MARCH 1980
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# eti
# ELECTRONICS TODAY INTERNATIONAL

## SUPER METAL DETECTOR
Build your own and join the treasure hunting boom

## SATELLITES FOR BUSINESS
Big business gets 'big brother'?

## PROTECT YOUR SPEAKERS
Simple project prevents disaster

## OVER-REV ALARM
Don't blow your motor, mate

## SIROTEM
Our CSIRO invents winning geo-search instrument

HI-FI FEATURES: Digital - a quandary still
REVIEWS Technics RS-M63 cassette deck
Akai amp and preamp

# A new dynamic generation of Maxell tapes.

When Maxell announces an improvement in the quality of its tape, you can bet the improvement has to be pretty dynamic. In fact, we think our new generation has even gone beyond our own standards of superior sound reproduction.

Take our high level ($CrO_2$) position tape — the UD-XL II. Maxell engineers have succeeded in expanding its dynamic range in the middle-low frequency range by 1 dB, while also pushing its sensitivity by 1 dB in the high frequency range. Then look at our normal position UD-XL I, UD and LN tapes — our engineers expanded the dynamic range at all frequency points, while also boosting output in the high frequency range. The new dynamic range, of course, allows for better music reproduction even for LN-type tapes.

On the UD-XL I and II, we also added an exclusive shell stabilizer for significantly improved tape running and track positioning.

One thing hasn't changed on all Maxell tapes — our functional features like 4-function leader tape, replaceable index labels for UD-XL series tapes and Maxell's through-production system — your guarantee of quality and superior sound reproduction.

Tape selector position UD-XL I, UD, LN: Normal position (Normal bias/120 μsec. EQ)
UD-XL II: High level position (High level bias/70 μsec. EQ)





For details on all Maxell Recording Tape write to
Maxell Advisory Service, P.O. Box 307, North Ryde, N.S.W. 2113

Available time length UD-XL I: 60, 90 min./UD-XL II: 60, 90 min.
UD: 60, 90, 120 min./LN: 60, 90, 120 min.

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WT126/79

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# eti ELECTRONICS TODAY INTERNATIONAL

## QUICK INDEX

FEATURES:



SOUND SECTION:



PROJECT SECTION:



THIS MONTH we have quite a diverse range of interesting articles, projects and reviews for you. From satellite business systems to a metal detector, from a simple siren project to the trips and traps in subjective equipment reviews.

The feature project is our new **metal detector.** While our 1977 induction balance metal detector (ETI-549) is still a currently popular kit, the current design is quite different in a number of ways. It exploits the old BFO technique in a new way and is considerably easier to construct — especially if you are a newcomer to this sort of thing. Happy treasure hunting !

**Satellite business systems** will provide unrivalled communications facilities for US companies in the very near future. Undoubtedly the concept will spread. Be prepared for the future today. One branch of Australia's Commonwealth Scientific and Industrial Research Organisation is currently very active in the geophysical exploration arena — this country has some unique problems when it comes to finding and exploiting our natural resources. Our other feature this month tells the story of **SIROTEM,** a remarkable geophysical exploration instrument (electronic - naturally) designed here, that has swiftly gained both international acclaim and commercial acceptance. It's a success story that deserves recognition.

On the hi-fi front it seems that the long-awaited commercial introduction of **digital sound equipment** will be further away than most people had hoped. Standards pose the most significant problem. For an insight, commence reading on page 108. In Sound reviews this month we have quite a surprising report on the **Koss Pro/4AAA headphones** plus the promised review of the **Technics RS-M63 cassette deck** and a preamp/amp system — **Akai's PS200C and PS200M**, of conventional design, 'built like a battleship', with solid performance.

The question of subjective equipment reviewing as an art/science is raised in **the gullible listener ,** commencing page 135, and correspondent John Gardiner provides much food for thought.

See you here next month.

Roger Harrison, Editor

# advertisers



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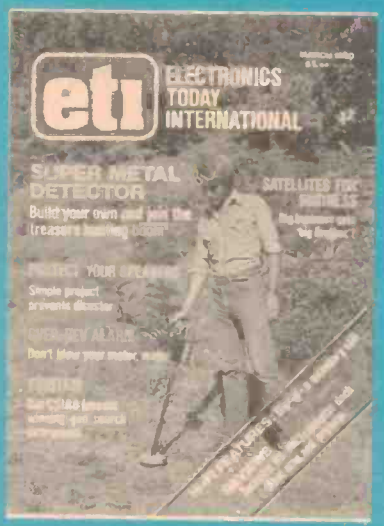
