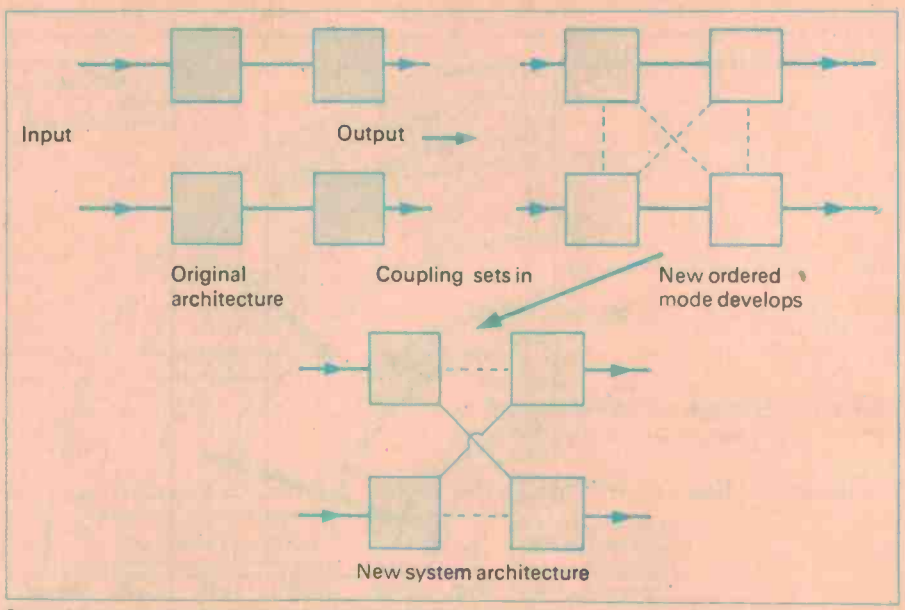


Figure 4. A synergetic electronic network. The blocks represent groups of devices in the VLSI array which communicate through built-in pathways and by interacting directly.

Co-operative networks

When the separation between devices approaches molecular size, it becomes more and more difficult to isolate any particular device from its neighbours. In a similar way to the superlattice example, the overall architecture of the VLSI system of devices may become more important than the host semiconductor in fixing the electrical properties of the array. Already, unexpected interactions have appeared between circuit elements. For example, the phenomenon of 'crosstalk' between memory cells in high density LSI memory chips is accepted as a reliability problem.

Exploiting such behaviour between devices could lead to more versatile electronic networks which would not need the high proportion of space-consuming wiring patterns that are now used in microprocessors. The behaviour of an orthodox electronic logic system is fixed once the pattern of devices and their interconnecting pathways has been established. A different behaviour might be imparted to it by rewiring, that is, re-ordering the devices, but this is normally impossible in integrated circuit systems.

At the University of Warwick we are studying an alternative approach. We have built theoretical models to simulate arrays of electronic devices which are only partially isolated from each other. The arrays are intended to undergo spontaneous self-organising, or co-operative transitions between differently-ordered electrical structures. The idea is illustrated in Figure 4, where groups of devices in the VLSI array are represented as blocks which communicate through built-in pathways and by the devices directly interfacing.

Information is received at the input in the form of coded electrical signals which are processed and passed to the output as additionally-coded signals. At the lowest input signal strengths the array behaves according to the built-in architecture. At some higher level of

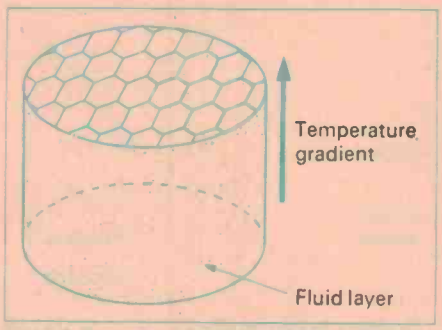


Figure 5. Example of a self-organizing system: the Benard instability. When a uniform fluid layer is heated from below it takes up well-ordered spatial patterns which differ according to the temperature gradient. At high gradients, the hexagonal patterns switch to more complicated forms.

input signal, cross-interactions between the devices arise through, for example, tunnelling of electrons. Competition between these new channels of communication and the original built-in coupling then gives rise to a differently-ordered electrical architecture. The new architecture, and hence the new processing function, is sustained as long as the input signal stays strong enough. This type of system has to have a great deal of freedom in the coupling between devices, a small number of which control the others, so many parallel paths are necessary.

Co-operative behaviour of this kind is well known in certain physical and biological systems. Professor H. Haken, of Stuttgart, has coined the term 'synergetic phenomena' for systems comprising many interacting subsystems which are able to re-organise themselves and lock themselves into differently-ordered structures when driven very far from their normal equilibrium.

A typical synergetic effect is the Bénard instability in fluid convection illustrated in Figure 5. This phenomenon occurs when a fluid is heated from underneath. If the temperature difference between its upper and lower layers is small, the fluid conducts heat uniformly, but when the temperature difference exceeds a certain critical value the conduction becomes unstable and a spatially well-ordered pattern of convection sets in. At higher temperature gradients the hexagonal patterns switch to still more complex forms.

Preliminary studies are encouraging enough for us to foresee many applications for biochips embodying co-operative VLSI networks. For example, they might be used in self-healing logic arrays that would be capable of repairing a certain amount of radiation damage. They might form the basis of memory systems capable of sorting and relating data, and of 'artificial intelligence' units to assist in processes such as pattern recognition.

Implantable electronics

Many problems, to do with the materials used, have to be solved before high intelligence, implantable electronic systems can come about.

First, the biochip must be effectively insulated against saline fluids so that it is not penetrated by unwanted dopant ions, such as sodium, which destroy semiconductor devices. The insulating layer, from a few tens of nanometres to several micrometres thick, must be chemically bonded to the chip: a conventional wrapping is incapable of preventing saline penetration to at least a few micrometres.

Second, the biochip must be compatible with the host biological material, so the outer layers must be made from materials which are chemically inert, such as plastics. This poses problems to do with the interface between the outer, inert layer and the relatively active electronic layers of the chip. The layers must stick together well enough to prevent the structure unpeeling.

Third, the phenomenon of electrolysis, which might cause the metal micro-electrodes to dissolve in their electrolytic surroundings when electric currents flow, poses long-term corrosion problems and may make it difficult to obviate toxic by-products. Though a number of new materials show promise, solving the problem of passivating the biochip implants will not be practicable for some time.

Bionic science is in its infancy. But in spite of design and other technological problems I believe it to be a promising area for inter-disciplinary research, with many potential benefits to medical science. ●

Dr Barker is a physicist at the University of Warwick in the UK. This article was originally published in Spectrum, the UK Government journal of science news.

Facts from Fluke on low-

cost digital multimeters.

When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's reputation for service and support.

Fact is, as electronics become more a part of our daily lives, dozens of new manufacturers are rushing to market their "new" DMM's. In theory, this is healthy; but in practice, crowding is confusion.

To help you deal with this flood of new products, here are some facts you should know about low-cost DMM's.

The economics of endurance.

Even the least expensive DMM isn't disposable. Accidents happen, and test instruments should be built to take the abuses of life as we live it.

Look for a DMM with a low parts count for reliability, and rugged internal construction protected by a high-impact shell. Make sure the unit meets **severe military tests for shock and vibration.**

Another feature to check out is protection against overloading, whether from unexpected inputs, transients, or human errors.

Just for the record, all Fluke low-cost DMM's meet or exceed military specs, and feature extensive overload protection.

The importance of being honest.

Just because a multimeter is digital doesn't mean it's automatically more *accurate* than a VOM – even though the LCD might give you that impression. The benchmark for accuracy in DMM's is *basic dc accuracy.* The specs will list it as a percentage of the reading for various dc voltage ranges.

Of course accuracy is more critical in some applications than others, and increasing precision and resolution in a DMM usually means increasing price. In the Fluke line, you can choose a model with a basic accuracy of 0.25% (the 8022A), others rated at 0.1%, or the new 8050A bench/portable at 0.03%.

Special measurements: getting more from your DMM.

Actually, for all the variations in size, shape and semantics, most DDM's perform five basic measurements: ac and dc voltage and current, and resistance. Prices vary according to the number of ranges and functions a DDM delivers.

	PRODUCT	FUNCTIONS	RANGES	DIGITS	BASIC DC ACCURACY	CONDUCTANCE	OTHER SPECIAL FEATURES
HANDHELD MODELS	8022A	6	24	3½	0.25%		Basic six-function DMM; lowest-priced
	8020A	7	26	3½	0.1%	X	**High accuracy; pioneer in conductance**
	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/ input level detector with selectable audible signal; peak hold capability.
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges.
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature.

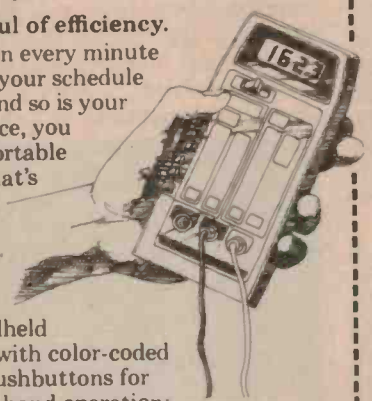
The Fluke line includes DMM's with from 24 to 39 ranges, 3½ and 4½-digit resolution, and some unique functions you won't find in any other DMM. Additional measurement capabilities like temperature, dB, conductance and circuit level detection.

If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

Another talented instrument is our new 8050A bench/portable. The microprocessor-based 8050A features a self-calculating dB mode in which dBm readings are displayed automatically referenced to one of 16 selectable impedance ranges – a real timesaver when servicing audio equipment.

And of course no discussion of DMM's is complete without considering conductance – a Fluke exclusive featured on five of our low-cost DMM's – which allows you to make accurate resistance measurements to 100,000 Megohms. You can't do that with any ordinary multimeter, but it's a must for checking leakage in capacitors and measuring transistor gain.

A handful of efficiency.



When every minute matters, your schedule is tight and so is your work space, you need a portable DMM that's fast and easy to operate. We designed our handheld DMM's with color-coded in-line pushbuttons for true one-hand operation: no need to hang onto the meter with one hand while twisting a rotary dial with the other.

But there's more to convenience than fingertip control. The 8024A, for example, is also designed to function as an instant continuity tester, with a selectable audio tone to indicate shorts or opens. It also has a peak hold feature to capture transients.

A word about warranties.

Last but not least, look closely at the company that manufactures a low-cost DMM. Their service is just as important as their product. Look for no-nonsense warranties, a large family of accessories, an established network of service centers and technical experts you can rely on.

That's how you'll recognize a knowledgeable supplier of low-cost DMM's, a company with experience, resources and a commitment to leadership in the industry.

Incidentally, you'll find it all at Fluke.

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MOSFET power amplifier

Part 1.

Employing recently released Hitachi MOSFETs, this power amplifier features a 'no compromise' design, is rated to deliver 150 W RMS maximum and features extremely low harmonic, transient and intermodulation distortion. As the circuit techniques and design problems will be unfamiliar to many readers, a thorough discussion of the theory and problems is included.

David Tilbrook

THE ENORMOUS SUCCESS of the series 4000/1 four-way loudspeaker has surprised even us. They were originally intended to be the 'flagship' of a range of loudspeakers and quite frankly we expected the biggest demand to be for the cheaper loudspeakers further down the range. This has proved not to be the case as sales of four-way kits continue to rise. It is evident that there is a big demand for the higher quality audio projects. We recognised this demand and eight months ago began the development of the Series 5000 power amp and preamp. The objective was to design an amplifier for home construction of the highest possible quality. The cost of the project was a secondary consideration, although in real terms the cost saving in "doing it yourself" is considerable.

discussion

Defining the problem

Of all the stages in the amplifier the output stage is subjected to the worst operating conditions: varying load impedance, heating due to the large power levels necessary to drive loudspeakers, and the occasional short circuit produced by the careless connection of loudspeaker cables or perhaps even loudspeaker failure.

The output stage is also the site of three distinct sources of gross non-linearity, that of amplitude overload (clipping), crossover distortion and slew rate limiting. All three generate a very large number of distortion products and are therefore particularly noticeable and fatiguing forms of distortion.

In order to understand the causes of these types of distortion it is helpful to look at the circuit shown in Figure 1. This is a very simple output stage using two transistors. The output to the loudspeaker normally sits at 0 volts, exactly half way between the positive (+V) and the negative supply (−V) rails. Now, if

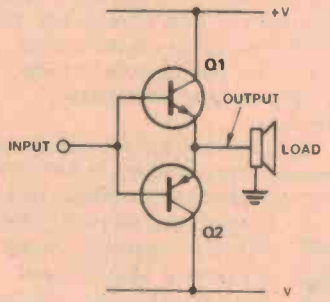


Figure 1. Simplified circuit of a bipolar output stage.

Q1 is turned on by a positive-going signal voltage the impedance between the output and the positive supply decreases and the output approaches +V. Similarily, if Q2 is turned on the impedance between the output and the negative supply rail decreases and the output approaches −V. When either output transistor is turned fully on, the output voltage will be equal to the supply voltage minus whatever voltage drop occurs across the output transistors. Any signal peak that exceeds this maximum output voltage will be amplitude limited or clipped (see Figure 2). It is possible to compress signal peaks that may otherwise cause clipping, but inevitably, the non-linearity still occurs. The large supply voltages associated with high powered amplifiers help reduce this problem and are one of the reasons that high power amps almost always sound better than low power ones . . . even at relatively low operating powers. In some respects

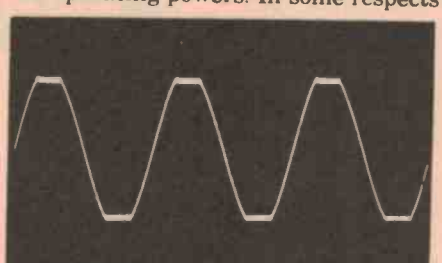


Figure 2. An amplitude-limited waveform — "clipping".

SPECIFICATIONS

Power output
100 W RMS into 8 ohms
(±55 V supply)

Frequency response
8 Hz to 20 kHz, +0 −0.4 dB
2.8 Hz to 65 kHz, +0 −3 dB
NOTE: These figures are determined solely by passive filters.

Input sensitivity
1 V RMS for 100W output

Hum
— 100 dB below full output (flat)

Noise
−116 dB below full output
(flat, 20 kHz bandwidth)

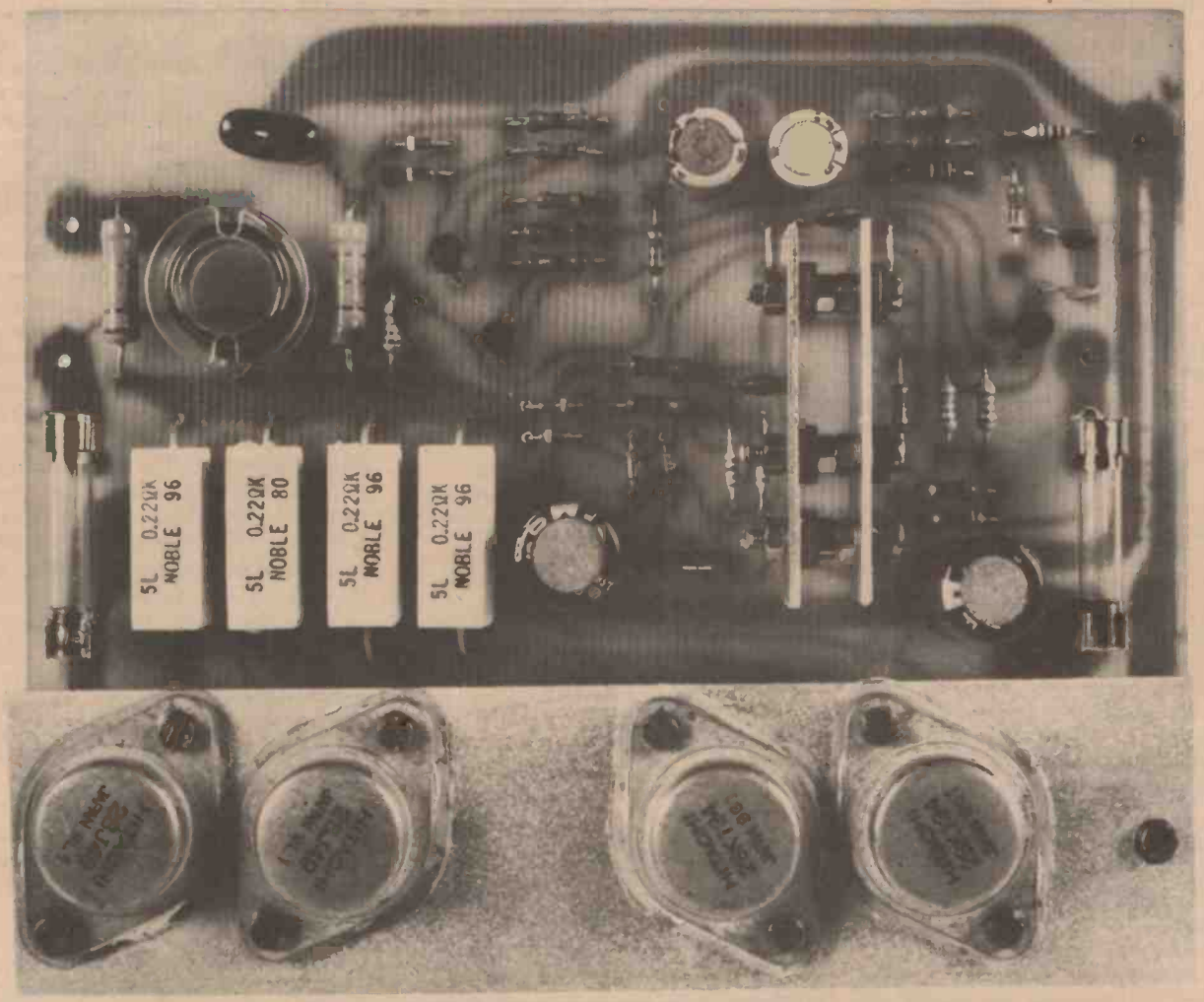
2nd harmonic distortion
< 0.001% at 1 kHz
(0.0007% on prototypes)
at 100 W output using a
±56 V supply rated at 4 A
continuous.
< 0.003% at 10 kHz and 100 W

3rd harmonic distortion
< 0.0003% for all frequencies
less than 10 kHz and all powers
below clipping.

Total harmonic distortion
Determined by 2nd harmonic distortion
(see above).

Intermodulation distortion
< 0.003% at 100 W.
(50 Hz and 7 kHz mixed 4:1)

Stability
Unconditional — see accompanying
oscilloscope photographs.



it is unfortunate that output power is measured using a continuous sine wave. This certainly tests the power amp power supply combination under continuous conditions but does not give any indication of the transient power capability. A modern, good quality record can easily cause transient signal peaks of the order of at least 20 dB above the average music level. A typical 50 watt power amplifier for example, with a supply voltage of approximately ±30 V unloaded could be driven into clipping by transients when the average music level is only 3 V RMS, i.e: slightly more than a watt into eight ohms. If on the other hand, the unloaded supply voltage is increased to ±50 V while keeping the loaded voltage the same as before (approx. 28 V) then the continuous power rating will still be 50 watts but the average music level before clipping is increased to 5 V RMS or 3 W into eight ohms. The difference between the continuous power output of an amplifier and its transient power capabilities is called *dynamic overload margin* or dynamic headroom and is given by the equation

$$\text{Dynamic Headroom (in dB)} = 10 \log \frac{P_T}{P_c} \quad \ldots\ldots (1)$$

where P_T is transient power (RMS) and P_c is the continuous power rating (RMS)

An amplifier with a good supply regulation like the first of the two amplifiers discussed above, will have a low dynamic headroom figure (approx 0.6 dB). The second of the two amplifiers with poorer supply regulation will have a higher dynamic headroom figure (approx. 4.4 dB), and could sound superior to the first amplifier. Of course, the poorer supply regulation would have to be taken into account when designing the amplifier. The supply rejection would have to be higher to ensure the same distortion characteristics as the first amplifier, and the output transistors must be capable of handling the higher supply voltage.

Crossover distortion

When a bipolar transistor is used as an emitter follower the relationship between the output and the input is a function of the load impedance and the forward transfer admittance of the output transistors. Specifically:

$$\frac{e_o}{e_i} = \frac{R_L}{(R_L + 1/y_{fs})} \quad \ldots\ldots (2)$$

where e_o is the output signal voltage
e_i is the input signal voltage
y_{fs} is the forward transfer admittance
and R_L is the load impedance.

It is the non-linear component of y_{fs} that causes distortion in the output stage. Equation (2) shows that if y_{fs} is large the value of $1/y_{fs}$ will be small and $(R_L + 1/y_{fs})$ will approach R_L. Therefore, for y_{fs} sufficiently large e_o/e_i will approach unity, and this is the ideal situation. ▶

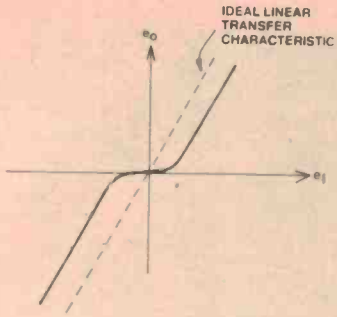


Figure 3. Illustrating the relationship between e_i and e_o for a bipolar output pair operated without bias, as shown in Figure 1. The result is 'crossover distortion'.

The problem with bipolar transistors is that, although their forward transfer admittance is high (approx. 40 Siemens for a typical output transistor and a current of 2 A) it drops dramatically if the base-emitter voltage drops below 0.6 V. In an output stage like that in Figure 1 the output signal voltage swings both positive and negative with respect to ground potential, with the transistor Q1 responsible for positive excursions and Q2 responsible for negative excursions. Whenever the voltage on the base of Q1 drops below 0.6 volts, or the voltage on the base of Q2 gets above −0.6 volts, (i.e: closer to 0 volts) the forward transfer admittance decreases rapidly, and the transfer characteristic of the output stage becomes grossly non-linear. This non-linearity produces crossover distortion (see Figure 3).

There are several methods commonly employed to overcome the problem of crossover distortion. Most make use of the concept of bias or quiescent current. With this technique, a fixed dc voltage of around 0.6 V is applied to the bases of the output transistors. In the output stage shown in Figure 4 this voltage is derived across the two diodes D1 and D2. If the diodes and the value of the resistor R3 are chosen correctly, then both output transistors are just turned on. With no signal voltage applied, the output of the stage is at 0 V so none of this dc current will flow in the load. Instead, this bias current flows directly from the positive to the negative rail and ac signal voltage is superimposed on this dc voltage. The base signal voltage must now reach −0.6 V to completely turn Q1 off. Since this region is now in the positive half cycle, Q2 has turned on and, with relatively high y_{fs}, will react essentially in a linear way to the input signal.

The same occurs when Q2 is turning off. It enters its low y_{fs} state in the region between 0 V and +0.6 V and being in the positive half cycle, Q1 will

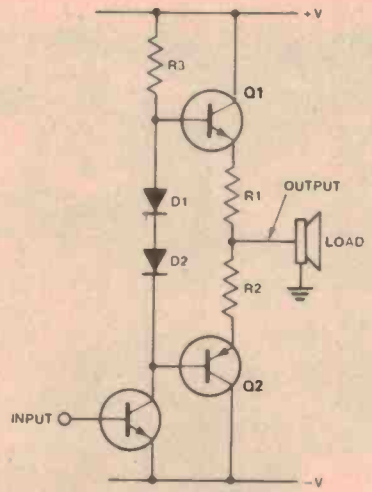


Figure 4. A common method of linearising the relationship between e_i and e_o in an output stage is to apply bias using two diodes (D1 and D2).

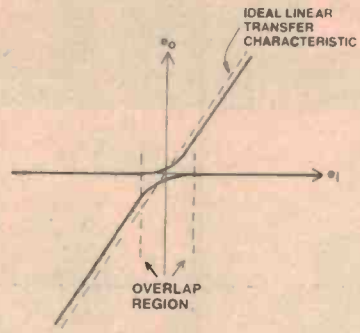


Figure 5. How the application of bias to the output devices affects the relationship between e_i and e_o — the 'transfer characteristic'.

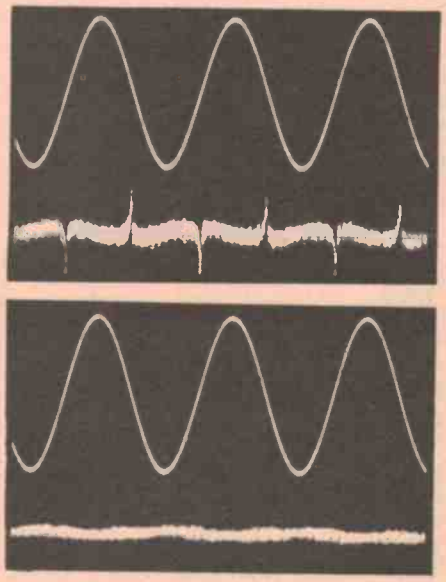


Figure 6. Oscilloscope photographs taken from the ETI-477 module in operation: upper trace in each pic is output at 5 kHz, 10 V RMS; lower traces shows distortion analyser output. TOP: crossover distortion, reduced bias. BOTTOM: bias correctly set, distortion below resolution of analyser (0.003%!).

have high y_{fs} and maintain the linearity of the stage. The graph in Figure 5 illustrates the effect of bias current. The curves shown in Figure 3 have moved parallel to the e_i axis and are now closer to the ideal linear characteristics. Figure 6 shows actual CRO photographs of an amplifier with and without bias current applied. The bottom waveform is the distortion obtained simply by filtering out the fundamental frequency of the input sine wave. Note that the distortion waveform has peaks that correspond to points where the sine wave crosses 0 V.

The use of bias current to decrease crossover distortion has its disadvantages also. The dissipation in the output stage is increased, causing heating of the output devices. An amplifier with a 50 V supply and a quiescent current of 50 mA must dissipate 2.5 W in each of the output devices so the output stage will run warm even with no input signal. Furthermore, bipolar transistors have a positive temperature coefficient. If the base-emitter voltage is held constant but the output transistor temperature increases, then the bias current will increase due to a decrease in the emitter-collector resistance. This increase in bias current causes a further increase in temperature and consequently a further increase in bias current. This condition is called *thermal runaway* and if left unchecked will destroy the output devices. In practical power amplifier circuits the temperature is sensed by a temperature sensitive element, like another transistor or a diode, and the bias current is adjusted accordingly.

The positive temperature coefficient of bipolar transistors also causes another problem that limits the maximum power handling of the output transistors. Since it is impossible to ensure that the heating produced in the transistor chip is perfectly homogeneous, some areas of the chip will heat up more than others. These areas will decrease in resistance, conducting more current and heating further. This effect is called *secondary breakdown* and causes hot spots on the chip surface that can destroy the device.

Slew rate limit

The third source of non-linearity normally associated with the output stage is *slew rate limiting*. Just as the output stage is limited in its maximum output voltage it is also limited in the time taken to change from one voltage to another. The time taken for the output stage to swing over a certain voltage

range is called the *slew rate* of the output stage. Furthermore since the output transistors have the biggest chip areas they are usually the slowest devices in the amplifier. If the signal slope (instantaneous rate of change of input signal voltage with respect to time) approaches the slew rate of the output transistors (or any other stage in the amplifier) distortion will be produced that is analogous to the distortion due to amplitude limiting. This distortion is sometimes called *transient intermodulation distortion* (TIM or TID) but it is important to realise that it is a slew rate limited phenomenon.

There are only two ways to eliminate this type of distortion, either by decreasing the signal slope of the input waveform or by increasing the slew rate of the output stage.

Decreasing the maximum signal slope implies decreasing the frequency response of the power amplifier. So if a good frequency response is to be obtained, the problem of slew induced distortions must ultimately be solved through the use of faster output transistors.

The MOSFET output transistor

The power MOSFET overcomes many of the problems discussed above. Hitachi are the first company to make available MOSFETs at a realistic price and with sufficient power handling for use in the output stage of audio power amplifiers. We have chosen the 2SK134 and the 2SJ49 devices for this project. These have a maximum power dissipation rating of 100 W, maximum drain to source voltage of 140 V and a maximum current of 7 A, which is a very formidable specification!

The first major advantage of MOSFETs over bipolar transistors is their very high input impedance. Figure 7 shows an equivalent circuit for a typical MOSFET.

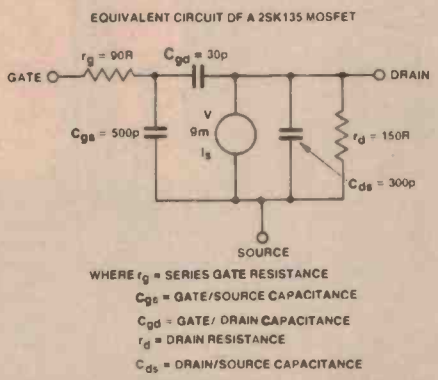


Figure 7. **Equivalent circuit of a typical power MOSFET (2SK135).**

The gate appears as a 90 ohm resistance in series with a 30 pf capacitance to the drain and a 500 pf capacitance to the source. At dc, the input resistance is the resistance of the two effective capacitors — essentially an open circuit. The equivalent circuit also gives us insight into another of the MOSFET's great advantages. The combination of the series gate resistance and the total equivalent gate capacitance determines the cut-off frequency of the device at around 3 MHz! When driven correctly, the MOSFET is capable of excellent frequency response linearity and its slew rate is *unmatched* by any bipolar device of similar power. The speed of the MOSFET is attributable to the absence of an effect called *minority carrier storage* and it can therefore switch a current of 2 A in roughly 3×10^{-8} seconds or *30 nanoseconds!* This is around *100 times* the capability of most bipolar transistors.

This very fast response, coupled with the high input impedance and gate capacitances make the devices prone to oscillation, although they are not difficult to tame if care is taken with the pc board layout and a few fundamental precautions are taken. The best approach is to ensure that all gate wiring is kept as short as possible and to increase the value of the series gate resistance. This increases the r_gC_{gs} time constant and limits the frequency response, greatly improving the device stability.

Figure 8 shows the frequency response of a typical power MOSFET and its relationship to the value of gate resistance. It is important that the distance between this resistance and the gate is kept to a minimum.

The extremely high slew rate of the MOSFET devices makes it possible to limit the maximum signal slope of the input signal while not affecting the frequency response of the amplifier inside the audio passband. In this way, the maximum signal slope cannot approach the slew rate of the output stage. Assuming no other stage in the amplifier slew rate limits this will overcome the problem of transient intermodulation distortion, but more about this later. ▶

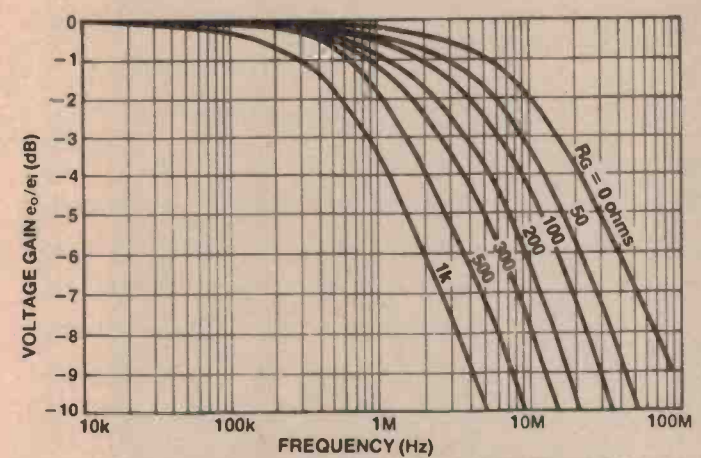
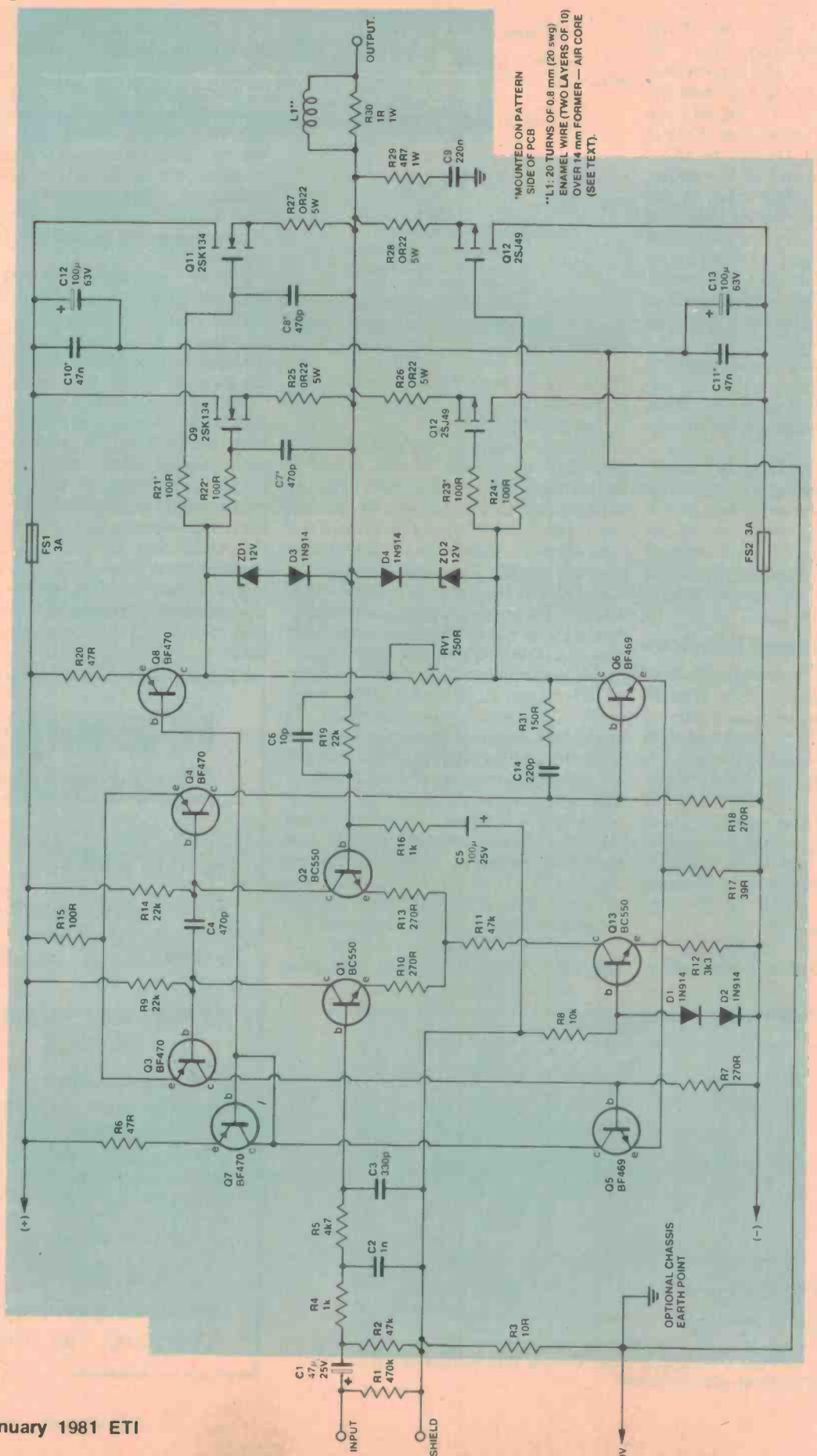
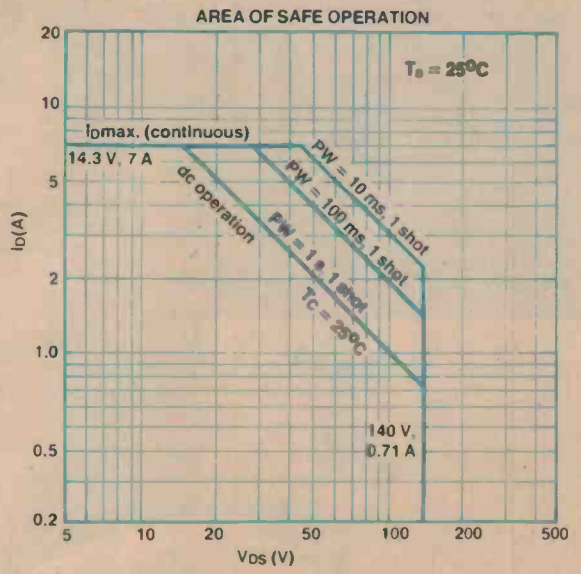


Figure 8. **Frequency response of a typical power MOSFET and how it is affected by series gate resistance.**



Circuit diagram of the ETI-477 MOSFET power amplifier module. A complete 'How It Works' description will be given next month.

(a)2SK134



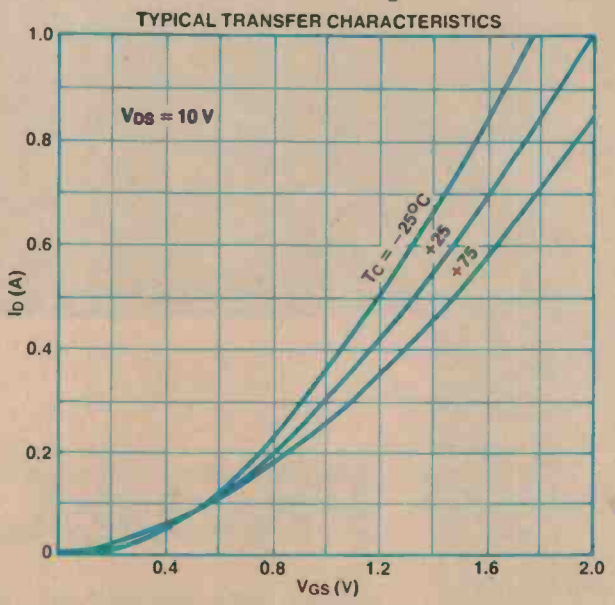


Figure 10. Typical transfer characteristics of a power MOSFET. Note that the greatest non-linearity occurs at low drain-source currents.

(b)MJ15003/MJ15004

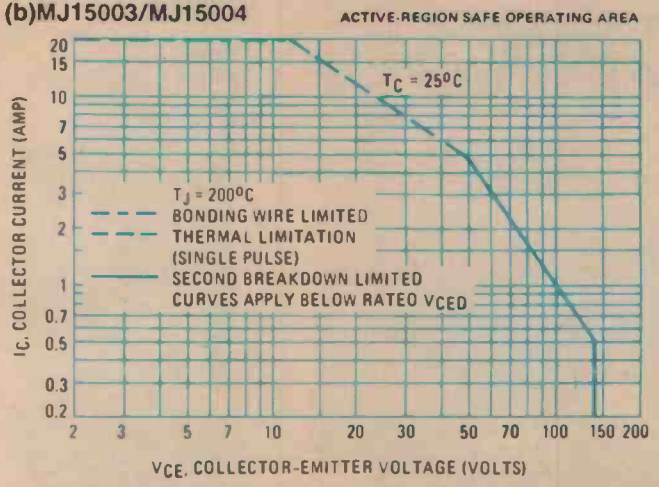


Figure 9 (a) SOAR curves for a 2SK134 power MOSFET. Compare with (b), the SOAR curves for a bipolar power transistor (MJ15003/MJ15004).

Another advantage of MOSFETs over bipolar transistors is their temperature characteristics. While the temperature coefficient of the bipolar device is *positive* the MOSFET has a *negative* temperature coefficient for drain source currents in excess of 100 mA. Heating of the devices causes an increase in the drain-source resistance and the current decreases. Furthermore, if one part of the chip surface heats more than any other, the increasing resistance in this area distributes current over the rest of the chip surface until the temperatures across the chip surface are equalised; so secondary breakdown is eliminated.

A look at the safe operating curves in Figure 9 shows a comparison between a MOSFET SOAR (Safe Operating ARea) and that of a good bipolar output transistor. Note that the bipolar has four limiting lines where the MOSFET has only three.

Crossover distortion and MOSFETs

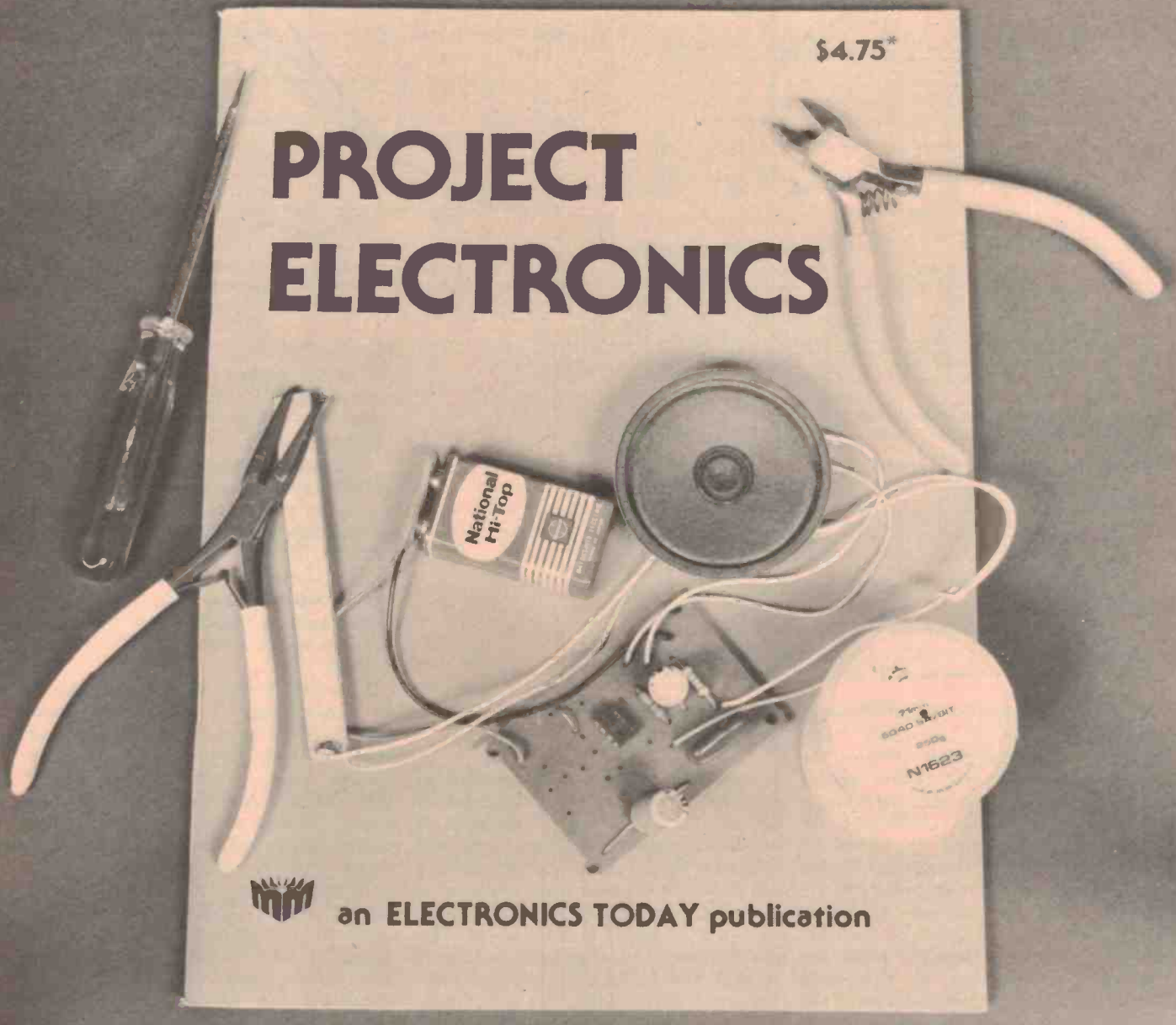
It has been stated in a number of journals that one of the advantages of MOSFETs lies in the elimination of crossover distortion. Their argument relies on the fact that the variation in the forward transfer admittance of a bipolar transistor is exponential, while that of a MOSFET is more linear. The problem with this argument, as I see it, is that the MOSFET's greatest non-linearity still occurs for low drain-source current (see Figure 10) and certainly the Hitachi devices never achieve the high value of y_{fs} attainable with bipolar transistors. The specification for forward transfer admittance of the 2SK134 for example is approximately 1 Siemen, and this is only a fraction of the 40 S quoted earlier for bipolar devices. Remember that it is the non-linear component of y_{fs} that gives rise to distortion, and as a result, a MOSFET output stage with these characteristics could be expected to cause ten times the distortion of a bipolar design.

Although the bipolar turn-on characteristic is more severe, it is restricted to a smaller range of emitter current and once overcome by the application of bias current, the higher y_{fs} will actually yield a stage *with lower distortion*. The CRO photographs in Figure 6 were obtained using a MOSFET power amp and the crossover distortion is clearly evident.

In order to reduce crossover effects to satisfactory levels with these MOSFETs it is necessary to apply at least 100 mA of bias current, and for really good results approximately 200 - 300 mA would be needed. If the supply voltage is around ±50 V, each output device will dissipate five to ten watts with no input signal applied, substantially more than most bipolar output stages. This is not really a problem considering the MOSFET's negative temperature coefficient, but you should expect a MOSFET power stage to run warmer than bipolar output stages.

Another problem caused by the relatively low value of forward transfer admittance is the voltage drop between the gate and the source, which can be in the order of several volts increasing at high power levels; see Figure 10. The Hitachi devices have a maximum allowable gate to source voltage of 14 V and care must be taken in the design to ▶

Just starting out?



THIS BOOK has been specially designed and produced to meet the needs of newcomers to electronics. Students following the three-segment Industrial Arts syllabus at high school or embarking on the Electronics & Communications or a similar certificate course, will find the projects in this book an eminently practical introduction to the 'works' in electronics. Project Electronics has been a runaway success since it was first published. There are 26 projects included, many are readily available as inexpensive kits, and the book also provides advice on tools, identifying components, troubleshooting, how to solder etc. Available from specialist electronic suppliers or direct from the **ETI Subscription Department, 3rd Floor, 15 Boundary St, Rushcutters Bay NSW 2011** *for $4.75 plus 45 cents post and packing.*

ensure that this limit cannot be exceeded.

The minimum drain to source on-resistance for the Hitachi devices is around 1.7 ohms so that a drain current of 7 A continuous can be expected to cause a voltage drop between the drain and source of approximately 12 V. In order to get the same power as a bipolar stage a higher supply voltage is necessary to compensate for the higher voltage drop across the output devices. In order to make a power amplifier conservatively rated at 100 W into 8 ohms it is necessary to be able to deliver in excess of 28 V RMS to the load. This is equivalent to around 39 V peak. Adding the drain-source voltage drop of around 12 V gives 51 V, and allowing a margin for supply regulation of around 5% increases this to 56 V. Adding a further 20% for ac mains supply regulation implies that the output stage must be able to handle a supply voltage of around ±65 V. This is well within the maximum voltage specification of the 2SK134 and 2SJ49.

Examination of the SOAR characteristics of these devices reveals that it will be necessary to use two MOSFETs in parallel to achieve 100 W into 8 ohms and still not exceed the maximum power dissipation ratings of the devices. If we could guarantee that the amplifier would always be used with purely resistive loads the SOAR requirements could be relaxed substantially. If the amplifier had supply rails of ±50 V the maximum voltage swing across the load will be approximately ±40 V, giving a maximum load current swing of ±5 A, into an 8 ohm load. The maximum dissipation in the output devices will occur when the load current is around half the maximum current, i.e: 2.5 A and the voltage drop across the operating output transistor is approximately 30 V. So the power dissipation in the output devices would be less than 30 x 2.5 = 75 W.

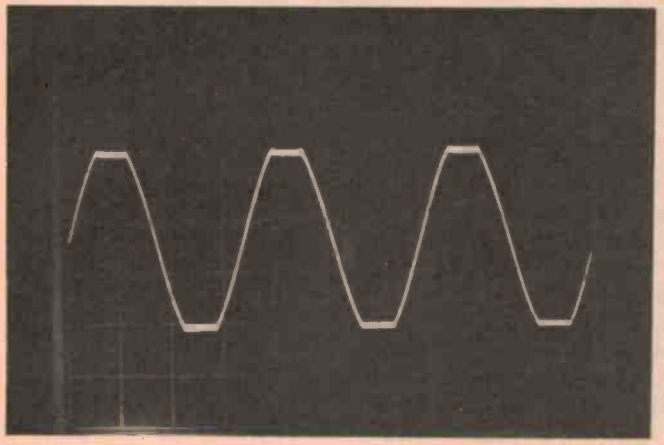
A single pair of output transistors would suffice.

Unfortunately, loudspeakers are not purely resistive loads. In some electrostatic loudspeakers for example, the amplifier load is actually the primary of a step up transformer, needed to supply the high signal voltage for the electrostatic elements. This can represent a highly inductive load and the output stage must be able to handle the associated phase shift. Similarly, it is not uncommon for the load to have a substantial capacitance, especially in loudspeakers with poorly designed crossovers. Under these conditions the charged capacitive or inductive reactance will supply energy back into the output stage. If, for example, in an amplifier with ±50 V rails an effective load capacitance is charged to the maximum negative voltage of, say, −40 V by a large negative going signal voltage, this potential will remain on the load when the output is subsequently driven to the maximum positive voltage of around +40 V. If the resistive component of the load impedance is not less than 8 ohms the maximum current in the load is now 10 amps. The worst case power dissipation in each half of the output stage will be around 5 A when the voltage drop across the operating output device is 40 V. The maximum power dissipation will therefore be around 200 W, so two pairs of output transistors will be necessary to ensure reliable operation.

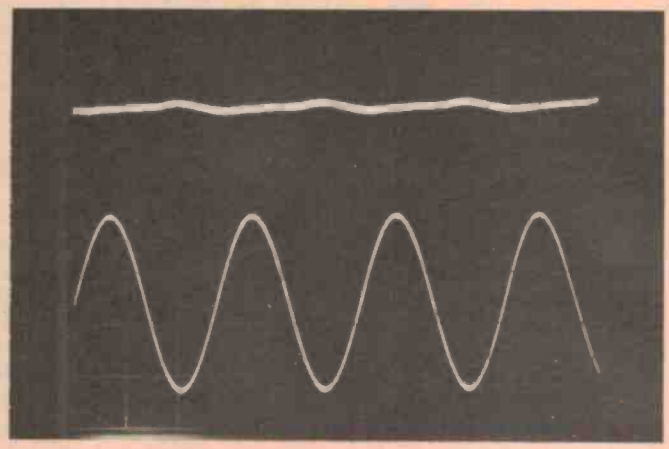
Since this problem is caused by the 'imaginary' (or reactive) component of the output load, these large signal currents will only exist momentarily while the load is charged or discharged to the new signal voltage. It is therefore possible for this load line to be marginally outside the dc safe operating area. Even taking this into account, a single pair of 2SK134/2SJ49s would not be sufficient. During the development of this power amplifier the output stage using two pairs of MOSFETs has been driven into hard overload, short circuits and even full power oscillation at over 10 MHz. Under these conditions the output device temperature was consistently measured in excess of 130°C. The MOSFETs are still performing perfectly, so these are extremely robust devices.

In summary, MOSFETs have both advantages and disadvantages when used in the output stage of an audio power amplifier. They are superior in speed and input impedance and are extremely robust. On the other hand, their higher distortion due to lower forward transconductance will necessitate an overall increase in the amount of negative feedback, so phase response will need to be carefully controlled to ensure stability. In general, the advantages outweigh the disadvantages, however, and it is for this reason that we have chosen these devices for the ETI-477 power module.

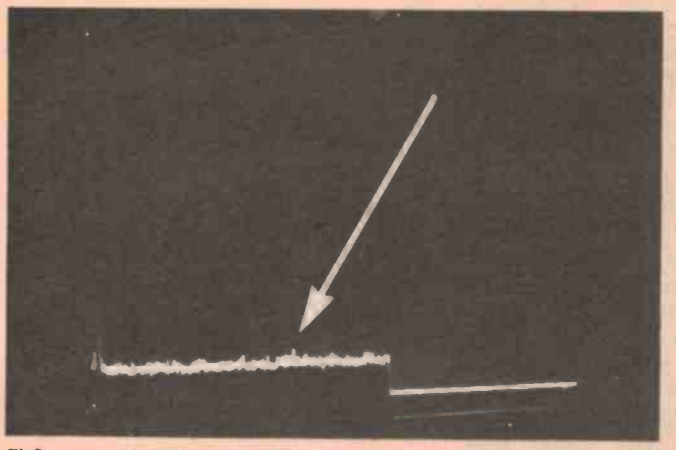
Discussion continued next month. Turn over for construction details for the module. ▶



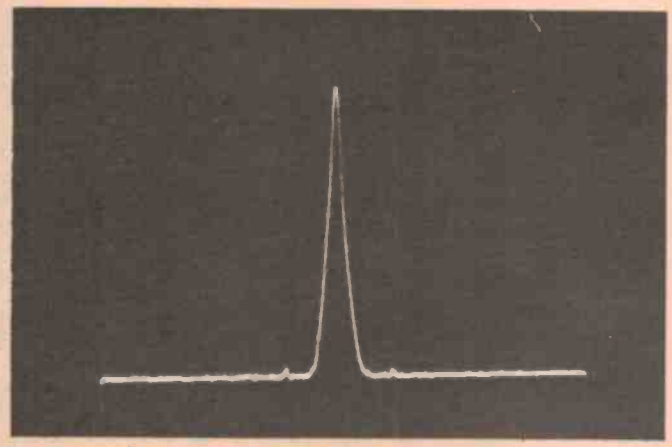
A) Overload recovery test. A 1 kHz sine wave input driving the module into amplitude overload (clipping). Note the amplifier remains stable when going into and coming out of overload.



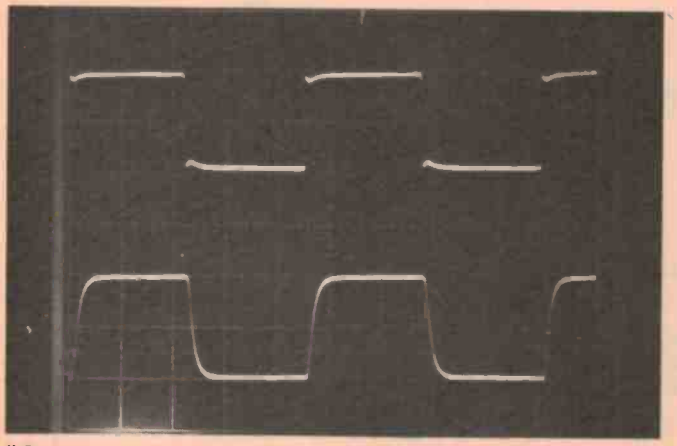
B) Total harmonic distortion measurement (AWA model F242A N. & D. meter). Lower trace is the 1 kHz, 10 W RMS output from the module. Upper trace shows output of the F242A, which in this case is at the limit of resolution (around 0.002% THD).



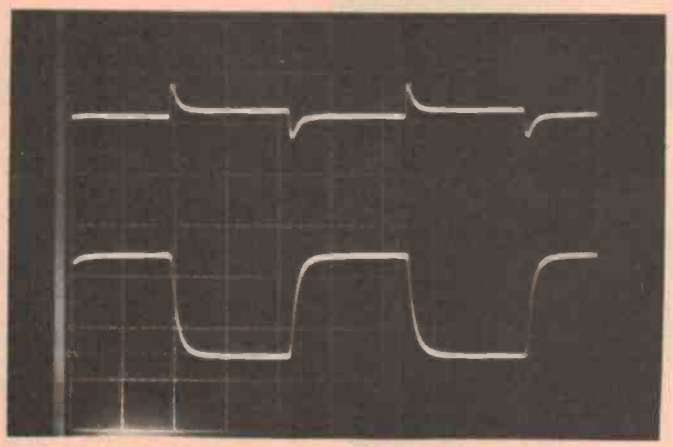
E) Spectrum analyser again. The peak on the left shows the fundamental: 20 kHz, 10 W RMS sinewave from the module. The second harmonic distortion is just visible above the noise (arrowed).



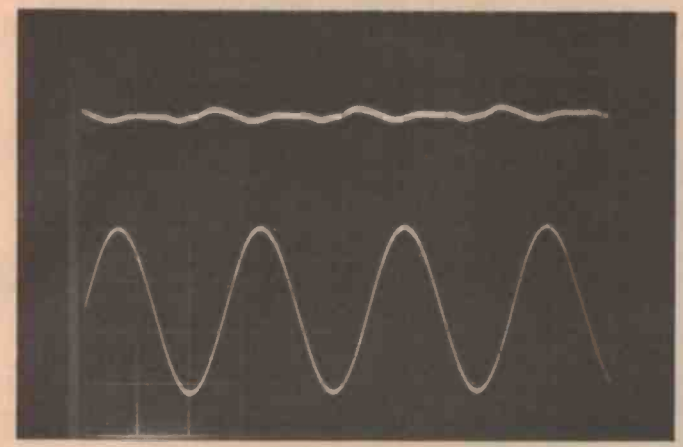
F) Intermodulation distortion proved as difficult to measure as THD, being below the resolution of most test equipment. A 50 Hz sine wave was mixed with a fundamental frequency in a 4:1 ratio. The fundamental was then varied over the audio range. Intermodulation products were not apparent for all frequencies below 7 kHz; i.e: less than 0.002%. This photo shows the IM products produced around a 7 kHz fundamental. Note they are just visible above the noise. This represents an IMD figure of around 0.004%.



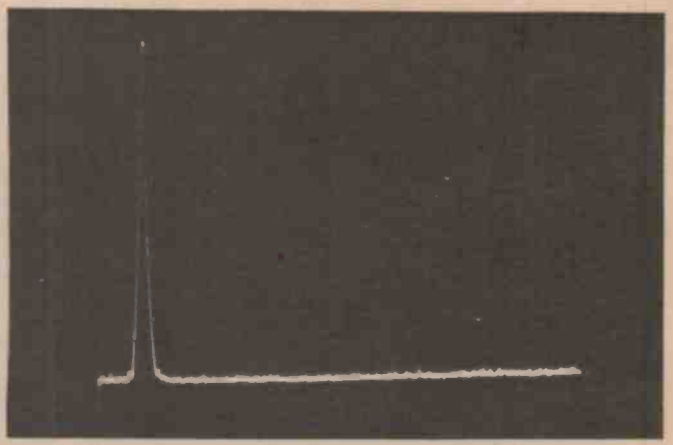
I) Square wave response at 10 kHz. Top trace is the input. The glitch after the rising and falling edges is due to a fault in the square wave generator. The harmonics produced, however, are well above the cutoff frequency of the input RC filter on the module. As a result, the output is a perfect band-limited square wave (lower trace).



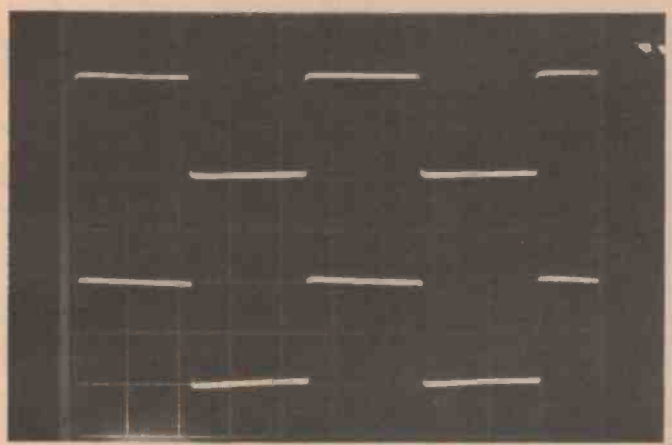
K) Oscilloscope photograph showing the error signal (top trace) in the negative feedback loop in response to a 10 kHz square wave drive producing 20 V p-p into an 8 ohm resistive load. Note that the error signal does not clip. This is a good qualitative indicator that the amplifier is free of transient-induced distortion. Scale for the error signal is 200 mV/division.



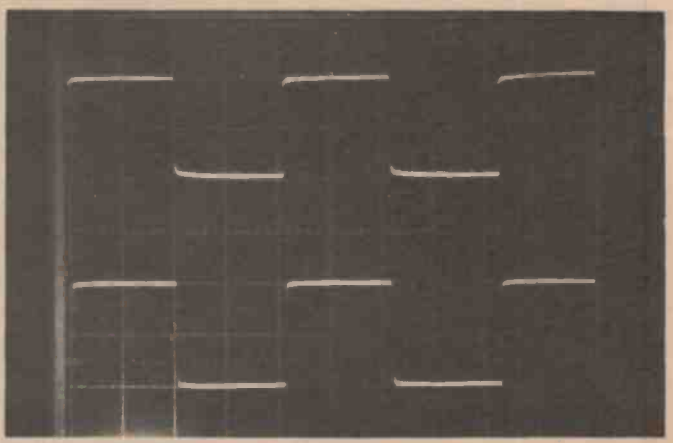
C) Total harmonic distortion, this time at 20 kHz, 10 W RMS output. The amplifier distortion is just becoming discernible above the resolution of the F242A. Note the difference between the distortion waveform shown here and that shown in B. THD here is around 0.004%.



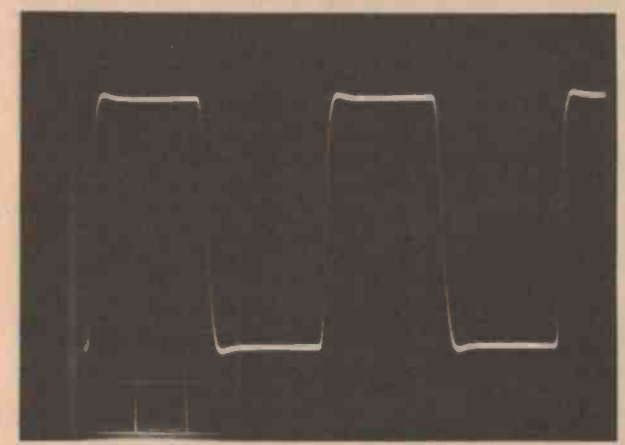
D) In order to measure the distortion products of the module it was necessary to use a Hewlett Packard 3580A spectrum analyser. This instrument can display a dynamic range of 90 dB on screen. The noise on the bottom of the trace here is around 0.002% of the fundamental. This photo shows the fundamental 1 kHz, 10 V RMS input from the module at far left. Notice that the distortion products are not visible above the noise. The THD/frequency curve shown elsewhere was obtained by fitting passive notch filters to the input of the 3580A analyser to increase its sensitivity. The limit of resolution of this technique obtained in ETI's laboratory is around 0.0003%, being the distortion generated by our AWA G233 sine wave oscillator!

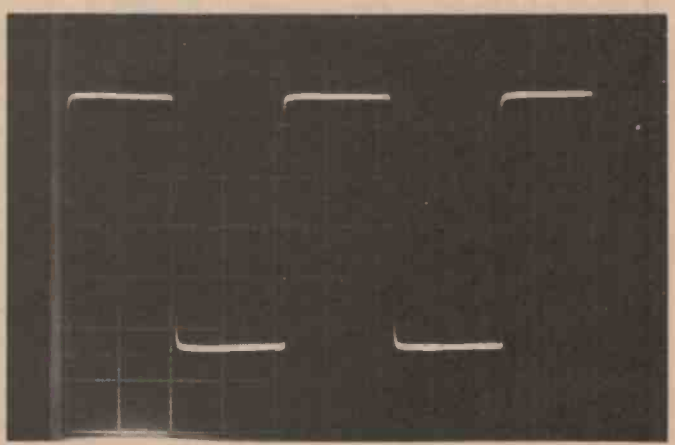


G) Square wave response of the ETI-477 module. Top trace is the 100 Hz input. Bottom trace is the resulting 20 V p-p output into an 8 ohm resistive load. The slight tilting of the output square wave occurs because of the high pass filter on the module's input and is therefore not a fault.



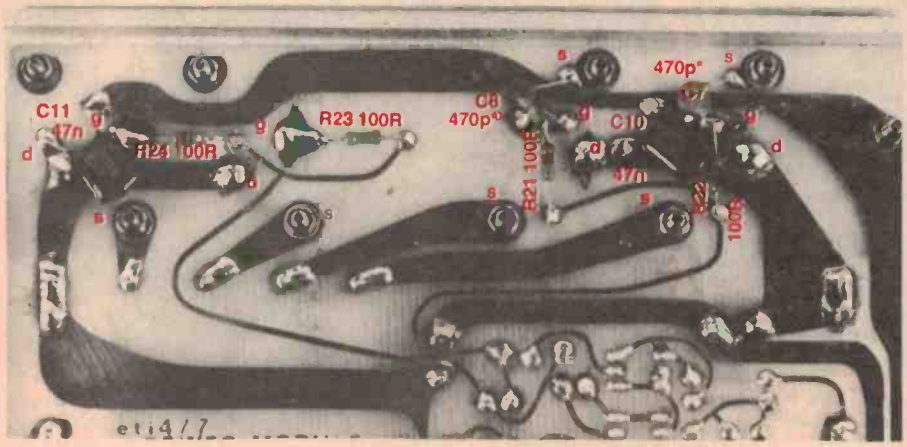
H) Square wave response of the ETI-477 with a 1 kHz input.

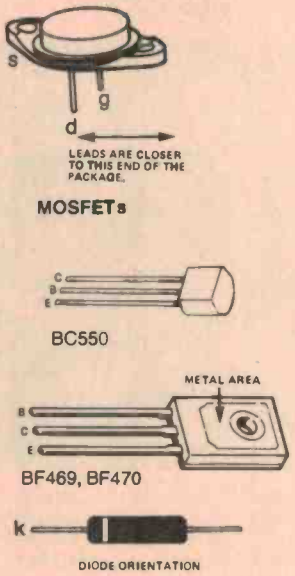




J) Oscilloscope photograph showing the module's performance into a reactive load. At left is the output waveform of the module, driven with a 10 kHz square wave. Output load is 2 uF in parallel with 8 ohms. Note that there is no sign of oscillation or instability. This is a very strenuous test as normally the reactive load would exhibit a series resistance which limits the charge and discharge times for the capacitance.

The photo on the right shows the output waveform from the module, again driven with a 10 kHz squarewave, the load this time being a 3 mH inductor. Again, the amplifier is totally stable.



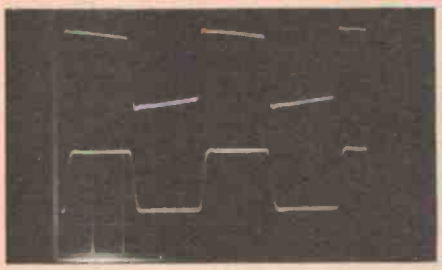


Overlay for the copper side of the pc board showing components mounted on this side.

Construction

The construction of the power amp module is not difficult since all the components are mounted on a single pc board. Since the design employs a fairly large amount of negative feedback, the pc board pattern is a critical factor in attaining the maximum theoretical performance. It would be virtually impossible to achieve the same performance if the pc board pattern were altered, without recourse to a distortion analyser with a sensitivity of at least 0.005% and a very good spectrum analyser. The pc board pattern shown ensures freedom from earth path interaction and therefore does not degrade the distortion performance of the design — but more about that next month.

Commence construction by soldering all the resistors onto the circuit board. The OR22 (0.22 ohm), 5 W source resistors in the output stage get warm if the amplifier is operated for extended periods at high power. They should never get hot enough to burn the circuit board, since any fault capable of causing this much power dissipation should blow the supply fuses first. Nevertheless, it is good construction practice to space these resistors a few millimetres off the surface of the board. The 4.7 ohm, 1 W resistor R29 should *definitely* be spaced off the board since it will overheat if a fault condition should cause oscillation of the amplifier at high frequencies. Do not mount the four 100 ohm resistors R21, R22, R23, R24 at this stage. These are mounted on the rear of the circuit board and are best left until after the MOSFETs are mounted.



L) A more rigorous test shows the magnitude of the error signal with 10 kHz drive giving 20 V p-p output across a 2 uF capacitive load. As before, lower trace is the module's output. The upper trace shows that, as expected, the error signal is much greater than with a resistive load, but still does not clip. This could safely be considered the worst realistic load from the point of view of TIM production. Scale for the error signal is again 200 mV/div.

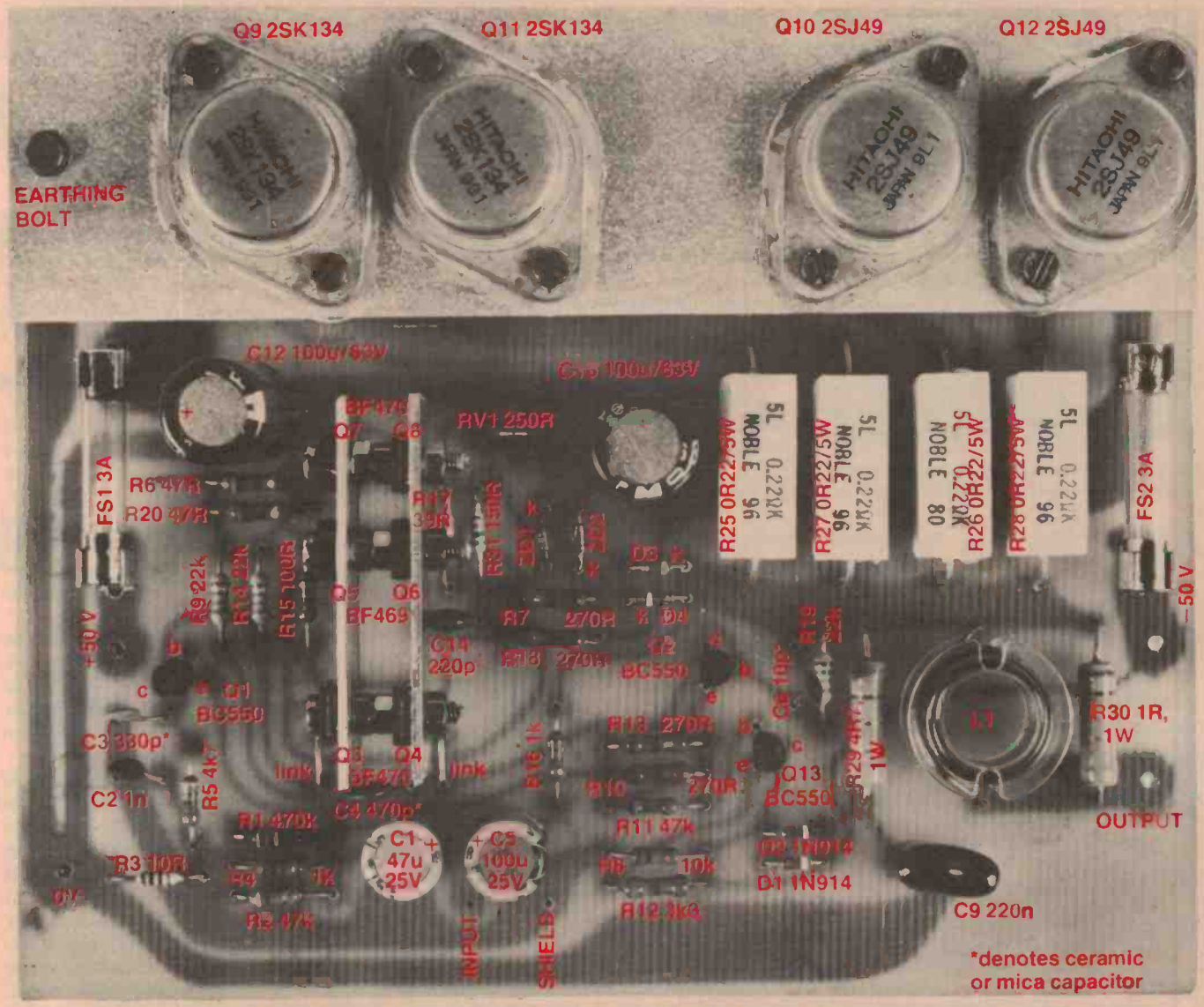
Solder the four pc board fuse clips into the board next. Now mount all of the capacitors, with the exception of C7, 8, 10 and 11. Once again, these mount on the rear of the board. Make sure the electrolytic capacitors C1, C5, C12 and C13 are inserted with the correct orientation as these are polarised components. Mount the 1N914s and zener diodes, taking care to orient them correctly. Solder the trimpot RV1 into place and then the small-signal transistors, Q1, Q2, and Q13.

Next step is to mount the six voltage amp transistors, Q3 through Q8. These are situated on the pc board in two parallel rows, each row with three transistors. In the prototype modules, these heatsinks were constructed from two pieces of aluminium, as can be seen from the photographs. The transistors are mounted using 6BA bolts, each passing through a pair of transistors. This forms a very strong assembly which can then be soldered onto the pc board. Insulating mica or plastic washers should be used between the metal side of the transistors and the heatsink strip, using a small quantity of heatsink compound between each mating surface. When this transistor-heatsink assembly is completed, but before soldering it into the circuit board, check that each transistor is effectively insulated from the heatsink. Using a multimeter on the resistance range, check for shorts between the centre lead (collector) of each transistor and the heatsink strip. Note that the bolts through the six transistors are automatically insulated from the metal rear of the transistor by the plastic body of the device so no additional insulation of the bolts should be necessary.

Before mounting the MOSFET output devices it is necessary to make the heatsink bracket. This is cut from a suitable aluminium extrusion. The pc board has been designed to suit extrusions with one of the sides at least 40 mm wide. The transistor mounting holes have been placed so that the heatsink brackets used in the ETI-466 300 W module are compatible, although there will be some unused holes.

If you are making your own heatsink bracket, drill the holes according to the drilling template and make sure that no aluminium chips or burrs remain around the holes. This is best done with the use of an oversize drill bit (about 13 mm). A couple of twists with the drill bit will put a slight chamfer around the hole and remove any rough spots.

The extrusion used really needs to be selected to be compatible with the particular heatsink that suits your application. Next month we will use two of these modules as the basis for a high quality stereo power amplifier with the▶



Overlay for the component side of the pc board. Artwork for the pc board appears on page 113.

PARTS LIST — ETI 477

Resistors all ½ W, 5%

R1	470k
R2, R11	47k
R3	10R
R4, R16	1k
R5	4k7
R6, R20	47R
R7, 10, 13, 18	270R
R8	10k
R9, 14, 19	22k
R12	3k3
R15, 21 - 24	100R
R17	39R
R25 - 28	OR22, 5 W
R29	4R7, 1 W
R30	1R, 1 W
R31	150R
RV1	250R trimpot

Capacitors

C1	47u, 25 V electro
C2	1n greencap
C3	330p ceramic or mica
C4, 7, 8	470p ceramic or mica
C5	100u, 25 V electro
C6	10p ceramic or mica
C9	220n greencap
C10, 11	47n greencap
C12, 13	100u, 63 V electro
C14	220p ceramic or mica

Semiconductors

D1, 2, 3, 4	1N914 or similar
ZD1, ZD2	12 V, 400 mW zener
Q1, 2, 13	BC550
Q3, 4, 7, 8	BF470
Q5, 6	BF469
Q9, 10	2SK134
Q11, 12	2SJ49

Miscellaneous

ETI-477 pc board; four pc mount fuse clips; two 3 A type 3AG fuses; one plastic bobbin (from P26/16 potcore, or similar); one metre of 0.8 mm dia. enamelled copper wire; two strips of 20g aluminium, each 15 mm wide by 47 mm long (for voltage amp heatsink — see text); 155 mm length of 40 x 12 mm aluminium extrusion for heatsink bracket (see text); assorted nuts, bolts, hookup cable etc.

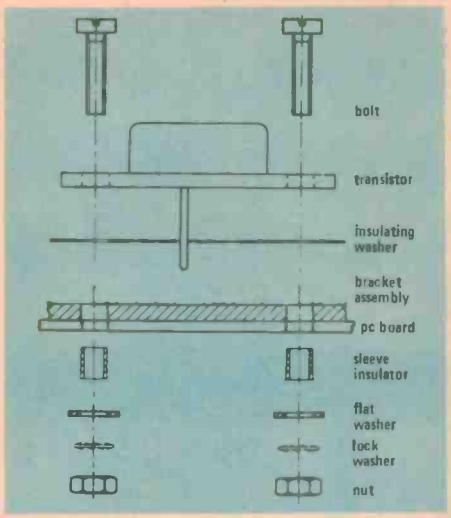
Price estimate

We estimate that the cost of purchasing all the components for this project will be in the range:

$62 - $68

(excluding heatsink and power supply)

Note that this is an estimate only and not a recommended price. A variety of factors may affect the actual price of a project, whether bought as separate components or made-up as a kit.



General diagram for mounting a TO3-cased device to a heatsink bracket and pc board assembly.

final specifications for the heatsink bracket. We will also discuss the problem of power supplies and the special precautions that should be taken to ensure good earthing to obtain maximum performance from the modules.

After the heatsink bracket has been drilled, the MOSFETs can be mounted onto the pc board. The bracket is held in place by the output devices and an 'earthing' bolt that connects the bracket to the 0 V rail (see overlay photo). The bolts holding the MOSFETs in place make the electrical connection to the source of each device, which is connected internally to the case. The bolts must be insulated from the heatsink bracket. Use a piece of spaghetti or heatshrink tubing cut to length such that the bolt will nowhere touch the heatsink bracket (see the accompanying TO-3 assembly diagram). Slip these into the holes in the heatsink bracket before assembling the MOSFETs.

Smear heatsink compound on one side of each of four mica or plastic TO-3 insulating washers and put them in place on the heatsink bracket. Smear heatsink compound on the under side of each MOSFET and put each in the correct place and secure them with bolts.

The output assembly should now be checked for shorts. Remove the earthing bolt first. The resistance between the case of each MOSFET and the bracket should be checked with a multimeter. If any device shows a short to the bracket it should be disassembled and the short found. Usually it is necessary to replace the TO-3 insulating washer as most faults of this type are the result of small metal burrs cutting through the washer when mounting the device.

Once the MOSFETs are mounted, the last passive components — resistors R21, R22, R23 and R24 plus capacitors C7, C8, C10 and C11 can be mounted on the rear of the circuit board. These are positioned on the rear of the board so that lead length is kept as short as possible. Cut the leads just short enough to mount the components in place. The accompanying photograph shows a close-up of these components on one of the prototype modules.

Set-up procedure

The recommended supply voltage for the modules is around +/− 55 V. With this voltage and reasonable supply regulation, the module will deliver around 100 W RMS into a nominal 8 ohm load. The power supply will be dealt with in more detail next month, but before applying power to the modules the following set-up procedure should be carried out.

First, re-check that the output devices are not shorted to the heatsink bracket. This is best done with the earthing bolt removed as mentioned earlier. If no shorts are found, replace the earthing bolt.

Do the same check for shorts between the six voltage amp transistor collectors and their heatsinks.

Check the polarity of all polarised components. It is often difficult to tell one end from the other on diodes since the markings are easily rubbed off. If in doubt, check these with a multimeter. Wind the wiper of the trimpot RV1 fully *counterclockwise* (least resistance). This ensures no bias is applied to the output stage. Now, remove the fuses from the pc board if they have been fitted and replace them with 10 ohm, ½ W resistors.

The module can now be connected to a power supply.

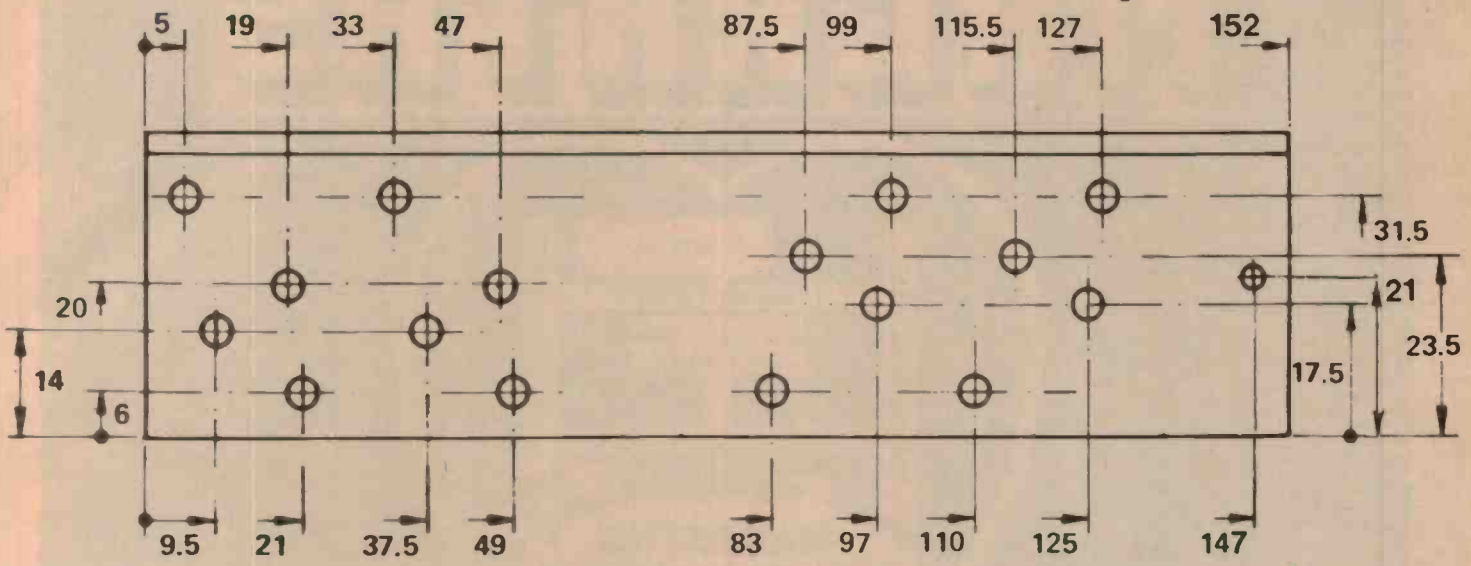
Make sure the power supply connections are sound, with good solder joints. If you have access to a current-limited bench supply it is best to connect the module to this for the set-up and initial test. If you can do this, set the current limit to around 200 mA. *Do not* connect a load to the output of the module at this stage.

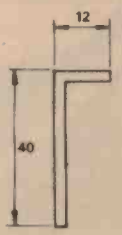
If the power is now turned on, the current through the two 10 ohm resistors replacing the fuses should be low. If these resistors start to smoke, this indicates a fault condition — turn the power off immediately.

If all is well, connect a multimeter across the 10 ohm resistor in the positive rail fuse holder and slowly wind the trimpot RV1 clockwise until the voltage measured is 1 V. This will set the bias current in the output stage at 100 mA. If the current sets up correctly, measure the voltage between the speaker output and 0 V on the power supply. You should see around ±25 mV. If you only have an analogue multimeter, this voltage may be too low to measure; in this case it is sufficient to show that the output is at 0 V.

If there is a fault in a direct-coupled amplifier like this, the output will usually be driven hard toward one of the supply rails and this is the reason the load should not be connected until these initial tests are done. Remember that 50 Vdc across an 8 ohm load equals a power dissipation in excess of 300 W, which would instantly destroy any loudspeaker!

If the module passes all these tests, it is safe to replace the fuses and connect a load. Make sure the power is off before removing the 10 ohm resistors from the fuse holder and allow time for the power supply electrolytics to discharge. There is 100 V between the fuses and *this is sufficient to cause electrocution.* Be *careful* when working with high power amplifiers. ●





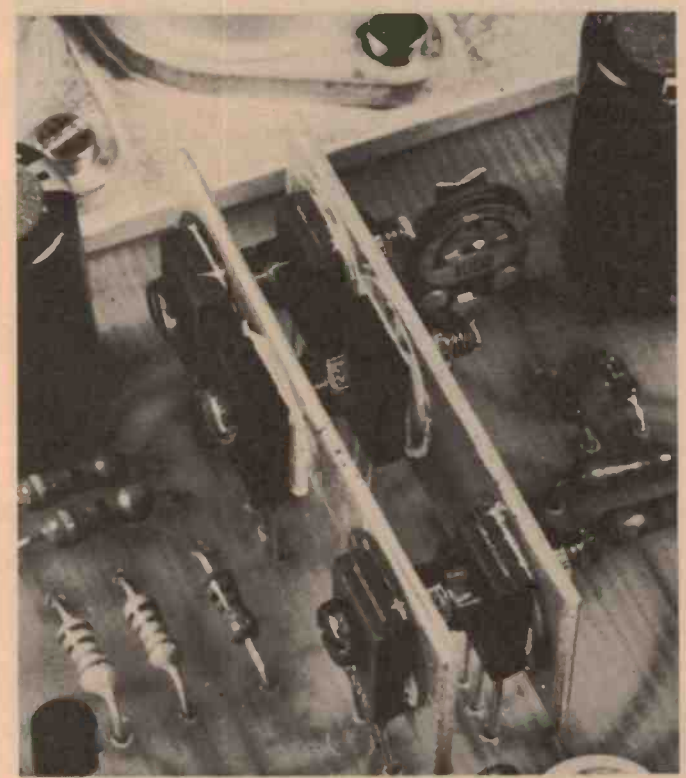
ALL 4mm DIA

MATERIAL 40 x 12 x3 ALUMINIUM ANGLE EXTRUSION

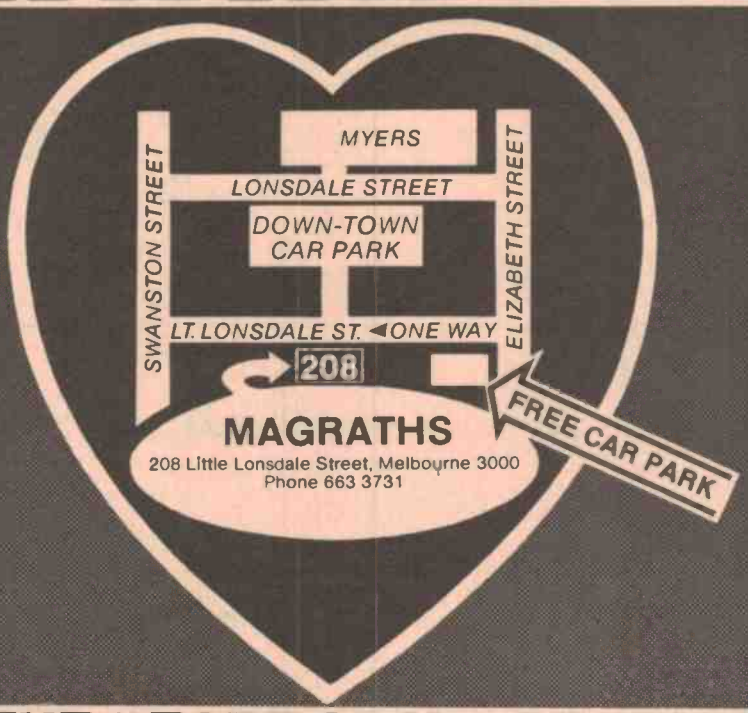
Drilling details for the heatsink bracket assembly. All dimensions are in millimetres. Suitable aluminium angle stock is available from Alcan Handyman stores.

Next month we describe how to attach a power supply so as to achieve the performance we obtained along with a complete description of how to build a stereo power amplifier. This will use a heatsink as a front panel, manufactured exclusively for ETI — don't miss it.

View of the voltage amp transistors and heatsinking assembly. In the prototypes we used two 20g strips of aluminium, each 47 mm long by 15 mm high. This is the minimum size we would recommend and brackets measuring 50 mm long by 30 mm high are preferred. Centre-to-centre drilling dimensions can be taken from the pc board (page 113), measuring between the collector pins of each transistor.



MAGRATHS



IN THE HEART OF MELBOURNE

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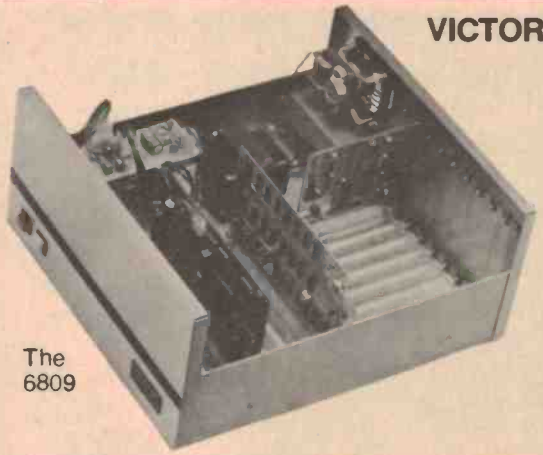

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See below for full details of this exciting new kit!
Individual Special Parts:
PCB (f'glass) ..... Cat H-8386 $9.95
Power Mosfets (2SK133 & 2SJ48 pr) .. Cat Z-1815 $15.00 pr

CYLON VOICE (See EA January)
PCB ..... Cat H-8387 $2.50
XR-2206 IC ..... Cat Z-6820 $5.50
All other parts are normal stock lines

AUTODIM (See EA Jan)
PCB (avail mid Jan) ..... Cat H-8388 $3.50
All other parts are normal stock lines

ETI MOSFET AMPLIFIER MODULE (See ETI January)
PCB (available mid January) ..... Cat H-8633 $9.95
Power Mosfets (low cost medium power types, as above) ..... Cat Z-1815 $15.00 pr

SELECTALOT (See EA December)
PCB ..... Cat H-8384 $3.00
All other components are normal stock lines

AC MILLIVOLTMETER
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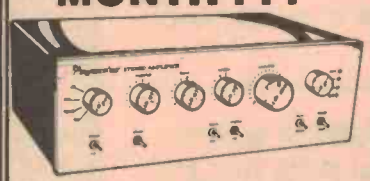
SYSTEM 80/TRS80 INTERFACE (See EA Nov)
PCB ..... Cat H-8383 $1.90
All other components are normal stock lines.

PLEASE NOTE: ABOVE PROJECTS AND PRICES ARE SUPPLIED FROM MAGAZINE'S ESTIMATES ONLY.

COMING NEXT MONTH . . .



This is it: the superb new Playmaster Power Mosfet Stereo Amplifier, as described in the current issue of Electronics Australia. It's the latest in the incredibly successful series of Playmaster amplifiers (over 10,000 Twin 25's & Forty/Forty's built!) but this one really has everything:

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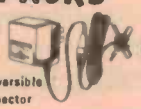

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CAIRNS, QLD: Thompson Instrument Services, 79-81 McLeod Street. Phone 512 404
COFFS HARBOUR, NSW: Coffs Harbour Electronics, 3 Coffs Harbour Plaza, Park Ave. Phone 525 684
DARWIN, NT: Kent Electronics, 42 Stuart Highway. Phone 814 748
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ROCKHAMPTON, QLD: Purely Electronics, 15 East Street. Phone 21 058
SOUTHPORT, QLD: Amateur's Paradise, 121 Nerang Street. Phone 322 644
TAMWORTH, NSW: Sound Components, 78 Brisbane Street. Phone 661 363
TOOWOOMBA, QLD: Hunts Electronics, 18 Neil Street. Phone 326 944
TOWNSVILLE, Qld: Tropical TV, 49 Fulham Rd, Vincent Village. Phone 791 421
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WINDSOR, NSW: Hawkesbury Electronic Centre, 111 George Street. Phone 773 411
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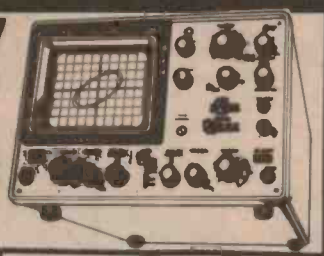

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Cat Q-1242

DICK'S OWN BUDGET CRO FOR HOBBYISTS!

Want a quality CRO at a budget price? We've sold hundreds of this quality 6.5MHz CRO — ideal for hobbyists or the service bench.

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COMPARE THE PRICE ELSEWHERE!!!

Cat X-1230

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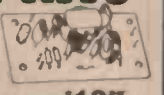
9kHz WHISTLE FILTER



Get rid of those annoying inter-station whistles from your tuner. This 9kHz whistle filter is just the thing to do it. Easily added to most hi fi amplifiers, suits the new station separations.

Cat K-3496

~~$19.95~~ **$14.50**

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A really versatile mixer, ideal for all sorts of applications, including movie sound! Has autofade, VU meter & tone controls. Really professional!

Cat K-3497

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MORSE KEYER

For really fast Morse code speeds, most amateurs use a Keyer. Until now, it was those who could afford them! Build your own and save a fortune! Has inbuilt monitor, variable speed, etc. A bargain.

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MORSE TRAINER

Know someone who wants to learn Morse? Maybe even you? Build this simple and economical code practice oscillator. Code is printed on top of lid — so it's easy to learn! (Key extra).

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FREE DATA SHEET AVAILABLE FOR THESE FLASHING LEDS

Yes, Flashing LEDs! An amazing breakthrough in technology has placed a tiny integrated circuit INSIDE the LED: so it flashes all by itself! And we have a specially prepared data sheet giving the LED specifications, plus 7 experimenter's circuits using them in different ways; even ways to make a conventional green LED flash alternately with the red flashing LED! (Data sheet available at all stores)

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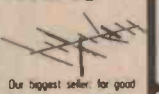
ALL-CHANNEL TV ANTENNAS

With the new channels in Sydney & Melbourne, you're probably finding the old antenna just isn't up to scratch. Fix the problem yourself at a fraction of commercial installation costs: with a new all-band antenna from Dick Smith.



Our biggest seller, for good 0-2-7-9-10 reception in metro & near fringe areas.

Cat L-4022

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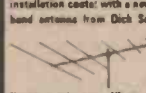
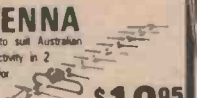


The big gun for more difficult areas. 75 ohm. Use co-ax or twinlead. Cat L-4030

$54.50

UHF ANTENNA

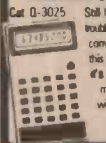


Specially made for Dick to suit Australian standards. Adjustable directivity in 2 directions: very important for good UHF reception. Uses standard 300 ohm ribbon, too. Cat L-4028

$19.95

NEW! TWO NEW BARGAIN CALCULATORS:

LCD METRIC CONVERSION CALC.



Cat Q-3025

Still having Metric troubles? Work out conversions with this beauty. And it's also a great memory calc, with auto shut off too!

$19.95

BUDGET POCKET/PURSE CALC.

A bargain for pocket or purse. Batteries last for ages, auto switch off.

Cat Q-3015

$9.95

A MUST FOR EVERY KIT BUILDER . . .

Do you suffer from burnt fingers when soldering PCB's? Your troubles are over with this unique soldering station from Dick Smith. Not only does it hold the PCB firmly and securely at any angle you want it, your roll of solder and soldering iron are also within easy reach. It's mounted on a heavy cast base so it won't tip up, leaving you both hands free to concentrate on the assembly job.

Once you've used it, you'll wonder how you ever soldered PCB's without it!

Cat T-5700

$19.50

WANT TO KEEP SOMEONE AMUSED OVER THE HOLIDAYS?

Here's a great idea: and it won't break the bank, either. Give them a copy of 'Dick Smith's Fun Way Into Electronics' — there are two volumes to choose from. Even complete beginners can build **safe** electronic projects that **actually do something!** And when they go back to school, they're all ready for school projects as well! Elsewhere in this magazine there's a full page showing you both the 'Fun Way' books and the kits. Check it out: you could solve those holiday boredom problems very easily — and start your youngsters off on a career in electronics!

STRICTLY LIMITED STOCK!

'COGNIVOX' FOR THE SORCERER: NOW OVER $20 OFF!

'Cognivox' is a unique accessory for your 16K Sorcerer. Imagine being able to play a video game by calling out your moves — and just as easily the computer can talk back to you! For the first time speech recognition and voice response are combined in a single low cost voice I/O terminal! You get the hardware necessary (including microphone and audio amplifier/speaker); plus a the basic driver program, two applications program packs (8 programs), two sophisticated voice operated video games, plus a talking calculator program (converts your Sorcerer into a four function floating point calculator that talks!)

Incredible? Well until you try it out!!!

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~~WAS $199.00~~

NOW ONLY $175.00!!!

Dear Customers,

Quite often, the products we advertise are so popular they run out within a few days. Or unforseen circumstances might hold up goods so that advertised lines are not in the stores by the time the advert appears. Please do not blame the store manager or staff: they cannot solve a dock strike on the other side of the world, or even locate a shipment that has gone astray.

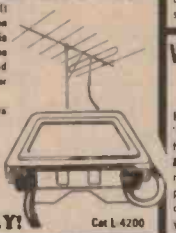
What we are trying to say is that, if you're about to drive across town to pick up a particular line at a Dick Smith Store, why not give the store a ring first (addresses and phone numbers below)... just in case! Thanks.

Dick Smith and Staff

NOT ENOUGH TV OR FM SIGNAL? AMPLIFY IT!

Add a masthead amplifier. It could be the difference between good reception and zilch! This is NOT a kit: ready to install (anyone can do it), includes the masthead amplifier itself, plus mains power supply to suit.

Large range of other TV antenna accessories also available.



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INCLUDES POWER SUPPLY!

Cat L-4200

WOULD YOU LIKE TO WORK WITH US?

Dick Smith Electronics is expanding — if you've been watching your local press you'll probably have noticed this already!

Opening new stores requires new staff. Good staff. Electronics enthusiasts who can be trained to become professional sales people and managers.

If you're talented and enthusiastic, we offer good wages and conditions. If you're above average, promotion can be very rapid. (One of our salesmen became general manager three years later!)

No matter what area you live in, if you'd like to work with us, drop us a line. When we open a store in your area, we'll be in touch . . .

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PO Box 321,
North Ryde, NSW 2113

A 600 MHz DFM UNDER $200?

Cat D-3000

Sounds almost impossible to believe? Yes, a beautifully made, 7 digit 600MHz digital frequency meter for less than you paid for your 100MHz version last year! Battery operated, (use Nicads if you like), highly accurate, and tiny: fits into one hand! Hurry, strictly limited stock of this item — don't say you weren't warned!

YES! ONLY $199!

Ni-cad batteries (4 req) Cat S-3300 $2.05 ea

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JUST RELEASED! FULLY APPROVED 'PHONE ANSWERING MACHINE

Imagine! A FULLY APPROVED telephone answering machine UNDER $200!!!

Yes! Dick Smith now has this superb telephone answering machine, fully approved by Telecom Australia for connection to Telecom phone lines, at a true Dick Smith Direct Import Price. Don't pay $300 or more — now every business, every busy person can afford a telephone answering service. Here's what it does:

- Greets incoming calls with your own prerecorded message.
- Allows callers to record their own message to you
- Allows you to monitor incoming calls without 'answering' unless you want to!

BUT THAT'S NOT ALL!!!!

With the optional 'Remote Beeper' you can actually dial your number from any other phone and listen to any messages that have been recorded! Imagine how handy that would be for busy people on the move: you can capture important calls without having to go to the office!

ANSWERING MACHINE: (Cat X-2173) **$199.00**

REMOTE BEEPER (Cat X-2174) **$39.00**

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die-cast box!

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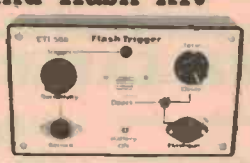

ETI 4000 amp cases

Choice of two deluxe cases to house your ETI 4000 amplifier.

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Affordable audio with ETI modules!

ETI 470 module

This superb module out-performs anything else for a simple to built, economical, high performance 60W amplifier. Just add power supply, heatsink and a case of your choice to build a high performance amplifier.

only **$29.90**

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High performance preamp/control unit is the perfect mate for the ETI 470 amp. All parts mount on the PCB for the ultimate in easy construction. module only **$47.90**

ETI 471 power supply

Complete power supply for a pair of 470s and a 471. Three versions to suit any needs and budget.

with standard transformer $47.90
with 'C-core' transformer $57.90
with Toroidal transformer $79.00

Toroidal transformer

As used in 471 power supply above. Also suits ETI 480 or any amp needing ±40V rails.

$59.90

Dual power supply

Perfect for preamps, equalisers or for experiments with op amps. ±15V output. Just add transformer **$9.50**

Speaker protector

ETI's proven 455 design. Stereo. Ideal for use with higher powered amps like the 470 series.

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Suits virtually any power amp needing 1V drive. Three band tone controls for the flexibility needed for guitars, keyboards etc. PC board and all parts except power transformer.

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NEW 150W MOSFET Power Module

Now you can build a high power amplifier that compares with the best commercial unit. Using the latest MOSFET power transistors, this unit can produce up to 150W rms (on ±70V rails) at a distortion level of 0.0005%! Yes, three zeroes! Because of the FETs inherent thermal stability, this amp is incredibly reliable—without elaborate protection circuitry. Kit includes fibreglass PCB, all parts and pre-drilled heatsink bracket. Heatsink and power supply are additional. See Jan ETI for full details on this superb module.

$59.90

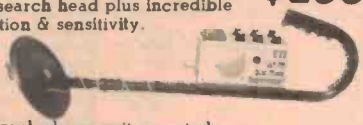
NEW pH meter

3½ digit display, easy to build pH meter. Ideal for pool or fish tank water testing, or lab use.

$79.50

NEW amazing metal detector only $199

Join the gold rush with this incredible discriminating metal detector project from ETI. Features 4 mode operation, ground balance pre wound search head plus incredible penetration & sensitivity.



NOTE:
photograph shows unit mounted on handle which is not supplied in the kit.

Own a microwave?

This simple to build kit checks any microwave oven for harmful leaks. ETI 724.

Complete kit only:
$14.95.

Engine Analyser kit

Keep your car in tune and save fuel. This unit measures RPM, dwell and battery voltage on any 4, 6 or 8 cylinder petrol engine.

Complete kit **$55.50**

NEW wideband receiver kit

Four ranges from broadcast to 30MHz. Complete kit (see EA Nov 1980 for details). only:

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NEW Utilux line connectors

This series of multi-way line connectors is just the thing for wiring looms in amplifiers, power supplies—in fact just about anything. And look at these prices! All are sold as a plug & socket pair. 2-way 75c; 3-way 98c; 6-way $1.40; 12-way $1.50. They're so new we don't even have a picture!

build these superb speakers & save!

The ETI 4000 speakers have set a new standard for build it yourself audio.

Complete kits (all speakers, crossover etc.)

ETI 4000/1 4 way. **$459** pair.
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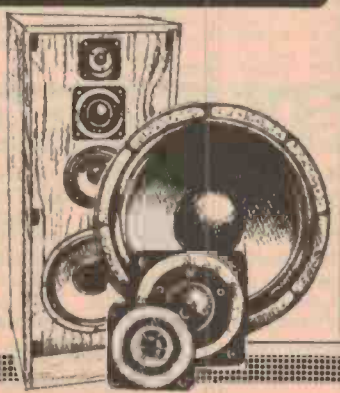
Cabinets.
Fully assembled & veneered.
For 4000/1 per pair $300.00 For 4000/2 per pair $200.00
Note "Freight on" only



We at Electronic Agencies believe that we have the best range of kits in stock in Australia. This page shows just a few of the proven designs we carry. All kits include fibreglass PC boards at no extra cost, all parts and full instructions.

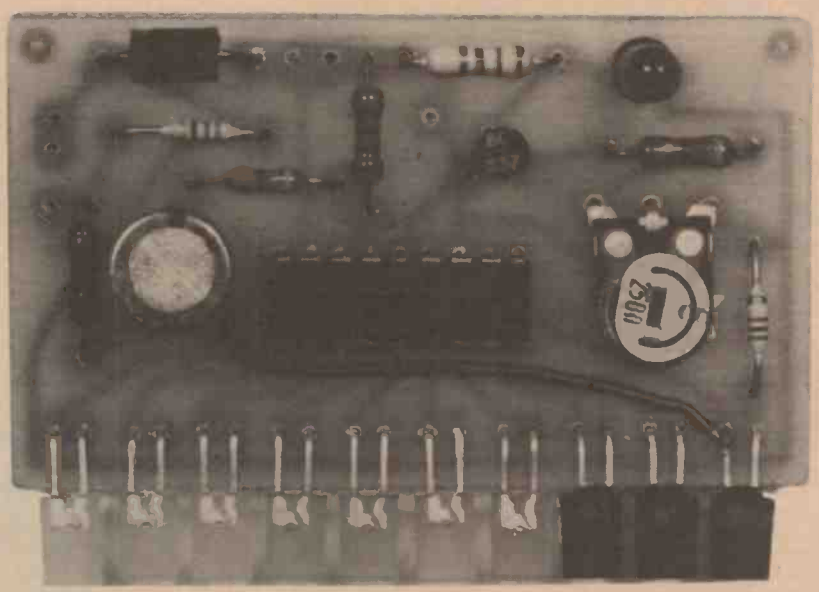
DEAR CUSTOMERS, Please phone us before coming in to check that what you're after is in stock and that the price is correct.
Bill Edge and staff.

Project 328

Build a LED oil temperature meter for your vehicle

Knowing your engine oil temperature can be very valuable, this instrument employs a readily available dipstick probe with a thermistor mounted in it as a sensor and displays temperature on a row of LEDs.

Phil Wait
Simon Campbell



JUST AFTER WWII, one of General Motors' vice-presidents located a virtually brand-new Bugatti Royale — one of Europe's most sought after collector's vehicles and of which a mere thirteen had been made. This example had run less than a hundred kilometres since new and had been stored throughout the war.

When the engine was subsequently stripped down *it looked totally worn out.* Every single bearing surface was damaged beyond belief.

Ten years later, GM's Bedford truck division began an extended study into similar phenomena. A striking example was two truck fleets running similar vehicles but in dissimilar service. Fleet 1 was in long distance haulage (London-Edinburgh) and averaged 500 000 km. Fleet 2's business was house-to-house coal deliveries in London's suburbs. Their record was *less than 20 000 km* between major overhauls!

In the case of the Bugatti and Fleet 2, the mechanical carnage was caused by acid build up in the vehicles' sumps. The wear was *chemical* not mechanical.

How it's caused

When a petrol engine is switched off, a quantity of unburnt and partially burnt fuel remains in the combustion chambers. This condenses on the cylinder walls and drops down into the oil in the sump. This condensed fluid consists mainly of water and sulphuric acid.

The acid content is boiled off when the oil exceeds 80°C (176°F). But if that temperature is not reached and maintained for at least some minutes (or if acid-diluted oil is left in the engine for extended periods) engine longevity will be massively reduced.

For most commuters the problem tends to be oil that's running too cool rather than too hot. Only too often an engine that appears to use no oil is simply having a regular top-up with acid!

If your vehicle usage is limited to short runs there's not a great deal you can do about it except be aware of the problem. If you care about it sufficiently, take the car for a good long run (at least 40 km) at least once a fortnight — or at least change the oil every second month regardless of distance driven. At least you now know why cabs regularly exceed 300 000 km between engine changes!

Too hot

Apart from its lubricating function, engine oil 'washes' heat from engine components. Its ability to do this decreases rapidly beyond 135°C (275°F). There is also evidence that some multi-viscosity oils revert permanently toward the lower end (i.e: thinner) of their range of viscosity if overheated.

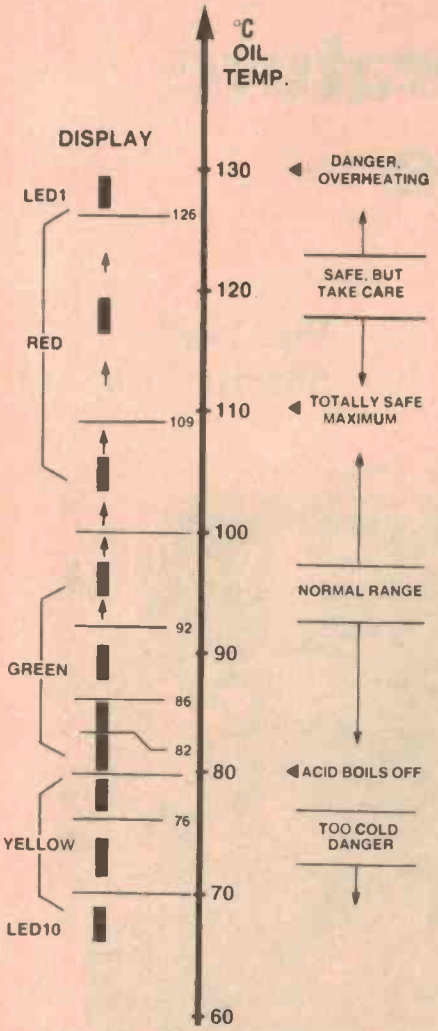
The *totally safe* oil temperature for continuous running is 110°C (230°F). Some oil companies quote 132°C (270°F) as an absolute maximum. Our Managing Editor's own experience (whilst with GM) is that, with the exception of air-cooled engines, 125°C is safe for continuous operation.

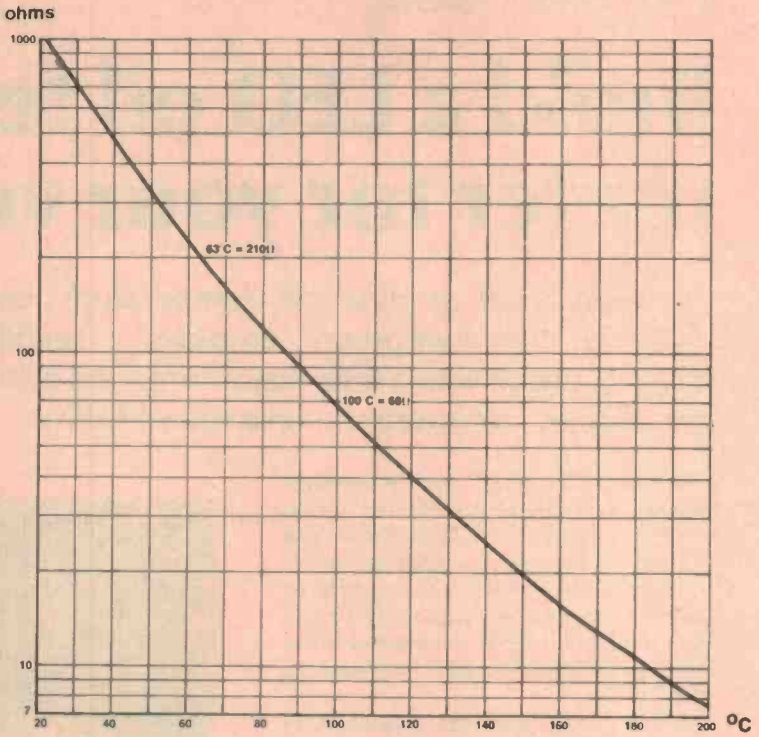
Few modern vehicles suffer from overheated engine oil (transmission fluid is something else again though!) A notable exception is some VWs (particularly Kombi versions) — few can be driven hard in an Australian summer without severe oil overheating and the risk of consequent severe engine damage.

Overheating engine oil is simpler to cure than oil that's insufficiently warm. Simply add an oil-cooler; obtainable from most specialist parts suppliers.

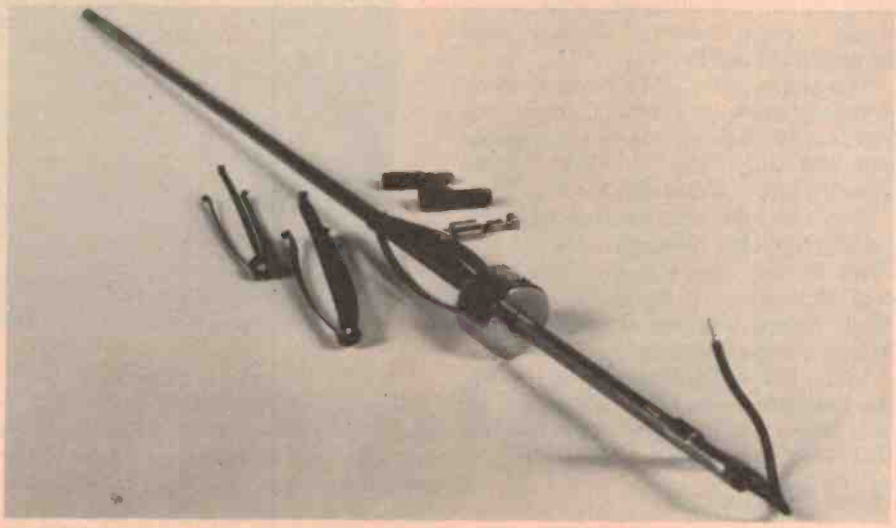
A monitor

Most cars these days, with the exception of Volkswagens, are fitted with some sort of water temperature indicator. Often this is no more than a warning light which hopefully never comes on during the life of the vehicle, and if it ▶





Calibration curve for the NTC thermistor in the dipstick probe.



The V.D.O. dipstick probe with its associated parts. Full assembly details are given on page 43.

does it's probably too late to avoid some engine damage.

Since the coolant temperature is controlled by the car's thermostat and radiator it is not a good indication of oil temperature, or true engine temperature.

Monitoring the oil temperature is a much better indication of the engine's operating temperature but the problem is how to measure it. Any temperature probe will have to be inserted deep inside the engine or through the sump. Accidental loss of oil caused by the sensor falling out would be *catastrophic*, not to mention very expensive. The most practical way to insert a probe into the engine is through existing holes, such as the sump plug or the dip stick hole. In fact, VDO instruments make thermistor sump plugs and dip stick probes for use with their oil temperature meters.

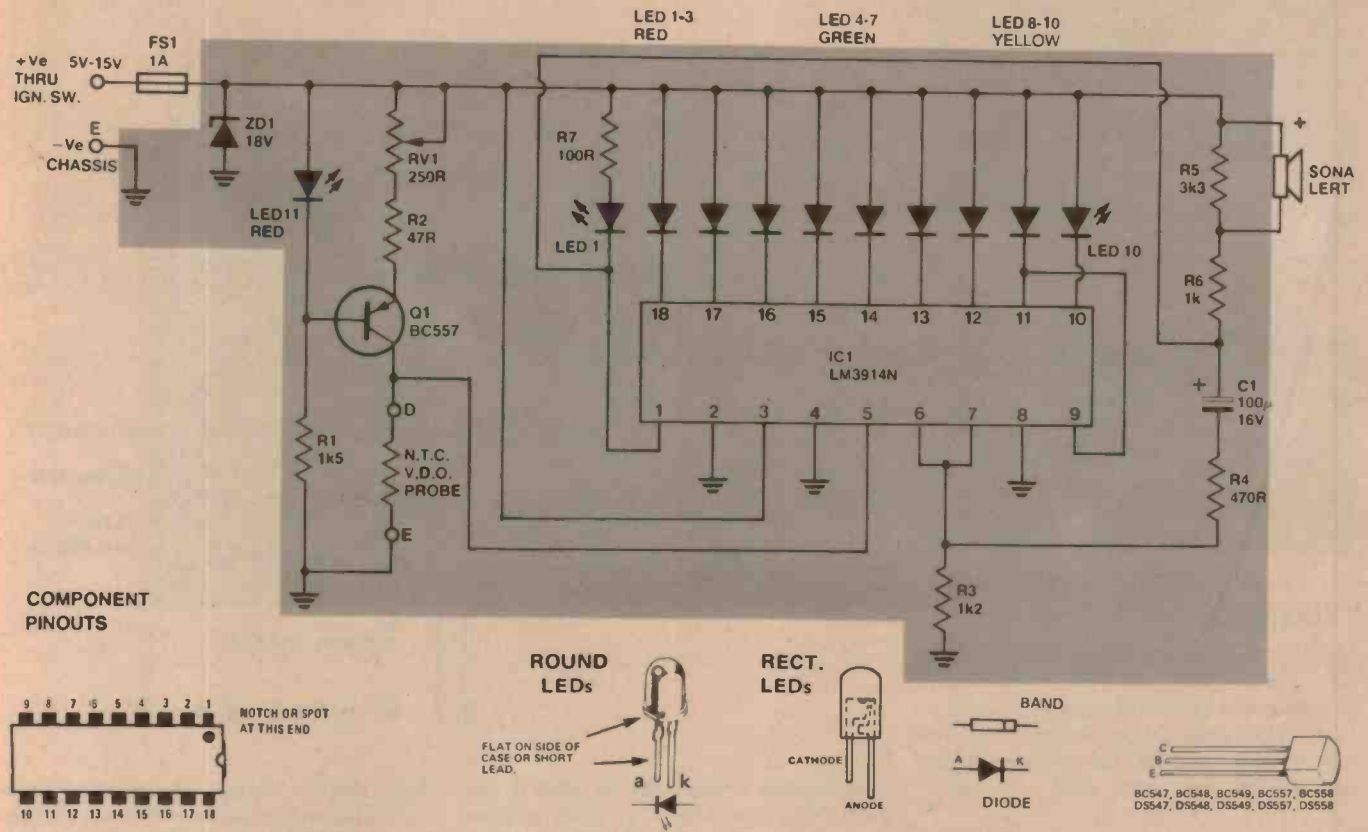
We have chosen the VDO dipstick probe for our project as it is easy to install without having to drain the sump, and the wiring to the probe is well protected in the engine compartment. The last thing you want is a heavy-fisted mechanic tampering with wires to the sump plug every time the coil is changed.

By the way, we *strongly suggest* you don't try to make your own dipstick probe as there is too much risk of something falling off with the severe vibration and temperature changes experienced inside the engine.

The temperature display employed in our project uses ten LEDs in a 'dot' mode (single LED lit at a time) bargraph display and is designed as a matching instrument to our LED Expanded Scale Voltmeter (ETI-326, September 1980). The display covers the range 70°C to 126°C with the first LED lit at temperatures below this range and the last LED remaining lit above this range as well as sounding an optional piezo audio alarm. Yellow LEDs are used for the 'cold range' to 80°C, when acids remain in the oil. Green LEDs are used for 80°C - 100°C in the normal operating range and red LEDs are used for the 'hot' range above 100°C. As we mentioned previously, some engines operate safely up to 110°C and may light the first red LED.

The instrument is easily calibrated by adjusting a trim potentiometer for a reading of 100°C when the thermistor probe is placed in boiling water. Water boils at very close to 100°C at sea level.

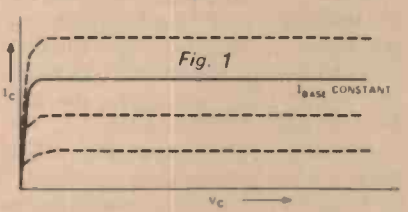
oil temperature meter



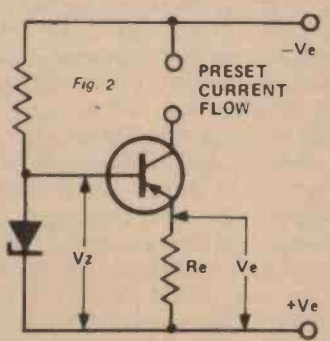
HOW IT WORKS — ETI 328

The circuit consists of a thermistor temperature sensor in a dipstick probe driven by a constant current source, the voltage across the thermistor, which is proportional to the oil temperature, being sensed and displayed by an LM3914 LED bargraph driver chip. The display is a series of ten LEDs, the LM3914 being operated in the 'dot mode' so that only one LED lights at a time.

The LM 3914 is operated at maximum sensitivity, as a 0 - 1.2 V voltmeter, with ten display steps at 120 mV intervals. An alarm function (optional) is provided by a piezo audio alarm driven from the LED that indicates the highest temperature. Reverse polarity and overvoltage protection are provided by the zener diode, ZD1.



First, let's see how a constant current source works. Transistor Q1 and associated components provide the constant current source for the probe. Figure 1 shows the collector characteristics of a typical silicon transistor. They show that, if you hold the base current constant, the collector current will remain substantially constant for a widely varying range of collector voltage. Figure 2 shows the general circuit of a constant current generator. The voltage between the base and the emitter return (common, the +ve supply line here) is fixed by the zener diode. Thus, the voltage across the emitter resistor (Ve) is fixed at a value equal to the zener voltage (V_z) minus the base-emitter voltage drop of the transistor (0.6 V for silicon transistors). With a fixed voltage across R_e, the current through it will be constant. Thus, the emitter current, and therefore the collector current, of the transistor will be constant. The resistor supplying current to the zener is generally chosen so that zener current is five to ten times greater than the base current of the transistor.



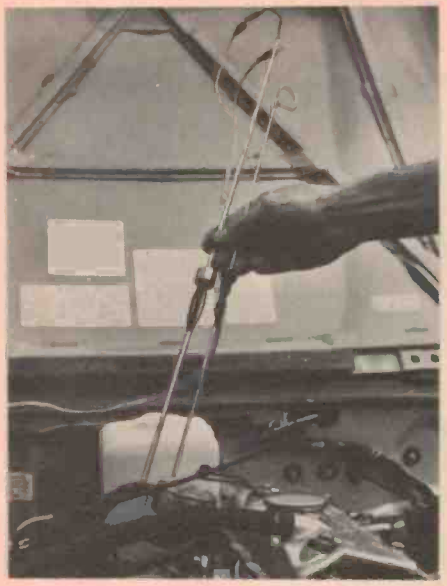
With this circuit, so long as there is about one volt between the emitter and collector, the collector current will remain constant at the chosen value until a load of too large a value robs the collector of its working voltage.

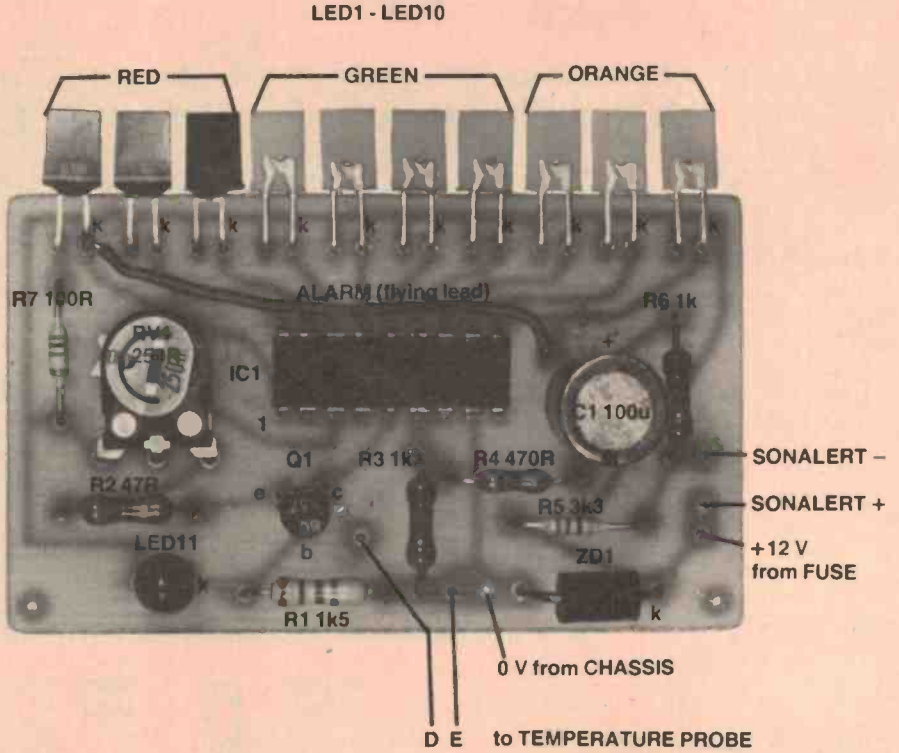
In the project circuit diagram, a LED (LED11) is used instead of a zener diode. The forward-voltage drop of a red LED is about 1.6 V and thus the base of Q1 is 'clamped' at about 1.6 V below the positive supply rail. Thus, the voltage across R2 and RV1 will be 1.6 V less the base-emitter junction drop of Q1, about 0.6 V, leaving 1 V. Thus, with RV1 at minimum resistance, the emitter current (and thus the collector current) through Q1 will be close to 20 mA. With RV1 at maximum, it will be about 3.4 mA, giving a range of about 6:1 variation which is more than adequate for calibration, yet provides a smooth adjustment.

As the temperature of the probe increases, the thermistor resistance will decrease. Since the probe is driven with a constant current, the voltage across the probe decreases linearly with its resistance and independent of supply voltage fluctuations. The temperature scale resulting is non-linear however, because the resistance variation of the thermistor in the probe is not linearly related to temperature. A graph has been provided in the main text.

The temperature range of the instrument, and therefore the calibration, is set by adjusting the current passing through the probe by means of RV1.

A complete description of the operation of the LM3914 was provided in the article on the Expanded Scale LED Voltmeter, ETI-326, published in the September 1980 issue of ETI.





Construction

Construction of the unit is simple and straightforward, but take a little care juggling the LEDs into place. In fact, it is best to commence construction by mounting the LEDs. We used rectangular LEDs for our unit, however, conventional types may be used if you wish. Note that there are three yellow, four green and three red LEDs.

The easiest way to ensure correct insertion of the LEDs is to place them on a table in front of you with all their leads oriented just as they are to be mounted in the board. Insert the first LED (red if you're working from left to right with the LEDs facing away from you), but don't solder it in place. Position it so that when you bend it over, the base of the LED comes flush with the board. Don't fumble this and attempt it twenty times or you're likely to end up with very short leads on your LED! When it's right, solder the leads in place and bend it back upright. This LED then becomes a guide for the correct lead length of the others. Insert the rest one by one so that they line up with the first LED and, when the row is finished, bend them all over and they should all lie flush with the edge of the pc board. Refer to the overlay photograph.

The rest of the components can be mounted, taking care with the orientation of the LM3914, Q1, LED11, the electrolytic capacitor and zener diode. The alarm lead is a length of insulated hookup wire, soldered directly to the cathode of the last red LED (see the overlay).

Calibration

When construction is complete, the display requires calibration. Basically, this involves putting the probe in boiling water and adjusting RV1 so that the required LED lights. The display can be adjusted to cover a variety of temperature ranges, but we found the range shown to be the most useful.

Calibration is best done away from the vehicle, mainly for convenience. You'll need some place to boil water and a power supply, nominally 12 Vdc, to power the unit. Connect the thermistor dipstick probe and the power supply but keep the probe out of the water to start with. When you apply power, the first yellow LED should light. Hold the end of the probe in the boiling water, but not too close to the bottom of the vessel to avoid hotspots or direct contact with the source of heat, otherwise you may obtain a false reading.

When you put the probe in the water, the display should 'step' towards the hot end (three red LEDs). After the display has stabilised, adjust RV1 so that the *last green LED* just turns off and the *first red LED* just turns on.

As the boiling temperature of water varies with atmospheric pressure, and therefore with elevation above sea level, if you're calibrating the unit at altitudes over several hundred metres above sea level, adjust RV1 so that the second-last green LED just goes off and the last green LED just turns on.

The temperature range of the display should now correspond to the scale shown.

PARTS LIST — ETI 328

Resistors ..... all ½W, 5%
- R1 ..... 1k5
- R2 ..... 47R
- R3 ..... 1k2
- R4 ..... 470R
- R5 ..... 3k3
- R6 ..... 1k
- R7 ..... 100R

Capacitor
- C1 ..... 100u, 16 V electro.

Semiconductors
- IC1 ..... LM3914
- ZD1 ..... 18 V, 1 W zener
- LED 1 - 3, LED 11 .. TIL220R red LEDs, or similar
- LED 4 - 7 ..... TIL220G green LEDs, or similar
- LED 8 - 10 ..... TIL220Y yellow LEDs, or similar

(Note: LEDs above are conventional but rectangular types have been used in our prototype).

Miscellaneous

ETI-328 printed circuit board; Piezo alarm Sonalert or similar type; VDO temperature probe dipstick with NTC thermistor sensor (see text).

Price estimate

We estimate that the cost of purchasing all the components for this project will be in the range:

$18 - $22

(excluding the dipstick probe)

Note that this is an **estimate** only and not a recommended price. A variety of factors may affect the actual price of a project, whether bought as separate components or made-up as a kit.

ASSEMBLING THE DIPSTICK PROBE

The VDO dipstick probe is supplied with the probe rod, several steel finger springs, a felt washer, steel collar and connectors. Two probe lengths are available, one 300 mm and the other 500 mm long, to suit a variety of cars. We fitted ours to a Suzuki four-wheel drive with an 800 cc engine and a 1950 model Dodge truck with an engine capacity close to five litres — just to make sure! The supplier of the probe will help you choose the correct one.

After you have purchased the probe, you will have to select the correct spring set and set the probe insertion length inside the engine. The accompanying diagrams show the assembly of the probe.

Panel 1
Three spring sets are supplied with the 500 mm probe and two with the 300 mm type. The spring set selected depends on the dipstick hole diameter in the engine block.

Panel 2
Compress the spring fingers with your finger and slip on the felt washer.

Panel 3
Holding the springs compressed, insert the ends into the steel collar. Release the springs and ensure their ends catch in the groove inside the collar.

Panel 4
Press down the felt washer into the bottom of the collar.

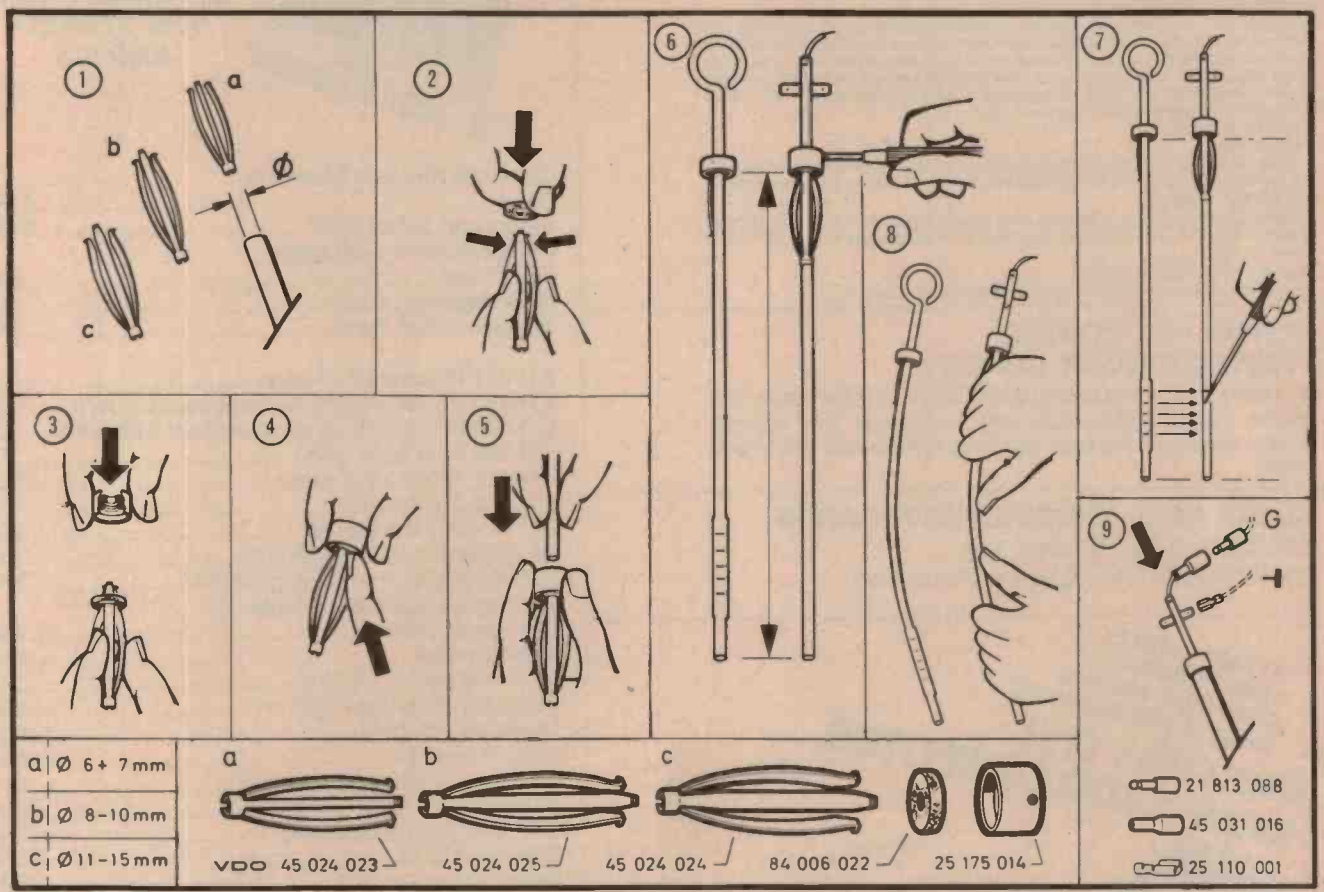
Panel 5
Slide the whole assembly over the probe. This may be a tight fit as the probe holds the ends of the spring fingers in place in the groove inside the collar so there is no danger of the springs falling out.

Panel 6
Remove the original dipstick and place it next to the dipstick probe. Slide the collar and spring assembly along the probe so the length to be inserted into the engine block is exactly the same as with the old dipstick. This is very important as an incorrect length will give a false oil level indication as well as possibly colliding with the crank shaft! Tighten the grub screw in the collar firmly.

Panel 7
The oil level mark can be scribed on the new dip stick or lightly engraved.

Panel 8
If your original dipstick is bent, the new dipstick probe can be carefully bent to the same shape.

Panel 9
Finally, connect sufficient wire to pass through the firewall and under the dash to the display pc board. We used 'figure-8' power flex soldered to the spade and in-line connector supplied with the probe.



Installation

The display pc board can be mounted in any convenient position in or under the dash of the vehicle, to the side of the driver's field of vision. For good visibility it should be mounted away from direct light. As mentioned earlier, the instrument has been designed to match the LED Expanded Scale Voltmeter and the two can be 'sandwiched' together, track side to track side with a spacer between the boards, and mounted in the vehicle. The high voltage end of the voltmeter will then be opposite the high temperature end of the Oil Temperature Meter.

The wires from the dipstick probe should be passed through the firewall alongside existing wiring or the speedometer cable, and taped to a support to prevent them catching in the fan. The battery supply can be taken from any convenient point under the dash, such as the fuse box, but make sure the instrument is switched off with the ignition. The 0 V connection can be made to any convenient chassis point. ●

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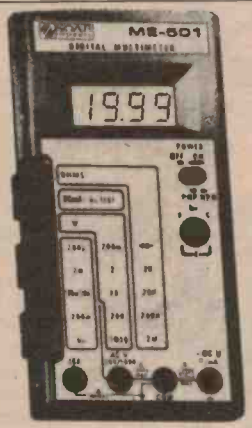

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IN5404	400v 3A rect.		30c	25c	20c
IN5408	1Kv 3A rect.		40c	32c	25c
IN914 / IN4148	diode		10c	8c	6c
RED LED	small 3mm		20c	16c	12c
RED LED	std. 5mm		15c	12c	10c
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A 'universal' antenna matcher for shortwave reception

Simon Campbell
Phil Wait

This simple project can be connected in almost any desired configuration to match a random 'long wire' antenna to the input of a shortwave receiver and give much improved performance.

FOR GENERAL RECEPTION purposes over the 1.7 MHz to 30 MHz range, an end-connected wire antenna is popular. This may be anything from a few feet of insulated wire indoors, to a long, high outdoor aerial. Such antennas can, and do, provide good long-distance reception, but the matter of matching the aerial impedance to the receiver is often totally disregarded. There is a maximum transfer of energy from the aerial to the receiver only when the end impedance of the antenna approximately matches the input impedance of the receiver input circuit.

Many specialised shortwave receivers have an antenna input impedance of about 50 ohms. With other receivers, the input impedance may be unknown, and in any case it is likely to alter with changes in operating frequency.

The end impedance of the antenna, in its turn, depends on the length of the wire in terms of wavelength. If it is a half wavelength long, or a multiple of half wavelengths, its end impedance is high — it may easily exceed 1000 ohms. On the other hand, if the aerial is a quarter wavelength long, or an *odd* multiple of quarter waves, its end impedance is low. In fact it will probably be under 50 ohms at some frequencies.

The length of a half-wave antenna is found with sufficient accuracy from

$$\text{Length} = \frac{143}{f(\text{MHz})} \text{ metres}$$

As much specialised shortwave listening takes place on the amateur bands, and as they are spaced at harmonic intervals throughout the HF spectrum (see accompanying table), it is convenient to use them as examples.

The project is housed in a plastic utility box, the front panel being dressed up with a Scotchcal Panel.

Say you have a long wire erected that has a total length of 10 metres. Now, this would work as a half-wave antenna on the '20 metre' amateur band since 143/14.3 gives an antenna length of 10 metres. The antenna would have a very high impedance at either end and this would have to be 'transformed down' to match the receiver's relatively low input impedance. At twice the frequency where the antenna is a half-wave long, i.e: 28.6 MHz, the antenna is clearly *two* half-waves and the end impedance is again high. But, at half the half-wave frequency, or 7.15 MHz, the antenna will be one-quarter of a wavelength long and its end impedance will be low. The exact impedance will depend on the height, ground conductivity and overall construction.

If you measured the impedance of the antenna throughout the HF range, from 30 MHz down to 1.7 MHz, it would be found to swing from one extreme to the other, reaching a low impedance at 'quarter-wave' frequencies and a high impedance at 'half-wave' frequencies. ▶

Amateur Bands up to 30 MHz	
160 metres	1.8 - 1.86 MHz
80 metres	3.5 - 3.7 MHz
40 metres	7.0 - 7.15 MHz
20 metres	14.0 - 14.35 MHz
15 metres	21.0 - 21.45 MHz
10 metres	28.0 - 29.7 MHz

Any random length of wire will exhibit these general characteristics.

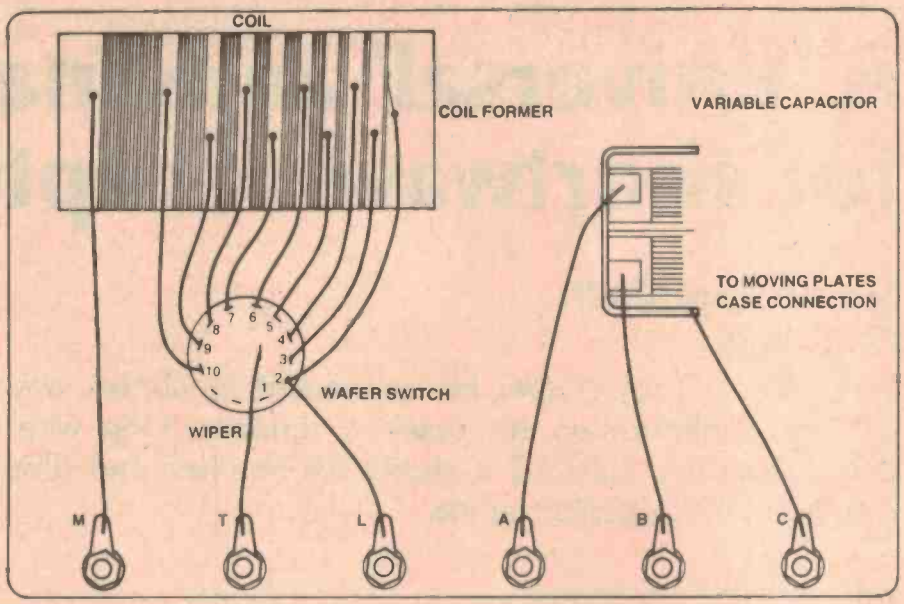
To enable one to tune a wide range of frequencies, and to gain the maximum power transfer from the minute signals on the antenna to the receiver input, some variable compensation or 'matching' system must be employed.

The best way to go about this is to use a resonant circuit that can be tuned across the entire range of frequencies of interest and can be connected in a variety of impedance transforming configurations. The matcher described here uses a coil tapped at convenient intervals and a dual-gang variable capacitor. The actual capacitance range of the latter can be different to the 10-415 pF (nominal) of the Roblan gang specified but you may experience some restrictions at the low frequency end of the spectrum if the range is smaller, apart from mechanical problems, unless you intend to use a different case or style of construction.

The coil tappings are selected by means of a single-pole rotary switch, while the coil and capacitor may be connected as desired by means of coloured terminals and jumper leads. Suggested circuit configurations are shown on page 51, but we'll get to that later.

Construction

We housed our matcher in a plastic utility box measuring 190 x 110 x 60 mm. The plastic 'lid' of the box is used as the front panel and all the components were mounted on this. Six 'banana' socket-binding post terminals were mounted along the 'top' of the lid to provide the coil and capacitor connections. The rotary switch and capacitor are mounted in line beneath the terminals, the switch on the left and capacitor on the right. The capacitor we bought uses three screws which hold it to the front panel, mating with threaded holes in the front section of the capacitor frame. If you have or wish to use a different type, then mounting arrangements may have to be different. The Roblan, and similar type, gangs are quite small and fit neatly into the box we chose. If you plan to use a different type, make sure that it will fit in this box without fouling any of the other components, otherwise you will have to vary the mounting arrangements or use another box. Many of the older-style 'broadcast' tuning gangs have a capacitance swing of 5 -

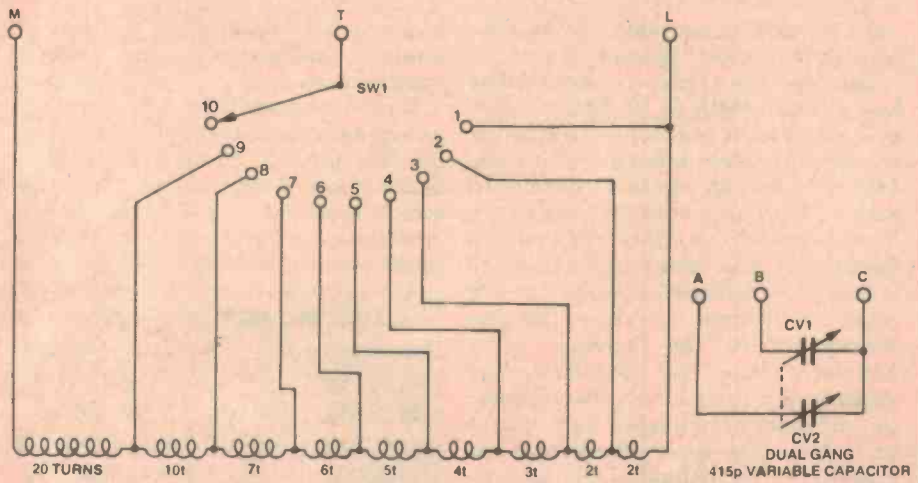


Wiring diagram. Compare this with the photograph on the right.

HOW IT WORKS — ETI 727

The unit contains a coil with multiple taps which may be selected by a single-pole, multi-position switch, and a dual-gang variable capacitor. Terminals provide connections to the circuit elements such that they may be interconnected in a variety of configurations. Thus, various common matching configurations may be achieved. I.e: L-match, Pi-match, T-match, parallel tuned, series tuned, end-loading (L or C only) etc.

The matching circuit will transform the unknown impedance of the feedpoint of a random length antenna to the impedance of the antenna input of the receiver, effecting maximum power transfer of the signal.



General circuit diagram, showing the number of turns on each coil section.

PARTS LIST — ETI 727

1 x dual-gang variable capacitor, 10 - 415 pF (nominal; Roblan type RMG2 or similar).
1 x single-pole, ten-position switch; C&K type RA, or similar.
6 x banana socket-binding post terminals, all different colours; plus banana plugs to suit (get the stackable variety).
2 x knobs with numbered skirts.
1 x plastic jiffy box, 190 x 110 x 60 mm.

Miscellaneous

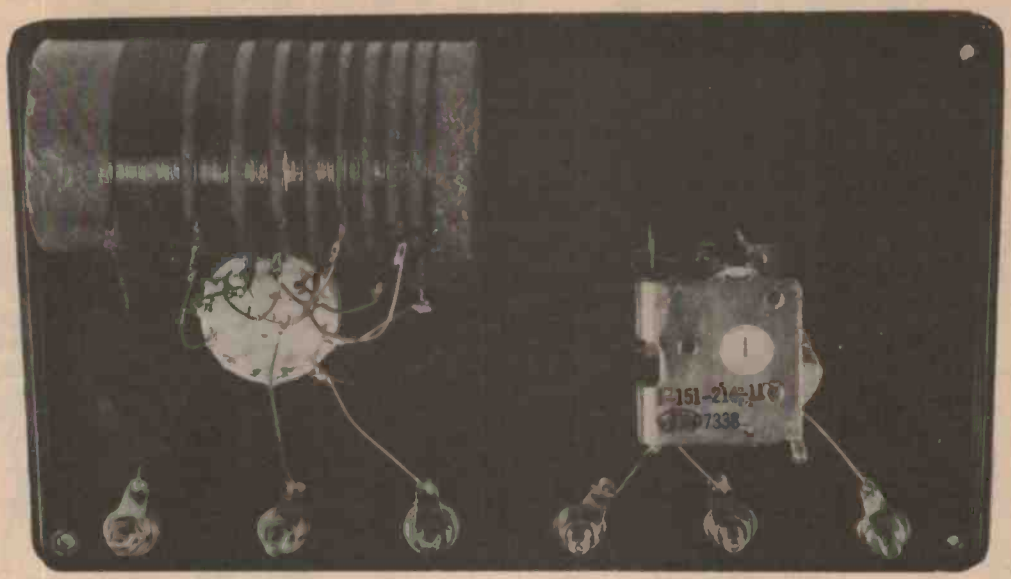
Coil former: 40 mm diameter, 80 mm long (see text); enamelled coil winding wire, any gauge between 22 swg and 28 swg; tinned copper wire; hookup wire; nuts, bolts etc.

Price estimate

We estimate that the cost of purchasing all the components for this project will be in the range:

$15 - $20

Note that this is an estimate only and not a recommended price. A variety of factors may affect the actual price of a project, whether bought as separate components or made-up as a kit.



365 pF, which is quite adequate, but are about twice the size of the modern types and may have a 9 mm diameter shaft, necessitating a 'shaft reducer' extension piece. We'll have to leave that up to you.

The coil is mounted directly behind the switch and, since it is very light, the wires from the windings to the switch lugs are used to support it. All interconnecting wiring in the project is made with 20 swg tinned copper wire.

First, drill the lid of the box. Mark out carefully the hole positions and centre-punch each one before drilling. You can use the front panel artwork as a template. If you are using a Scotchcal front panel, don't remove the backing at this stage. Drill the holes in the front panel *before* attaching the Scotchcal, otherwise you're likely to tear it.

Having drilled the holes, carefully deburr them with a larger size drill bit. Now you can attach the front panel artwork. Next step is to attach the terminals, switch and capacitor. Take care not to damage the front panel artwork when tightening screws or nuts.

The coil

Now wind the coil. We wound ours on an 80 mm long piece cut from a cardboard mailing tube about 40 mm in diameter. You can buy these from newsagents and stationery suppliers. Alternatively, the centre tube from a toilet roll could be used but is not quite as rigid. The drawing here shows how the coil is wound. Start by 'locking' the wire to one end of the former by looping the wire through two small holes poked in the end of the former about 5 mm apart. Pull the wire tight and commence winding from left to right, passing the wire over the former, away from you then up towards you etc, for 20 turns to the first tap. The coil is wound in sections, the tap in between each section being wired to the switch. To make the first tap, form a small loop in the wire and, while still maintaining tension on the already-wound section, put several twists in the loop. Commence winding the next section about 4 mm from the end of the first. Wind 10 turns and make another tapping. Start each successive section 4 mm from the end of the previous section, making tappings as you go, until you reach the finish. Refer to the diagram for the correct number of turns for each section. Anchor the end of the winding as you did the start. Don't forget to leave sufficient length of wire at the start and finish of the coil to reach the terminals to which they connect. About 80 - 100 mm is sufficient. You can give the coil a coating of acrylic cement to help hold it in place and prevent moisture affecting it.

Using a knife or other sharp blade, carefully scrape the enamel off the ends of the tapping points and solder 50 mm length of tinned copper wire to each. Taking care to get everything in the correct sequence, solder each wire to the appropriate lug on the rotary switch. The coil will then be supported by these wires from the switch. The 'start' end of the coil (beginning of the 20-turn section) should be soldered to the 'M' terminal, while the other end of the coil connects to the 'L' terminal. Terminal 'T' is connected to the pole of the rotary switch with a length of tinned copper wire.

Next wire the capacitor. The frame (common connection for the moving plates) connects to terminal 'C', while the two fixed plates' connections go to terminals 'A' and 'B'. If your capacitor doesn't have a solder lug connection for the frame you will need to attach a bolt to some convenient point on the frame and put a solder lug under the bolt head to provide a connection point.

That completes the internal wiring of the project; however, you will need to make up a number of 'jumper' wires to 'patch' the different terminals together to get the circuit configuration you want. 'Banana' plugs are convenient connectors and will mate with the terminals we have specified. Get the 'stackable' variety. The jumper leads should be no longer than 200 mm, and something between 100 mm and 200 mm will be fine. It's an advantage to use different coloured hookup wire to make the jumpers so that you can identify the leads more readily when changing or making up a circuit configuration. Make up a length of coaxial cable for the receiver antenna connection with the appropriate coax plug on one end and the banana plugs on the other.

Transmitting use

It is possible to use this project to match a low power transmitter to a long wire antenna, but we haven't actually tried it. We estimate transmitter output power should be no higher than 5 W - 6 W carrier or 12 - 15 W PEP on SSB. It would be fine for Novice amateur use or for the QRP enthusiast, providing the power limitation is kept in mind. The principal problem is the voltage rating ▶

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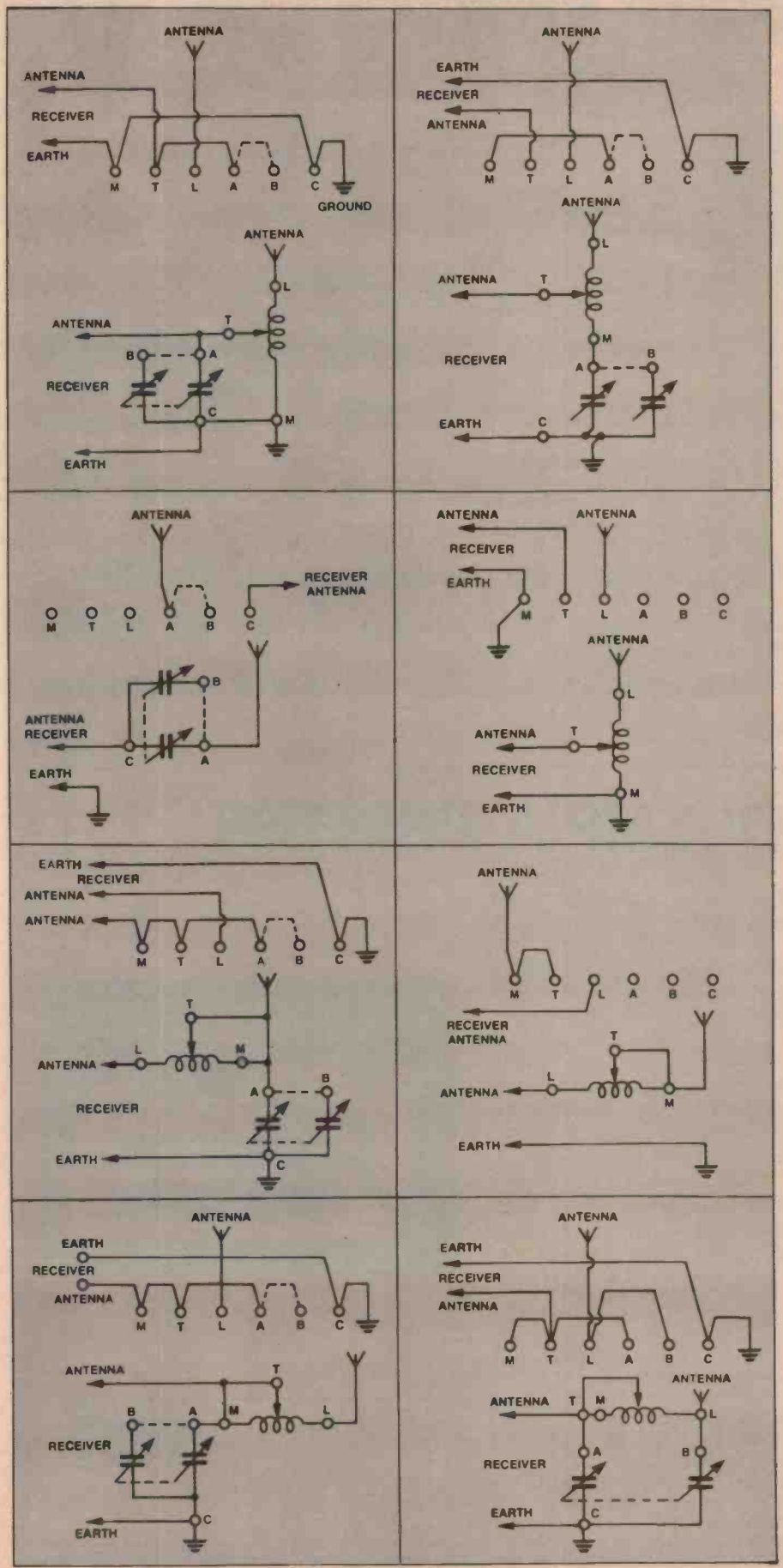

of the capacitor and switch when using the matcher on an antenna having a high impedance at the feedpoint. Voltages can get *very* high, sufficient to cause flash-over, possibly destroying your matcher and/or your transmitter final amplifier.

Using the matcher

A variety of useful circuit configurations (by no means all the possibilities) are indicated in the accompanying diagrams.

Write down or make a mental note of the *total* length of your antenna, including the lead-in wire. When you tune to a particular band of interest, do a quick calculation to determine whether the antenna is close to an even number of half wavelengths long, close to an odd number of quarter wavelengths long, or shorter than a quarter-wave. This will indicate whether the antenna is likely to have a high, low or high impedance at the lead-in, respectively, and will point to the sort of circuit configuration to use.

Having determined that, make the appropriate jumper connections and tune in a signal. Adjust the matcher controls for a peak in the receiver's S-meter reading. For best results, use a weak signal when peaking the matcher's controls.

You'll find that tuning adjustments are relatively broad when you have a longish antenna connected, but peak more sharply for short antennas. A little experimentation will soon indicate the best configuration for each band of interest. It is wise to keep a note of the circuit, jumper connections and control settings for each situation. Those configurations using the coil *and* the capacitor will allow small increments of adjustment, permitting better 'fine tuning'.

For best receiver performance, a configuration that shows 'sharp' (i.e: high circuit Q) tuning will considerably reduce the strength of signals away from the band of interest. This will aid 'double-spotting' problems with those inexpensive single-conversion receivers prone to this problem as well as reduce the problem of crossmodulation and front-end overload — quite apart from the benefit of improving the signal strength by matching the antenna to the receiver input! However, there is a slight drawback in that if you wish to move frequency by several hundred kilohertz within a band then you will most likely have to retune the matcher's capacitor. If you want 'broader' tuning (i.e: lower circuit Q) then use less 'L' and more 'C'. Some 'hand capacity' effects may be noticed at the higher frequencies when tuning high impedance antennas. ●

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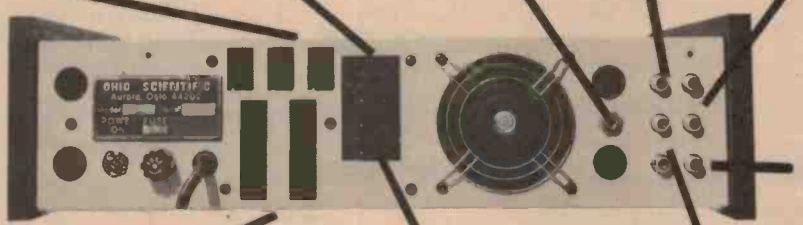

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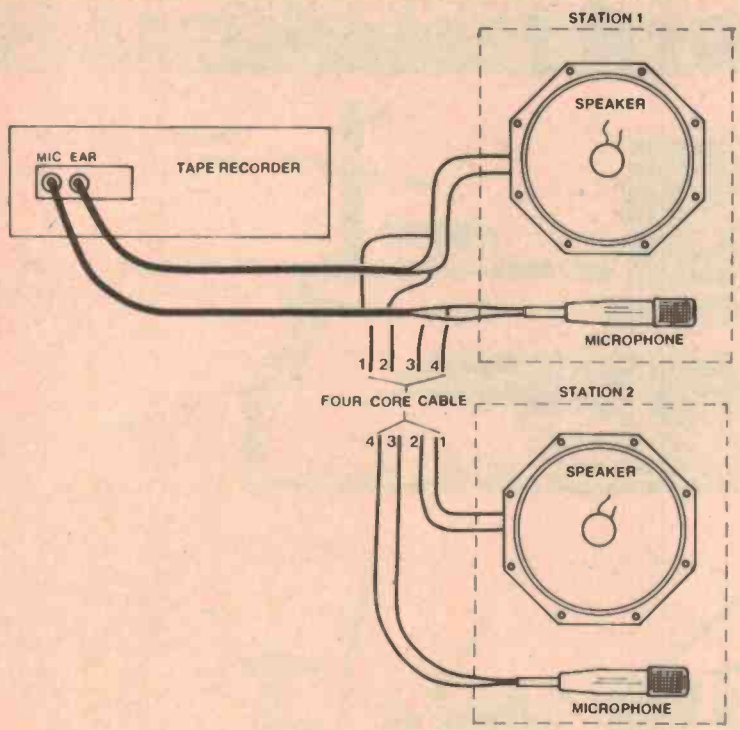
Ideas for Experimenters

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.



'Jury-rig' intercom

This intercom can be 'jury-rigged' in an instant (well, . . . almost), yet is very effective. You need a tape recorder (say, a cheap cassette deck or whatever you have on hand), two small speakers and two crystal or dynamic microphones (crystal types are best).

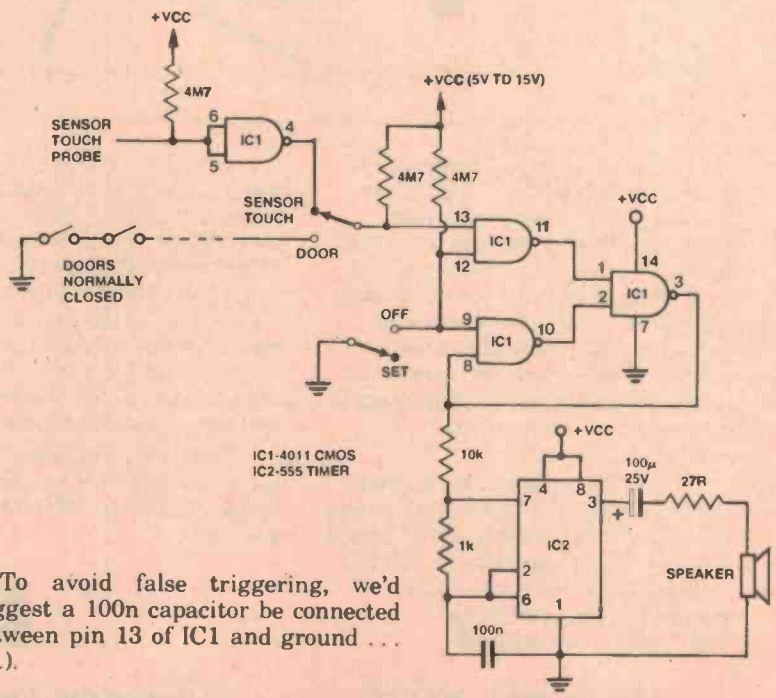
It uses the 'monitoring' function in the tape recorder in the recording mode. When a person at either station talks into the mic. the signal passes through the recorder, is amplified and passed to the speakers. To avoid feedback, levels should be kept low and the mic. and the speaker physically shielded from each other at each station. Alternatively, a DPDT slide switch could be connected to switch the mic. in and speaker out during 'talk' and vice versa during 'listen'. A 'dummy' cassette has to be inserted to 'fool' the recorder.

That's quite an ingenious idea from **Craig Forsythe of Williamtown, Vic.**

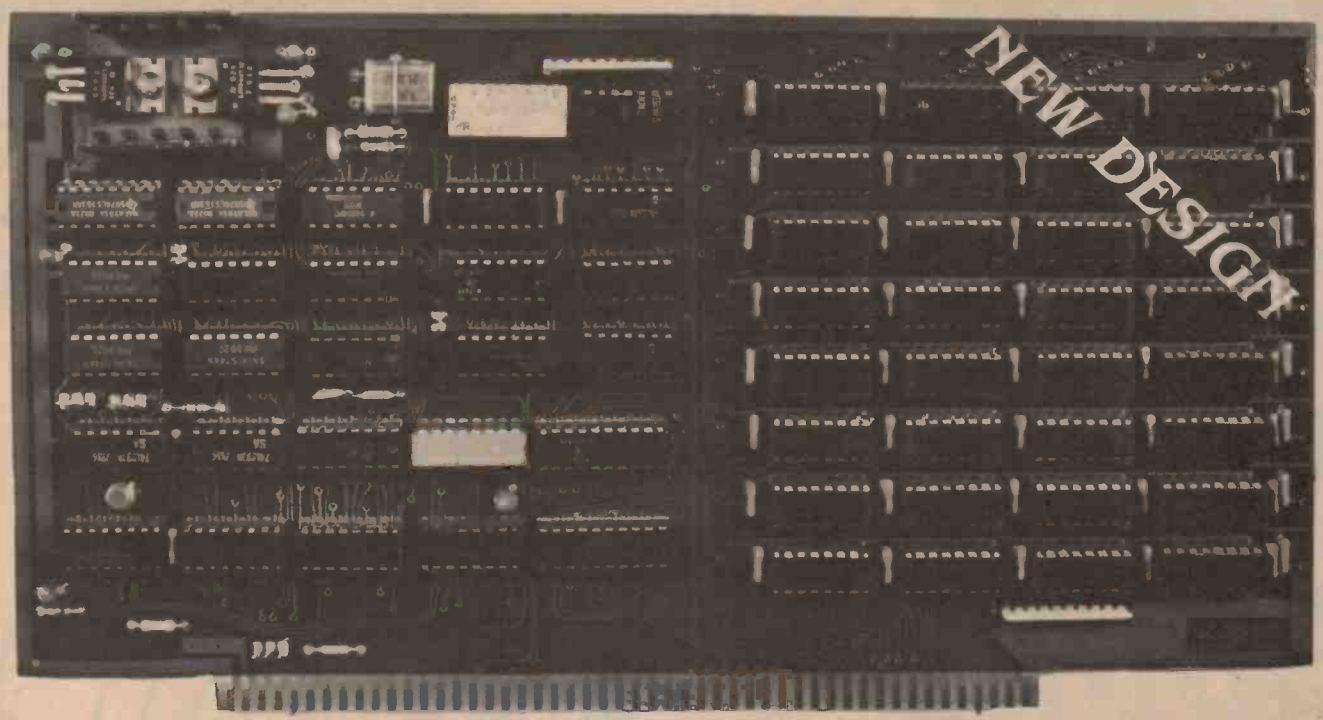
Burglar alarm cum water level detector

This circuit can be used to suit your own alarm applications and comes from **Lim Beng Cheng of Singapore.**

The 'sensor touch probe' can be used to trigger the alarm circuit from a person touching it or from a probe in a water vessel being covered by the water (or some fluid). For conventional burglar alarm operation the alarm can be triggered by normally closed contacts such as reed switches, window tape etc. A switch permits selection of the mode of operation. Another switch permits the alarm to be 'SET' or turned 'OFF'. IC1 is a 4011 CMOS quad NAND-gate while IC2 is a 555 timer used to derive an audio alarm. Three gates from IC1 are connected as a flip-flop. When both inputs are high, the output goes high and IC2 will oscillate, providing an audio alarm. The sensor touch alarm is simply one CMOS NAND-gate connected as an inverter. When the sensor touch probe is touched, the gate input will go low and the output high, activating the flip-flop.



(To avoid false triggering, we'd suggest a 100n capacitor be connected between pin 13 of IC1 and ground . . . Ed.).



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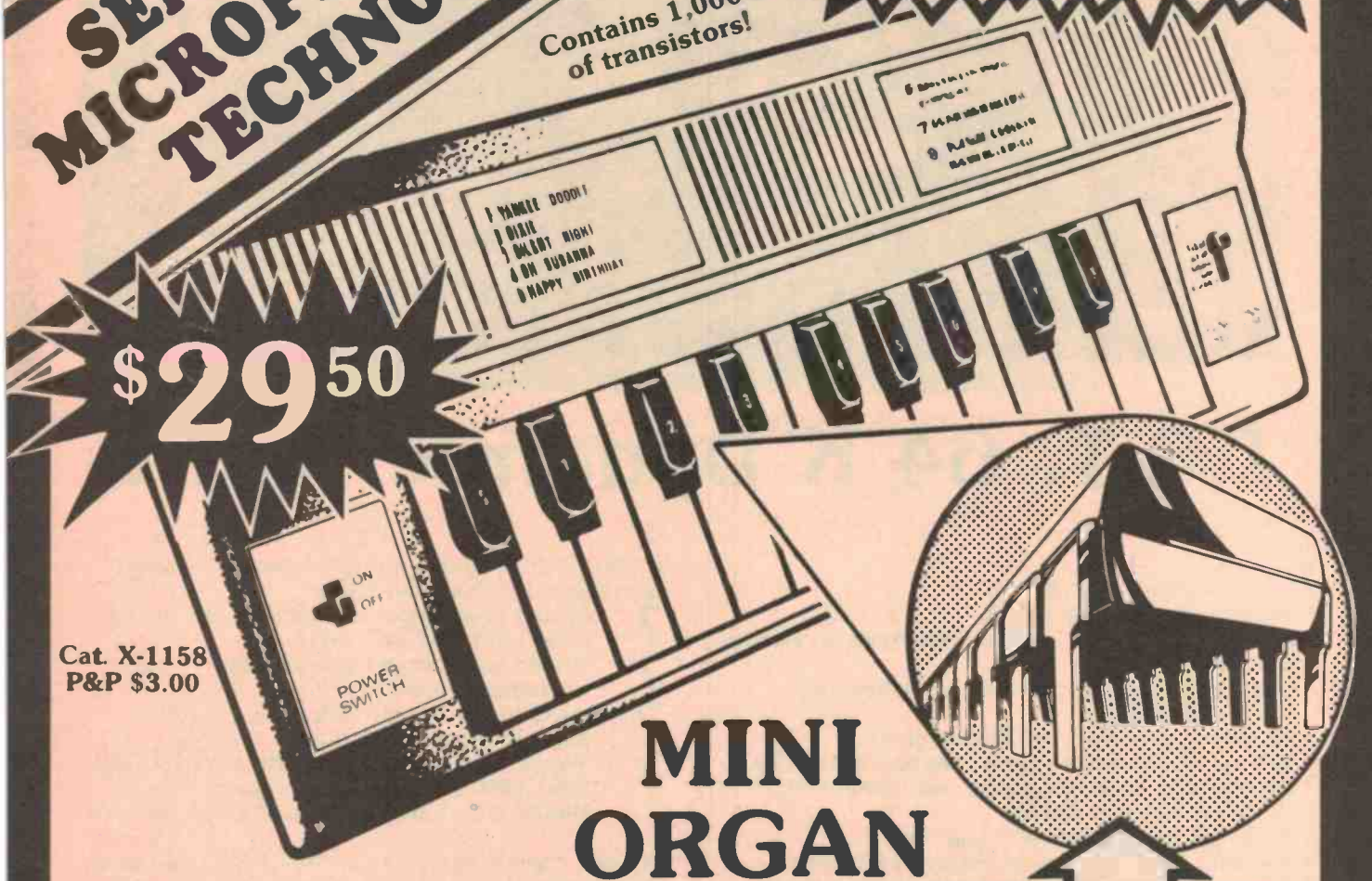

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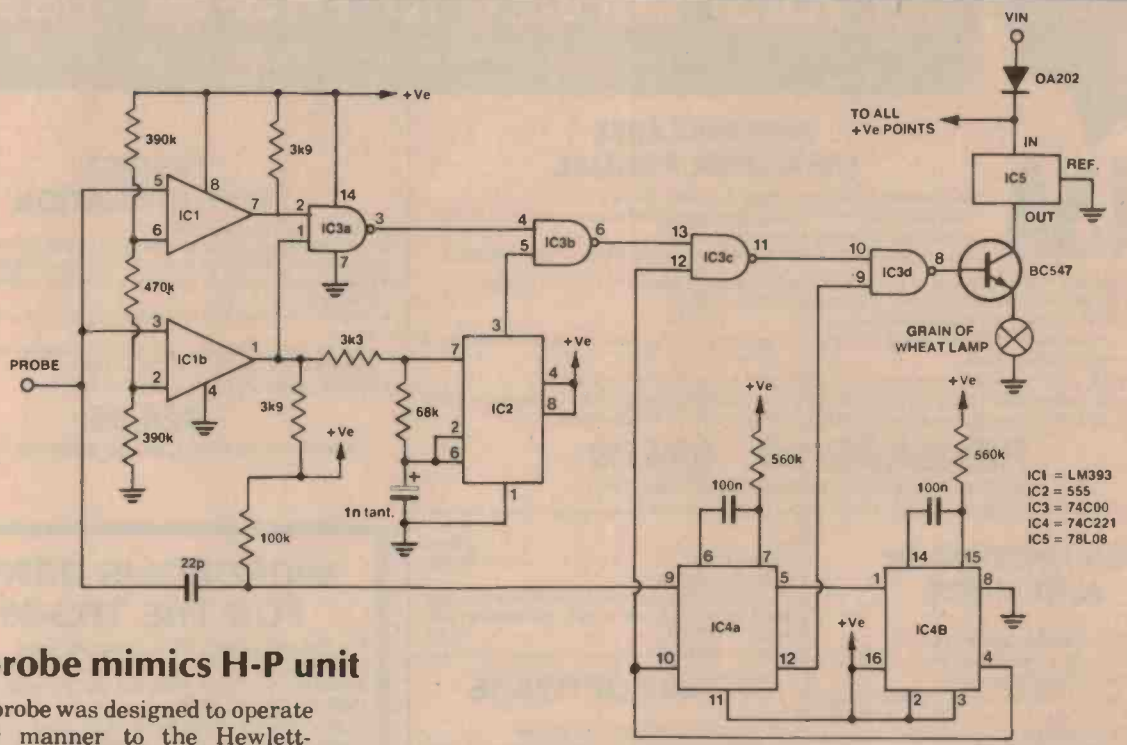
SEE THE OTHER DICK SMITH ADS IN THIS MAGAZINE FOR STORE ADDRESSES & PHONE NUMBERS

Ideas for Experimenters



Logic probe mimics H-P unit

This logic probe was designed to operate in similar manner to the Hewlett-Packard Logic Probe. It uses a single lamp to indicate all states including open circuit and pulse trains, says **R.A. Jackson of Glenelg, S.A.**

IC1 is a dual comparator: IC1a detects the logic 1 level threshold and IC1b detects the logic 0 level. The resistor network is set for CMOS levels but can easily be changed for TTL.

With the probe input open circuit, IC1a output is low and IC1b output is high. IC2 oscillates at about 100 Hz and the square wave output is fed through gates IC3b, c and d to drive the lamp with a 50% duty cycle square wave. This gives half brilliance.

When a logic 1 is applied, both the comparator outputs go high. IC3a output goes low thus inhibiting gate IC3b and driving the lamp to full brilliance.

A logic 0 input gives low outputs from the comparators. IC2 stops oscillating and its output goes high. This gives IC3b two high inputs and the lamp is turned off.

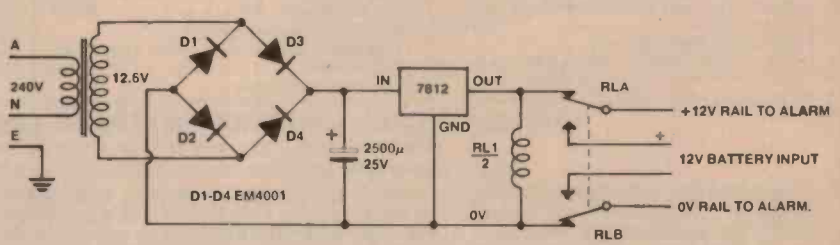
If a pulse is present at the input, its negative-going edge is coupled to the trigger input of IC4a. This is one half of a dual monostable. Pin 5 goes high for approximately 50 ms, and then goes low. This triggers IC4b for 50 ms. The Q output of IC4b is connected to the inhibit input of IC4a. This prevents retriggering until 100 ms after the first pulse. The Q outputs of IC4 drive gates IC3c and d. This arrangement turns the lamp off, then on, giving a positive indication of a pulse, regardless of the input level or the pulse frequency.

IC5 is an 8 V regulator. This limits the lamp voltage when the input voltage is high (up to 18 volts). The diode protects against reverse voltage.

With careful construction the probe can be built into a penlight torch case.

Alarm power supply

House alarms require a power source in the event of a mains failure. This unit, from **Mark Tiddy of Highgate S.A.**, is a simple unit to fulfil that function. Most alarms operate from a 12 Vdc rail so that a 12 V battery may be used to supply power during mains failures. The circuit employs a conventional transformer-bridge rectifier configuration and a three-terminal 12 V regulator. The coil of a relay is connected directly across the 12 V regulated supply rail and is held operated during mains operation.



During mains failure, the 12 V supply rail from the regulator will discharge and the relay will drop out, connecting the supply rail for the alarm through to a 12 V battery.

A suitable resistor (or even a diode) from the positive output of the bridge rectifier to the positive terminal of the battery, plus a diode between the 0 V RAIL TO ALARM and bridge rectifier negative will keep the battery trickle charged.

BARGAIN BASEMENT BOOK SELLOUT!



ETI CIRCUITS NO.2.
A collection of ideas and data for the electronics experimenter. This book contains 25 chapters: Alarms, Amplifiers, Automobiles, Batteries, Comparaters, Conversion Tables, Crossovers, Crystal Oscillators, Detectors, Digital, Filters, Indicators, Logic Data, Miscellanea, Miscellaneous Data, Mixers, Preamplifiers, Power Control, Power Supplies, Sequence Timing, Signal Generators, Signal Processors, Special Effects, Switching, Test. As you can see, it covers many fields and there are a wealth of circuits. 100 pages.
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This rare gem contains over 30 projects covering every field from audio to digital, physical measurement to RF. You'll find ever-popular projects like the ETI-438 Audio Level Meter, the ETI-704 Crosshatch/dot Generator, the ETI-129 RF Signal Generator, the ETI-121 Logic Pulser and ETI-122 Logic Tester plus power supplies, a temperature meter, simple frequency counter etc., etc. 116 pages
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A STEAL! $1.50 (was $3.95)

PROJECT ELECTRONICS
Our all-time best seller. Over 25 projects in this book, most of which have *never* appeared in ETI. All simple, easy to get going projects using common parts and generally powered by a single 9 V No. 216 transistor radio battery. Kits are currently available from several sources. Inside are such goodies as a continuity tester, two crystal sets, an AM radio, a battery saver, a simple intercom, a LED dice, a tachometer, an intruder alarm, a train controller, a hi-fi speaker — and lots more. *Plus* a guide to project construction, how to solder and how to find your way around components. A must for the beginner or tinkerer. 84 pages.
HELLS BELLS! $1.75 (cover price $4.75)

SIMPLE PROJECTS VOL.2.
Another winner for the beginner/tinkerer — and a rare one now. Over 20 popular simple projects: Induction Balance Metal Locator, Photographic Strobe, Selecta-game (TV game), Touch Switch, Car Alarm, Morse Practice Oscillator, Mini Organ etc., etc. *Plus:* colour codes, component connections etc. 100 pages.
A RIPPER, $1.25 (was $2.95)

SIMPLE PROJECTS VOL.1.
A collectors item! Last chance to get this one. Over 25 great projects, including Three Simple Receivers, TV Masthead Amplifier, Simple Speaker, Simple Stereo Amplifier, Monophonic Organ, Simple Loudhailer, Courtesy Light Extender, Cannibals & Missionaries Game, Transistor Tester, Drill Speed Controller, Light Operated Switch, Spring Reverb Unit, Pool Alarm, simple intercoms etc. Complete your collection. 92 pages.
A BUST! $1.00 (was $2.00)

SONICS 1980 YEARBOOK
The definitive book for the musician/electronics enthusiast. Australia's *first comprehensive guide* to electronic musical instruments and equipment. The book has ten fealure articles covering keyboards to lighting, mics to speakers etc. It has a comprehensive instrument and equipment directory under thirteen categories plus a distributors index and a brand index. PLUS — there's a 48-page multitrack tape primer for home/amateur recording engineer/enthusiasts.
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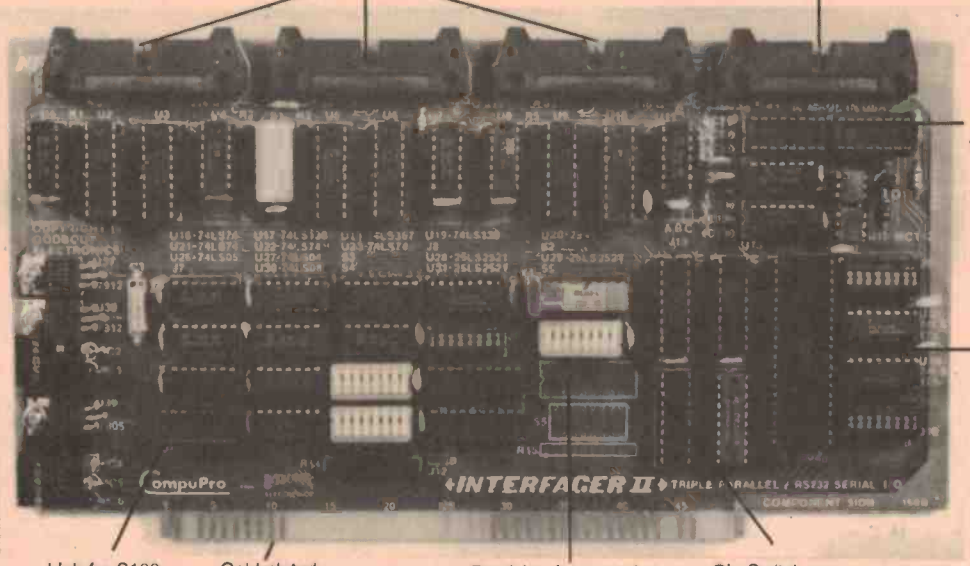

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Shoparound

This month's projects generally use widely-available components and readers should experience few difficulties in obtaining the required parts. Few suppliers *will not* be stocking the Hitachi MOSFETs for the **ETI-477** power amplifier module; in fact they have been advertised by several well-known suppliers for the past few months. The only thing not generally stocked is the dipstick probe for the **ETI-328 LED Oil Temperature Meter.**

V.D.O. dipstick probes

Phil Wait has done a little digging and come up with a list of stockists for the V.D.O. dipstick probe, which costs about $15 and can be obtained in various lengths to suit your engine. The NTC thermistor sensor is the same in each probe. Stockists in each state are:

General Auto Instrument Service
47 Egerton St
Lidcombe NSW

Automotive Instrument Service
180 Coventry St
South Melbourne Vic.

M.A.X. Instruments
662 Beaudesert Rd
Salisbury Qld.

Auto Instrument Service
11 Dequetteville Terrace
Kent Town S.A.

Auto Instrument Service
153 Francisco St
Belmont W.A.

Philco Electronics
1134 Sturt Hwy
Winnellie, Darwin N.T.

In addition, All Electronic Components indicated they might be stocking probes along with the kit. Every supplier we spoke to prior to publication indicated they would be either carrying kits or else they had the components in stock and would be stocking the pc board.

The U.K.-made ILP series of encapsulated audio modules should prove popular with audio enthusiasts. These plug-in modules make the assembly of a sound system quick and simple. Apart from preamps, a range of power amps are available ranging from 15 W to 240 W priced from around $30 to $150. Contact Electromark, 40 Barry Ave, Mortdale NSW 2223.

Antenna matcher

Those seeking dual-gang capacitors for this project should have little difficulty as they are widely available. In fact it's easier to say that Dick Smith doesn't stock them, nor do Silicon Valley stores. Everything else for this project can be obtained 'off the shelf'.

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BUT THEY'RE NOT 35¢ EA!

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So most people settled for 5 or 10 percent resistors and circuits were designed to accommodate high variations.
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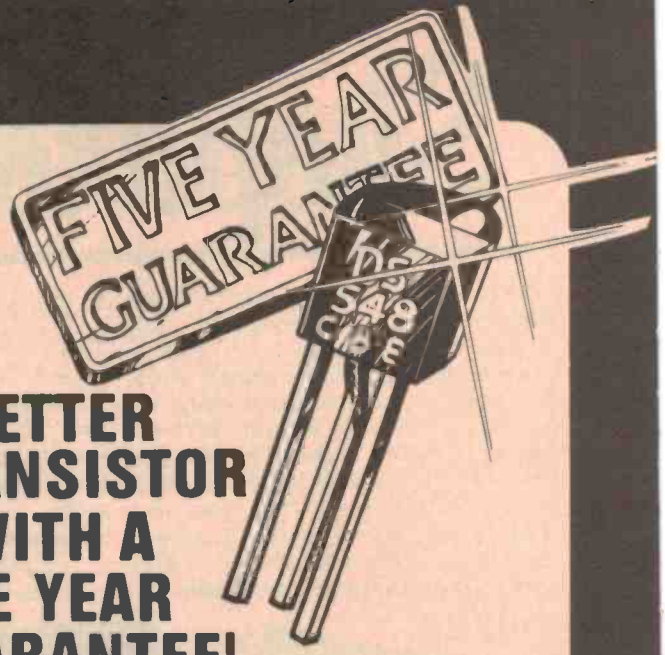

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We decided to change all that. We found a manufacturer who could make transistors as good as any that were on the market.
And if we were prepared to pay a little extra he would make them even better.

We paid a little extra - and we got a better BC548.

The good news is that you don't pay any extra. We're selling our own branded BC548's (we call them DS548 to distinguish them from the rest) at the same price – perhaps even lower – than you're probably paying now.
And just to make things easy, we're even branded the leads so you won't make mistakes.
They're so good we're prepared to back them with a full five year guarantee: as long as they are used within specifications, we'll replace any of our DS... series transistors that fail within five years!

Does anyone else give you that sort of guarantee?

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LETTERS

Dear Sir,

I was reading the article in communications in your magazine eti Elec. today, Aug 80, on C-B radio. I am a pirate C-B operator and have 25, 26, 27, 28 mghs band, in what use to be an 18ch set. There are many operators with these and more frequencies around the world, in fact somedays it is had to find a clear channel in these frequencies.

If 40 ch's were made available for citizens band operation, I would be one of many thosands in Australia to get a licence, despite extra channels.

Permits, can be obtained for 3 element beams, only in country areas. I have a five element beam in a country area, but this is an illegal antenna.

We want no restrictions on antenna's and no restrictions on power. We are allowed 12 watts PeP 3 watts AM, and want at least 25 watts Pep.

What the P & T department intend to achieve by cutting 27 mghs nobody knows, but what about the operators with up to $600.00 worth of equipment left lying arond or thrown out. millions of dollars worth of radio equipment suddenly worth nothing. Is this what our Politicions call justice? If it is nothing is. This is what our fight is all about.

I hope I have made you aware of a few facts about our fight, and hope to make others aware to.

If you intend to publicate some or all of this letter in your own words or otherwise. Please do not include my name use depresst C-Ber or somthing similar.

All right —
Depresst C-Ber.

Sir:

Your News Digest item and Brian Dance's article (ETI, Sept.) treated the 1985 return of Halley's comet as an infallible event, which may not be the case.

No one knows what orbital perturbations it incurred during its last passage through our solar system in 1910 and, hence, if its orbit is still a closed path.

Comets were so numerous in Roman times that their occasional *absence* was newsworthy. Some looped around the sun only once before departing forever. Others cycled through our system several times before likewise leaving us, after each passage had caused orbital changes.

Dole money for far-out scientists and socially-useless technocrats is one thing. Given the tragedy of desperately hungry people in the world, to squander several hundred million dollars on a comet-chasing satellite merely to pander to extremely esoteric interests is to display a sadly perverted sense of social values.

This is even more the case if the body long ago set sail for parts unknown, leaving us to gaze forlornly from the rose garden of foolish endeavour.

George Lindley
Redfern, NSW

Dear Sir,

In the article on turntables in your August issue, it is alleged that the first direct drive turntable was made by Technics in 1970.

I came across a directly driven turntable as long ago as 1934, when I was working in the service department of a major Sydney radio manufacturer. It was fitted in a 'radiogram' as they were called in those days, and of course it was designed to operate at 78 rpm! On the underside of the turntable platter there were a number of metal strips arranged like the spokes of a cartwheel. Unfortunately I have now forgotten what the stator element beneath it looked like, nor can I remember the name of the manufacturer, but it was certainly a genuine factory-made direct drive turntable.

John Keenan
Bathurst, NSW

Dear Sir,

Perhaps you or one of your readers can help me? Some time ago I bought a Clare-Pender 63 key fully-encoded ASCII keyboard from the US, but received no data with it about the connections.

The circuit contains a large number of 7400 series TTLs, but the heart of it is a 40-pin ceramic chip which has the following digits on it: 78372C-027 in small print and in large print 7426. The back of the circuit board has an assembly number 720926-K3 etched in the surface. On the edge of the board are two edge connectors, one with 34 pins and the other with 26.

I have tried for many months to find out how it works but have now almost given up. Surely someone, somewhere has one of these keyboards working?

Terry Smith
4/440 Parramatta Rd
Burwood, NSW

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INCL. ZX80 BASIC MANUAL

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N.B. Your Sinclair ZX80 may qualify as a business expense.

sinclair ZX80 -British made.

Until now, building your own computer could cost you around $600 — and still leave you with only a bare board for your trouble. The Sinclair ZX80 changes all that. For just $295 you get **everything** you need including leads for direct connection to your own cassette recorder and television. The ZX80 really is a complete, powerful full-facility computer matching or surpassing other personal computers costing much more. The ZX80 is programmed in BASIC and you could use it for anything from chess to running a power station.

Two unique and valuable components of the Sinclair ZX80: the Sinclair BASIC interpreter and the Sinclair teach-yourself BASIC manual. **The unique Sinclair BASIC interpreter:** offers remarkable programming advantages — unique 'one touch' key word entry. The ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST etc) have their own single key entry. Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately, preventing entry of long and complicated programs with faults only to discover them when you run.

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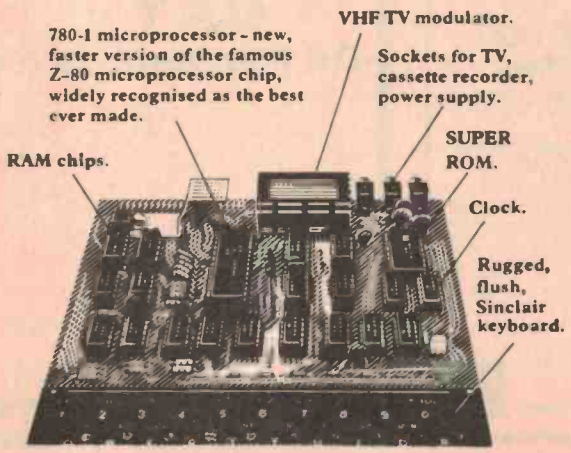
Exceptionally powerful edit facilities, allows modification of existing program lines. **Randomise function**, useful for games and secret codes. **Timer under program control.** PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine. **High resolution graphics** with 22 standard graphic symbols. **The Sinclair teach-yourself-BASIC manual** 96 page book free with every kit.

Fewer chips, compact design, volume production means MORE POWER FOR YOUR DOLLAR! The ZX80 owes its low price to its remarkable design: the whole system is packed onto fewer, newer more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer because the ZX80's brilliant design packs the RAM so much more tightly. (Key words occupy just a single byte). You can add to the memory via the expansion port, giving a maximum potential of 16K.



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	RAM Memory chips — standard 1K bytes capacity.	$ 10.00	
	Sinclair ZX80 Manual(s) free with every ZX80 computer.	$ 15.00	
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Book is arranged so that the intending user of the ZX80 entering computing may start using the system and gradually gain a better appreciation of the machine and facilities. The informed computer user will find the later sections useful in applying his knowledge to the ZX80 which has brought a breath of fresh air to the personal computer scene.

Linsac Software comes on C12 Cassettes with **Full Documentation** including
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Rearrange the rings to build a new tower.

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Find the hidden number with hints from the ZX80.

G003 Mastermind
Break the four digit code.

G004 Sketcher
Draw patterns of your choice with memory mapping.

G005 Hurkle
Hunt the horrible hurkle in the 15×15 grid.

G006 Nim
The familiar game of skill.

G007 Symbol Simon
Try and match the complex increasing pattern.

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A word game for two players — possibly fatal.

G009 The Maze Game
Find the treasure as the maze grows around you.

G010 Plain Sailing
Steer a yacht against dangerous currents.

G012 Noughts & Crosses
The ZX80 plays an excellent strategic game.

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Can you rearrange the blocks in the right way?

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The game of antiquity.

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ETI2

Lilliput computers!

A review of the Tandy TRS-80 and Sharp PC-1211 pocket computers

Are computers shrinking or calculators growing? Pocket computers are the latest development in the computer field to hit the market here. Tom Moffat runs his practised eyes and fingers over a pair.

Tom Moffatt

39 Pillinger Drive, Fern Tree Tas. 7101

POCKET CALCULATORS have been around for quite a few years now. The first ones stemmed from the development of four-bit CPU chips, the first microprocessors. As chip technology grew the chips themselves grew into 40-pin, 8-bit devices that were really too big for hand-held machines; and their power expanded much quicker than their size. Before long it was possible to get a 40-pin chip that would do the same work it took a room full of equipment to do a decade ago.

These microprocessors first hit the market as evaluation kits, with a few other bits and pieces thrown in to make them usable as rudimentary computers or process controllers, programmed in machine code. Eventually, interpreter routines became available to translate high level languages such as BASIC into the microprocessors' machine code and the home computer was born.

While all this was going on, the development of pocket calculators continued, the simple four-function machines getting smaller and smaller until they could be built into a wrist watch. The "calculator-sized" calculators kept gaining more features and power, with the latest ones able to accept programs of several hundred steps to carry out quite elaborate mathematical routines. Now the two lines of development have collided head on in the form of pocket sized machines capable of being programmed in BASIC.

Are they scaled down computers, or scaled up calculators ? It's hard to make an exact definition, but if we accept the fact that the little machines can do programmed routines, work in a high level language (speak English), and make decisions based on the results of previous operations, they must be computers. That's what their promoters are calling them, anyway.

Two importers have brought out models in Australia; Tandy with their TRS-80 Pocket Computer, and Sharp with their PC-1211. By the time you read this there may be others. Both Tandy and Sharp claim to be the first to bring them out, but it doesn't seem to make much difference because for all practical purposes they are the same machine with different nameplates. Whether Tandy designed the machine and got Sharp to make it, or Sharp designed it and got Tandy to sell it, is hard to determine. It appears that Tandy has done a deal to sell the computer exclusively in the USA for one year, although elsewhere the two computers are being sold in competition with each other. But, regardless of who originated the idea, it's a mighty machine.

Tandy announced its Pocket Computer in Australia with an enthusiastic

press release in September 1980 and inquiries to their Sydney head office brought an envelope stuffed with material promoting their position in the computer industry (which is strong and getting stronger) and a beautifully presented service manual for the TRS-80 Pocket Computer and its accessory cassette interface (yes, it has one of those too, as does the Sharp). Hobart's Tandy dealer supplied one of the little computers for hands-on evaluation (also known as a good fiddle). Here's how it came up.

The machine in detail

The Japanese make some really classy goods, like their cameras, and some pretty crummy stuff as well. The pocket computer definitely falls in the first category . . . it's nice to look at, appears well made, and it just *feels good to handle,* like a good camera. Housed in a package only slightly larger than a programmable calculator, it has a 24-character alphanumeric LCD display, an alphabetic keyboard in the "QWERTY" format, a separate numeric keypad, and various control keys. At the left hand end is a small plastic cap that covers a connection plug for the cassette interface and printer. PRINTER ??? Yes, that's on the way too, more on it later.

Now on to computing. The blurb from Tandy says the machine is "programmable in powerful Level I BASIC . . . " Here, they're selling themselves short! It's got Level I BASIC all right, or most of it. But there's one big difference: number crunching. Level I can only add, subtract, multiply, and divide, and that's it. Anything else, such as square roots, must first be prepared as a subroutine and then called when needed. The pocket version has all the trig functions, such as SIN, COS, TAN, and their inverses; and LOG, EXP, and some handy routines to convert decimal degrees to degrees, minutes, and seconds, and vice versa. Other statements specify angular mode inputs and outputs in degrees, radians, or grads. Any of these functions can be written in as part of a BASIC program, which makes the machine a very powerful number cruncher indeed. Imagine trying to write a program like "Great Circle Computer" (see accompanying box later) in "standard" Level I BASIC . . . you could do it in time, but only by using a collection of subroutines to compute the trig functions. The pocket computer has precision out to 12 digits, and using scientific notation it can handle numbers from 10^{-99} to 10^{99}.

On the debit side, the pocket computer is miserably slow compared to its 'big' brothers. Because of the maths involved it takes it about ten seconds to run the Great Circle program; and to run the full 21 numbers in the Number Sorting program (see P.73), about 5¼ minutes. Although the results that come out of the computer are first class, you must be patient to get them. It's a small price to pay for the power and convenience you get, though.

With such a tiny keyboard, data entry is bound to be a bit fiddly. Each key is less than one finger's width from its neighbour, although the numeric keys are a bit bigger. If you tried to type with all ten fingers you wouldn't even be able to *see* the computer, and two fingers tend to smash into each other. So one finger at a time is the rule. It's not as bad as it sounds, though, as BASIC statements such as PRINT and INPUT can be shortened to 'P.' and 'I.', much like Level I BASIC. But the computer stores the commands in such a way that after they're ENTERed, they pop up on the display in their full form.

The 24-character display is a bit limited, although the computer can accept lines up to eighty characters long. To look at a whole line you press a right hand arrow key, and a cursor scoots along the display. When it hits the end of 24 characters, the characters themselves scoot to the left, so it's much like viewing a normal computer screen through a slit cut in a piece of cardboard. Other keys let you view the next line up or the next line down.

The cursor is part of a powerful editing function. If while it's sitting on a character, you press SHIFT-INS, everything from the character under the cursor and to the right of it moves along to reveal a space contained in a small box. You can now enter an extra character in the space. To get rid of a character you position the cursor on top of it and hit SHIFT-DEL, and it simply disappears. The top two rows of keys have two functions, selected by the SHIFT key. One shift function is shown on the Sharp but not specified on the Tandy, although it does work. If you hit SHIFT-Y you get Y=, the Japanese symbol for Yen.

What's inside

The pocket computer isn't a scaled down version of something like a full-sized TRS-80. It uses two four-bit microprocessors that talk to each other continuously over a common data bus. The four-bit format, along with a 256 kHz clock, explains the computer's slow speed. The first processor accepts instructions, interprets them, and then sends them along to the second processor to be carried out. Both processors also contain housekeeping routines that control the cassette interface, display, ▶

The Sharp PC-1211 handheld computer mounted in its cassette interface.

printer, clock, and even turning the computer on and off.

The data bus also connects with three RAM chips and three display chips (which contain some more user RAM). It's a bit hard to express the RAM capacity in a meaningful form, but it's big enough to contain 1424 program steps, which represents a fair bit of material. All the programs presented in this article will fit in the RAM together.

Although neither Tandy nor Sharp offer a printer at the time of writing, it's obvious one is on the way. The computer is already arranged to control a printer with the appropriate routines stored in the CPU, and in/out lines brought out to the cassette interface connector. A printer would be a most useful accessory as it would overcome the problem of only being able to see one line of data at a time.

The cassette interface is also driven directly by a microprocessor. It uses a frequency shift system (not Kansas City Standard) that sounds like it runs at about 300 baud. The computer divides data up into blocks and then confirms them with check sums, so the system is pretty foolproof. It takes just over two minutes to dump or load a complete computer full of data. Once on tape, data can be read back and compared against what's in the computer to check for errors. A lousy load is signalled by an error message, which usually occurs only if the cassette recorder's volume control is set too low.

Physically, the cassette interface is a cradle into which the computer slides, making contact with the connector on the left hand end. A cord comes out of the cradle, terminating in plugs for earphone socket, mic socket, and remote. The interface seems to work well with just about any good quality cassette recorder.

In the computer itself is a small beeper that can be made to beep once or twice or whatever under program control. When the cassette interface is running the beeper makes "data noises" to confirm something is actually happening.

The computers are powered by button batteries that provide a claimed 300 hours running time. This hasn't been confirmed yet as the computer tested is still on its first set of batteries and still going strong, and it's had a hell of a lot of use. You must be careful when buying replacement batteries. The Sharp is arranged to use three silver oxide cells and the Tandy wants four mercury cells . . . both add up to much the same voltage. Tandy specifies the type 675 batteries, but there is a trap: in Australia at least, there appears to be two types of 675 cells, mercury and silver oxide, and both marked the same. The mercury cells have a terminal voltage of 1.4; the silver oxides are 1.5. So if you're buying 675 cells it's probably safest to measure them before handing over your money to make sure you're getting the right ones.

Tandy's TRS-80 pocket computer uses two four-bit microprocessors which communicate with each other via a common data buss. The first MPU accepts and interprets instructions, then passes them along to the second processor for execution.

Even when the computer is "turned off" a tiny amount of battery power is still being fed to the RAMs. This gives the effect of a non-volatile memory. Programs once loaded into the computer stay there ready for use, even after the "OFF" key has been pressed.

Programs

Five programs have been presented to show what the pocket computer can do. You'll notice they've all been written as loops, with a GOTO at the end throwing back to the beginning. They're called in the computer's "DEFINED" mode by simply typing "SHIFT-(letter)". For example, SHIFT-B calls the Bandpass Filter program. If you get tired of this and want to run your soccer pools numbers you can type in SHIFT-G at any time and the computer will break out of 'Bandpass' and begin 'Gambling Selector'. You can still run any program in the RUN mode by typing RUN 500 or RUN"B". The first character of the first line of each program specifies what letter will call it (from the Reservable keys at the bottom two rows of the keyboard); eg. "G" at Line 10.

The Reservable keys can also be used to call up commonly used blocks of pro- ▶

Synopsis of Facilities

Size	175mm by 70mm by 15mm
Keyboard	Full alpha plus numeric pad, cursor and special function keys
Display	24 character, 5 x 7 dot matrix LCD with 80 character buffer
Language	Microsoft compatible BASIC with many added features
CPU	Unknown, no machine code access
Memory	1424 program steps (1.9K RAM)
Power	3 silver oxide cells, 0.009 W normal, 0.011 W with cassette
Program Storage	Cassette via plug-in adapter unit, supports named program and data files.
Data Structure	Header followed by block formatted data. Baud rate and format are unknown but it's not very fast. Price $249 (Tandy); $49 for cassette interface.

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gram from the computer's "reserve memory", an area completely separate from the program memory. For instance you might specify "RESERVE-M" as the expression "2πF". Then, when you're writing an electronics program and you need "2πF" you type in SHIFT-M and up it comes in the program line.

The GAMBLING SELECTOR program was conceived as a bit of a giggle. It was written and debugged while lying in a tent during a bushwalking trip (how many computers can you do that with?)! It uses an elementary random number generator, with the seed developed from the square root of the product of the user's birth date and the current date, combined with a previous random number. Many different people have run numerous games with this program. So far, its total winnings amount to $1.20 in Soccer Pools. Oh, well.

The PAUSE statement at line 80 is a version of PRINT that pops up on the display for about 3/4 of a second before continuing execution of the program. PRINT remains displayed until you hit ENTER, then the program continues. You'll notice that INPUT statements can contain a message telling the user what data is required, as in Line 20.

COIL COMPUTER and BANDPASS COUPLER DESIGN are handy programs for the radio freak. They were developed from formulas in the "RSGB Radio Data Book", and show how formulas can be turned into programs with little effort. COIL COMPUTER was written with "Air-Dux" type prewound coil stock in mind. Since Air-Dux sizes are measured in inches, the program is written in inches.

NUMBER SORT accepts from 2 to 21 numbers in random order, and rearranges them in proper numerical order. It was adapted from a program published in the April 1978 issue of Byte. It shows how a program published in "Brand-X BASIC" can be translated into "Pocket Computer BASIC". The major change, other than the input and display routines, is the designation of the variables at the top end of the alphabet. This allows the computer to run its arrays in the bottom end, instead of using extra memory that's taken up by other programs.

GREAT CIRCLE is a number cruncher's delight that demonstrates the pocket computer's maths capability . . . see lines 750 and 760. You can use it to determine the precise heading and distance from your home or whatever to any point on earth, so you can point your beam antenna in the right direction, or target your nuclear missiles with ease!

Lines 710 and 720 input the destination latitude and longitude in degrees, minutes, and seconds. At the end of each line they are converted to decimal degrees by the DEG statement, and made negative for southern latitudes and eastern longitudes. Lines 730 and 740 contain your home latitude and longitude in decimal degrees (both are negative in Australia). You can work them out on a map and then convert them to decimal degrees before entering them as part of the program. If you enter lines 730 and 740 "as is", the program will be centred on Fern Tree, Tasmania, so you'll certainly have to work up your own figures.

After you've entered all the above programs in the computer you can try another feature. Type in "MEM" and the display will show something like "6STEPSOMEMORIES". Since you started with 1424 steps it's telling you it's just about chock-a-block.

Conclusions

So what's a pocket computer good for ? If you're a pilot or a yachtie you can load it up with navigation programs and then whip it out when needed. Surveyors and engineers can do the same. And computer freaks need never be without the cause of their addiction . . . you can take it on holidays, walking trips, fishing trips, or even to the office, where you can quietly work on your own programs and then slip the computer in your pocket when the boss comes along.

This article hasn't covered every facet of the pocket computers . . . to do so would take the whole magazine. But it should give you some idea of what they're like and what they're good for.

The author would like to thank Tandy for their help in the preparation of this article, and J. Walch and Sons of Hobart for their assistance with the Sharp machine. ●

PROGRAM LISTINGS

POOLS AND TATTSLOTTO SELECTOR

```
 10: "G" PAUSE "GAMBLING SELECTOR . . ."
 20: INPUT "ENTER BIRTH DATE: ";E
 30: INPUT "ENTER TODAY DATE: ";F
 40: INT √ EF
 50: INPUT "POOLS OR TATTS? ";C$
 60: IF C$="POOLS" THEN 90
 70: IF C$="TATTS" THEN 100
 80: PAUSE ". . . TRY AGAIN!":GOTO 50
 90: D=55:N=11: GOTO 110
100: D=40:N=6
110: X=INT (12+G+X)
120: FOR A=1 TO N
130: B=23X
140: X=B-INT (B/101)*101
150: IF X  D THEN 130
160: USING "###": PRINT "NUMBER";A;" =";X
170: USING: NEXT A
180: PAUSE ". . . GOOD LUCK IN ";C$;"!"
190: GOTO 50
```

BANDPASS COUPLER PROGRAM

```
500: "B" PAUSE "BANDPASS COUPLER DESIGN."
510: BEEP 1: INPUT "DAMPING R (K)? ";R: R=R*E3
520: INPUT "BANDWIDTH (MHZ)? ";B
530: INPUT "CENTRE FREQ. (MHZ)? ";F
540: K=.84*(B/F)
550: Q=1.86/K
560: L=R/2πFQ
570: C=(1/L)*(1/2πF) 2
580: M=CK/(1-K)
590: C=C*E6: M=M*E6
600: BEEP 1: USING "######.#"
610: PRINT "C=";C;" PF"
620: PRINT "L=";L;" UH"
630: PRINT "COUPLING C=";M;" PF"
640: PRINT "Q=";Q
650: USING: GOTO 500
```

GREAT CIRCLE HEADING AND DISTANCE COMPUTER

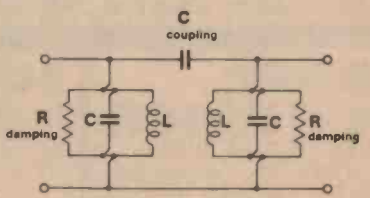
```
700: "H" PAUSE "GREAT CIRCLE (EX HOB.)"
710: INPUT "LATITUDE (D.MS)? ";B,"N OR S? ";I$:B=DEG B:IF I$="S" LET B=-B
720: INPUT "LONGITUDE (D.MS)? ";D, "E OR W? ";J$D=DEG D:IF J$="E" LET D=-D
730: A=-42.9169
740: C=-147.2605
750: X=60*ACS(SIN A*SIN B+COS A*COX B*COS (C-D))
760: Y=ACS((SIN B-COS(X/60)*SIN A)/(SIN(X/60)*COS A))
770: X=1.852X: IF SIN(C-D)<0 LET Y=360-Y
780: BEEP 1: PRINT "*HEADING=";USING "####.#";Y; "DEGREES"
790: PRINT "*DISTANCE=";USING "######.##";X;"KM": USING
800: GOTO 700
```

NUMBER OF COIL TURNS PROGRAM

```
200: "C" PAUSE "COIL COMPUTER.": BEEP 1
210: INPUT "INDUCTANCE (UH)? ";L
220: INPUT "COIL DIAM. (ICH)? ";A:A=A/2
230: INPUT "TURNS PER INCH? ";N
240: X=(5L/NA^2)*(1+√(1+.36N^2*A^3/L))
250: BEEP 1: USING "####.#"
260: PRINT X;"TURNS"
270: USING: GOTO 200
```

NUMBER SORTING PROGRAM

```
300: "N" PAUSE "NUMBER SORT:"
310: INPUT "HOW MANY NUMBERS? ";Y
320: IF Y  21 THEN 310
330: FOR X = 1 TO Y
340: USING: PAUSE "NUMBER ";X
350: INPUT A(X)
360: NEXT X
370: W=Ø
380: V=Y-1
390: FOR X=1 TO V
400: IF A(X)  =A(X+1) THEN 430
410: Z=A(X): A(X)=A(X+1): A(X+1)=Z
420: W=1
430: NEXT X
440: IF W=1 THEN 370
450: BEEP 1: FOR X=1 TO Y
460: PRINT "NUMBER ";X;"= "; A(X)
470: NEXT X
480: GOTO 300
```



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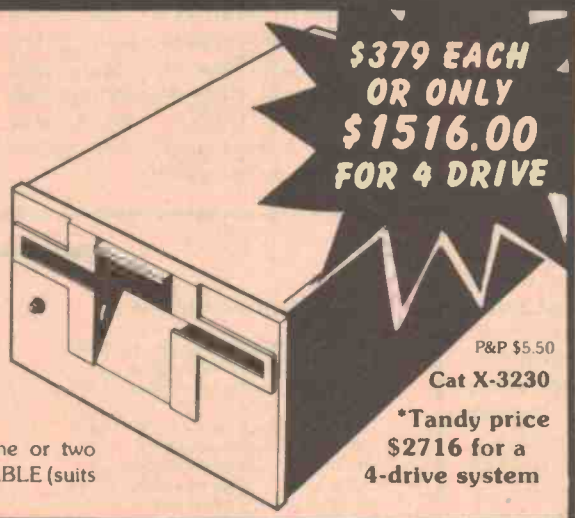

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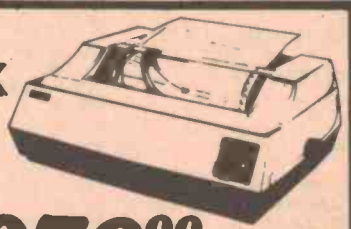

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Print-out

If only they could talk . . .

A high-quality speech synthesis chip, designed to generate synthetic human speech or other complex sounds, was launched by General Instrument Microelectronics at the Electronica '80 exhibition in Munich in November last year.

The new chip is a 28-lead LSI device known as the SP-0256, and is intended for use in such areas as control equipment and instrumentation, computerised telecommunication and radar systems, automotive warning systems, test and diagnostic equipment, security systems, etc.

Designers in all these areas have been searching for many years for practical and economical methods of generating voice patterns, to warn, aid or instruct the user.

The key factor to success in this type of market is cost, and the SP-0256 should be available to original equipment manufacturers at under $10 each.

Although designed primarily for use in single-chip form, the SP-0256 is available in association with the company's PIC microcomputer and speech ROMs in a module, as the customer's application requires.

Complex word repertoires or very high quality speech synthesis may be needed, both of which can be provided either by the chip alone or with the addition of external ROMs.

The chip has its own built-in 16K ROM memory which may be expanded to directly address 491K bits of memory and up to 3825 sequences (usually words or phrases).

Without the extra ROM, the SP-0256 is capable of reproducing up to 256 discrete sequences, each sequence being called by loading its 8-bit address into the command register of the device.

Unlike other electronic voice-generating devices, the SP-0256 offers the designer a trade-off between voice quality and the number of words spoken. Very high quality generation may be achieved — including the production of accents and inflection — using about 2000 data bits per second, while lower quality but understandable speech can be coded at a considerably lower bit rate.

The company claims that, "The quality and fidelity of output is normally significantly better than telephone voice quality and approaches that obtainable by domestic AM broadcast receivers." Memories of Hal, 2001's talking computer, R2D2 and his ilk . . .

The powerful instruction set allows commonly used speech sounds to be stored once and used repeatedly to make different words or phrases. In many vocabularies this represents a large reduction in data storage requirements.

According to GIM, the chip is extremely easy to interface to existing systems, due to its single 5 V power supply requirements, TTL-compatible levels and single 8-bit input port. It will therefore be both quick and inexpensive for customers to design speech output into their existing systems.

For further information please contact Steve Maine, GIM Ltd, Regency House, 1-4 Warwick Street, London, England.

6809-based machine from SWTPC

Featuring a 20-bit address buss, SWTPC's latest micro, the S/09, employs Motorola's 6809 processor, claimed to be "... the most powerful 8-bit general purpose MPU available".

The 20-bit address buss permits direct addressing of up to 768K of memory without the hassles of bank switching. RAM is designed with independent control and array cards for economical expansion of memory. The DMA and processor boards can access memory independently for different tasks.

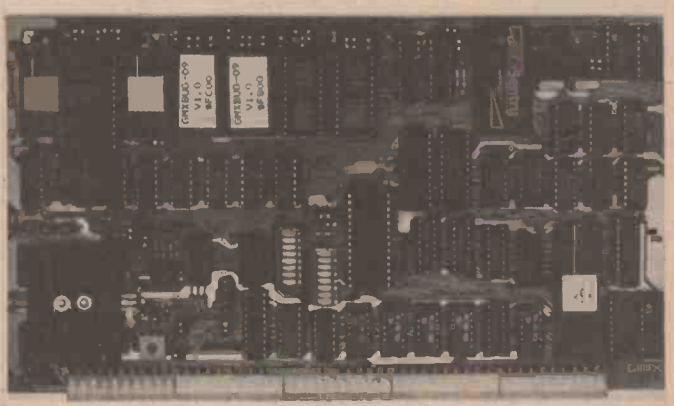
The S/09 has multi-user capability built in. No additional hardware is required to operate additional terminals. A dynamic memory management system can allocate available RAM in as small as 4K blocks to the various users or tasks.

I/O ports are quick and easy to add in as address decoding is supplied. All serial I/O cards may be quickly programmed to run at standard baud rates from 110 to 38 400. BASIC, PASCAL and an assembler plus multi-user/multitasking operatings systems are available.

The S/09 system starts at $3350.

Also new from SWTPC is the GIMIX 6809 system CPU card. Claimed to be the most versatile SS-50 buss processor board available, it features selectable clock speeds of 1 MHz, 1.5 MHz and 2 MHz. There is provision on-board for such goodies as a 9511 or 9512 arithmetic processor, 6840 programmable timer, time of day clock with battery backup, 1K of scratch-pad RAM (can be CMOS with battery backup) and four PROM/ROM/RAM sockets that can hold up to 32K of software on board.

More information on the S/09 and GIMIX board from SWTPC, 7a Burton St, Darlinghurst, NSW 2010. (02) 357-7511.



67-9306

That's the new phone number for A.J.F. Systems and Components, just in case you've tried to ring them recently and been unsuccessful.

They also have a new telex number. It's AA31261. You can still contact A.J.F. Systems and Components through G.P.O. Box 1286K, Melbourne 3001.

TRS 80 and SYSTEM 80 OWNERS

TRS 80 and SYSTEM 80 OWNERS

CAN YOU AFFORD NOT TO SUBSCRIBE TO MICRO-80?

MICRO-80 is a monthly magazine dedicated to users of SYSTEM 80 and TRS-80 microcomputers. Owned and produced entirely in Australia, each issue of MICRO-80 contains at least six programs, articles, useful hints and answers to readers' problems; all designed to help YOU get the most out of your SYSTEM 80 or TRS-80. Since MICRO-80's first issue in December 1979, we have published over 80 major pieces of software and 10 hardware projects. Most of the programs and articles are written by our readers to whom we pay publication fees thus enabling them to make their hobby pay. MICRO-80 readers can save money by buying Tandy products at 10% discount from an authorised dealer — for details see any issue of MICRO-80. Our sister business, MICRO-80 PRODUCTS, sells Australian designed and produced software and high quality, imported goods at low, sensible prices. We repeat, if you own a SYSTEM 80 or TRS-80,

CAN YOU AFFORD NOT TO SUBSCRIBE TO MICRO-80? . . . . . 12 month subscription delivered to your door, only $25.00

CASSETTE EDITION only $60.00 for 12 months

If you do not have enough time at the keyboard to type in the program listings which are published in MICRO-80 each month, then you need a cassette subscription. As well as MICRO-80 magazine, you receive a cassette each month containing all the programs listed in the magazine.

SPECIAL OFFER TO ALL NEW SUBSCRIBERS TO MICRO-80

A FREE cassette containing 6 programs (3 Level I + 3 Level II), together with complete documentation, will be sent to every new subscriber to MICRO-80.

Suspicious of mail order? Then send $2.50 for a single copy of MICRO-80 and see for yourself that this is the magazine for you!

77 TRACK DISK DRIVES

DOUBLE YOUR CAPACITY

DD-7S $775

Micropolis Floppy Disk, 77 Track, 100% larger capacity than most mini-floppy drives, complete with cable, power supply, chassis, and includes NEWDOS '80.

DD-7 . . . . . $649

Same as above but no cable or Newdos '80.

DC-4 . . . . . $45

4 drive connector cable.

MPI DISK DRIVES

MPI is the second biggest manufacturer of mini floppy disk drives in the world. They produce a family of high quality 5¼" drives with super-fast track-to-track access times (5ms!)

40 TRACK SINGLE HEAD $339
40 TRACK DUAL HEAD $449
80 TRACK SINGLE HEAD $499
80 TRACK DUAL HEAD $599

Dual head drives use both sides of the disk and occupy two drive positions — it is like having two drives for little more than the price of one!

Prices quoted are for bare drives. Add $10 per drive for a cabinet and $30 per drive for a power supply.

DISKETTES FOR TRS-80

NASHUA 40 track single side . . . .$4.50 ea
VERBATIM 40 track double side. .$5.90 ea
VERBATIM 77 track single side . .$5.90 ea

THE FABULOUS NEWDOS 80

IN STOCK NOW!

ND-80 . . . . . $149

The disk operating system that gives:

- New basic commands that support variable record lengths up to 4095 bytes long.
- Mix or match disk drives — supports any number of tracks from 18 to 80. Use 35, 40 or 77 track 5" mini disk drives or 8" disk drives, or any combination.
- A security boot-up for basic or machine code programs. User never sees "Dos-ready" or "Ready" and cannot "break" clear screen or issue any direct basic statement including "List"...

. . . and much, much more

EXATRON STRINGY FLOPPY

$352.50 incl p&p

15 times faster than cassette, infinitely more reliable. Completely under computer control, the stringy floppy is easier to use than disks and is a very much cheaper alternative. Will save and load any L2/16K software. Special software also available.

Wafers for Stringy Floppy
$3.50 ea. Any Size

SYSPAND 80 FOR THE SYSTEM 80 $119.00

SYSPAND 80 is a self-contained module which connects to the expansion port on your SYSTEM 80 and gives you a CENTRONICS parallel port to drive a printer PLUS the TRS-80 40 line bus. SYSPAND 80 allows you to connect all Tandy peripheral, including the expansion interface, disk drives, MICROTEK MT-32 memory expansion unit and the fabulous EXATRON STRINGY FLOPPY.

TRS-80 MEMORY EXPANSION UNIT MT-32 ... $149.00

The MT-32 is manufactured by MICROTEK Inc., USA. It provides a CENTRONICS printer port and sockets for up to 32K of dynamic RAM. It comes complete, ready to plug into the expansion port of your Level II 16K machine. (Will also work with your SYSTEM 80 via SYSPAND 80).

MT-32A without RAM $149.00
MT-32B with 16K RAM $208.00
MT-32C with 32K RAM $262.00

16K MEMORY EXPANSION KIT.

ONLY $59 incl. p&p

These are prime, branded, 200 ns (yes, 200 ns!) chips. You will pay much more elsewhere for slow, 350 ns chps. Ours are guaranteed for 12 months. A pair of DIP shunts is also required to upgrade the CPU memory — these cost an additional $4.00. All kits come complete with full, step-by-step instructions, no soldering is required. You don't have to be an electronic type to instal them.

DISK DRIVE HEAD CLEANING DISKETTES

$29.00 plus $1.20 p &p

Disk drives are expensive and so are diskettes. As with any magnetic recording device, a disk drive works better and lasts longer if the head is cleaned regularly. In the past, the problem has been, how do you clean the head without pulling the mechanism apart and running the risk of damaging delicate parts. 3M's have come to our rescue with SCOTCH BRAND, non-abrasive, head cleaning diskettes which thoroughly clean the head in seconds. The cleaning action is less abrasive than an ordinary diskette and no residue is left behind.

AUSTRALIAN SOFTWARE

We have a wide range of Australian software available. Send for a free catalogue

MICRO-80 has converted the new OLIVETTI ET-121 DAISY WHEEL typewriter to work with the TRS-80 and SYSTEM 80 or any other microcomputer with a Centronics parallel port (RS 232 serial interface available shortly). The ET-121 typewriter is renowned for its high quality, fast speed (17 c.p.s.), quietness and reliability. MICRO-80 is renowned for its knowledge of the TRS-80/SYSTEM 80 and its sensible pricing policy. Together, we have produced a dual-purpose machine:- an attractive, modern, correcting typewriter which doubles as a correspondence quality Daisy-wheel printer when used with your micro-computer.

How good is it? - This part of our advertisement was typeset using an ET-121 driven by a TRS-80. Write and ask for full details.

To: MICRO-80
P.O. Box 213, Goodwood, S.A. 5034

Please rush me the items checked below:

- ☐ 12 month subscription to MICRO-80 and my free software cassette $24.00
- ☐ 12 month subscription to MICRO-80 and the cassette edition, plus my free software cassette $60.00
- ☐ The lastest Issue of MICRO-80 $2.50

PLUS THE ITEMS LISTED BELOW

DESCRIPTION	PRICE
TOTAL ENCLOSED	

Name .....

Address .....

..... Post Code .....

bankcard welcome here No .....

Please debit my Bankcard $ .....

Expiry date .....

Signature .....

ETI

MICRO 80 PRODUCTS

(08) 272 0966

284 GOODWOOD ROAD,

CLARENCE PARK, ADELAIDE

Printout

The Automated Office

A new microcomputer store, 'The Automated Office', has opened in Chatswood NSW to serve the small business user.

In addition to a range of S100 microcomputers and printers the store sells business software, floppy discs, listing papers, custom forms and other business and word processing supplies.

It also provides a complete range of services, including installation, on-site training, systems design and programming.

The owner and manager, Michael Morton, is a qualified accountant with many years' experience in management consulting. He said the store was established to give small businesses a competitive edge by using low-cost computers and foolproof software.

An example of this 'foolproof software' is the new Vehicle Information System for motor dealers. The program can instantly recall details of over 700 vehicles, owners or prospects, print sales summaries, Government forms and stock lists, and even transmit stock lists between branch offices over an ordinary telephone, yet Mr. Morton maintains it can be operated by people who have never seen a microcomputer before.

The Automated Office is located on the 1st floor, 414 Victoria Avenue, Chatswood 2067 NSW, one block down from Chatswood station. (02) 411-1892.

Moose-ICs ?

A new linear integrated-circuit process from National Semiconductors (called 'Moose') produces power ICs with as much as six times the current rating of the best of previous monolithic parts.

The new bipolar process adds some steps found in the fabrication of high-power discrete transistors, and the result is to multiply the power output per unit area.

According to National, the new regulators made using this process will be as easy to use as standard voltage regulators, but just put out more power.

Designers of systems requiring from 5 A to 20 A will be able to make an entire system power supply with just one part rather than with several, each on one card, as has been the practice.

Computerised livestock

Graziers interested in improving the quality of their breeding stock may find a new computer program from Computerland Melbourne useful.

The program sorts livestock in order of merit breeding, with up to ten different values for each animal being entered into the computer. The animals may then be sorted in order of tag number or by the size of any value.

An overall 'selection index' considers all the values for an animal simultaneously and produces a list in order of rank of the breeding value of the animals. Thus objective measurements are used to help evaluate and improve the farmer's breeding stock.

The records are stored on magnetic disk. for future use, when new animals or values may be added.

The Stud Book program, released in September last year by Computerland, is now available in an expanded version, suitable for recording stud livestock for studs with up to 500 breeding animals. The Livestock Selection and Stud Book programs are compatible, as data in the Stud Book files can be automatically retrieved by the Livestock Selection program.

A spokesman for Computerland said that the programs and manuals have been written in such a way that they may be used by people who are not familiar with computers.

Computerland believe they now have more software relevant to the farming industry than any other microcomputer supplier in Australia.

Further details are available from the following Computerland stores: Melbourne — 555 Collins Street (03)62-581/62-6737; Sydney — 55 Clarence Street (02)29-3753; Brisbane — 127 Creek Street (07)221-9777; Adelaide — 131 Pirie Street (08)223-5083; Perth — 197 St. Georges Terrace (09)444-6851.

Hardware mail order

Mail order can save you heaps, according to a new Sydney-based company run by a group of microcomputer enthusiasts, Direct Computer Retail.

Specialising in Apple equipment, the company provides full after sales service, and intends expanding its range to include the best of personal computing equipment.

Direct Computer Retail plans an innovative marketing strategy to sell Australia-wide.

The company will open its offices on weeknights so that customers may save money on STD calls. Enquiries may be made between 7 pm and 10 pm weeknights and 9 am to 10 pm Wednesdays, on (02) 908-2235.

Direct Computer Retail's address is 32 Lloyd Avenue, Cremorne, 2090 NSW.

Vector Graphic system to be used in schools

Compulator Australia's Vector Graphic System 6 Microcomputer System has been officially approved for use in schools by the West Australian Education Department.

Based on the Vector Graphic System B computer and modified to Education Department specifications, the System 6 offers versatility, expandability and compatibility with other microcomputers, and can also support a printer.

For more information, please contact Lex Edmonds on (09)321-5924.

MENSA COMPUTERS PTY. LTD.

Suite 3, 454 St. Kilda Road, Melbourne, 3004. Telephone: (03) 26-5683, 26-6150.

FINDEX — The Real Computer

THE WORLD'S FIRST PORTABLE MICROCOMPUTER
Battery or mains operated

RAM 48K to 2 megabytes, bubble memory to 2MB, gas plasma display, optional audio, printer, mass storage mini floppys to 800K bytes, hard disk to 195 megabytes, acoustic coupler, S-100 bus, battery optional, CPU with real time clock. For dynamic businessmen on the move. Ideal for real estate agents, insurance brokers and accountants.

SUPERBRAIN™ SERIES

BUSINESS SYSTEMS

Priced competitively from as low as $45.00 p.w. lease cost including sales tax and software.

Powerful, multi-purpose microcomputer systems.

TYPICAL APPLICATIONS

Debtors ledger and statements, creditors ledger and remittances, general ledger and trial balance, order entry/invoicing, sales analysis, payroll/wages, enquiry, word processing, mailing, record keeping, ledger card, doctors office, real estate, agency accounting, hotel/motel accounting, branch office accounting.

Priced from $4995

OPAL 1000

The OPAL 1000 is an 8 slot S-100 system conforming to the new IEEE standards. A Delta Products Z80a 4 MHz CPU card, with 2 RS232c serial and 3x8 bit parallel ports, is used in conjunction with the Delta Products Disk Controller. Memory is provided by a 4MHz 64k dynamic RAM Board by Measurement Systems and Control. The memory board is fully bank selectable and is designed for upgrading to a multi-user system. Disk drives are 2x8" Shugart SA801R running at double density (480k/drive) and fitted with our exclusive Disk Saver which prolongs the life of the drives and floppy disks by turning off the AC power to the drives 14 seconds after the last drive select and thus reduces routine maintenance. The Disk Saver also reduces the risk of data loss due to power failures. The software is CP/M version 2.2 with Delta Product's utilities which include DTEST (for testing drives and floppy disks) and M2 (a comphrehensive memory test program). The Delta PROM monitor enables fault finding to be carried out independently) of the Disk Drives. The system is mounted in an attractive pressed Aluminium housing with a cast front panel fitted with reset button and key operated on/off switch.

Dealers for Opal in Victoria.
Sole Distributor for Findex, Victoria and NSW.

SUPPLIERS FOR NDKS S-4000

MATHEMATICS

$$F(w) = aT\frac{\text{Sin } wT/2}{wT/2}\ e^{-jwT/2}$$

$$e_{ns}^2 = 4KTR(f_2 - f_1)$$

$$L_1 = 10\log\frac{1}{80} \times S_o\ (dB)$$

$$A^2+B^2=C^2$$

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Printout

Clean your heads !

It only takes a few microscopic particles of dirt, dust or oxide on the read/write heads of your disk drive to foul up a data or word processing operation.

You get error, lost data, job re-runs, disrupted schedules, disgruntled customers, frustrated staff — a whole lot of trouble. And since it only takes minute specks of dirt to cause the problem, it can happen in even the cleanest computer room environment.

3M have now brought out a do-it-yourself cleaning diskette, called the Scotch Head Cleaning Diskette, which can cure the problem of dirty heads in half a minute.

The cleaning diskette contains a white fabric which you saturate with the cleaning solution. Then you simply insert the diskette into the disk drive, turn it on, and the rotating cleaning fabric alternately wipes the heads with the solution and the dry surface, removing contamination from the read/write head.

The kit is claimed to be completely safe. Materials and solution are non-flammable, non-abrasive, and won't harm metals, plastics, fabrics or people. Over or undersaturating the cleaning element won't affect the cleaning diskette or the equipment.

The cleaning diskette can be used with most drives, both single and double-sided. Each cleaning diskette can be used for approximately 15 cleanings, and 3M claim that keeping the heads thus free from debris gives them longer life and leads to fewer disk replacements.

Multi-user micro first

Melbourne-based Microprocessor Applications Pty Ltd have been appointed Australian distributors for Micromation Inc. of San Francisco, whose products include what is claimed to be the world's first multi-user microcomputer with a CPU and 64K RAM for each user.

A master Z-80A MPU determines buss usage and performs I/O functions for the satellites, and in its maximum configuration consists of eight boards; a master Z-80A with 64K of RAM, a multi-user I/O, four Z-64 satellites, a hard disk controller and a double-density floppy disk controller.

All of this gives the user 320K of RAM, five Z80A CPUs, single and double-density control for up to four disk drives, 20M of Winchester storage, four terminals, two printers and a real-time clock.

For further information contact Microprocessor Applications Pty Ltd, Maskell's Hill Road, Selby 3160 Vic. (03)754-5108.

TI-99/4 Home Computer

Canberra Television will be the national distributors for Texas Instruments' TI-99/4 Home Computer.

Canberra TV claims that both beginners and skilled computer users will have no trouble operating the TI-99/4, which has an expanding library of software on home management, personal finance, education, entertainment, etc.

The TI-99/4 features TI-BASIC, a built-in 13-digit, floating point BASIC programming language; up to 72K memory capacity; 16-colour graphics capability; music and sound effects with five octaves and three simultaneous tones; built-in equation calculator; a 34 cm colour monitor and a staggered Qwerty, full travel style typewriter-like keyboard.

New users group

A new microcomputer users group has started up in NSW's Riverina District, based at Griffith.

If you live in south-west NSW and have been bitten by 'the bug', no matter whether you're interested in Z8s or PDP-8s, Apple IIs or LSI-11s, then contact Ingmar Meins, 131 Erskine Rd, Griffith 2680, or phone (069) 62-1412 after hours and he'll sort out your membership. Meetings are held at the Griffith Police Citizens Boys Club, dates and times to be arranged.

ROMless computer

Zilog recently announced a new member of its Z8 single-chip family that omits mask-programmed ROM and instead offers alternative combinations of input/output lines and buss compatabilities.

The ROMless Z8681 is compatible with the Z8000 microprocessor's peripheral circuits and offers an alternative to multi-chip solutions to such high-performance applications as smart terminals, printers and controllers with specialised I/O requirements.

These applications can now be addressed by the mask-programmed Z8 with its internal ROM, but Zilog claims that the new ROMless version has a lower price, inherently greater flexibility, and no minimum quantity requirement.

A complete microcomputer, the Z8681 contains 124 bytes of on-chip RAM, up to 24 I/O lines, two eight-bit counter/timers for real-time control applications, a UART for serial communications, six levels of interrupts, and an on-chip oscillator. An expandable buss interfaces up to 62K each of external program memory and external data memory.

Under program control the Z8681 can be configured as a traditional microprocessor that manages up to 124K of external memory, or as a parallel-processing element in a system with other processors and peripheral controllers linked by Zilog's Z-Buss Component Interconnect.

In all configurations, a large number of pins remain available for I/O purposes.

Housed in a 40-pin dual-in-line package, the Z8681 requires a typical current of 150 milliamps from a +5 V power supply. The device is priced at $18 in 100-unit quantities.

For further information contact Vic Kramer on (02) 438-4533.

1984 . . .

The 1984 International Conference on Computer Communications will be held in Sydney.

Appropriately for this Orwellian year, the theme of the conference will be 'What lies ahead', with emphasis on communications developments in the Asian/Pacific region and the interconnection of the international telecommunications network.

The Overseas Telecommunications Commission and Telecom Australia are to be joint hosts of the 1984 conference, which will be the first time the biennial event has been held in the southern hemisphere.

The 1980 conference was held in New York, and London is scheduled for 1982.

OTC and Telecom feel that 1984 will be an appropriate stage of the nation's communications development for delegates from all over the world to come to Australia, as by then packet switching techniques will be benefitting both OTC and Telecom customers.

Printout

YX-3200 — another new business computer

Sharp Electronics, perhaps best known for their calculators and consumer electrical products, have just released a computer for the small businessman — the YX-3200.

The complete system includes a Central Processing Unit (CPU), high-resolution green CRT display, dual-drive floppy disk and an impact printer.

The desk-top system has an expandable 32K ROM, 64K RAM, and features the Automatic Program Generator, which asks the user questions that, when answered by a simple yes or no in most cases, actually design the program.

Once entered into the unit's Z-80 processor, the program can be stored indefinitely or used at the operator's convenience.

The YX-3200 also features an easy-to-understand extended BASIC language.

The YX-3200 can accommodate up to 72K of ROM and 128K of RAM, plus a maximum of eight disk drives.

The high-resolution 300 mm CRT display offers upper and lower-case characters on an 80 column/24 line screen for a total of 1920 characters.

The character size may be increased for group viewing or graphic purposes, giving up to 40 characters per column on a 15-line display for a total of 600 characters.

The system printer is also designed to be flexible, and has an 80/132 column per line capability from the bi-directional, dot-matrix, 80 character per second printer.

Sharp has formed a new Systems Division to handle the YX-3200, and will also produce peripherals, software and other computer-related products.

New developments from Cromemco

Cromemco has just announced a new high resolution graphics software package that brings a new level of user-oriented programming convenience to the company's high resolution graphics system.

The Cromemco graphics system can be used to display colour or black-and-white images with up to 756 x 482 point resolution on a high quality RGB monitor.

The graphics software package is designed to work with Cromemco's 48 KTP and 16 KTP (two port) memory boards and will operate with one or two pages of two port memory. Two pages of 48 Kbytes of RAM are required for complete utilization of all available software options.

For those using the graphics software package, the subroutine calls provided are sufficient to fully utilize all the capabilities of the Cromemco SDI high resolution graphics interface board. These subroutines allow the user a number of powerful capabilities including: fast line generation; fast generation of regular shapes such as circles, rectangles, and polygons; area fill of these shapes in a designated colour at video rates; text generation and rotation; the ability to open and close windows in the page of memory being displayed; the ability to simulate motion (animation); the ability to CLIP which eliminates problems which might arise from trying to plot outside the screen area; and the ability to scale the display area of the work page.

The programmer can generate and display an image in high resolution (756 x 482 points) as well as the 16 colour medium resolution (378 x 241 points) using the same system. In addition, the programmer has the choice of plotting explicitly (i.e. specifying within a cal all needed location and colour information) or implicitly (i.e. specifying needed location information with regard to an implied cursor).

The software and hardware permit the user to select 16 colours for the colour map from a palette of 4096 colours. The contents of any colour in this colour map can be modified by the user with a simple call define colour command. In addition, when programming in FORTRAN or Assembly language, the programmer has the option of creating colour maps using the command CMAPGEN.

The colour graphics package is written for both ease of use and to take full advantage of the SDI hardware — consequently it is very efficient and extremely fast.

The SDI colour graphics software package is available on either 5" (Model SGS-S) or 8" (Model SGS-L) diskette, which have also been the subject of some new developments by Cromemco.

The new 16FDC Disc Controller Board provides full read/write/format capability for any combination of the discs, and can control up to four 5" drives and four 8" drives simultaneously.

The 16FDC provides a complete system for floppy disc operation including serial I/O for an RS-232 terminal and a pre-programmed Read Only Memory with system boot strap and diagnostic subroutines. The 16FDC is designed for use with the industry standard S-100 buss and is compatible with the complete line of Cromemco computer systems.

For additional information on the graphics software package and the 16FDC Disc Controller Board, contact Adaptive Electronics Pty Ltd, 77 Beach Road, Sandringham 3191 Vic. (03) 598-4422.

CONFIGURATION	ATZ80/2K. STARTERS KIT	ATZ80/16K. BASIC SYSTEM.	ATZ80/32K. UNIVERSAL SYSTEM.	ATZ80/48K/D/P. COMPLETE SYSTEM.
Processor	DGZ80	DGZ80	DGZ80	DGZ80
Display Unit	DG640	DG640	DG640	DG640
Operating System	DGOS	DGOS	DGOS/MDOS	DGOS/MDOS
Keyboard	Touch	Clare C70	Clare C70	Clare C72
Memory	On Z80 Board	AT16K	AT16K	AT16K
	Option	Option	AT16K	AT16K
	Option	Option	Option	AT16K
PCG Graphics	Option	Option	Option	ETI681KG
Cassette I/F	Option	USCI	USCI	USCI
Mother Board	3 Slot	JC100	JC100	JC100
Card Frame	Option	Option	JC200	JC200
Power Supply	Option	JC300	JC300	JC300
Software	Z80 Course	12K Basic	12K Basic	24K Basic
			Assembler	Assembler
	Sample	Games	Utility	Utility
	Program	Pack	Package	Package
Printer	Option	Option	Option	8300P
Disc Drives	Option	Option	Option	At1043/L
High Resolution	Option	Option	Option	NT300
Price	**$399.**	**$699.**	**$1,299.**	**$3,299.**

MICROMODULES FROM APPLIED TECHNOLOGY.

Configure your own Micro-computer System.

CONCEPT:
Applied Technology Micromodules are a complete range of compatible functional boards based on the S100 bus. Start with the powerful DGZ80 CPU, DG640 VDU and add as your requirements grow.
Prices start at $399.00 and you can build up in easy stages to a fully CP/M compatible disc based system.

HARDWARE.
Select from a proven range of modules including the DGZ80 CPU (Z80 based with on board RAM, ROM, PIO, CTC and power on jump). Add the DG640 VDU (16 lines, 64 characters, upper/lower case with full graphics), add the AT16K reliable STATIC memory modules and select from other options such as ETI 681 Programmable Character Generator, ROM – N – RAM, disc controller, I/O boards as your requirements grow.

SOFTWARE.
The Z80 is probably the most popular and powerful 8 bit processor in the world.
Our support includes an exclusive operating system (DGOS) 12K Microworld Basic, a powerful Editor/Assembler, Games packages and an exclusive programming course which will guide you into the world of Micros.

PRICES.
All items available separately.

ATZ80 OPTION PRICING:	Kit	Assembled/ Tested
DGZ80	$199.00	$249.00
DG640	$149.00	$159.00
AT16K	$209.00	$239.00
ATPCG	$140.00	$165.00
JC100 Mother Board	$49.50	
JC200 Card Frame	$49.50	
JC300 Power Supply	$69.50	
USCI Cassette Interface		$25.50
Clare C70 Keyboard		$165.00
Clare C72 Keyboard		$179.50
DGOS IN 2516 ROM		$40.00
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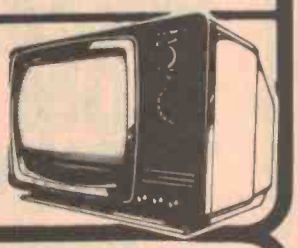

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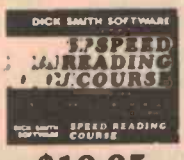

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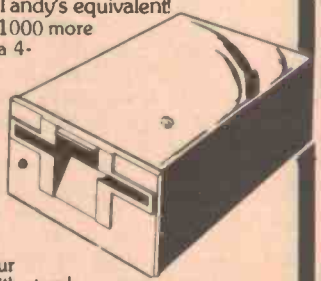

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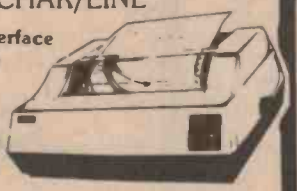

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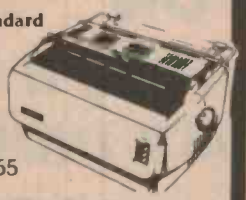

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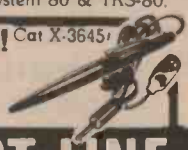

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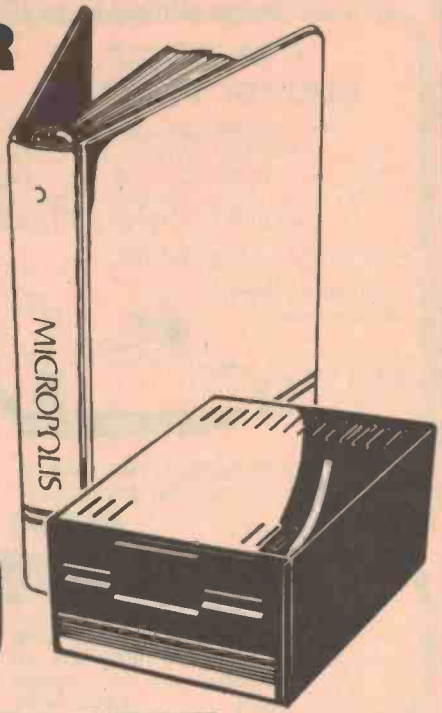

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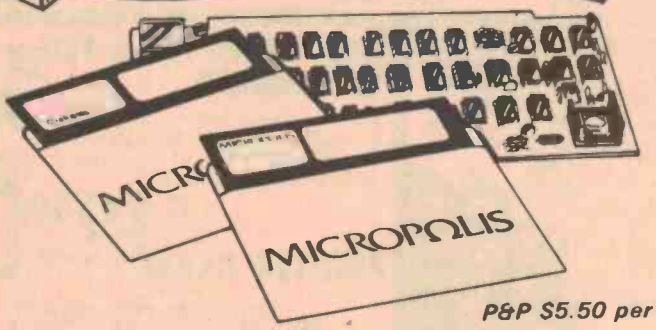

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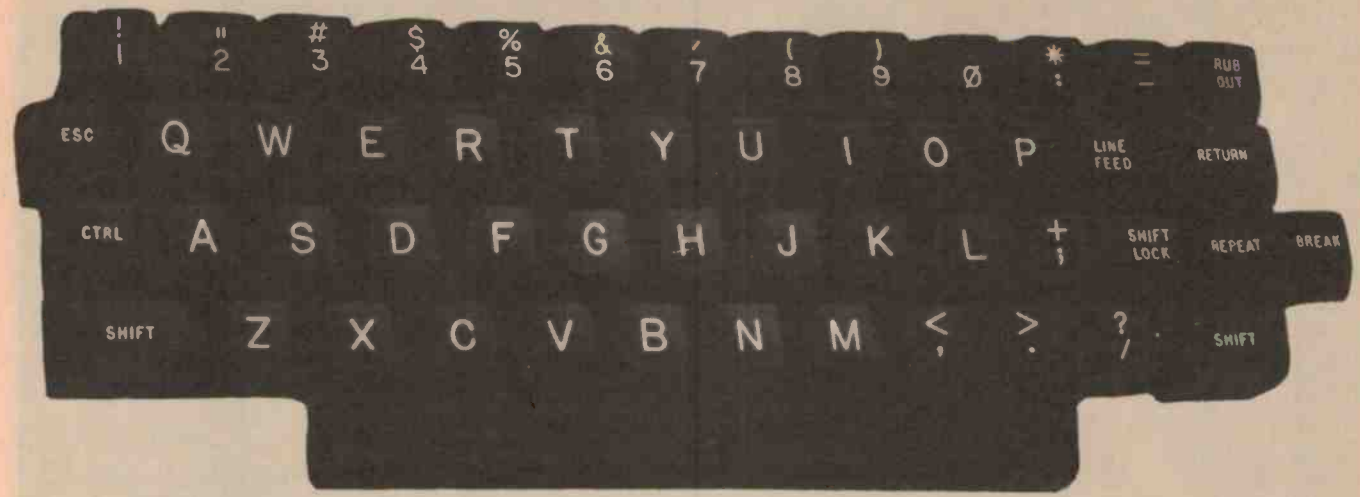

Back door into BASIC Part 2.

Phil Cohen

In the first part of this series Phil Cohen explained the similarities (and some of the differences) between a computer and a calculator. This month he goes on to show how a computer can be used as a calculator — using BASIC.

THE FIRST BASIC word which has to be learned is 'PRINT'. This causes the machine to output information onto the VDU screen or display. The information which the computer will output is determined by what the user puts in to the right of the word PRINT.

Say you type in 'PRINT 4'. The computer would show what you typed as you typed it, then it would reply (on the line below) with the answer, '4'.

At this point, it is worth mentioning the 'RETURN' key. This is a key at the extreme right-hand end of the keyboard, which is the same place as the *carriage return* on an electric typewriter. When you press the RETURN key it is a way of telling the computer to "read what has just been typed in".

Although the computer will show what is being typed in by putting it on the screen, it will not act on it until the RETURN key is pressed.

So, if you type in 'PRINT 4', you then press RETURN. The computer will look at 'PRINT 4', see that the word PRINT means to output whatever is to the right of it, decide to output the value 4, and reply with '4'.

By the way, it may have struck you that, logically, the word should have been DISPLAY, rather than PRINT. The reason for using PRINT is that, at the time that BASIC was developed, teletypes (digitally controlled typewriters) were much more often used than TV-type displays. When the computer PRINTed something in those days, it really *printed* it!

What happens if we put in something a bit more complex? What about 'PRINT 3+4'. The computer will reply with '7'. The computer has looked at what was to the right of the word PRINT, found it to be more than just a simple arithmetic value, worked out the answer and printed that.

Let's look at some more of the BASIC arithmetic functions. If we type 'PRINT 7−6', the answer is '1'. No surprises there.

What about division? 'PRINT 8/2' will give '4'. Notice that the ÷ (divide) symbol is not used. The '/' symbol means that same, and is more commonly found on typewriters and computer keyboards.

Similarly, the '×' symbol is not used in BASIC for multiplication. It has been dropped from computer languages for the same reason it is dropped in algebra — it is easily confused with a lower case x, which is a commonly-used variable name. The symbol for multiplication in BASIC is '*'. So 'PRINT 3*4' will give the answer '12'.

Priority of evaluation

Now we come to something which is not usually a problem in calculators. Say we type in 'PRINT 3+4*2'. On most calculators, this will give the answer 14. Not so in BASIC. In BASIC, as in most computer languages, the answer will be '11'.

The reason is that the computer has done the multiplication first. 4 times 2 is 8, and 8 plus 3 is 11. This is in keeping ▶

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with a general rule which is used in almost all computer languages. Once learned by the user, it makes computer arithmetic much easier to use than calculator arithmetic.

The rule goes like this: Work things out in the following order —

- First see if there are any brackets and work out the bits inside the 'deepest' set of brackets first, then the next deepest, and so on.
- Work out any trigonometric and other complex functions next, such as sine, cosine, log, etc.
- Work out any arithmetic which calls for powers or roots.
- Do any multiplication or division.
- Lastly, do the addition and subtraction.

Within these rules, the computer will work from left to right. so if there are a string of additions and subtractions it will do the left-most one first. If there are brackets in a ( ) ( ) structure, it will work out the left-hand set first.

Some examples will make things a bit clearer.

'PRINT 3*4−2*3

will cause the computer to work out 3 times 4, then 2 times 3, then 12 (the result of the first part) minus 6 (the result of the second part), giving an aswer of '6'.

The BASIC symbol for exponentiation (or raising to a power) is an 'up-arrow' — ↑ . This is used in the following way: If you want to find 2 to the power 3, then, rather than writing 2^3, as you would in mathematics, you instead write 2 ↑ 3. (If you like, the up-arrow shows that the next number is to be shifted up one space).

'PRINT 6.7 + 3 ↑ 2' would cause the computer to work out 3 to the power 2, then add the answer to 6.7, giving the result '15.7'. Notice that the exponentiation was done *before* the addition, in accordance with the rules.

Other Functions

What about functions such as sine and log? In BASIC, these more complicated functions are written as a word to the left of a number in brackets. For example, 'PRINT SIN(17)' will give the sine of 17 radians. Notice that in most cases, BASIC trigonometric functions work in radians and BASIC logs are natural logs. No space is allowed between the N and the start of the brackets, by the way.

In the above example, we used the BASIC word for sine. The BASIC word for cosine is COS and for logarithm is LOG. Not all that difficult to remember. EXP gives the power of e — natural antilogs, if you like.

The number inside the brackets need not be a simple arithmetic value. COS(5-2) will give the cosine of 3 radians.

BASIC Functions

There are many other functions in BASIC which use a name in front of a set of brackets. Some of the more common arithmetic ones are given in the table here. There are various other types which we will deal with in due course.

Variables

I said previously that a computer has memories in which it can store numbers

BASIC FUNCTIONS

Function	BASIC Name	Description
Absolute	ABS	Gives a positive value if the number is negative. For example, ABS(8) is 8, but ABS (−5) is 5.
Arctan	ATN	Gives the inverse tangent. This function is often found even where the computer is not provided with a tangent function, as the tangent of an angle can be worked out easily from the sine and cosine.
Cosine	COS	Gives the cosine.
Exponential	EXP	Gives e to a particular power.
Integer	INT	Gives the integer part of a number. For example, INT(8.97) would be 8.
Log	LOG	Gives the natural logarithm (base e).
Sign	SGN	Gives a value which shows the sign of the number: SGN(−8) is −1, SGN(−4) is −1, SGN (9) is 1, and so on. SGN(0) is 0.
Sine	SIN	Gives the sine.
Square root	SQR	Gives the square root.
Tangent	TAN	Gives the tangent.

in much the same way as a calculator can. In computer jargon, these are called 'variables' because any given part of the memory can store any value — and the value may change ('vary') during the course of the program.

In a computer, the memory is not committed to storing numbers. Parts of it can also be used for storing the program — the memory in a computer is completely 'general purpose'. For this reason, when the machine is turned on, none of the memory contains variables.

If the computer is then told to store a particular value, it will first allocate a small part of its memory for the storage of that value. These small 'pigeon holes' in the computer memory are allocated as required, and each is given a unique name.

In BASIC, the names given to the various memory 'allotments' (or 'variables') take the form of a letter of the alphabet followed by a digit. For example, inputting 'A1 = 3' into the computer will cause it to allocate an area of memory for the storage of one variable, call that area of memory "A1", and then store the value 3 in it.

In BASIC the "=" sign means 'replaced by' rather than the familiar 'equals'. Thus, 'A1 = 3' means 'replace the value in A1 by 3'. A subsequent input of, say, 'A1 = 9' will cause the computer to put the value 9 into A1. This will replace the original value of 3, by the way.

Figure 1 shows what happens during a typical memory transaction. At the start, none of the memory is allocated to any particular variable name. This is in fact a bit of a simplification, as part of the memory is used for program storage and other tasks which we will go into later.

The first input of 'A1 = 4' causes the computer to look around its memory for variable A1, and finding that it does not exist yet, to allocate it a space in memory. It then fills that space with the value 4.

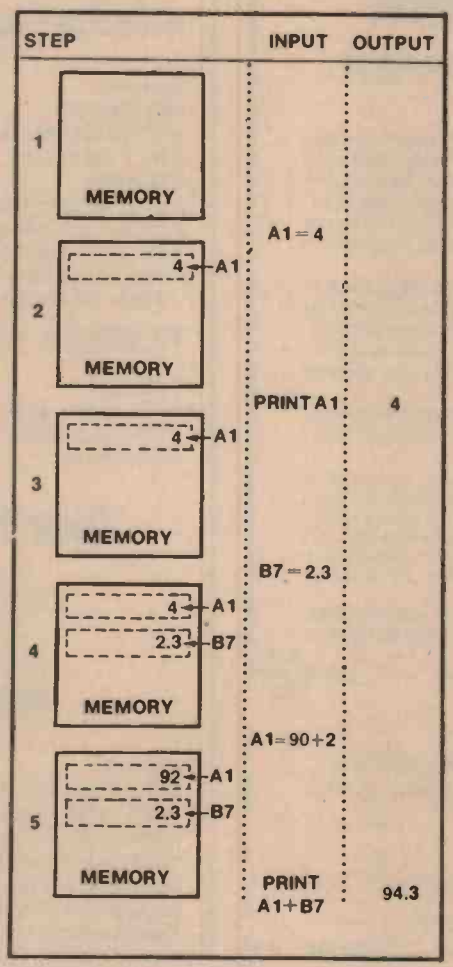

Figure 1. Memory at various steps during a calculation.

The next step is the input of 'PRINT A1'. This will cause the computer to look for variable A1 in its memory. It then takes the value that it finds in A1 and outputs it.

If A1 had not existed at this stage, by the way (for example, if you had typed 'PRINT A2' by mistake) then the computer would have been confused. In circumstances like this, most computers output a rather terse message, like 'A1 DOES NOT EXIST'.

The next step is 'B7 = 2.3'. The computer will search for B7 and, finding that it does not exist, will allocate space to it and put in the value 2.3.

The input 'A1 = 90+2' will first cause the computer to work out what 90 plus 2 is. It will then search its memory for A1 and, finding that it *does* exist, will put the value 92 into it (thus obliterating the previous value of 4).

The final step will make the computer search for both A1 and B7 and finding that they both exist, to add their values together and output the result.

By the way, in most versions of BASIC, variable names such as A and B are allowed, so that there are a total of 286 possible names: A, A0, A1, . . . A8, A9, B, B0, B1, . . . Z9.

Memory Usage

Each computer has only a certain amount of memory — it can hold only so many numbers or so much program at any one time. For this reason, when it is necessary for a particular program to use a lot of variables, and where the variables are not going to need fractions, 'integer' variables are used.

Integer means that the number held in that variable can only be a whole number: 2, 45 and −986 are OK, but 5.6 is not.

In BASIC, the way to get an integer variable is to put a % sign after the variable's name. For example, A3% is a valid integer variable. 'A3% = 9' will cause the machine to allocate an area of memory for variable A3%, then put the value 9 into it.

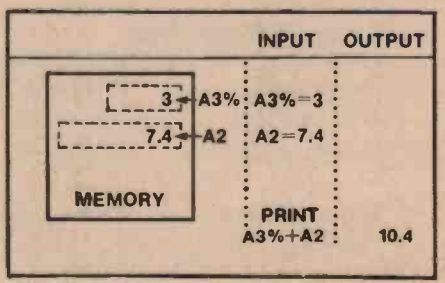

Figure 2. Integer variables take up less memory.

Figure 2 shows the use of integer variables. Notice that they take up less room than other number variables.

In mathematics, numbers which are not integers are called 'real' numbers. This nomenclature is also used in computing. So we have two types of variables (there are others, which we'll come to later): integer and real. ▶

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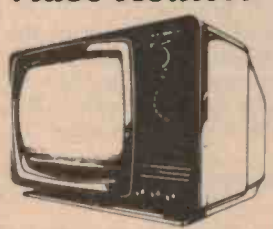

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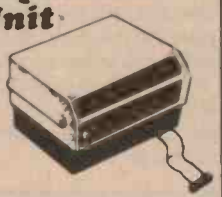

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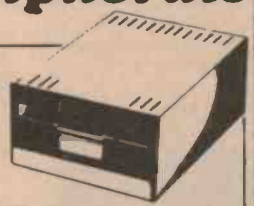

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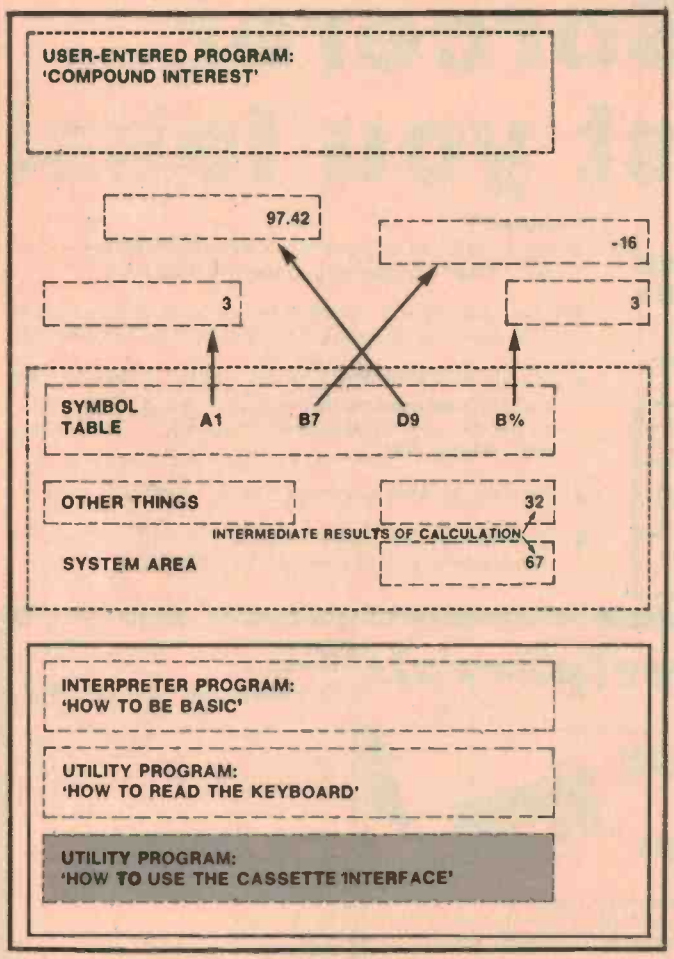
INSIDE THE MEMORY

The diagram here shows what the inside of a computer's memory looks like to the computer. Although it looks a bit complicated at first, a few minutes contemplation will convince you that it really *is* complicated. That's why I've put it into this box — it's not *absolutely* necessary to know the memory's inner workings in order to be able to program.

It *is* necessary, however, if you want to be able to program well.

The first thing which should spring to notice is the shaded box at the bottom. This is the 'Read-Only Memory' (ROM), and is the only part of the computer's memory which is not cleared when the machine is turned off. This is achieved by using memory chips which have had their contents 'blown' into them. (If you like: engraved on their memories in letters of fire!). This is very useful in that they will remember their contents when the machine is turned on, but with the disadvantage that they then cannot remember anything else.



Inside the ROM are a number of programs not written in BASIC, but in the computer's own language — 'machine code' — which is very difficult for humans to learn, but can be understood by the microprocessor without any help!

There are various 'utility programs' (utility is a word used by the Americans to describe water supply, garbage disposal, swimming pool cleaning and other essentials), which tell the microprocessor how to use the various hardware units connected to it. They tell it, for example, how often to check the keyboard to see if a key has been pressed. They also tell it what format to use when it records programs on cassette, and what format the programs are in when the cassettes are played back.

Also in this ROM is the BASIC 'interpreter'. This is a program (again written in 'machine code') which tells the microprocessor how to read BASIC.

In some machines (such as the Sorcerer) the ROM part of the memory is interchangeable — the ROM chips can be replaced with other ROM chips which tell the microprocessor how to read APL, for example, rather than BASIC.

The rest of the memory outside the ROM can be written into and read by the microprocessor at will. For this reason, it is called 'Random Access Memory' (or by some 'Read And write Memory') — RAM.

At least part of the RAM has to be used by the computer just for its 'housekeeping' tasks — like remembering when it last checked to see if any of the keys on the keyboard had been pressed.

The machine will also store the intermediate results of calculations in system RAM. For example, if it is working out 6*2-5*4, the intermediate result of 6*2 will have to be stored while it works out what 5*4 is.

The 'symbol table' is also stored in the system part of the RAM. This is a list of variables which tell the computer where the values of the variables are to be found. "Why not just label them?", I hear you ask. Well, take the example of the computer looking for the value of B7. If the place where the value of B7 (in this case, -16) was labelled with 'B7', the computer would have to search the whole memory before it was sure of finding it. Using a symbol table, it only has to search the table, then go straight to where the value is kept.

Note that the integer variable takes up less room.

In many computers, the system area used by the machine has a movable boundary — the less it needs, the less it will take up. This means that more is available for other uses.

The rest of the memory is available for any use that is required of it. In the above diagram, four variables are shown, but it is just as possible to have 4000 — if the memory is big enough.

At the top of the diagram is a BASIC program. This calls for variables A1, B7, D9 and B%. Every time the program is run, the computer will clear its symbol table (which *effectively* clears the numbers stored in memory), then as it comes to the first time A1 is mentioned in the program, it will enter it into its symbol table, set aside a place in memory for it and put in the value the program calls for.

The 'other things' mentioned in the system RAM will be dealt with in due course.

Some versions of BASIC (particularly those for very small machines) *only* use integer variables. In this case, it's a means of reducing the complexity of the 'interpreter' (the program which is permanently stored in the machine which tells it how to read BASIC). Integer-only BASICs usually *don't* use the % method of signifying integers — *all* of the variables are going to be integers anyway, so there's no possibility of confusion.

Figures 1 and 2 are a little incomplete; they don't show the 'system' part of the memory. This includes the interpreter (in fixed memory — or 'Read-Only Memory' (ROM)) and any temporary storage the machine may need in order to operate. For example, there must somewhere be a 'symbol table' for the BASIC. This is a table (in the sense of a table on a printed page) which holds the names of all the variables, and where they are to be found in memory.

If you haven't understood *all* of this part of the series — don't worry. Probably the best way to approach it is to put the article down for a day or two, let the ideas settle in, then re-read it.

It's only necessary to understand the bare bones of the internal workings of a computer to be able to program one. It is necessary to understand it in some depth if you want to be able to program well, however. ●

• *Next month, Phil Cohen looks at string handling — which forms the basis of the word processor.*

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COMMUNICATIONS

Controversy on the biological hazards of RF

The debate on what standards should be set for 'safe' levels of "non-ionizing" radiations has occasioned a great deal of argument in the technical press and some statements bordering on the hysterical in the mass media.

The media controversy on the biological hazards of non-ionizing radiation continues to rage with statements, even in the same article, ranging from 'the sublime to the ridiculous'.

Overseas statements picked up by the local media and mangled either intentionally or unintentionally, have tended to obscure, even more, the efforts of research workers, scientists and engineers to bring some degree of order into the chaos which is claimed to exist with regard to maximum permissible limits of radiation of this kind.

The biological effects of microwave radiation should certainly not be confused with other effects caused by ionizing radiation or 'biological stress' said to be caused by anything from electric power lines to FM radio broadcasts.

To put the matter straight, the American National Standards Institute had been criticised for re-endorsing its 1966 standard which sets a permissible radiation limit for frequencies from 10 MHz to 100 GHz which, stated for the continuous wave situation, represents a power density of 10 mW/cm^2. This figure for modulated fields is averaged over any 0.1-hour period and was based on the body's known ability to handle temperature rises.

The original decision to publish guidance based only on thermal effects was taken on the basis that thermal effects were considered to be most harmful — being the best documented. Sufficient information on other variables, particularly in the long-term, is not available.

However, the medical profession is adamant that short-term treatment with microwave diathermy equipment at very much higher intensities than that recommended has proved beneficial in relieving pain, promoting healing and improving muscle tone. Doctors are equally adamant that over decades of use no long-term damage to the patient has been observed by qualified practitioners.

The ANSI standard was re-endorsed for much the same reasons as originally given. This is not to say that the standard cannot be improved.

There are areas giving concern but despite the recent spate of papers, there is no hard evidence that other effects are hazardous. Most information comes from short-term tests on small or infant animals. Extrapolation of this information to long term effects in human beings is fraught with problems even for the most adventurous researcher.

Probably the best advice which can be given on the basis of known effects under normal environmental conditions, is that microwave radiation of average power densities above 10 mW/cm^2 is potentially hazardous.

Average power densities between 1 and 10 mW/cm^2 can be regarded as safe for incidental or occasional (short term) exposure, while power densities below 1 mW/cm^2 can be regarded as safe for indefinitely prolonged exposure.

(R.K. Profitt, from the November '80 issue of 'The Australian Standard', journal of the Standards Association of Australia. See the July issue of T.A.S. for the SAA's position).

Rendezvous, Gosford VK2

The Gosford Showground turns into "Mecca" every February as hundreds of amateurs from all over Australia, plus ring-ins from N.Z. and other countries, gather for the annual Central Coast Amateur Radio Club's Field Day.

It's a social and 'sporting' event, with foxhunts, scrambles, quizzes etc revolving around the trade and club displays, the 807 stand and disposals stall. The fun starts at 8 am on Sunday 22 February.

The disposals stall is one of the event's most popular attractions — many a 'bargain' in discarded equipment is sold or picked up there. Indeed, some items return each year, looking for a new owner! If you've got something to sell, book it in in advance by ringing Bill Smith VK2TS at (043)74-1207.

The event is held at the Gosford Showgrounds, Showground Rd, Gosford. Registration costs $4 for men, $2 for women, $1 for children 16 and under. Family registration is $7. The fee includes morning and afternoon tea, event entry and outings. For non-radio people there are trips to the nearby reptile park and a scenic bus tour.

Foxhunts are conducted on 10m and 2m and include mobile as well as pedestrian events. Bring your sniffers (see page 96 this issue). If you're without transport, trains depart Newcastle at 7.33 am, Sydney at 7.25 am and 8.50 am. See you there!

Reagan to reshuffle FCC

A reshuffle of the American Federal Communications Commission along more conservative lines is near the top of Republican priority lists when Ronald Reagan's new Cabinet takes up office early this year.

Reagan will appoint at least three, possibly four of the seven FCC commissioners, including a new chairman, and although there must by law be at least three Democrats, there are, as has been said, "lots of different kinds of Democrats".

Chairman Charles D. Ferris must resign his post and is expected to resign his membership as well; conservative Robert E. Lee, at present an FCC member, is considered a possible successor as chairman.

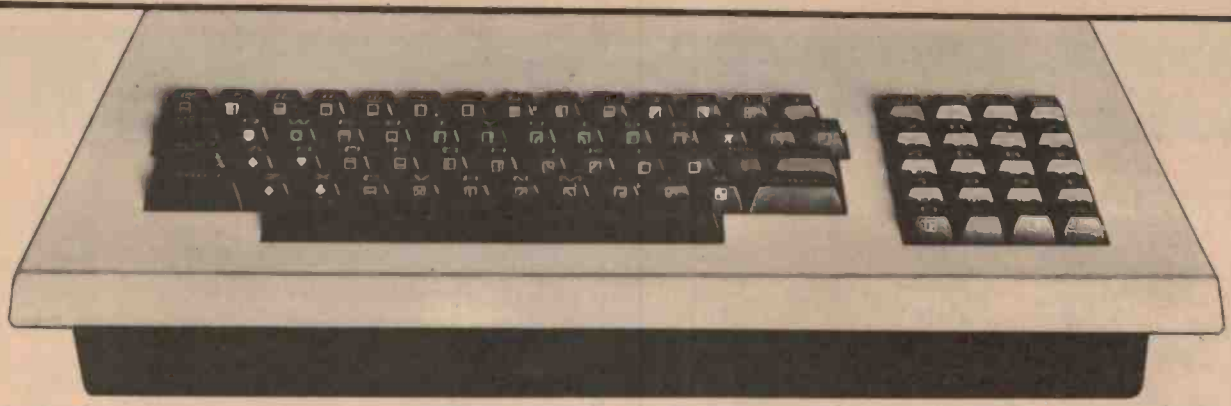
North Queensland Convention

Preparations are already well in hand for the fourth biennial North Queensland Convention to be held by the Townsville Amateur Radio Club over the weekend of 26/27 September 1981.

This will be a gathering of amateur radio operators and enthusiasts not only from Australia but also from overseas. As far as is known, the Convention will be one of the first planned to make use of the new international airport facility at present being constructed at Townsville.

The convention has already attracted the interest of several amateur radio operators from South America, and it is hoped that a number will also arrive from Japan and USA.

Not only will there be activities and displays for radio amateurs and computer hobbyists, there will also be items of interest for other members of the family. Accommodation will be available at the venue if required over the weekend of the convention.



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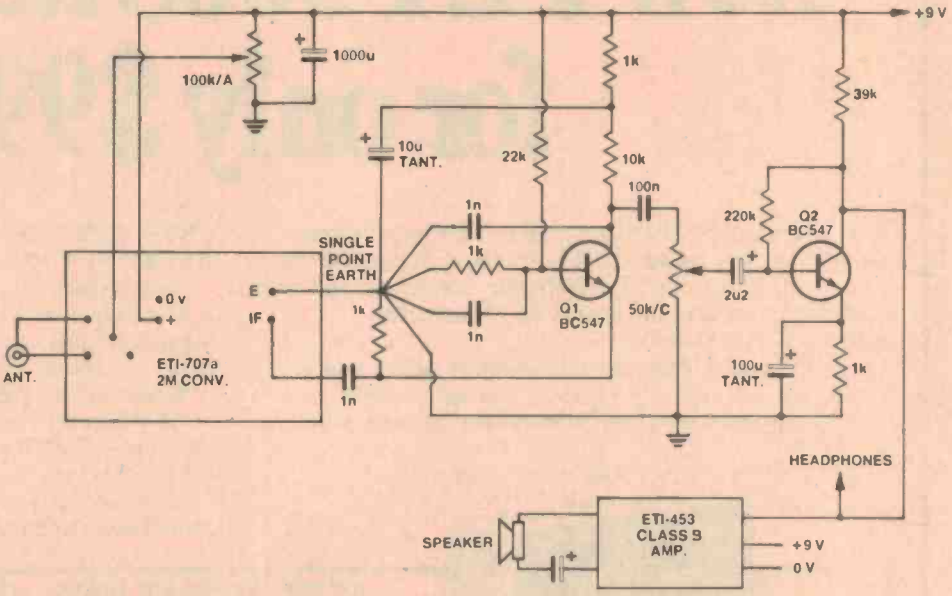
A 'sniffer' for two metre hidden transmitter hunts

Roger Harrison VK2ZTB

HIDDEN transmitter hunts or 'fox-hunts' as they are popularly called, are part and parcel of every amateur radio field day or convention. Foxhunts are generally divided into two classes: mobile and pedestrian. Both require the use of a 'sniffer' to locate the hiding place of the 'fox' — a low power transmitter that is modulated with a tone and automatically keyed on and off at intervals.

Sniffers range from elaborate arrangements consisting of a mobile transceiver carried on a back pack with accompanying batteries (NiCads or sealed lead-acid) plus four element hand held yagi, to virtually a crystal set attached to the feedpoint of a wire-and-dowel rod two-element beam. This one is placed somewhat between these two extremes.



The antenna

The antenna is a simple two-element yagi as anything much bigger doesn't provide vastly greater directivity. It also has the advantage of being compact. It was constructed by cutting down a TV antenna that featured 'collapsible' elements. This makes the beast easy to stow in a vehicle. Dimensions are given in the accompanying diagram.

A standard 'trombone' balun was used to match the feedpoint to the converter input. The halfwave loop was constructed by first calculating the length of line required, cutting the cable a little longer and determining the correct length with a dip oscillator. The cable is RG58.The approximate length is given by:

$$L = \frac{0.5 \times 300\,000}{146\ \text{MHz}} \times 0.66$$

= about 680 mm

I cut the cable to 690 mm and exposed the inner conductor for 5 mm at each end and fanned out the braid. I then twisted the braid and inner conductor together at one end and formed the inner and braid into a small loop at the other (about 6 - 7 mm diameter). Calibrating the dip oscillator with a receiver, I then coupled it to the loop and searched for a dip below 146 MHz. I then cut about 5 mm off the cable at the shorted end, re-made the short and searched for another dip. You should be able to get it on frequency without much trouble. Don't worry if you're +/− 500 kHz of 146 MHz as the bandwidth of the balun is several MHz.

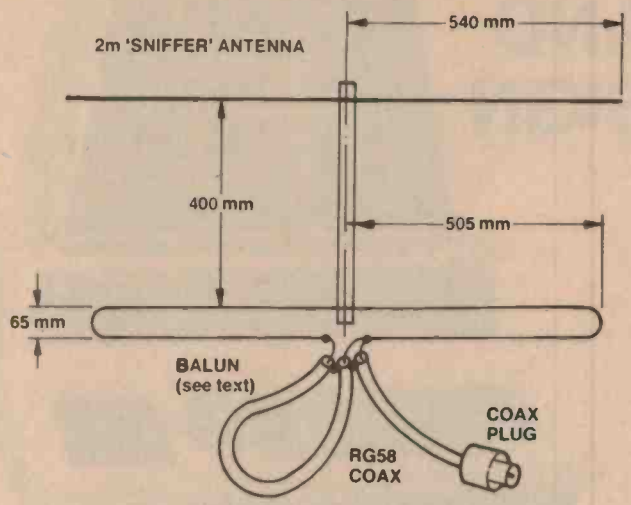
The balun is attached to the antenna feedpoint in the conventional manner. My antenna had wing nuts so I made the leads detachable.

The receiver

The sniffer receiver consists of an ETI-707a Two Metre Converter (February 1976) with a class-B detector attached to the IF output. This is followed by a volume control and one stage of audio amplification. Headphones can be attached to the output of this stage but for loudspeaker output I added the ETI-453 General Purpose Amplifier Module (April 1980).

The components for the class-B detector were literally 'hung' directly off the IF output terminals and the volume pot.

To prevent the fox overloading the receiver when very close, I added an RF gain control — there's provision made on the converter board for this. There is a link between the junction of R2/R3 and R1/C2 on the ETI-707a pc board. This is removed and the wiper of the RF gain



pot is connected to the junction of R1/C2. The RF gain control varies the voltage on gate 2 of Q1, varying its gain. In practice ample gain reduction is obtained while still permitting the converter to operate at full gain when required.

If you don't want the expense of a crystal in the converter then simply short out R8 and adjust L7 to peak a signal on 146 MHz.

The base-bias resistor for the class-B detector (22 k on the circuit here) will most likely need to be chosen individually to account for the characteristics of the particular transistor used. It may be as low as 10k or as high as 39k, perhaps. Substitute resistors until you get the maximum sensitivity.

I mounted (crammed is a better word) all the electronics in a convenient zippy box with the two pots mounted on the front panel, along with a coax antenna socket. The speaker I used measured 30 mm across the cone and fitted neatly on one of the box walls. A small phones jack I mounted on another wall. A No. 216 9V battery is quite adequate, but you may have to add a hefty bypass electrolytic somewhere to avoid low frequency audio feedback ('motorboating'). Decouple the detector and converter supply rails with 220 ohm resistors and large value electrolytic capacitors if you have difficulty getting rid of this problem.

The whole set up is remarkably sensitive and a 2 μV signal at the antenna can be clearly heard at maximum RF gain. You can start sniffing when quite some distance from the fox, long before the simpler sniffers can be used. ●

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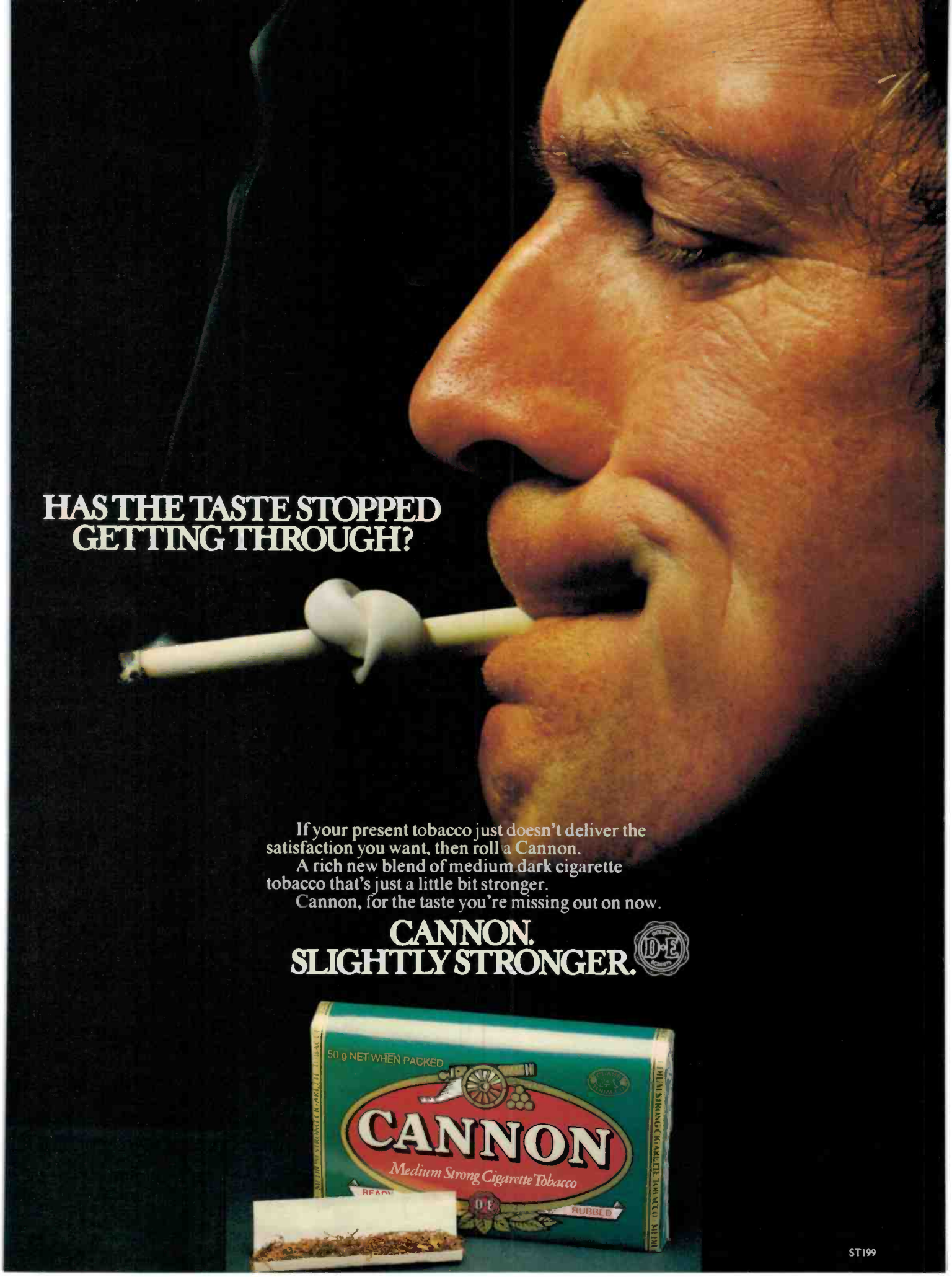
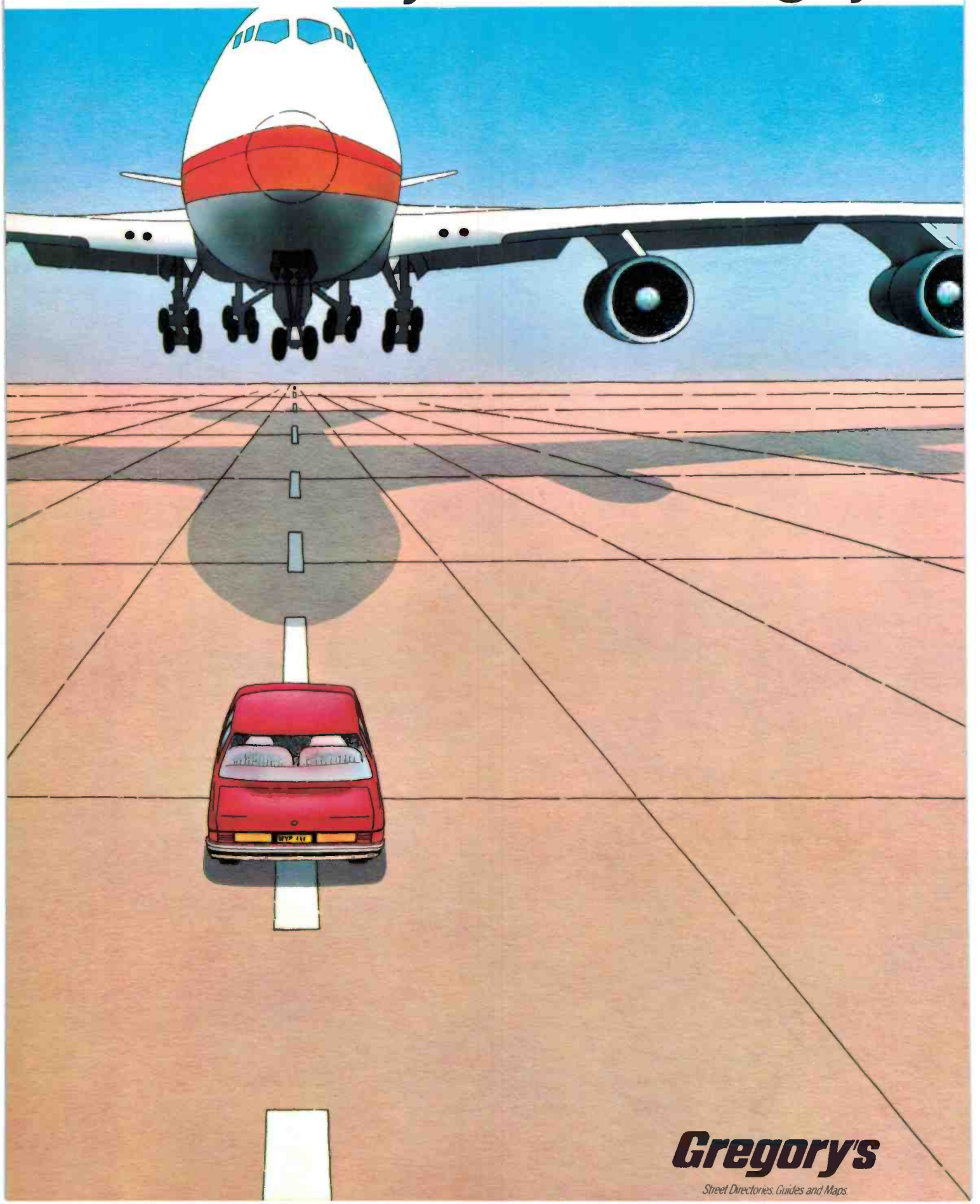

HAS THE TASTE STOPPED GETTING THROUGH?
If your present tobacco just doesn't deliver the satisfaction you want, then roll a Cannon.
A rich new blend of medium dark cigarette tobacco that's just a little bit stronger.
Cannon, for the taste you're missing out on now.
CANNON.
SLIGHTLY STRONGER.
50 g NET WHEN PACKED
CANNON
Medium Strong Cigarette Tobacco
RUBBED
ST199

Sooner or later you'll need a Gregory's.



Gregory's

Street Directories, Guides and Maps.

Canada makes big changes

Radio Canada International, with studios in Montreal, made wholesale schedule re-arrangements for the transmission period in effect up to the beginning of March.

A feature of RCI's schedule is now the Sunday only programmes in English and French especially for Canadians abroad.

These transmissions include English from 2300 to 0000, and French 0000 to 0100 Mondays GMT date. Frequencies used for this weekly service are 11 850 and 5960. These same two channels also have Saturday only broadcasts, with English from 2300 to 2330, and French through to 0100.

Radio Canada International's European service broadcast, weekdays only, has been re-timed from 2100 sign-on to the new time of 2200 sign-on, and runs until sign-off at 2300 with programmes in English. Frequencies now used for this service are 5995 (via Daventry in England) and 9760, 11 925 and 15 325 all via Sackville in New Brunswick on the Canadian eastern seaboard.

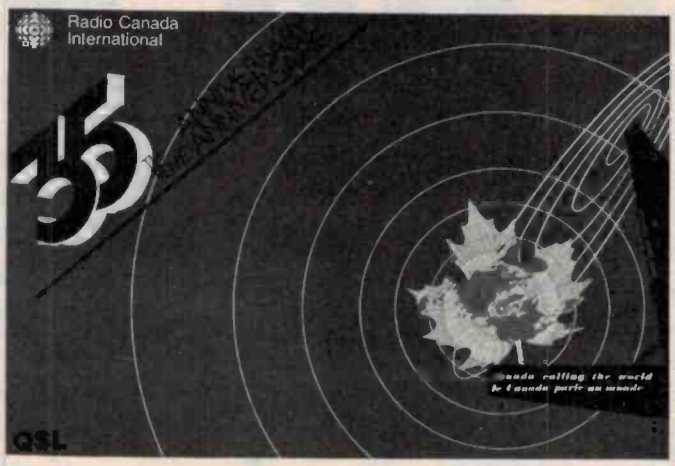
A special feature of Radio Canada International's broadcasts is the weekly programme for shortwave hobbyists, known as "DX Digest", which is beamed to America, Europe and Africa at weekends.

The programme is heard in the service for the Americas each Sunday (GMT date) in the various half hour programme blocks in English, at 0100 on 11 940 and 11 850; at 0200 on 11 940 and 11 845; at 0300 on 9535, 11 770, 11 845 and 11 940; and in the 0400 service on 11 845 and 11 770. DX Digest is broadcast to Europe each Sunday in the English service 1900 to 2000, on 17 875, 15 325, 11 905 and 5995.

The RCI African service has DX Digest every Saturday GMT, in the service 2130-2200 (early Sunday morning in Australia) on 11 945, 15 150, 15 325, 17 820, and 17 875.

DX Digest includes reports on technical aspects of radio listening, plus latest shortwave listening tips from Glenn Hauser.

Radio Canada International mails out their broadcast schedule twice each year. If you would like to have your name added to their mailing list then you should write requesting a transmission schedule to RCI, P.O. Box 6000, Montreal, Canada H3C 3A8.



Chile moves to summer time

With Chile's recent introduction of summer time, several Chilean stations are now audible on the 31 metre band.

Early sign-on by the Chilean stations means reception is now possible during our early evenings prior to signals from Asia becoming too prominent.

Radio Agricultura in Santiago is heard on 9630 from sign-on at 0900, with news, advertisements and local music. After 0930 reception suffers from increased interference.

Also heard at present is Radio Mineria, also in Santiago, on 9750. Mineria also opens transmission at 0900 (sign-on time is 1000 at other times) and gives fair reception up to about 0930, when there is increased interference from Radio Malaysia on the same frequency.

NOTE! All times are given in Greenwich mean time (GMT). To convert to Australian Eastern Standard Time, add 10 hours (11 hours during Daylight Saving Time, November to February). To convert to Central Standard Time, add 9.5 hours and Western Time add 8 hours.

All frequencies are given in kHz.

These notes are compiled by Peter Bunn on behalf of the Australian Radio DX Club (ARDXC). Further information on DXing or the activities of the ARDXC may be obtained from P.O. Box 79, Narrabeen, NSW 2101, for a 22¢ stamp.

European late summer fadeout

During our summer evenings, DXers should be able to note that signals from Europe in our late afternoons/early evenings will remain audible for longer periods.

The northern winter and the consequent later sunrise in Europe means that signals on, say, the 31 metre band are now audible up to about 1000 in our evenings. By contrast, during our winter months such signals would not usually be audible much beyond 0800 on 31 metres.

Signals from Europe during our late afternoons reach us via the long reception path over the Atlantic, the Americas and the Pacific mostly via a darkness path. Signals which have recently been audible up to 1000 include Trans World Radio in Monte Carlo on 9495, and Spanish Foreign Radio in Madrid on 9585.

Meanwhile, Radio-televisione Italiana (RAI) in Rome is audible on 9580 with the Italian service to Australia right up to sign-off at 0930. During the winter months in Australia this transmission is seldom audible beyond the 0830 sign-on time!

This pattern of late fadeout of European signals on 31 metres (as well as on 25, 41 and 49 metres) should be a feature of DX reception up to the end of January.

Pakistan home service

Radio Pakistan's Home Service is currently noted on several outlets during our evenings, highlighting improved reception of Asian signals during our summer months.

Islamabad transmitters are audible on 9645 up to sign-off at 1130, as well as on 7090 from sign-on at 1300. Programmes are in Urdu, with much local music typical of southern Asia broadcast during all transmissions.

Radio Nepal frequency switch

Radio Nepal in Kathmandu has recently moved to a new outlet for the evening service in English.

Kathmandu now uses the new outlet of 5005, parallel with the usual 3425, for English between 1435 and 1520. Both transmitters are rated at 100 kilowatts.

Meanwhile, Radio Nepal is carrying out its annual tests of its low power (5 kilowatt) transmitter, on 9590 with programming in parallel with 5005 and 3425.

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BUY NOW AND ENTER!

~~FRG-7 FRG-7000~~

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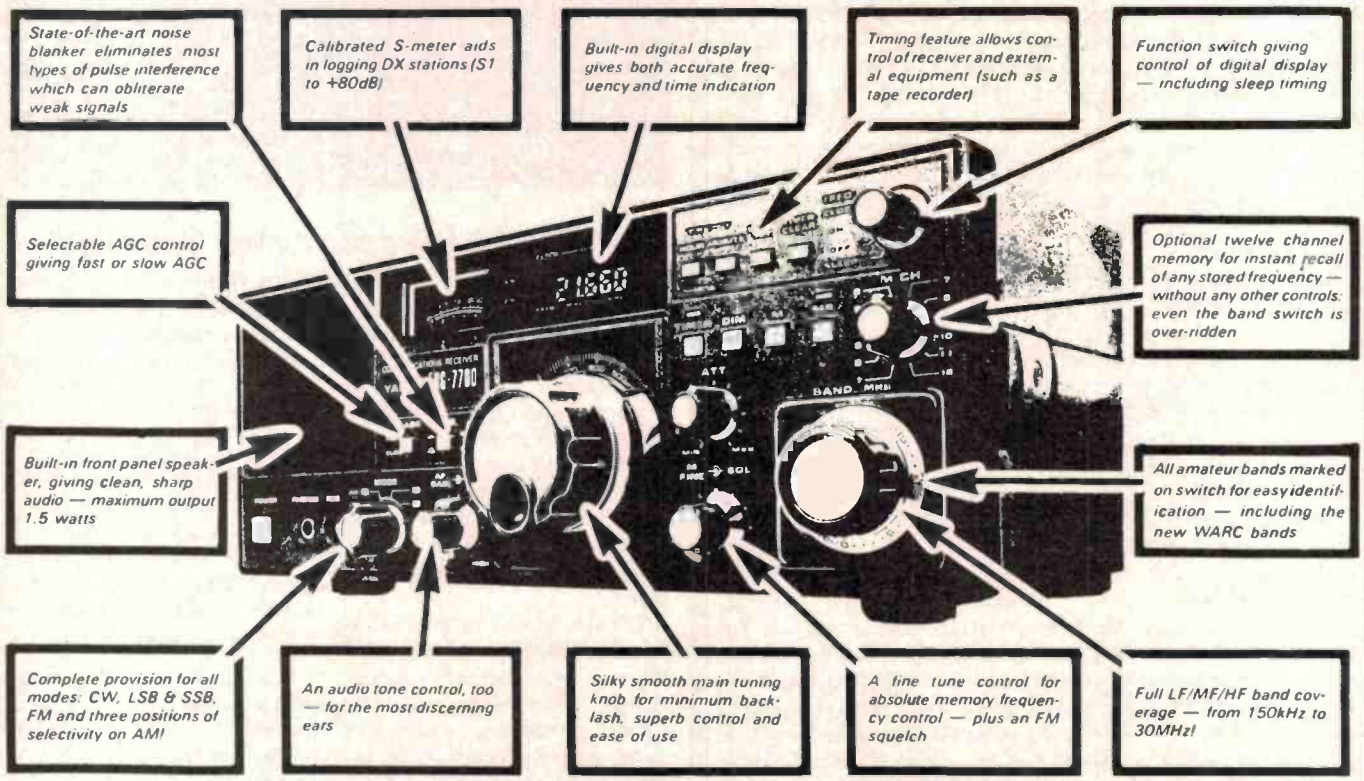
FRG-7700

We've sold thousands of the superb Yaesu 'FRG's. Now there's a brand new model: the superb FRG-7700 . . . All mode (even FM) and a brilliant new design. Isn't it time you up-dated your communications receiver (FM is great with converters!)



Of course, the front panel is only half the story.
Take a look inside the new Yaesu FRG-7700 and you'll find a superb state-of-the-art circuit, giving you outstanding performance and ease of use.
And the really good news: the FRG-7700 is actually cheaper than the model it replaces.
A better receiver for less money!
And with the optional memory unit, the FRG-7700 gives you the ability to store up to 12 commonly used frequencies — recalled at the touch of a button! (It even holds them when the unit is turned off!)
The all-mode Yaesu FRG-7700 is the receiver for the 80's — a worthy successor to the world famous FRG-7 & 7000.

YAESU FRG-7700 RECEIVER

Cat. D-2840
P&P $5.50

$525

Terms available from $55 dep & 25.74 mth (24 months)

OPTIONAL 12 CHANNEL MEMORY UNIT Cat. D-2842 $145.00. P&P FREE IF PURCHASED WITH ABOVE UNIT

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BRISBANE: Half hour earlier.
ANY TERMS OFFERED ARE TO APPROVED APPLICANTS ONLY

PREDICTIONS

FEBRUARY 1981

These GRAFEX style computer generated predictions are provided courtesy of the Australian Ionospheric Prediction Service, Dept. of Science and Technology.

Covering 3 MHz to 40 or 60 MHz, these predictions show the times radio contact is possible between the areas designated beneath each graph, as well as the possible 'mode' and reliability. Vertical columns indicate time — commencing at 0000 UT on the left, to 2300 UT at right. For reliable predictions follow the times and frequencies indicated by the F character.

Complete information on using these predictions can be obtained by sending a stamped, self-addressed envelope to:-

ETI — Predictions
3rd floor 15 Boundary St
RUSHCUTTERS BAY NSW 2011.

KEY TO SYMBOLS

A blank area means no normal propagation is possible.

● . . . path open less than 50% of days in month.

% . . . path open 50-90% of days in month.

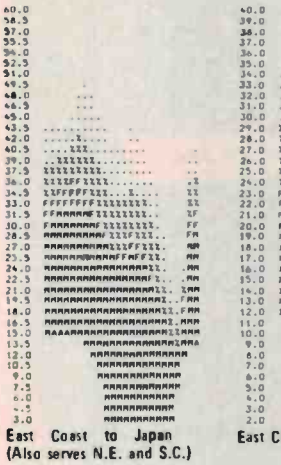
F . . . path open at least 90% of days in month.

X . . . complex mixture of modes. Expect abnormal propagation.

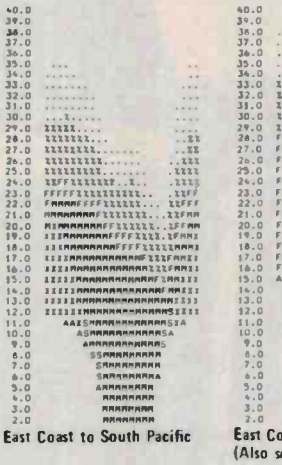
M . . . propagation possible by both 1st and 2nd F-layer modes. Expect strong fading.

S . . . propagation possible by 2nd mode (also 3rd and mixed E and F modes). Expect strong fading, weak signals.

A . . . High absorption indicated. Expect weak signals.



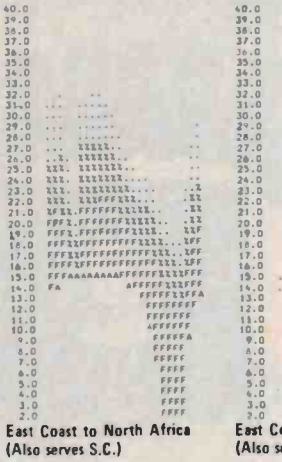
East Coast to Japan
(Also serves N.E. and S.C.)



East Coast to South Pacific

East Coast to North America
(Also serves N.E. and S.C.)

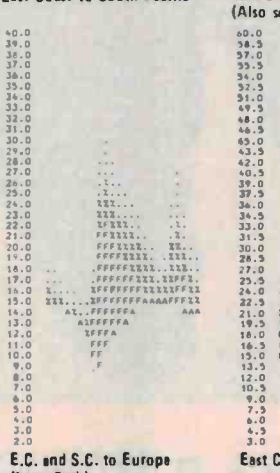
East Coast to South America
(Also serves S.C.)



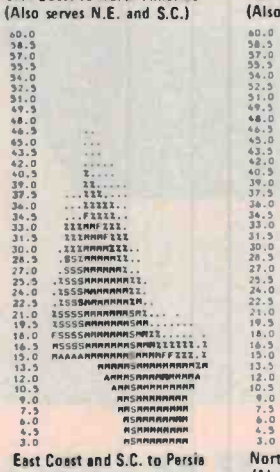
East Coast to North Africa
(Also serves S.C.)

East Coast to South Africa
(Also serves S.C.)

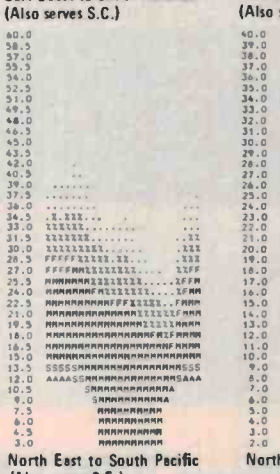
East Coast to Europe
(Short Path)



E.C. and S.C. to Europe
(Long Path)

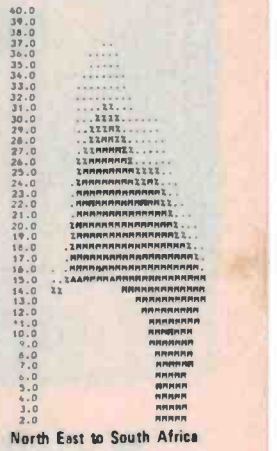


East Coast and S.C. to Persia



North East to South Pacific
(Also serves S.E.)

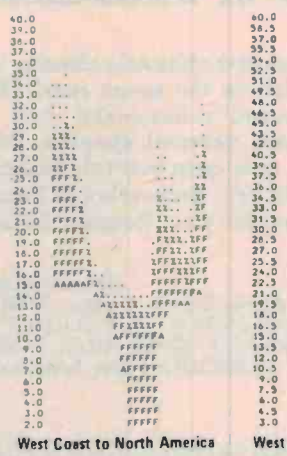
North East to North Africa



North East to South Africa

North East to Europe
(Short Path)

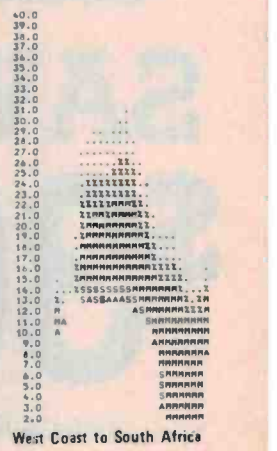
S. Central & W.C. to Europe
(Short Path)



West Coast to North America

West Coast to Japan

West Coast to North Africa



West Coast to South Africa

An Admiral Idea at a Pirate's Price

P & T Approved

Realistic's New TRC-II Marine 2-Way Radio

SAVE $30

Till Jan 31, 1981

Features like all 6 new marine channels already installed and variable SQUELCH control make it the best CB-value on the seven seas! TRC-II has steady sea legs — a mounting bracket that can be secured to horizontal shelf, overhead or bulkhead, while SPK jack allows you to cruise with external speaker. Plus it has a push/pull audio amplifier, switchable ANL circuit, auto-gain control, modulation indicator. Whether you're a week-end skipper or a seasoned salt, drop achor at Tandy and christen TRC-II for seaworthy CB at a price that won't capsize you. Regular Retail Price 129.95 cut to only 99.95 until January 31. 21-9141

Specifications

TRANSMITTER: Power Output 4 watts. **RECEIVER:** Sensitivity 0.7 uV for 10 dB (S + N)/N; Selectivity 6 kHz @ −6dB; Adjacent Channel Rejection 36 dB: **GENERAL:** Channels-Supplied with A: 27.860 MHz B: 27.880 MHz C: 27.900 MHz D: 27.910 MHz E: 27.940 MHz F: 27.960 MHz: Power Requirements 12.5—15VDC, negative ground only.

Available at all Tandy Stores and Participating Dealers Around Australia or Mail Order Department, P.O. Box 229, Rydalmere.NSW.2116

TANDY ELECTRONICS

sound

sound news

Digital disc improvements

Sony and Philips have co-operated to improve the modulation and error correction of the Philips laser-read audio disc system.

They have also developed a compact player, which was given its first public demonstration at the All Japan Radio Fair in October. The high density recording system allows a continuous playing time of 60 minutes on one side of a 120 mm disc, compared to the maximum 30 minutes on a conventional 300 mm LP.

The two companies have submitted this 'Compact Disc Digital Audio' system to the Digital Audio Disc Standardisation Conference and are making every effort to get the system accepted as a world-wide standard.

The discs are pulse code modulated, using 16 bit linear quantisation per channel at a sampling frequency of 44.1 kHz, to produce a pattern of black lines which is read by a tiny solid state laser and photo-sensitive device. This produces a digital voltage which is passed through error correction circuitry (which uses the Cross Interleave Reed Solomon Code) and then demodulated into an analogue audio signal. An EFM, or 'Eight to Fourteen', modulation technique is used to make the recordings.

Philips and Sony are obviously hoping that their digital disc system will have the same impact and popularity as tape cassettes enjoyed when they were introduced. The development of a digital player small enough to be carried around will certainly help their chances and laser-read discs have the additional advantage that the coded surface is overlaid with a layer of clear plastic which protects it against careless handling. Small scratches do not detract from the quality of reproduction at all.

Third octave audio analyser

The Abacus one-third octave audio analyser may be used in conjunction with an oscilloscope or X/Y monitor to display real time intensity and spectral distribution of sounds.

The use of an external display enables the analyser to be priced economically and allows the user to choose either a large screen display for laboratory work or a service oscilloscope for on-site measurements.

An internal pink noise generator allows an accurate and rapid determination of system frequency response. Applications include loudspeaker and microphone response measurements, amplifier, tone control and filter response checks, signal and hum tracing, loudspeaker crossover design and crosstalk and noise measurements.

An optional accessory, Abacus type 500, is available as an aid for equalisation of sound reproducing systems in large auditoria.

For more information contact The Dindima Group Pty Ltd, P.O. Box 106, Vermont, Vic. 3133. (03) 873-4455.

Ferris for your wheels

Improved frequency response and a restyled facia panel are two of the changes Ferris have made to their car stereo units.

Like its predecessor, the latest model JMPA 3020 has a built-in five band graphic equaliser, with each band variable by 12 dB up or down. For best results it should be used with a three-way speaker system.

Other features include FM muting, a local/DX switch, an equaliser bypass switch and balance control. Power output is around six watts per channel and the frequency response extends from 50 Hz to 12 kHz.

The JMPA retails for just under $250. For more details, contact Ferris Audio Products, 353 Victoria St, Brunswick, Vic. 3055. (03) 387-3844.

Small KLH speakers

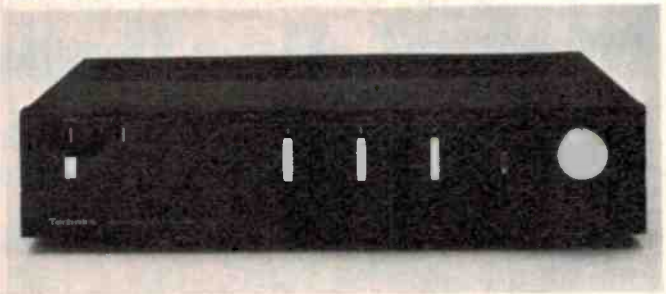
Two new bookshelf speaker systems from American manufacturer KLH have just been released in this country.

The KLH-160 is a two-way acoustic suspension system with a 200 mm polypropylene woofer and a 25 mm soft dome tweeter. The two drivers are offset from each other to minimise irregularities in frequency response caused by the cabinet and are supplied in mirror image pairs to provide better stereo imaging. They measure 489 x 267 x 203 mm and retail for $398.

Rather more expensive at a recommended retail price of $598 are the KLH-150 speakers. These are a three-way reflex design and use the same tweeter and woofer as the KLH-160 system, with the addition of a 100 mm polypropylene mid-range driver.

Both the KLH-160 and KLH-150 are nominal eight ohm speakers and produce a sound pressure level of 90 dB at one metre for one watt input. The two-way system is designed to be driven by amplifiers with outputs in the range from 15 watts to 50 watts and the three-ways are happy with input power from 20 watts to 75 watts.

KLH loudspeakers are distributed in Australia by Concept Audio Pty Ltd, P.O. Box 422, Dee Why 2099. (02) 938-3700.



Stereo DC control amplifier

The SU-A4 preamplifier recently introduced by Technics is a genuine class A amplifier which is claimed to have impeccable phono equalisation.

Ultra-low-noise FETs are used in both the moving coil and moving magnet input stages, which results in an overall signal to noise ratio of 90 dB for moving magnet and 78 dB for moving coil sources.

The tone control circuitry can be bypassed for "straight DC" operation in which the only capacitors in the signal path are one for downstream moving coil and another for moving magnet coupling. With AUX inputs, the entire signal path from input to output is strictly direct-coupled.

A special buffer amp gives the SU-A4 an extremely low output impedance, which allows remote power amp placement close to the speaker systems to improve damping ability.

When the tone controls are needed, four band equalisation is possible. In addition to the normal bass and treble adjusters, there are "super-bass" (with a turnover frequency continuously adjustable between 50 Hz and 200 Hz) and "super-treble" controls.

Conductive plastic and multi-contact are used for volume control and all selectors and switches, and all the jacks are gold-plated.

Plus series turntables

Top turntable in Sanyo's new 'Plus' series is the quartz-locked direct drive Q60 model.

This is a fully automatic turntable with a completely separate motor for the tone arm. Sanyo claim that the additional dc motor reduces lateral bearing friction by as much as 30%.

Following what is nowadays almost standard practice, the Q60 has a straight tonearm. The combination of a hollow tonearm and a carbon fibre headshell is said to give good transient response and tracking ability and to minimise subsonic warp signals.

The diecast platter weighs 1.5 kg and is driven by a twenty-pole, thirty-slot motor. The unusually large diameter of this motor gives it significantly higher torque, which is claimed to eliminate starting lags.

A digital readout on the angled front panel normally displays speed and speed variation, but it can also be used to show stylus pressure and the amount of time that the stylus has been used since it was fitted.

Sanyo say the Q60 turntable is immune to most acoustic feedback, partly because of specially designed rubber dampers inside the feet and partly because of the high density bulk moulding compound used in the base.

At a recommended price of $739, the Q60 is likely to be beyond the average budget, so Sanyo are backing it up with two other models, the fully automatic Q40 at $315 and the semi-automatic Q25 at $288. All Plus series components are covered by a five year warranty on parts and labour.

It's a better system, at a better price, and it's Sony. In Sony's new TC-K81 three head cassette tape deck, each head has its own individual casing and suspension system.

You get precise azimuth alignment,* equal record and playback head-to-tape pressure, and reduced magnetic leakage flux.

It's a unique three-head system, with two-motor, closed-loop dual capstan drive with metal tape compatibility.

The new TC-K81 also has microcomputer control and feature-touch operation, and LED Peak Programme Meter, bias and record level calibration system, and Dolby** NR.

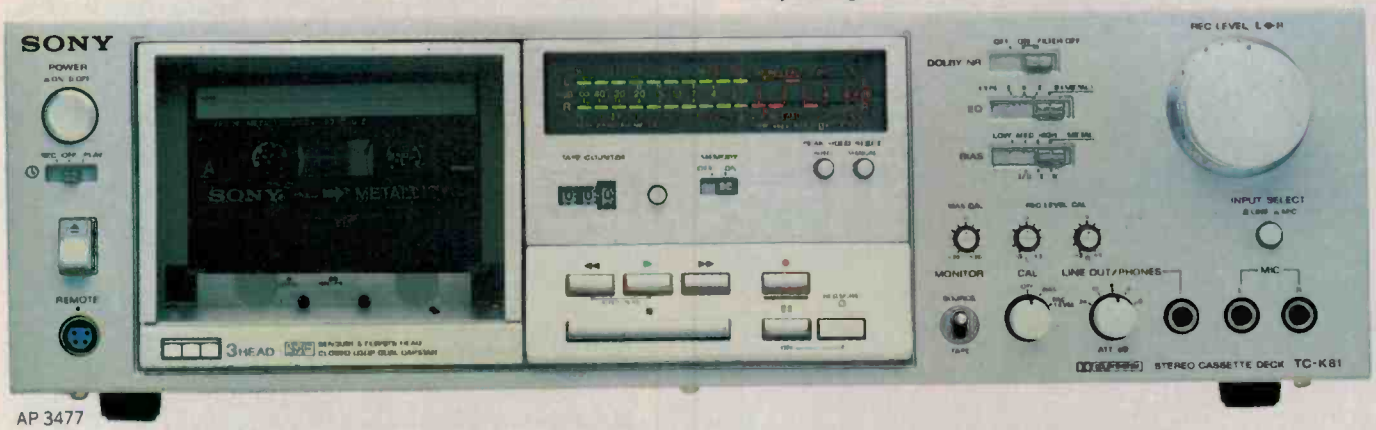
It's an exceptional new system, at an excellent price. And it's Sony.

So in three-head technology, we're three-ways better.

Sony's 3 head system. It's 3 ways better.

SONY®

*Factory aligned.
**Dolby is a registered trademark of Dolby Laboratories.



AP 3477

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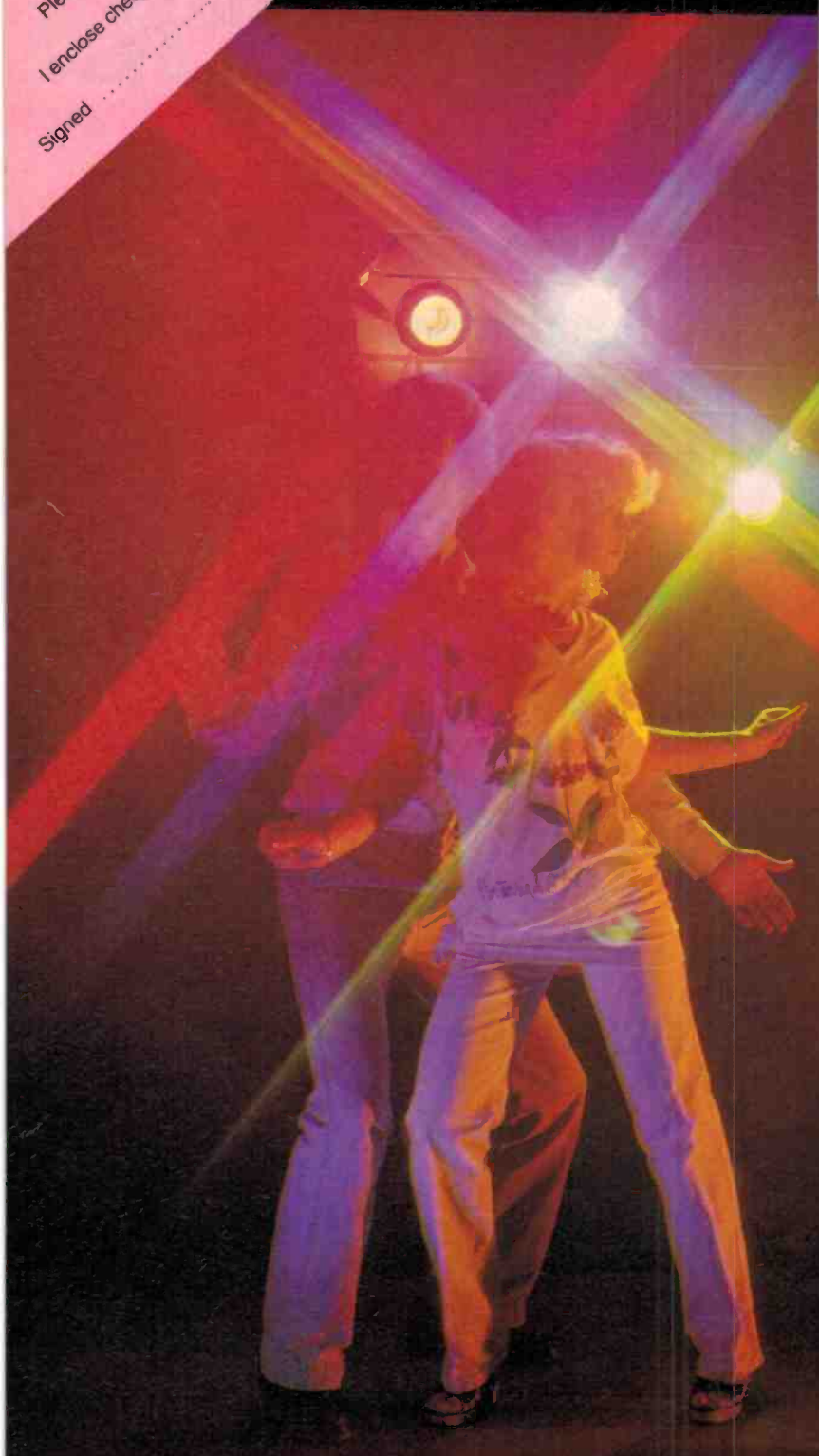
Please send me ... Disco Lite units @ $49.99 each plus $2 post and handling. TOTAL $ .....

I enclose cheque/money order, No. .....

Signed .....

MAIL ORDER DISCO LITE

3-IN-1 LIGHT CONTROLLER



PC410

- Great for parties, advertising displays, Christmas tree lights etc.
- Light dimmer for mood and effects lighting
- Variable speed strobe
- Flashes lights to beat of music

FEATURES

• Plugs directly into 240 V power socket, no wiring needed • Three position switch selects (1) "music colour" (using coloured lights) that flashes lights to beat of music — built in microphone, variable sensitivity control; (2) "strobe" effects for flashing lights at variable speed; (3) light dimmer with variable intensity • Continuously variable control provides complete flexibility in all modes of operation • Can be used with 240 V filament lamps to the total of 500 watts • Double insulated • S.E.C. approved and fully guaranteed.

$49.99

Post and Handling: $2.00

We regret we cannot supply New Zealand readers.

Mail this coupon or a photostat to: **'Disco Lite Sales', ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.**

This magazine is acting as a clearing house for orders. Make out your cheque or money order to 'ETI Disco Lite Sales'. We will process your order and send it on to A & R who will mail you the goods. Please allow up to four weeks for delivery.

The PC410 Disco Lite is a product of A & R Electronics, manufactured under the Arlec label.

While these units are sold through some retail outlets, they are not generally available and ETI has arranged to offer them to readers via mail order.

Ortofon's VMS range extended

Two new Variable Magnetic Shunt (VMS) cartridges have been introduced by Ortofon to back up their successful VMS 20E MkII.

The VMS 30 MkII has a 'Fine Line' diamond tip, a dynamic lateral compliance of 25 micrometres per millinewton and an equivalent stylus tip mass of 0.45 mg. The makers claim it has outstanding tracking ability and say it will improve the performance of even the most expensive turntables.

The VMS10E MkII cartridge, with a dynamic lateral compliance of 15 micrometres per millinewton, is designed to mount on tonearms with a relatively high mass.

The Variable Magnetic Shunt principle employed in these cartridges involves mounting a light tubular armature on the end of the stylus cantilever. This armature moves in the field generated by a ring magnet, altering the magnetic flux and inducing voltages in coils wrapped around the magnet. According to Ortofon, the low cantilever mass results in better tracking and consequent improvement in the high frequency and transient response.

Ortofon, which manufactures its products in Denmark, was until recently owned by US companies, but it is now once again an entirely Danish-owned firm.

Audio programme timers

Akai have recently introduced two programme timers to complement their range of hi-fi equipment.

They can be set to turn on the tape recorder, tuner, turntable or any other equipment and turn it off again at predetermined times. Possible uses include recording FM broadcasts when you are out of the house, replacing the clock radio with hi-fidelity sound, or as a means of fooling potential burglars into thinking that an empty house is occupied.

The DT-100 timer can be turned on and off once every 24 hours. It uses a crystal oscillator to measure time intervals and indicates times on a fluorescent digital display. A special time limit system can turn it off after two hours.

The DT-200 is a more sophisticated microprocessor-controlled unit with a quartz reference oscillator. This timer runs over a seven day period and can memorise four different programmes. The digital fluorescent display shows the day, the time and the memorised time and also includes an automatic dimmer.

Both timers are available in either silver or black panel finish. They are distributed by Akai Marketing Services Australia Pty Ltd, whose head office address is P.O. Box 309, North Ryde. NSW 2113. Phone (02) 887-2311. The company also has branch offices in Melbourne, Brisbane, Adelaide and Perth.

Receivers with spectrum analysis

Three new stereo receivers from Sansui all incorporate a fluorescent histogram display of the programme frequency content.

Models 9900Z, 8900ZDB and 7900Z are equipped with phase-locked loop frequency synthesis and indicate the tuned frequency on a digital display. They also have a 'Frequency Range Finder' feature that uses red LEDs to show the approximate position of the tuned station on an analogue tuning dial.

The 9900Z and 8900ZDB have tuning knobs linked to a rotary 'encoder' disc, which generates current pulses to raise or lower the tuned frequency. The 7900Z has two buttons instead of a tuning knob. Touching the UP or DOWN button causes the tuner to scan up or down and lock onto the nearest station. Up to six FM and six AM stations can be stored in memory.

All three receivers use DC power amps equipped with protection circuits that prevent damage from overloads, overheating and offset voltages, as well as muting power-off 'pop' noises.

The 9900Z and 8900ZDB use heat pipes to conduct heat away from the output transistors and dissipate it from cooling vanes. The 8900ZDB relies on simple convection to achieve this, but the 9900Z, which is the more powerful receiver, uses a fan as well for forced cooling.

The 7900Z delivers 100 watts per channel, the 8900ZDB gives 125 watts per channel and the 9900Z gives 160 watts per channel, all into eight ohms. Total harmonic distortion at these output levels, with both channels driven, is less than 0.02% for all three receivers.

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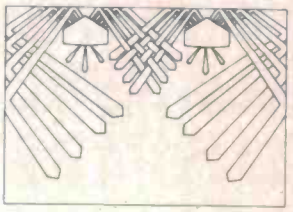

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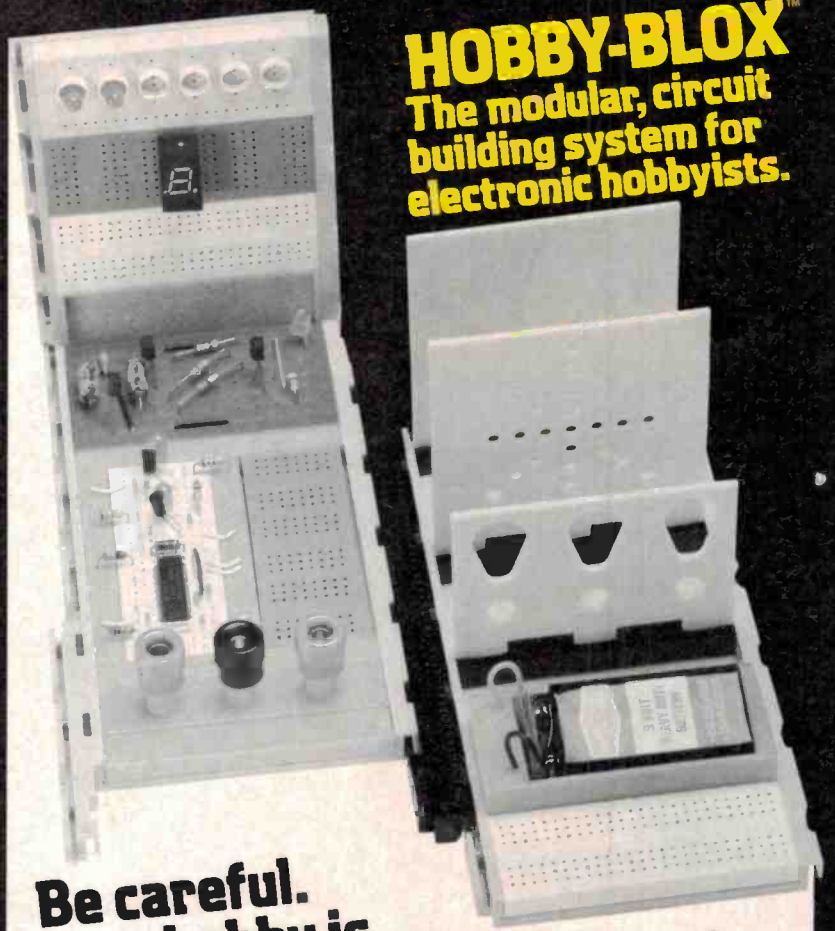

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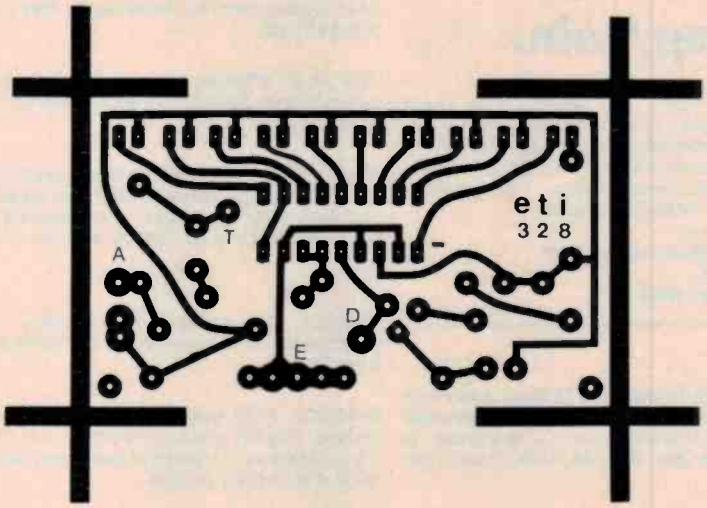
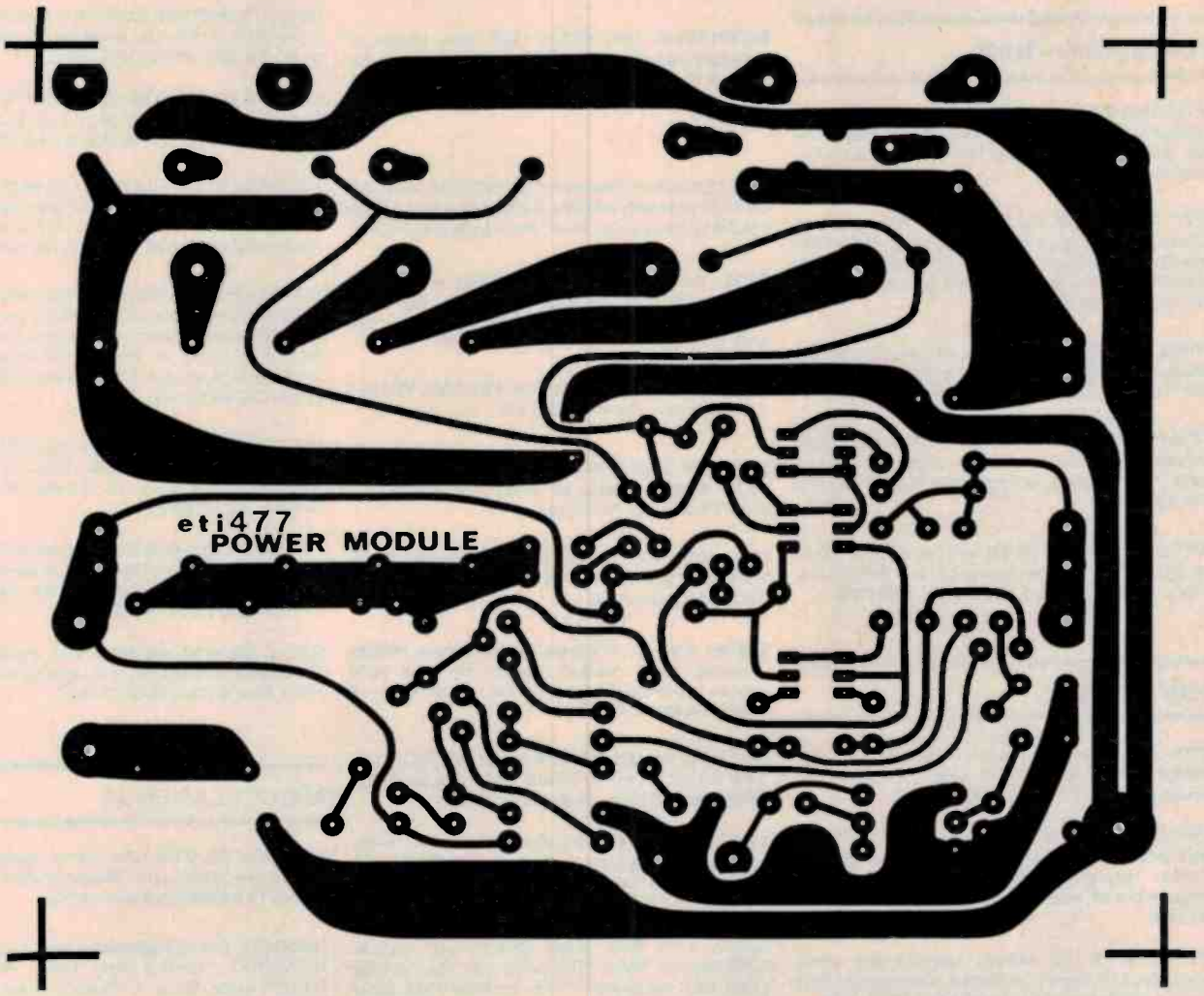
Instructions on how to make your own pc boards using the Scotchcal method and exposing through this page may be found on page 113 of the March '80 issue.





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SELL: Semcon 8K RAM board $125 and unused Semcon 8K/16K EPROM board $80. Suit 6800 system. EA VDU board with single supply CGR $50. W. Geary, Koolan Island, WA 6733.

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SELL: Heathkit ETS-3400 microprocessor course and trainer computer $350. D. Morton, P.O. Box 66, Darling Hts, Qld 4350.

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SINCLAIR ZX80 users' group newsletter to be printed, original software exchange etc. Contact Tony Mowbray, 87 Murphys Ave, Keiraville, NSW 2500. Phone (042) 28-5296.

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WANTED: Electronic hobbyist penpals age approx 15. Contact Ajay Shah, 38 Patrakar, Gandhinagar Road 4, Bandra (East), Bombay-400051, India.

SELL: ICs 7447 S$2.10, 4017 S $2.20, 4011 S$0.80. Others available. Write to Tarun Kumar, 65 Dunbar Walk, Singapore 1545. Payment: Draft in Singapore Dollars.

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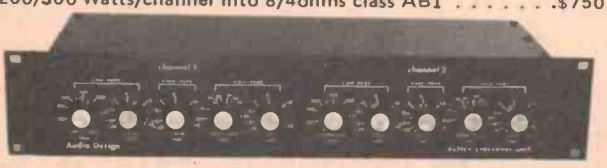

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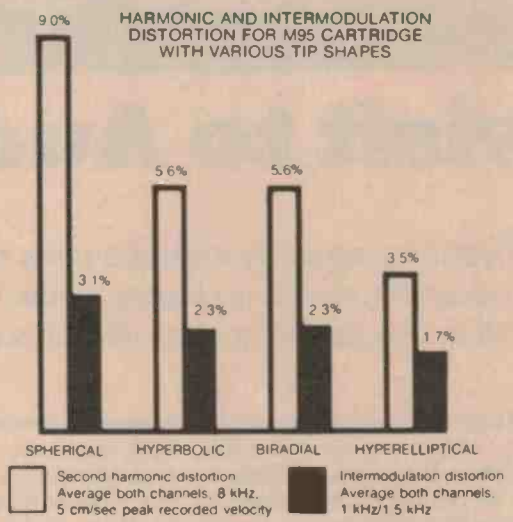

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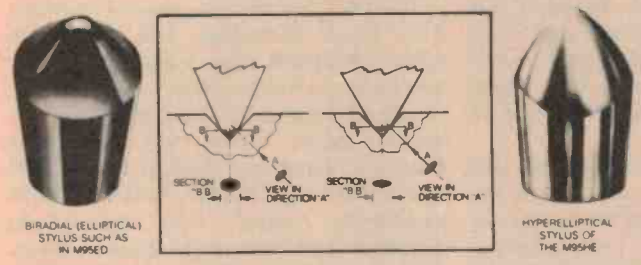
As a result of the optimized contact area of the Hyperelliptical tip, both harmonic distortion (white bars in graph above) and intermodulation distortion (black bars) are dramatically reduced.

the Hyperelliptical stylus tip



The Hyperelliptical nude diamond tip configuration represents a significant advance in tip design for stereo sound reproduction. As the figures show, its "footprint" (represented by black oval) is longer and narrower than the traditional Biradial (Elliptical) tip-groove contact area. Because the Hyperelliptical footprint geometry is narrower than both the Biradial and long-contact shapes such as the Hyperbolic, it is pre-eminent for reproduction of the stereo-cut groove.

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A visit to Audio-Technica

Audio-Technica recently invited a party of reviewers to visit their production plants in Japan. Louis Challis was one of them and in this article he describes his impressions.

THE NAME of Audio-Technica is not particularly well known in Australia, even though the company is now close to becoming the largest manufacturer of record player cartridges in the world. They make about six million units per year under their own brand name as well as the cartridges they provide for other equipment manufacturers.

The company was founded some 18 years ago by Mr Hideo Matsushita, who is still their president today. In those 18 years, Mr Matsushita has achieved more than most other men would hope for in a lifetime. He became involved in the development of pickup cartridges as a result of his general dissatisfaction with what he was able to buy for his own personal use twenty years ago.

When he realised how much better his prototypes were than most other cartridges, he decided to exploit their commercial value. With a staff of only three he started the Audio-Technica Corporation.

The company has grown beyond his wildest expectations to become one of the largest and most enterprising cartridge makers. Innovation has been the cornerstone of the company's development and Audio-Technica now hold a number of world patents for their original designs. This innovation extends beyond cartridges to include headphones, microphones and tone arms of unusually high quality.

Mr Matsushita is proud of his facilities and I was myself impressed by a number of aspects of his enterprise. The lengths to which Audio-Technica have gone in the automation of their production line are quite outstanding. A typical example is their use of lasers to cut miniature square holes in the ends of their stylus cantilevers to accept the square shanked nude tip diamonds — an innovative approach to a nasty problem.

We watched the laboratory staff checking the profiled tips of diamond styli with an electron microscope to ensure the maintenance of perfect polished profiles. Other production staff used low powered lasers to ensure the correct alignment of the diamond tips which were being inserted and then bonded into the beryllium cantilevers. This approach results in perfect alignment and is a considerable advance on previous techniques.

We were more than a little surprised to find that every single cartridge on the production line is tested for frequency response and subjected to a listening test before being packed and shipped by the company. Any cartridge which fails to pass their quality standards is rejected and discarded. Unlike the early days of Japanese production, when unsatisfactory products were passed onto somebody else as lower grade products Audio-Technica makes sure that substandard items are not used again.

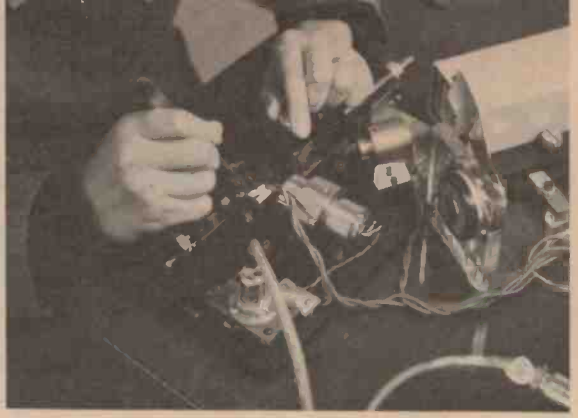
Statistical data of production output, production quality control and the spread of parameters are constantly logged by computers. As well as being monitored by management, this data is referred to staff meetings where the results are discussed with the workers themselves.

The working environment is well lit and well ventilated. Audio-Technica have replaced the assembly line system (which was once universal in Japan) with a system where key components are assembled automatically, but each individual product is assembled by only one worker who is responsible for inspecting the quality of his or her own work. This results in a pride in workmanship which is not matched in the production line systems of other countries.

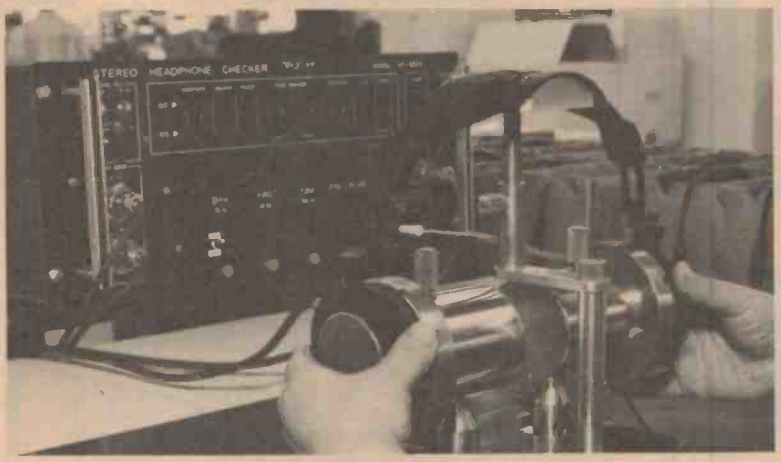
In the beginning, Audio-Technica only made cartridges but they have since widened the range of their products, as much because of their own needs as because of the demands of the market place. When they found that they could not buy tone arms with all the features the company's development engineers needed, they decided to produce their own range of arms. When they found that existing loudspeakers were not adequate for the checking of the audible output of their cartridges, they produced a range of capacitor headphones with the necessary frequency response and dynamic range.

Having diversified this far, it was reasonable that they should market a range of advanced microphones suitable for professional as well as domestic use. In each case their research and development led to the production of extremely well engineered products at competitive prices.

As a result of their expansion, Audio-Technica have built impressive new



Above: Lasers are used to weld stylus tips to cantilevers
Left: President Matsushita's listening room.



Using an 'artificial ear' to test the response of headphones.

Left: The profile of every stylus tip is examined on a projector.

Measuring the response of a cartridge in the development laboratory.

A scanning electron micrograph of an elliptical stylus tip, magnified 200 times.

factories in rural areas of Japan.The primary reason for placing them in these locations was to obtain a stable labour force, but their remoteness from the cities has allowed the company to provide exceptional facilities for work and play.

At two of their plants they have constructed large auditoria which are used for orchestral concerts and amateur entertainment and are also particularly suitable for large group subjective evaluation of cartridges, record players and loudspeakers. One of these auditoria, at Takefu to the north west of Kyoto, had obviously been finished immediately before our arrival. It was very well designed and gave excellent diffusion, no trace of colouration and an overall acoustical quality which I was unable to fault. In addition it was well heated and well lit.

Despite the wide range of products they currently sell, Audio-Technica's strength is still very much based on the manufacture of record player cartridges. In view of developments in optical tracking discs, one might well ask how Audio-Technica will cope in the future. Their production facilities are still tied to the technology of conventional record players, but this is not yet a disadvantage.

The record and the record player as we know them today are undoubtedly threatened, but the radically different new products will be very much more expensive and are unlikely to supplant current designs for at least ten years. In the meantime something like 15 million record players are made every year worldwide. Conventional 33 and 45 rpm records are not about to die in the same way as the 78 died with the introduction of the early microgroove records. ●

PUT A CONCERT IN YOUR CAR WITH DICK SMITH CAR STEREO

$45 Cat. A-5980

$129 Cat. A-6480

$99 Cat. A-6486

DELUXE AM RADIO

An 8 transistor radio with push button tuning for only $45? Yes it's true. A similar radio to this one was sold by this company in 1976 for a massive $79 — our direct import buying allows us to beat inflation!
Complete with all bits and pieces, including a large speaker, this radio will fit most cars in the standard cut-out aperture. Powered by your battery (12V DC negative earth) this radio produces a massive 5 watts output. All you need is an antenna and you'll be listening to your favourite stations in no time at all.

AM + FM STEREO + CASSETTE

The FET front end plus its small size are only two of the outstanding features of this AM/FM cassette stereo. Measuring only 120(d)x180(w)x44(h)mm it will fit into most facia cutouts, the small size has been acomplished by placing the tuner dial in the cassette flap! Indicator lights tell you when you have FM stereo and when you have a tape playing. Ideal for any 12V DC negative earth vehicle. Use with any of the speakers shown below.

AUTO REVERSE STEREO

No more troubles with turning the tape over at end of play – this unit automatically plays the other side. If you wish to fast forward or reverse the tape then it is easy – the controls lock down and then pop out at the end of the tape. Ideal for under dash installation the unit works from 12V DC negative earth. The 4 IC and 2 diode construction boasts a healthy 8 watts maximum output – enough power for even the most avid audiophile. Can be used with any of the speakers shown below.

Dual Cone Speakers

Cat. A-7080

A massive 280 gram magnet, plus 4 ohm impedance and a rating of 20 watts – ideal for those high power systems. Excellent bass and treble response.

$29.90

Co-axial Speakers

For top quality sound from the in-built tweeter and bass unit. Handles 20 watts into 4 ohms and comes complete with superb grille.

$39.50 Cat. A-7000

Rear Shelf Speakers

$16 Cat. A-6980

Rated at 4 ohms impedance and 8 watts power. Mount on your rear shelf or can be removed from box for flush mounting.

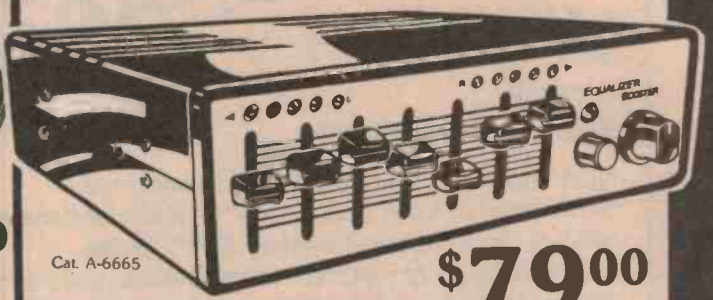
Flush Mount Speakers

$18 Cat. A-6985

All speakers are sold and priced as pairs

130mm diameter speakers with a rating of 4 ohms and 10 watts maximum power. Soft padded speaker grille for that touch of luxury. Mount on rear shelf or in doors.

ALL NEW EQUALISER/AMPLIFIER



Cat. A-6665

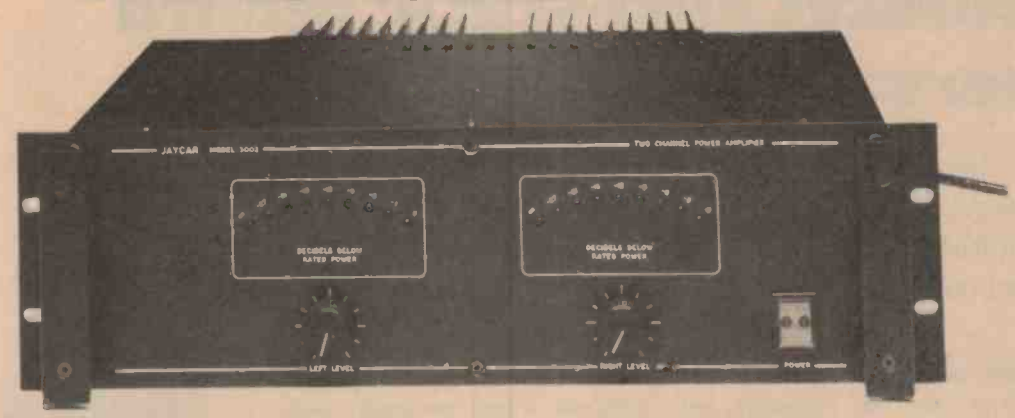
$79.00

Boost up your power to 25 watts per channel and at the same time be able to control 7 different frequencies! The slider controls will enable you to set-up the sound that you like thereby compensating for any deficiencies in the cars acoustics. One pair or two pairs of speakers may be used and if using two pairs there is a fader between the front and rear speakers. Use with 12V DC negative earth.

SEE THE OTHER DICK SMITH ADS IN THIS MAGAZINE FOR STORE ADDRESSES & PHONE NUMBERS

PROFESSIONAL AUDIO EQUIPMENT

MODEL 3002 — 2 CHANNEL POWER AMPLIFIER



FEATURES

- 300 Watts per channel.
- Massive rear mounted heatsinks.
- Multiple speaker protection circuits.
- Peak output power meters.
- Constructed to withstand the tortures of 'On the road' use.
- Standard 19" rack mounting.
- Separate power supplies for each channel.
- Dual RCA input sockets to allow bridging to other amplifiers.
- Equally suited to Hi Fi use or P.A./Disco situations.

BRIEF SPECIFICATIONS

Output Power — 300 watts/channel into 8 ohms.
200 watts/channel into 4 ohms.
Frequency Response — 20Hz to 20kHz ± 0.5dB.
Hum and Noise — 105dB below rated output.
Harmonic Distortion — Less than 0.05% to 80 watts.
Less than 0.15% at rated power.
Input Sensitivity — 1.0 volts for rated output.
Dimensions — 482mm x 133mm x 340mm.
Weight — 20 kgs.

$452.00 plus freight.

MODEL 2801 — ⅓ OCTAVE EQUALISER

The 2801 is a single channel graphic equaliser that divides the audio spectrum into twenty-eight one third octave bands. Each frequency segment is controlled by a slider that provides up to ± 10 dB of adjustment in standard ISO steps.
The 2810 was designed primarily to compensate for any deficiencies in the linearity of speaker systems, acoustic peculiarities of the hall or listening room, and inadequacies of program source quality. In P.A. application the equaliser may be used to improve sound quality and increase intelligibility by attentuating problem frequencies that cause ringing, boominess, or other disruptive resonances that occur in acoustically difficult rooms. The 2801 allows sound systems to be "tuned" according to the special acoustics of a room, to maximise output and minimise feedback. As a creative tool in sound recording or re-recording the 2801 allows complete freedom in contouring response over the complete audio spectrum from 31.5 Hz to 16 KHz.

$198.00 plus $3.00 freight.

MODEL 2010 — 2 CHANNEL EQUALISER

The 2010 is a two channel graphic equaliser featuring ten adjustable controls on octave centre frequencies (independent for each channel). Each control provides up to ± 14dB of adjustment. Each channel is also equipped with a level match control giving an overall gain of adjustment of ± 14dB.

The functional versatility of the 2010 equaliser is unsurpassed. Eight modes of operation are available from the push button switches on the front panel.

Included amongst these are the ability to equalise both recording and playback when dubbing tapes.

The 2010 has been designed to be compatible with all commercially available equipment and is ideal for use in a Hi Fi system or P.A. system.

$162.00 plus $3.00 freight.

For further information, please send a 35c stamp for full specification sheets, or call at our showroom for a demonstration.

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Permostat anti-static record preservative kit

Experience has taught us to look askance at claims made by manufacturers of record care equipment, but this one can't be faulted. Spray it on once and it removes static for at least six months and maybe forever. Louis Challis reports.

WITH RECORD prices sky-rocketing and the quality of the best available records improving at a comparable rate it is not surprising that there are now many new brands of record cleaners, dust removers and static charge eliminators available to extend the life and quality of your records. These two types of products are actually required for two different but associated problems which affect the life and performance of every record.

The most serious problem is dust which collects on the surface of your records and, more insidiuously, in the grooves themselves. Electron microscope photographs of typical records show that dust collects in the grooves in such a way as to change the audible content of the recording whilst simultaneously providing an abrasive obstacle course which your unfortunate stylus must traverse.

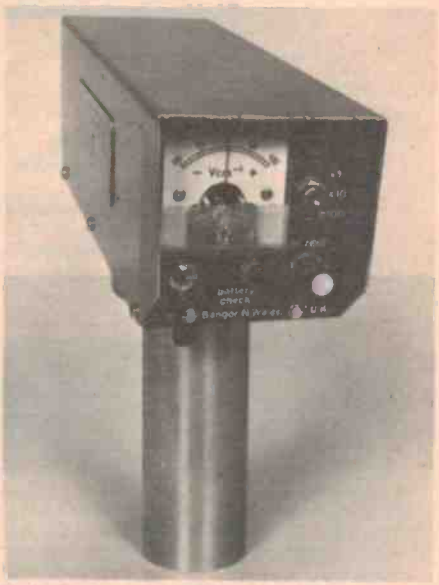
Obviously, serious and dedicated audiophiles purchase a cleaner or brush of some sort to clean their records and thereby feel that the problem is solved. But, no! After the brush or cleaner is removed from the record a strange effect occurs. It is as if every bit of dust in the room is suddenly attracted to the record and after using most dust removers, that is exactly what *does* happen. Brushes may take off some dust but they replace it with an electrostatic charge. In a dusty environment, this can actually result in the records ending up dirtier than they were before they were cleaned.

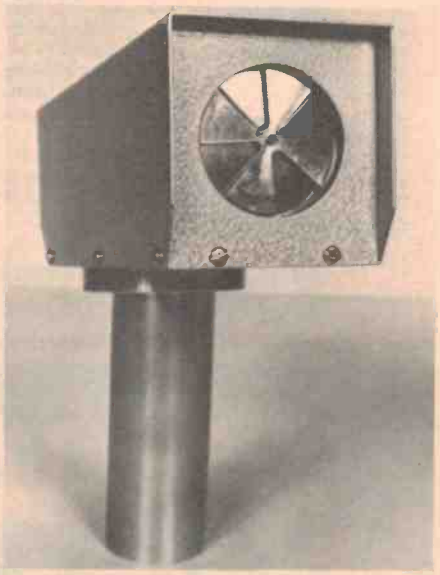
This process can develop into an audiophile's nightmare, which is exacerbated by plastic record sleeves whose use can have similar results. Even the rotation of a record on the turntable when it is being played can increase the static electric charge on your records and compound an already complex problem. There are many cases recorded of the differential surface charge on a record causing uneven attraction of the cartridge and tone arm to the record which results in further anomalous behaviour. To overcome this problem requires the cancellation of the electrostatic charge on the records and maintenance of that condition for as long as is possible.

The Permostat record coating system was developed in America to provide simple and long-lasting anti-static treatment that minimises the likelihood of subsequent attraction of dust. The aim was to produce a smoother, more stable groove surface for the stylus to traverse. All that one has to do is to clean the record, (preferably with a proprietary record cleaner) hold it vertically and spray it from a distance of 100 mm, spraying lightly with 8-10 applications. One must then lay the record flat on a clean surface and buff the surface with the special velvet pad supplied until the record is shiny.

Field tests

To test the manufacturer's claims requires the use of some fairly sophisticated equipment. The first instrument we used was a hand held "electrostatic field mill" produced by Industrial Developments Bangor Ltd in the UK. This cleverly designed device makes it possible to perform precision measurements of the electrostatic charge on the surface of an insulating material by measuring the field it produces, in volts per metre from zero to $+/-10^6$. Provided the mill is located at a precise spacing from the insulating surface, it is possible to determine the electrostatic voltage on the surface being examined.





Two views of the field mill, which we used to measure the surface electrostatic charge on records.

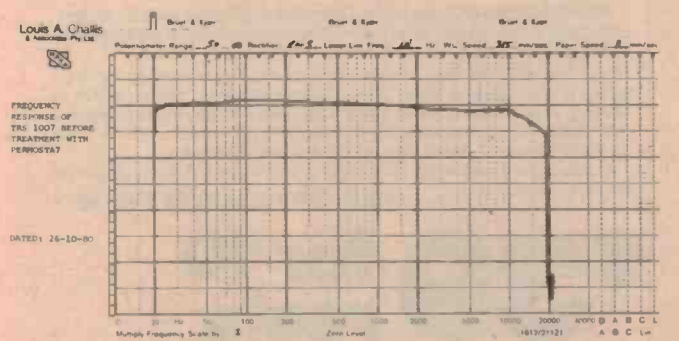
We checked out a number of our test and ordinary music records and were surprised to find surface voltages exceeding 3000 volts on a number of them. We made use of this electrostatic voltage detector with a series of special test records and digitally recorded records to determine as many parameters as we possibly could.

The first two records we chose were Bruel & Kjaer QR2009 test records, (one new and one well used) which were cleaned in the normal manner before the frequency responses were measured, then treated with the Permostat before being retested. The same exercise was repeated with a brand new JVC TRS1007 test record which is moulded from a different formulation on the other side of the world. As the results on these pages show, in each case there was a remarkable improvement in the high frequency response of the record and a dramatic reduction in spurious high frequency jitter which was not really intended to be part of the original recordings. The improvement amounts to a reduction of surface noise of at least 1 dB, up to 2 dB between 5 kHz and 10 kHz, and a dramatic smoothing out of the response between 10 kHz and 20 kHz.

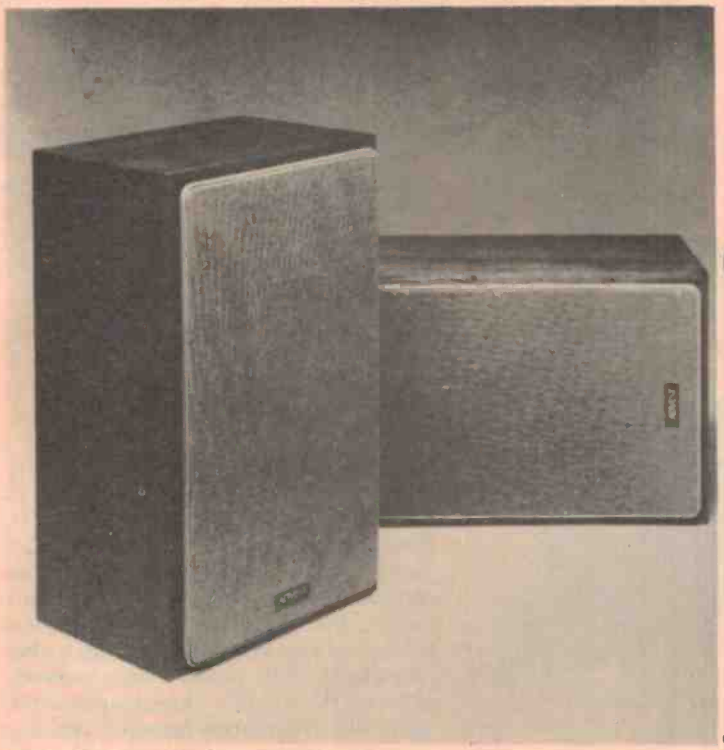
In our next series of tests we used a Denon XG7004 test record that we had treated with Permostat six months before to determine the extent to which the anti-static treatment persisted in the long term. The record was removed from its cover and checked for electrostatic charge. *There was absolutely no trace of charge apparent.* We cleaned the record, played it, stuck it back into its cover, took it out again, measured it and still found no trace of charge, nor for that matter any significant trace of surface dust.

The next tests involved examining two different types of square wave test records for their harmonic linearity and signal response before and after treatment with Permostat. The first record was the Ranger record RRM-002, which is intended for RIAA equalisation. To perform this test we used a Hewlett-Packard 3582 narrow band real time spectrum analyser. On each occasion we cleaned and played the record taking a four second signal average of the same section of the record, before and after treatment. The results were remarkable, as the display photographs show, with the differential between odd and even harmonics of the 1 kHz signal being cleaned-up all the way to 25 kHz. More important, the use of Permostat resulted in the stability of the signal being dramatically enhanced, which the photographs cannot really show.

The next record we evaluated, the Audio Technica AT6607 test record, was brand new, and not intended for RIAA equalisation. It has far less pronounced harmonic components and thereby makes it somewhat easier to view the difference in signal stability on an oscilloscope, as well as simplifying measurements of the resulting harmonic balance using the narrow band real time analyser. The results here were even more dramatic than on the Ranger record, with both the stability and the harmonic balance being re-▶



HOW TO TELL ADVENT SPEAKERS FROM EVERYBODY ELSE'S.



COMPARE. No matter which turntable, tape deck or amplifier you choose, a pair of Advent speakers will help you make the most of them.

BASS. All Advent speakers use the acoustic suspension principle in their low-frequency design. This "air suspension" is far more uniform in action than the best conventional, mechanical suspension.

Inside Advent's meticulously designed enclosure the speaker cone can make long excursions to push and pull air for low bass response with very low distortion.

HIGH FREQUENCY. All Advent speakers have a thoroughly researched driver with a correctly small diaphragm which has the ability to radiate a large amount of high frequency energy over a wide area. They supply the right proportion of the upper harmonic frequencies that give musical instruments their differing, individual timbres.

Now that you have the facts, listen closely and at length to a pair of Advent speakers, preferably using musical material with which you are familiar, we believe you will have no trouble hearing why the Advent reputation has spread around the world.

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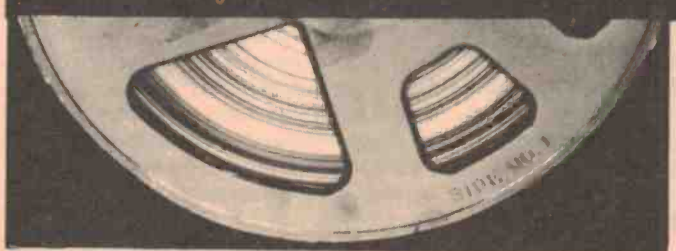

THE USA AMPEX CORPORATION has made available a substantial quantity of 'off-cut' tapes from their highest grade material. All tapes are 1800 ft (549 m) by ¼", 1 mil ferric oxide on standard 7" reels.

There's a slight gamble involved — but one in which you either win a lot — or a hell of a lot!

Here's why:

The tapes offered are of differing types and you take pot luck on which you receive.

BUT, The lowest quality is Ampex' superb Ampex Plus series! The highest is Ampex' Grand Master series!

SO. If you draw the Ampex Plus you'll be paying about one-third the usual price. If you score the Grand Masters you'll be paying about a quarter usual price.

YOU CANNOT LOSE. If you are not totally and completely satisfied with your purchase, Dindy guarantee to return the full purchase price without question provided the tapes are returned within 14 days in the original packing.

Identical tapes to those offered are marketed in the USA by Ampex, using the trade name 'Shamrock'. This trade name is also used for those offered here.

NOTE: This offer is made by Dindy Marketing (Aust.) Pty Ltd and this publication is acting as a clearing house only. Cheques should be made payable to **'Ampex Tape Offer', ETI Magazine, 15 Boundary Street, Rushcutters Bay NSW 2011.** *We will then process your order and pass it on to Dindy, who will send you the goods. Please allow up to four weeks for delivery.*

Owing to the exceptionally low offer price the minimum ordering quantity is ten tapes (total $39).

Note: Offer closes 28 February

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Please supply .....tapes at $39 for ten $.....

Plus post and packing, any quantity:– $2.50

TOTAL $.....

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

Signature .....

$39 for 10 reels

ARE YOU FEEDING YOUR TWO CHANNEL AMP WITH A SINGLE MAGNET CARTRIDGE?

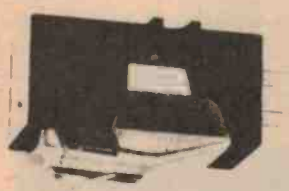
here's what the laboratory says about

audio technica

"The Audio Technica AT-12E, although very modestly priced, features one of the flatest responses provided by any of the cartridges we have reviewed over the last 15 years . . . this cartridge performed as well as many cartridges selling at five times the price . . ."

Reproduced from a review in ETI Feb. 1980, by Louis A. Challis & Associates Pty. Ltd.

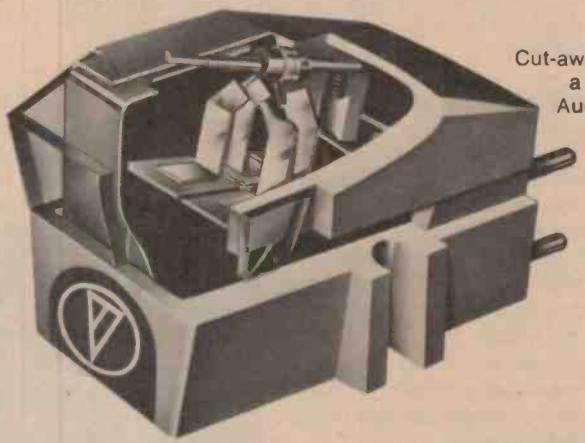
AT-12E



AT-11

AT-11E

AT-10



Cut-away section of a dual magnet Audio Technica cartridge.

To obtain top performance you must look for a cartridge with a dual magnet system, as perfected by Audio Technica.

AT 12E

Value leader among elliptical stylus models. Employs finely-crafted 0.4 x 0.7 mil bonded diamond mounted to thin-wall cantilever. Dual Magnet design assures flat response and excellent stereo separation. For all modern record changers and turntables.

AT 11

Flat response and remarkable tracking ability distinguish this Dual Magnet cartridge. Spherical bonded tip is best for use with older or budget record changers. High output matches moderately-priced systems.

AT 11E

Our lowest cost elliptical stylus cartridge yet built to high Audio-Technica standards. Bonded 0.4 x 0.7 mil elliptical tip and thin-wall cantilever combine to offer unusual high frequency tracking ability in this price category. Excellent replacement for older cartridges to improve your system.

AT 10

Almost identical to the AT-11, the AT-10's flat response and remarkable tracking ability enables high quality stereo sound reproduction. Uses bonded spherical stylus. Has same characteristics that fit moderately priced systems so well.

audio technica

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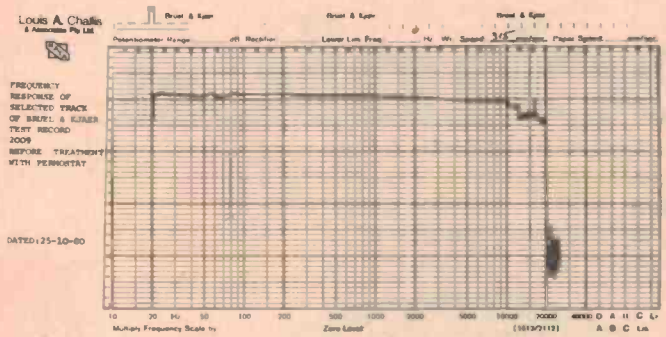
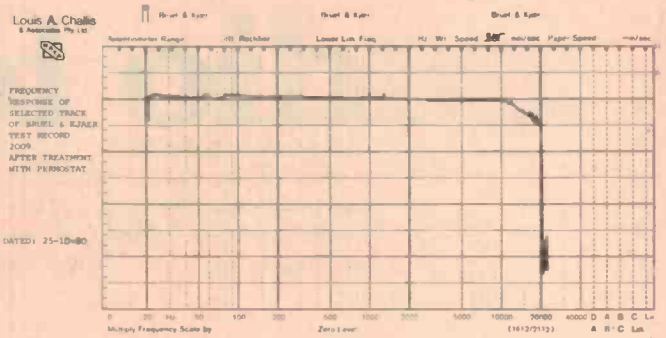


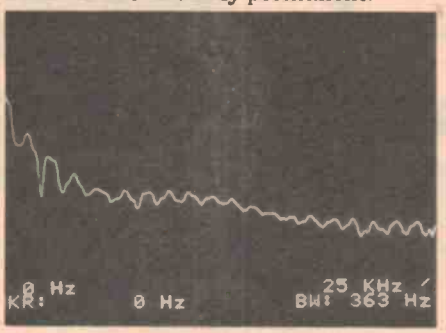


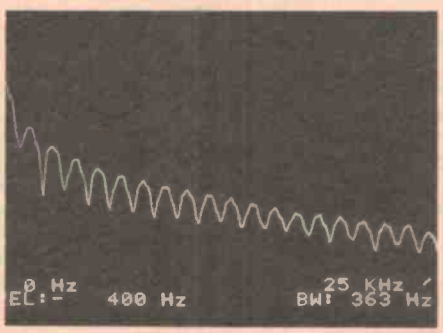
markably improved. What is more significant is that the distortion characteristics of the Audio Technica record were reduced and it is clear that the overall quality of reproduction had been thereby improved. After this record was treated with Permostat it was played 100 times and re-tested with the narrow band real time analyser to determine the extent to which the signal had changed. As can be seen from the photograph there was no significant increase in the harmonic components nor in the level of background noise.

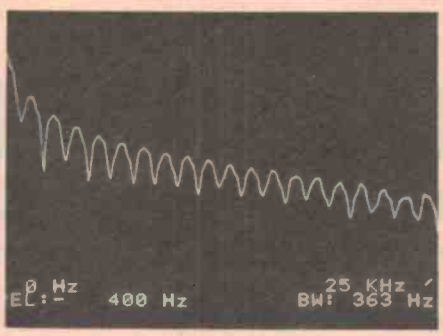
Next we tried to determine whether the Permostat reduces surface noise on records in the absence of any signal. We used an EMI Australia wow and flutter test record which provides both steady state 3.15 kHz test signal and silent grooves. After cleaning but before treatment the spurious charges and dust on the record made it impossible to record a suitable signal to show the level of background noise with the real time analyser. After treatment the effect of random dust was significantly reduced and it then became possible to record the background noise level.

Subjectively

In the last series of tests I took two examples of Sheffield records (Lincoln Mayorga in Volumes 2 & 3), which I cleaned with a Decca carbon fibre brush. I played the records, then treated them with Permostat and played them again. The results lacked the visual impact of my laboratory tests but the records were unquestionably cleaner. The audible clicks and pops from the invisible samples of dust in the record grooves were significantly attenuated, if not completely removed. Insertion and removal of the records a dozen or so times from their covers resulted in no measurable change in their surface electrostatic charge and as our separate test on the Denon record indicated, there is no reason to believe that this result is not virtually permanent.

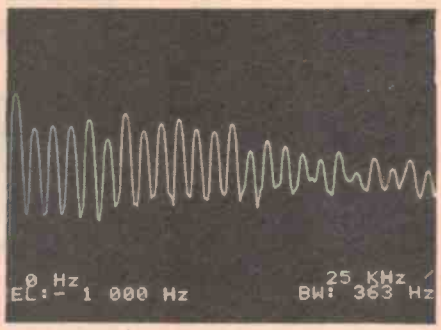


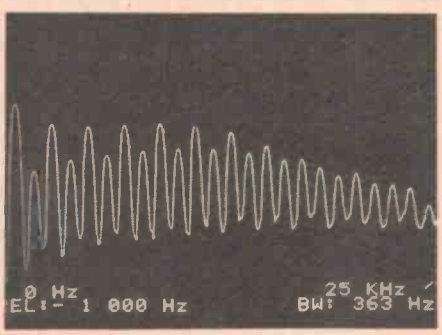




Response from the AT 6607 test record, measured with a real time analyser. Top, before treatment with Permostat; centre, after treatment; bottom, after treatment and 100 playings.

The problem of dust and static build-up can now be safely and easily overcome. Permostat is undoubtedly the best product for this purpose that I have so far seen. ●





Response from the Ranger RM002 test record. Top, before treatment; above, after treatment with Permostat.

PERMOSTAT ANTI-STATIC RECORD PRESERVATIVE KIT

Supplied in box with spray applicator bottle holding 85 grams, velvet buffing pad and self-adhesive 'P' labels.
Manufactured by Milty Products in the UK.

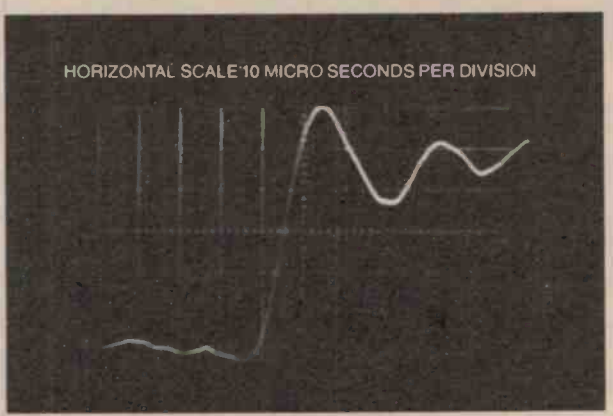
The moving coil replacement from Stanton Magnetics... the revolutionary 980LZS!

Now from the company to whom the professionals look for setting standards in audio equipment comes a spectacular new cartridge concept. A low impedance pickup that offers all the advantages of a moving magnet cartridge without the disadvantages of the moving coil pickup. At the same time it offers exceedingly fast rise time—less than 10 micro seconds—resulting in dramatic new crispness in sound reproduction—a new "openness" surpassing that of even the best of moving coil designs. The 980LZS incorporates very low dynamic tip mass (0.2 mg.) with extremely high compliance for superb tracking. It tracks the most demanding of the new so called "test" digitally mastered and direct cut recordings with ease and smoothness at 1 gram $^{+\frac{1}{2}}_{-\frac{1}{4}}$.

The 980LZS features the famous Stereohedron™ stylus and a lightweight samarium cobalt super magnet. The output can be connected either into the moving coil input of a modern receiver's preamps or can be used with a prepreamp, whose output is fed into the conventional phono input.

For "moving coil" audiophiles the 980LZS offers a *new standard* of consistency and reliability while maintaining all the sound characteristics even the most critical moving coil advocates demand. For moving magnet advocates the 980LZS provides one more level of sound experience while maintaining all the great sound characteristics of cleanliness and frequency response long associated with fine moving magnet assemblies.

From Stanton...The Choice of The Professionals.



Actual unretouched oscilloscope photograph showing rise time of 980LZS using CBS STR112 record.

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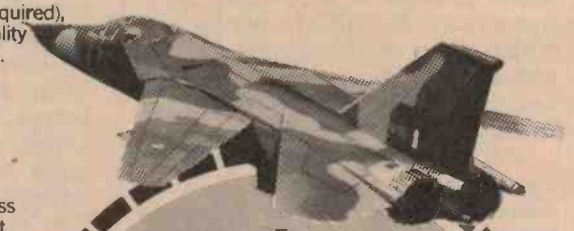

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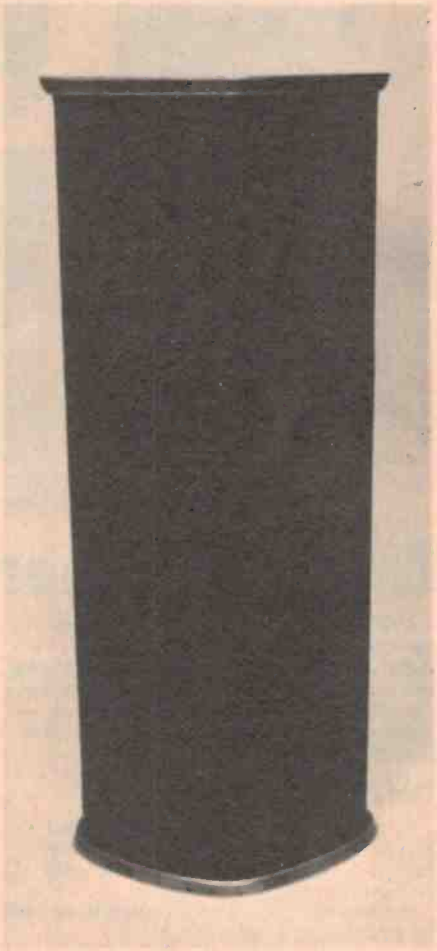
DCM 'time window' loudspeakers

The DCM philosophy is that one listens through loudspeakers and not to them. Louis Challis found that these loudspeakers "... offer many of the attributes of conventional dynamic speakers with some of the characteristics of electrostatic speakers..."



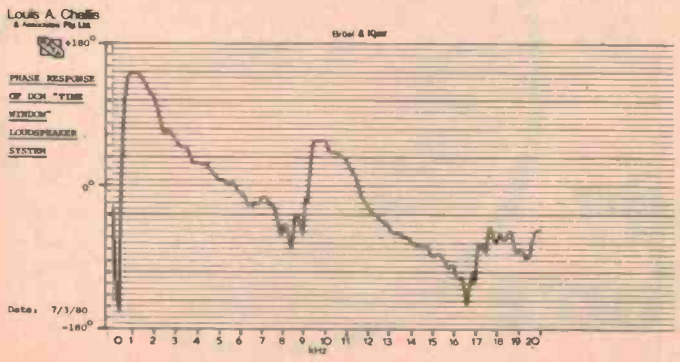
HARDLY A YEAR now goes by in which we do not see three or more variactions on the conventional rectangular enclosures for loudspeakers. Dealers and audiophiles are no longer surprised by speakers with strange appearances ranging from flat panels to pyramids, from egg shaped enclosures to cylindrical columns and various combinations of individual enclosures sitting on top of one another looking for all the world like the work of children playing with blocks.

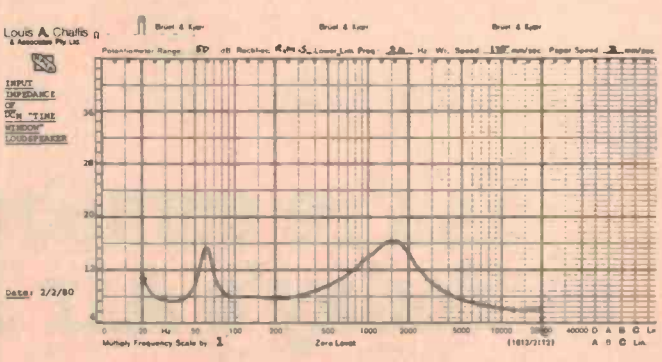
Nearly all of the loudspeakers we currently use for referencing purposes in our listening room vary from the norm in some way or other, so the appearance of the DCM is not really disturbing and would probably be more attractive than a conventional rectangular box to people concerned with the appearance of their living rooms.

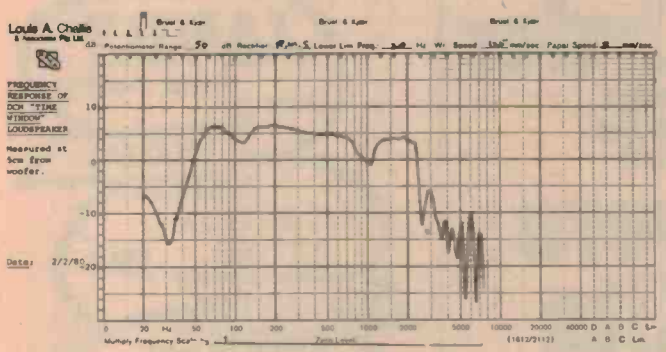
The DCM Time Window is another variant on the cylindrical column theme, and features veneered wooden tops and bottoms with what can only be described as an amorphous mass of black reticulated urethane foam in between, which covers a framework containing an array of loudspeakers in an enclosure which is vented with double loading ports. The manufacturer neglects to describe the technical details of the system's construction, and the type of covering used in no way simplified our task in trying to determine what its main features are. The method of sealing the urethane foam at the junction line on the rear of the enclosure precluded us from baring the secrets of its construction without mutilating the cover.

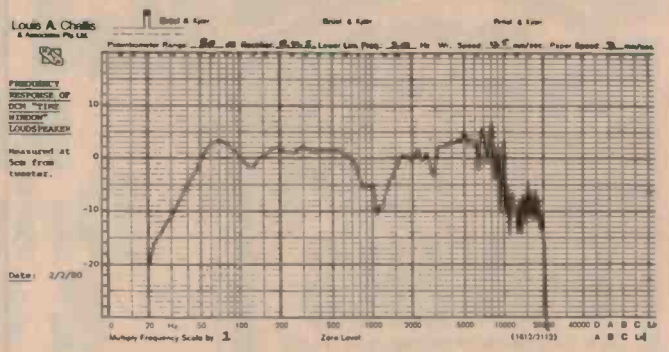
The literature provided with the speaker makes some bold claims as to the subjective attributes of the system, the most significant of which is the statement that one listens "through them and not to them". Frankly I thought this was generally true for all loudspeakers, although I must acknowledge that there is a growing trend amongst many audiophiles to deviate from this principle.

Some of the literature contains photographs of the transient response of









a series of some 15 well known loudspeakers when subjected to an impulse step response. DCM state that out of all of these systems tested the DCM Time Window provides the best response. Our own interpretation of the results they present is that the DCMs provide a performance that is as good as the best of the systems they evaluated and that the Quad electrostatic loudspeakers (which are generally regarded anyway as having a good transient response) appear to provide a comparable performance.

DCM have very little to say about the design of their speakers except to indicate that each front baffle board contains a 25 mm dome tweeter and a 150 mm diameter woofer. The front panels are apparently constructed from normal compressed particle board whilst the curved rear section is fabricated from a stressed fibre laminate. It is this lightweight rear panel which apparently eliminates the problems associated with parallel surfaces. As the name implies this system seems capable of transmitting the sound energy instead of just creating it and preferentially directing its propagation.

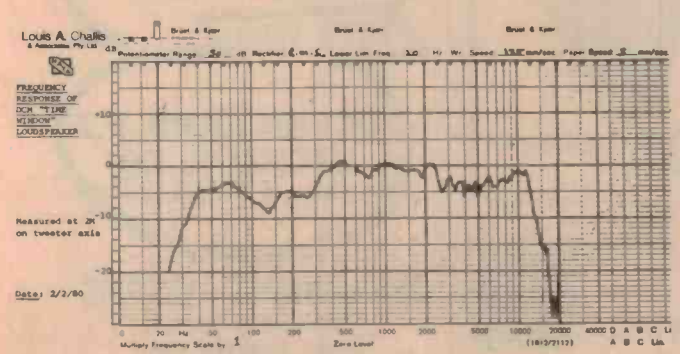
In the anechoic room

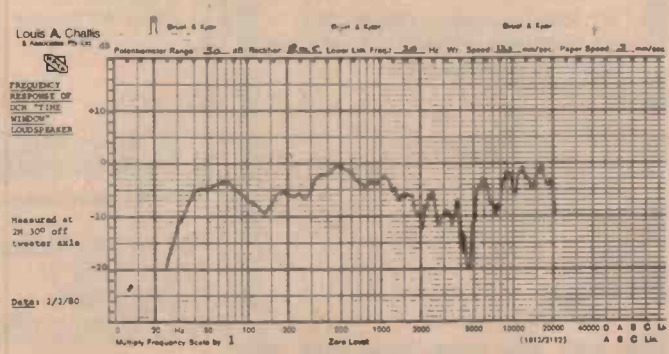
The objective testing of the loudspeaker in our anechoic room revealed that many of the manufacturer's claims were apparently justified. The first and most significant feature was the broad frequency response which extends from 35 Hz to at least 14 kHz on axis and beyond 20 kHz at 30° off axis. The woofer response is extended beyond the direct output of the speaker itself through some clever loading effects in the enclosure body and the peak which occurs at 70 Hz is effectively broadened to achieve a very commendable bottom end response. The crossover between the woofer and tweeter is apparent in the near field measurements but is almost completely hidden at two metres.

One would expect from some of the statements made in the manufacturer's literature that the phase response would be remarkably smooth. This is not in fact borne out by the on-axis measurements which show three distinct steps in the phase response, although admittedly the magnitude of those fluctuations is not massive nor does it involve the typical 180° excursion which we have come to expect with poorly designed speakers.

The impedance curve is particularly smooth with maximum peaks occurring at 60 Hz and 1.5 kHz of 15 and 16 ohms respectively. The impedance drops to a low value of just over 6 ohms between 12 and 20 kHz. Nevertheless, it should be possible to parallel another speaker system with nominal 8 ohm impedance without risk of excessive currents.

The distortion characteristics of the system are remarkably good at our standard testing level of 90 dB at two metres but rise rapidly with increasing power input at the low frequency end of the spectrum. A doubling of power to as little as 28 watts input at 100 Hz produces distortion levels which border on the unacceptable. The transient performance of the system, measured using conventional tone burst signals, showed a generally exemplary performance except around 2 kHz and 6 kHz where there was observable ringing resulting from excitation of natural resonances within the system. The efficiency of these speakers is particularly low and ▶





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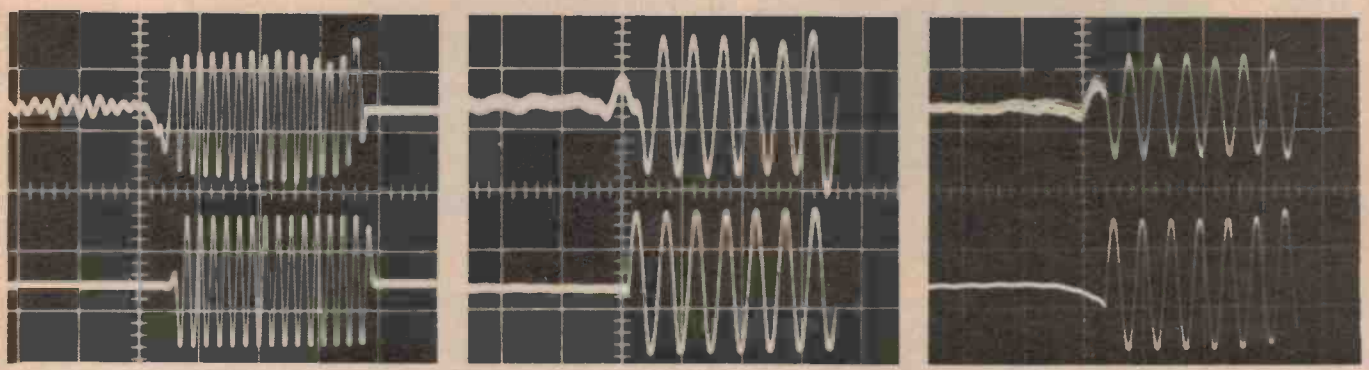

Tone burst response: left, at 100 Hz; centre, at 1 kHz; right, at 6.3 kHz.

14 watts of signal level is required to produce 90 dB of sound pressure level at two metres.

Unlike many other contemporary American speakers, which feature loads of presence, strident treble or artificial bass, the Time Window System achieves a reasonable balance between bass, mid-range and treble, as the frequency responses clearly show. In fact, over the range from 35 Hz to 13 kHz, they performed remarkably well both on and off axis.

To the ear

Subjective evaluation proved to be rewarding because these speakers seem to become more audibly attractive as you play them over an extended period of time. I played a number of conventional test records, as well as direct cut and digital recordings which offer extraordinary transient signals or other programme content which really puts a speaker through its paces. I was particularly impressed by the way the speakers responded to the new Sony/CBS record "Nocturn" by the Tokyo Quintet (28AG 165). The performance was silky smooth and the nasty transients did not really seem to disturb the Time Windows. On the new Telarc record (10048) of Greigs "Peer Gynt", the quality of reproduction was excellent and whilst the speakers add some colouration to the recorded material, they did not noticeably detract from the sound quality.

In general the DCM speakers show up well on drums, guitar, and violin, and even offer reasonable reproduction on the spoken word and singing. By contrast when playing rock music with a loud bass content the distortion and overload characteristics fell short of what we would like for a speaker which you are intending to "listen through rather than listen to".

Summary

The DCM Time Window speakers are a good speaker system for classical music, offering many of the attributes of conventional dynamic speakers with some of the characteristics of electrostatic speakers, which they emulate but could never completely replace. For classical music they are most certainly worthy of consideration, provided one is prepared to steer clear of hard rock and even some of the soft rock. Their major attribute, apart from their fidelity, is their appearance, although I have some doubts as to how many people would be enamoured of a cylindrical black mass of urethane foam. ●

Louis A Challis and Associates Pty Ltd

MEASURED PERFORMANCE OF
DCM "TIME WINDOW" LOUDSPEAKER
SERIAL NO. 10491

FREQUENCY RESPONSE:	38 Hz to 12 kHz			
CROSSOVER FREQUENCIES:	2.4 kHz			
SENSITIVITY:	10.6 VRMS			
(for 90dB average at 2m)	= 14 Watts (nominal into 8Ω)			
HARMONIC DISTORTION:		100 Hz	1 kHz	63 kHz
(for 90dB at 2m)		(87 dB)	(90 dB)	(90 dB)
	2nd	-46.7	-54.4	-55.5 dB
	3rd	-40.6	-51.5	-61.5 dB
	4th	-58	-64.5	- dB
	5th	-53.5	-	- dB
	THD	1.1%	0.33%	0.19%
INPUT IMPEDANCE:	100 Hz	8 Ω		
	1kHz	13.5 Ω		
	6.3kHz	7 Ω		
Minimum at :	15kHz	6 Ω		

DCM TIME WINDOW LOUDSPEAKER SYSTEM

Dimensions:	*915 mm high x 375 mm wide x 300 mm deep*
Weight:	*14.5 kg*
Price:	*$1198 a pair*
Manufactured by:	*DCM Corporation, AnnArbor, Michigan, USA.*

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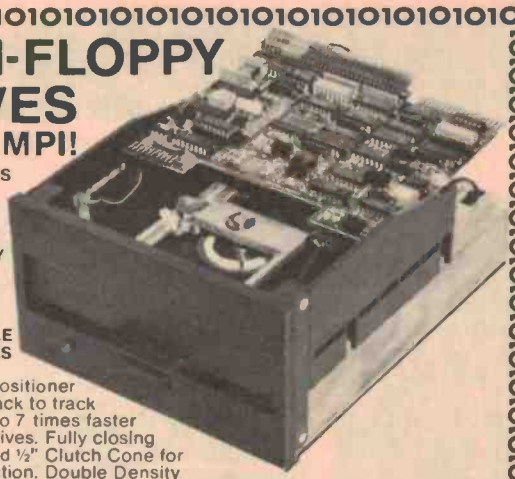

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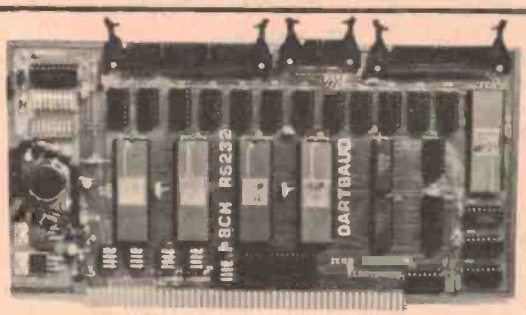

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Serial Ports: 8 Independent ports using Zilog DARTs (sync) or optionally S10/0 (may be retrofitted for synchronous parts, for any pair (S10 and DART are dual devices).

Baud Rates: 6 Independent, crystal-controlled, software selectable rates for each port selected from the 16 standard rates between 50 and 19,200 baud.

Parallel Ports: 2 Independent ports using Zilog P10, selectable as either input or output.

Interrupts: Full on-board interrupt control provided. On-board devices daisy chained. Rotating priority control provided for running multiple boards (through top connector). Jumper selection of interrupt control (local, rotating, vectored). **PRICE: POA & MANUAL AVAILABLE**

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PRICE: $240 ● without case — $200 ● Assembled and tested — add $60

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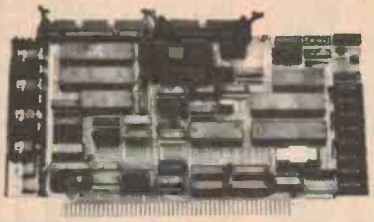

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4k bytes of onboard monitor program with features such as block move etc., 16k bytes of onboard dynamic ram which can be replaced with the new 64k dynamic ram chips since provision has been made for same. 2100 baud high speed cassette interface which is under software control and cassette supplied with unit holds program for 300 baud Kansas City standard. Extended memory addresing feature to address up to 16 megabytes. On board ram can be externally D.M.A. accessed and all peripheral devices are interupt driven.
User options can either be of a serial video and keyboard (terminal) or parallel keyboard and memory mapped video (software in monitor program controls E.T.I. 640 type video). User option of either parallel or (parallel centronics) or serial printer.
The big surprise with this card is that the board has allowed for the addition of the components for an optional DMA controlled, CP/M compatible double density disc controller! This controller will control up to a maximum of 4 drives in either 8" or 5¼" single or double headed drives. The bootstrap for CPM is already in the monitor program and in fact a full 64k of memory can be addressed due to the monitor "go away" feature. The on board 16k bytes of ram can be upgraded to 64k onboard or external ram cards such as our DYNARAM II can be added to the bus.
The card also comes as standard with a rear panel plug card which contains some minor logic and all of the connectors for the various IO devices. These connectors are 2 x RS232 sockets, centronics parallel printer socket, parallel keyboard socket, cassette interface socket and sockets for 5¼" & 8" disc drives.
Manual available — refundable with order — $4.
PRICE: with 16k Ram — $495 ● with 64k of Ram (delivery Feb.1981) $945 ● Disc controller option in both cases, extra $175 ● Assembled and tested add $150 without disc controller ● $200 with disc controller.

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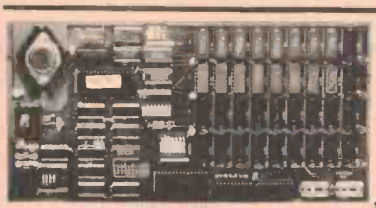
*Does not include the joystick interface.

PRICE: $140 ● PCG option $32 ● Assembled and tested, add $45.



DYNARAM II

This Ram card will hold up to 64k of dynamic Rams of the 4116 type and is supplied with 200 nano-second Rams as standard for 4MH_z max speed of operation. It can be used with either 8 bit or 16 bit processors (in 16 bit mode 2 cards required) extended memory addressing feature, phantom feature, switch selectable for Z80, 8080 or standard S100 bus timing. Invisible refresh and self refreshing during long wait state or reset pulses. Uses digital delay line for accurate timing. Bank selectable in 16K blocks and also can be fitted by user with parity error detection bit
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Assembled and tested — $60

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R.Torrens

• Some circuits are completely new — others are more familiar designs. The projects can be split into simple building blocks to enable readers to combine circuits for specialised needs.

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D.W.Easterling

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227: BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS
R.A.Penfold

• Enables total beginners to tackle practical electronic so he or she can confidently build electronics projects such as published in ETI and other magazines and books. Subjects include component identification, tools, soldering, various building methods, cases, legends etc. Practical basic projects are also included.

112 pages **Price $4.60**

BP1: 1ST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
B.B.Babani

• Complete transistor equivalents guide. More than 25 000 transistors with alternatives and equivalents. Covers devices made in UK, USA, Japan, Germany, France, Europe, Hong Kong etc. See also BP 14 (below).

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BP 14: 2ND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
B.B.Babani

• The second book contains data on devices not included in the first. This book supplements BP1, no data is duplicated.

208 pages **Price $4.05**

BP 24: 52 PROJECTS USING IC 741
Rudi & Uwe Redmer

• Originally published in German, this book achieved huge European sales. Now translated into English with copious notes, data and circuits, this book is a must for those interested in any way in this inexpensive and most versatile IC.

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BP 33: ELECTRONIC CALCULATOR USERS HANDBOOK
M.H.Babani

• An invaluable book for all calculator users. Presents formulae, data, methods of calculation, conversion factors etc, often with examples. Includes way to use simple four-function calculator for Trig functions (sin,cos,tan); Hyperbolic functions (sinh,cosh,tanh), Logs, Square Roots & Powers.

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• Contains 50 interesting and useful circuits and applications in many different branches of electronics.

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F.G.Rayer

• Relays, SCRs and Triacs have a wide range of applications — from motor speed control, dimming, heating, timers, light-sensitive circuits, warning devices, light modulators, priority indicators, circuit breakers etc. Book gives tried and proven circuits which will tolerate wide latitude of components and values allowing easy modification to suit special needs.

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BP 39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS
F.G.Rayer

• Field effect transistors are used in many circuits. The projects here include amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, plus miscellaneous devices. The FET used is not critical and many other types will work as well. This book will be of interest to all enthusiasts, shortwave listener, radio amateur, hi-fi buff or general electronics experimenter.

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BP 40: DIGITAL ICs AND PIN CONNECTIONS
Adrian Michaels

• Equivalents and pin connections of a popular user-orientated selection of digital ICs. Shows details of packaging, families, functions, manufacturer and country of origin. Includes devices by Fairchild, Ferranti, Harris, ITT, Motorola, National, Philips, RCA, Signetics, Sescocem, SGS-Ates, Siemens, SSSI, Stewart Warner, AEG-Telefunken, Texas, Teledyne. Companion volume to BP 41 — Linear ICs.

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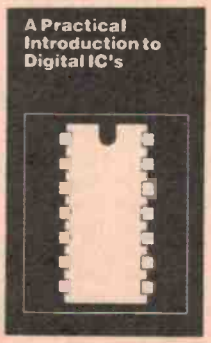

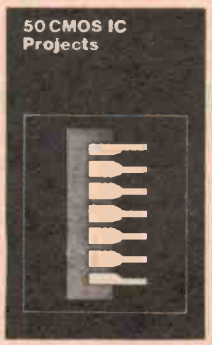

BP 41: LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
Adrian Michaels

• Essentially similar in concept to above but deals with linear integrated circuits.

320 pages **Price $10.00**

BP 42: 50 SIMPLE LED CIRCUITS
R.N.Soar

• 50 interesting and useful circuits and applications using LEDs. A useful book for beginner and advanced enthusiast alike.

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BP 44: IC 555 PROJECTS
E.A.Parr

• Every so often a device is made that is so useful one wonders how life went on before it! The 555 IC is one such. Frist made by Signetics it is now manufactured by almost everyone in the business. It is very cheap and readily obtainable.

Included in this book are basic and general circuits, motor car and model railway circuits, alarms and noise makers plus a section on the subsequent 556,558 and 559 devices.

160 pages **Price $6.45**

BP 45: PROJECTS IN OPTO-ELECTRONICS
R.A.Penfold

• Opto-electronic projects of interest to all electronics enthusiasts. Included are simple circuits using ordinary LEDs as well as more sophisticated designs such as infra-red transmitters and receivers, modulated light transmission and photographic projects.

112 pages **Price $4.95**

BP 47: MOBILE DISCO HANDBOOK
Colin Carson

• Most people who start mobile discos know little about equipment or what to buy. This book assumes no preliminary knowledge and gives enough info to enable you to have a reasonable understanding of disco gear.

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BP 48: ELECTRONIC PROJECTS FOR BEGINNERS
F.G.Rayer

• This book gives the newcomer to electronics a wide range of easily built projects. Actual component and wiring layouts aid the beginner. Some of the projects may be built without using soldering techniques.

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R.A.Penfold

• A collection of the most popular types of circuits and projects covering radio, audio, household and test equipment.

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• This book shows how electronic music can be made at home with simple and inexpensive equipment. It describes how sounds are created and recorded to build up a final composition. It shows how to build a small studio including mixer and various sound effects units.

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• This book is for the practical person's workshop bench. It bridges the gap between technical theory and cut-and-tried methods which may work but leave the experimenter unfulfilled. There's a strong practical bias. Tedious and higher maths has been avoided where possible. Many tables are included. This one's a beauty!

256 pages **Price $8.25**

BP 56: ELECTRONIC SECURITY DEVICES
R.A.Penfold

• Simple and more sophisticated burglar alarms using light, infra-red and ultrasonics; also other types of alarm such as gas and smoke detectors, flood alarms, doorphone and baby alarms etc.

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ELEMENTS OF ELECTRONICS
F.A.Wilaon

BP 62 — Book 1

BP 63 — Book 2

BP 64 — Book 3

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Book 3 . . . Semiconductor technology leading to transistors and ICs.

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224 pages **Price $8.25 (each volume)**

BP 65: SINGLE IC PROJECTS
R.A.Penfold

• All projects in this book are simple to build and are based on a single IC. A few projects use one or two transistors in addition. A strip board layout is provided for each project together with special constructional points and setting up info. The five chapters are: Low level audio, Audio power amps, Timers, Op-amps, Miscellaneous circuits.

128 pages **Price $5.50**

BP 66: BEGINNERS GUIDE TO MICROPROCESSORS AND COMPUTING
E.F.Scott

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WE GET MANY enquiries from readers wanting to know where they can get kits for the projects we publish. This list is a guide to suppliers of kits and components for ETI projects.

We have listed here most of the projects published over the last few years which are either available as kits or can still be made up by shopping around for components. Suppliers listed against a particular project will either stocvk it as a kit or stock the pc board plus the other components.

Printed circuit boards

Those suppliers listed against specific projects here are able to supply pc boards for those projects. Printed circuit boards for every project ever published in ETI are available through the following companies (to the best of our knowledge):

RCS Radio
651 Forest Rd
Bexley NSW

Radio Despatch Service
869 George St
Sydney NSW 2000

For current projects and a more comprehensive list of pc board suppliers refer to the Shoparound page in this and previous issues. This list will be updated roughly every four months.

Key to Companies

A Applied Technology Pty Ltd, 1A Paterson Avenue, Waitara, NSW 2077. Ph. (02) 487-2711.

B Bill Edge Electronic Agencies, 115 Parramatta Road, Concord (PO Box 1005, Burwood North 2134). Ph. (02) 747-6472.

C J.R. Components, PO Box 128, Eastwood, NSW 2122. Ph. (02) 85-3385.

D Dick Smith Electronics P/L, Cnr Waterloo & Lane Cove Roads, North Ryde, 2113. Ph. (02) 888-3200.

E All Electronic Components, 118 Lonsdale Street, Melbourne, Vic 3000. Ph. (03) 662-3506.

F Tasman Electronics, 12 Victoria Street, Coburg, Vic 3058. Ph. (03) 354-5062.

J Jaycar Pty Ltd, PO Box K39, Haymarket, NSW 2000. Ph. (02) 211-5077.

K SM Electronics, 1096 Doncaster Rd, Doncaster East Vic 3109. Ph. (03) 842-3666.

L Ellistronics, 289 Latrobe Street, Melbourne, Vic 3000. Ph. (03) 602-3282.

M Mode Electronics, PO Box 365, Mascot, NSW 2020. Ph. (02) 666-6324.

N Nebula Electronics Pty Ltd, 15 Boundary Street, Rushcutters Bay, NSW 2011. Ph. (02) 33-5850.

O Orbit Electronics, PO Box 7176, Auckland, New Zealand.

P Pre-Pak Electronics, 718 Parramatta Road, Croydon, NSW 2132. Ph. (02) 797-6144.

R Rod Irving, PO Box 135, Northcote, Vic 3070. Ph. (03) 489-8131.

V Silicon Valley, 23 Chandos Street, St. Leonards, NSW 2065. Ph. (02) 439-4655.

W Willis Electronics, 993 Hay Street, Perth, WA 6000. Ph. (09) 321-7609.

Y Trilogy, 40 Princes Highway, Fairy Meadow, NSW 2519.

Project Electronics

041 Continuity Tester ... W,R,D,B,Y,L
042 Soil Moisture Indicator ... R,B
043 Heads or Tails Circuit (Oct 76) ... W,R,D,E,A,F,B,Y,L
044 Two Tone Door Bell (Oct 76) ... W,R,D,E,O,A,F,B,Y,L
045 500 Second Timer ... W,D,E,A,B,Y,L
047 Morse Practice Set ... W,D,O,A,B,Y,L
048 Buzz Board ... W,D,A,B,Y,L
061 Simple Amplifier (Oct 76) ... W,R,D,E,A,B,Y,L
062 Simple AM Tuner (Mar 77) ... W,D,E,B,Y
063 Electronic Bongos ... R,D,A,B,Y,L
064 Simple Intercom (Nov 76) ... W,A,
065 Electronic Siren ... W,R,D,E,O,A,B,Y,L
066 Temperature Alarm (Dec 76) ... W,D,E,A,B,Y,L
067 Singing Moisture Meter ... D,B,Y
068 LED Dice Circuit (Oct 76) ... W,R,D,E,A,B,L
070 Electronic Tie Breaker (Jan 77)
071 Tape Noise Limiter (Jun 78) ... R,E,F
072 Two-Octave Organ (Jun 78) ... W,D,B,Y
081 Tachometer (Mar 77) ... W,E,O
082/528 Intruder Alarm ... W,R,E,A
083 Train Controller ... W,R,E,L
084 Car Alarm ... W,R,D,E,A,B,Y,L
085 Over-rev Alarm ... W
086 FM Antenna ... W
087 Over-LED ... W,E
088 Hi-Fi Speaker ... W

Test Equipment

132 Experimenter's Power Supply (Feb 77) ... E,O
133 Phase Meter (Apr 77) ... E
134 True RMS Voltmeter (Aug77) ... E
135 Digital Panel Meter (Oct 77) ... E
136 Linear Scale Capacitance Meter (Mar 78)
137 Audio Oscillator (May 78) ... W,D,E
138 Audio Wattmeter (Nov 78) ... E,B
139 SWR/Power Meter (May 78)
140 1GHz Frequency Meter-timer (Mar 78)
141 Logic Trigger (Jan 79) ... E
142 High Current Power Supply (Feb 79) ... W,E
143 Curve Tracer (Jan 79) ... W
144 Expanded-scale RMS Voltmeter (Jun 79) ... E
148 Versatile Logic Test Probe (Jul 79) ... E,L

Simple Projects

243 Bip Beacon (Apr 77)
244 Alarm Alarm (Feb 77) ... F
245 White Line Follower (Nov 77) ... F
246 Rain Alarm (Apr 78) ... F
248 Simple 12V to 22V Converter (Jul 78) ... W
249 Electronic Combination Lock (Apr 79) ... E
252 The Passionmeter (Aug 79)
253 Electronic Grenade (Hot Potato) (May 79)
254 Egg Timer (Jun 79) ... W

Motorists' Projects

316 Transistor Assisted Ignition (May 77) ... W,E,O,K
317 Rev. Monitor Counter (Jul 77) ... E
318 Digital Car Tacho (Jul 78) ... W,E,K
319 Variwiper MK II (Sep 78) ... W,E,O
320 Battery Condition Indicator (Apr 79) ... E,L

Audio Projects

448 Disco Mixer (Nov 76) ... W
449 Balanced Microphone Amp (Nov 76) ... W,D,E,J,F,Y
450 Bucket Brigade Audio Delay Line (Dec 77) ... W,E
451 Hum Filter (Jul 79) ... D,E,F
470 60 W Amp Module (May 79) ... W,R,E,F,B,P,L,A,V
471 High Performance Stereo Preamp Control Unit (Jun 79) ... W,R,E,F,B,P,A,V,L
472 Power Supply — the Series 4000 Stereo Amp (Jul 79) ... W,R,E,F,B,V,L
473 Series 4000 Moving-coil Cartridge Preamplifier ... F,J
480 50-100 Watt Amp Modules (Dec 76) ... A,W,R,D,E,J,O,Y,L
481 12V 100 Watt Audio Amp (May 77) ... R,E
481 High Power PA/Guitar Amp (Jun 77) ... W
482 Stereo Amp (Jan 77) ... O,E
482 Stereo Amp Part 2 (Feb 77) ... O,E
483 Sound Level Meter (Feb 78) ... E
484 Simple Compressor Expander (Jul 77) ... A,E
485 Graphic Equaliser (Jun 77) ... W,E,J,O
486 Howl-round Stabiliser (Nov 77) ... J
487 Audio Spectrum Analyser (Feb 78) ... E
489 Audio Spectrum Analyser 2 (Apr 78) ... E,J
490 Audio Compressor (Dec 78)
491 Simple Graphic Equaliser (Mar 79) ... W,E
495 Transmission Line Speakers (Aug 77)

Miscellaneous

546 GSR Monitor (Mar 77) ... W,E
547 Telephone Bell Extender (Jun 77) ... E
548 Photographic Strobe (May 77) ... W,E
549 Induction Balance Metal Detector (May 77) ... W,D,E,L
550 Digital Dial (Aug 78) ... E,O
551 Light Chaser (Sep 78) ... W,E,O
552 LED Pendant (Sep 78) ... A
553 Tape/Slide Synchroniser (Oct 78) ... E
556 Wind Speed/Direction Indicator (Dec 78)
557 Reaction Timer (Feb 79) ... E
558 Mast-head Strobe (Feb 79) ... E
559 Cable Tester (Mar 79)
575 Portable Fluorescent Light Wand for Car, Camping (Aug 79) ... W
577 General Purpose Power Supply ... J
581 Dual Power Supply (Jan 77) ... W,E,Y
582 House Alarm (Jul 77) ... W,E,O,A,
House Alarm — Installation Instructions (Aug 77) ... W
583 Marine Gas Alarm (Aug 77) ... D,E,M
585 Ultrasonic Switch (Sep 77) ... R,D,E,O,F
586 Shutter Speed Timer (Oct 77) ... E
587 UFO Detector (May 78)
588 Theatrical Lighting Controller (Nov & Dec 77 Jan & Mar 78) ... N
589 Digital Temperature Meter (PCB135) (Dec 77) ... E
590 LCD Stopwatch (Oct 78) ... O,N
591 Up/Down Presettable Counter (Jul 78) ... D,E
592 Light Show Controller (Aug 78) ... E
593 Colour Sequencer (Dec 78)
594 Development Timer (Apr 79) ... E
595 Aquarium Lamp Controller (May 79)

Electronic Music

602 Minl Organ (Aug 76) ... W,D,E,A
603 Sequencer (Aug 77) ... W
604 Accentuated Beat Metronome (Sep 77) ... E
605 Temp Stabilized Log-exponential Converter (Sep 78)

Computer Projects

630 Hex Display (Dec 76) ... E,A
631 ASCII Keyboard (Dec 76) ... W,E,O,A
631 Keyboard Encoder (Apr 77) ... W,E,O,A
632 Video Display Unit (Jan 77) ... A,E,O
633 TV Sync Generator (Jan 77) ... A,E
634 8080 Educational/Prototyping Interface (Jul, Aug 78)
635 Microcomputer Power Supply (Sep 77) ... O
637 Cuts Cassette Interface (Jun 78) ... V,E,A
638 Eprom Programmer (Jul 78) ... W,E,A
639 Computerised Musical Doorbell (Mar 78) ... A
640 S100 VDU (Apr, May, Jun 78) ... W,O,A,V
641 S100 Printer (Sep 78) ... O
642 16k S100 RAM Card (Feb 79) ... K
650 STAC Timer (Nov 78) ... A,E,L
651 Binary to Hex Number Converter (Jun 79) ... E

Radio Projects

712 CB Power Supply (Jun 77) ... W,E
713 Add-on FM Tuner (Sep 77)
714 VHF-Log-Periodic Antenna (Feb, Mar 78)
715 VHF Power Amplifiers (Nov 77)
716 VHF Power Amplifiers (Jan, Feb 78)
717 Crosshatch Generator (May 78) ... W,D,E,A,Y
718 SW Radio (Oct 78) ... E
719 RF Field Strength Indicator (Nov 78)
720 2m VMOS Power Amp (Jan 79)
721 Aircraft Band Converter (Mar 79) ... W,E
722 Antenna for Aircraft Band Converter (May 79)
724 Microwave Oven Leak Detector (Jul 79) ... D,E,B
725 Simple SSB Generator employs Polyphase Network using Standard Components (Aug 79) ... E,L
730 Get Going on Radioteletype (Aug 79) ... E,L

Electronic Games

804 Selectagame (Nov 76) ... O
804 Selectagame (Rifle Project) (Mar 77) ... O
805 Puzzle of the Drunken Sailor (Oct 77)
806 Skeet (Jan 78) ... O
810 Stunt Cycle TV Game (Jun 78) ... D,O
811 TV Tank Game (Oct 78) ... O
812 Wheel of Fortune (Dec 78)
813 Race Track Game (Jan 79) ... O
814 The 'Dinky-Die' (Aug 79)

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By Mail: There is no charge for replies but a foolscap-size stamped addressed envelope **must** be enclosed. Queries relating to projects can **only** be answered if related to the item as published. We cannot advise on modifications to projects, other than errata or addenda, nor if a project has been modified or if components are otherwise than specified. We try to answer letters as soon as possible. Difficult questions may take time to answer.

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DREGS

Oh, the wayward wind . . .

♫♪♪

THE GREAT Dregs Awful Puns Competition continues apace this month with a little inspired tomfoolery from readers and staff. To kick off, our Managing Editor, Collyn Rivers, has rethought his position regarding that little known unit the millihelen (i.e: that amount of beauty just sufficient to launch one ship). He now feels that this unusual unit has both positive and negative values Hence, −1 millihelen would cause one ship to run aground!

From our Canadian edition, Assistant Editor John Van Lierde contributes the following: "Some years ago there was a dreadful shortage of precision resistors amongst the electronic manufacturers in the American West. One man emerged as the one-stop source of all resistance products — The Ohm Arranger!"

Computer puns seem popular among readers. Fourteen-year-old Paul Jennings from Whangarei in N.Z. had several plus a 'digital' pun about gymnastic ICs — the 'flip-flop' family, while fifteen-year-old John Jenik of Quakers Hill, NSW, had a computer all tied up with dozens of unwanted loops — complete with cartoon of a mummified computer!

This month's Great Awful Pun comes from Tony Lohsey of RAAF Base Amberley, QLD. "It's beyond my capacity to resist such biased attitudes about integrated circuits . . . you might say I have a 'FETish' about them"!

Alright, alright, you win, Tony.

Keep those entries coming, folks! If you can think up an original pun which incorporates an electronics/communications/audio theme, then you could win a copy of Test Gear 2/30 Audio Projects/Computers & Computing (nominate which). You may send as many entries as you wish. Write to: The Great Dregs Awful Puns Competition, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

UNTIL WE DEVELOPED THE STEREO GROOVE, HI-FI WAS PRETTY HO-HUM!

The world of hi-fi owes a lot to the original and continuing innovation of JVC. Few companies, if any, have done as much to help turn records and record-players into the virtual musical instruments they are today . . . or to lead the way in developing so many *firsts* in the more recent concepts of sound amplifiers, cassette decks and computer-designed speaker systems. Hi-fi, as we know it today, had its beginnings in 1956, with JVC's development of the 45°/45° groove for stereo records. The fact that this system still remains as the world standard is, in itself, outstanding testimony to the technology of JVC. The development revolutionised not only the record-*making* industry, in which we've been involved since 1930; it also paved the way for enormous advancement in the design and engineering of record-playing equipment. Now, hi-fi has expanded to

R-S77. Super-A FM/AM Stereo receiver

embrace a wealth of highly-sophisticated electronic equipment; and it's not surprising that JVC has continued to play a leading role in so much of its development.

HR-3660 EA. VHS Colour Video Cassette recorder

THAT WASN'T OUR ONLY FIRST, EITHER.

We also pioneered Japan's television industry, introducing their first TV receiver just over 40 years ago. A more recent innovation is VHS, the home video recording system now gaining world-wide acceptance as *the* system for such equipment. In the course of staying ahead, we've introduced a number of world *firsts* of radical importance: the Quartz Lock turntable is one of them.

THE QUARTZ LOCK TURNTABLE. MANY TIMES MORE ACCURATE.

It stands to reason that if your equipment is at the top end of the range, then your turntable must be capable of comparable performance. Only Quartz Lock ensures this, tying the speed of the turntable to the unvarying pulse of the atom, and providing a level of accuracy far in excess of conventional turntables.

MORE MILESTONES IN HI-FI.

To match the superb quality of Quartz Lock, we produced the S.E.A. graphic equalizer system. Then we refined it to such a degree it even compensates for the effect your furniture has on sound when it leaves the speakers! To expand the capabilities of tape, we designed ANRS and

SEA-80. Stereo Graphic Equalizer

Super ANRS — automatic noise reduction systems which not only reduce distortion and 'hiss' but actually extend the dynamic range of the tape. Similarly, with speakers: at JVC we employ computers in their design to help provide the ultimate in sound reproduction.

AND NOW, SUPER-A.

In its own way, as significant a hi-fi development as the stereo groove. Imagine an amplifier which combines the *best* features of the two recognised amplifier classes (A and B) . . . an amp which combines the *efficiency* of one with the *low distortion* of the other. Some engineers said it couldn't be done; but not those at JVC. Enter the Super-A amplifier . . . the *latest* JVC *first!*

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JVC
the right choice

THE FUTURE.

It's already with us. For instance, we were so far ahead in the new metal tape technology that our cassette decks were metal-compatible before the tapes were generally available. And now there's the JVC Electro-Dynamic Servo Tonearm, damping tonearm resonance by means of a purely electronic system and two 'thinking' linear motors. Who was it who dubbed JVC, 'the innovators'?

1861

The year of the bioelectronic tonearm.

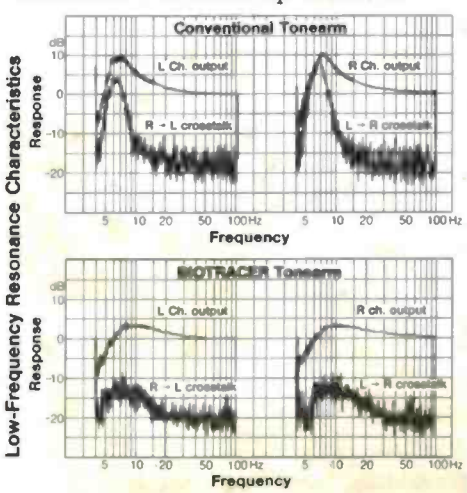
Fully automatic and electronically controlled for the ultimate in high fidelity sound reproduction.

Turntable technology is at its peak. Motors, platters and cabinets have almost all reached their performance limits. Only the tonearm remains as the last great challenge to turntable perfection. And Sony has revolutionized that with the Biotracer Tonearm.

Biotracer has dismissed tonearm resonance. Those wayward harmonics that used to break up the romance between the listener and his music. By combining a microcomputer, velocity sensors and three linear motors in the tonearm to control every movement. All unnecessary tonearm movement caused by its own resonance or eccentricities in a record, like warping, are immediately detected by horizontal and vertical sensors. A microcomputer responds to the slightest variation and directs Biotracer's linear motors to compensate.

Sound reproduction is clear. Rich bass is richer. And high frequencies more brilliant.

All other turntable functions are also automatically orchestrated by the microcomputer. Record selection is automatic. So is repeat, lead in and out, and even stylus muting whenever it is lifted up or down.



A linear torque BSL motor, together with a quartz crystal lock and Magnedisc servo system, assures stable speed and precise platter rotation.

PS-X75

The PS-X75's cabinet is made of of SBMC (Sony Bulk Molding Compound) to stifle howl. And gel filled insulators absorb acoustical energy and prevent feedback between turntable and speakers.

And Sony has paid attention to the little things. Like convenient total front panel operation including stylus force adjustment when the dust cover is down.

All of your music will live up to your wildest expectations. Because Sony has now perfected the entire turntable system. Even the tonearm.

The new PS-X75 turntable with Biotracer. A new year for your music.

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AP3527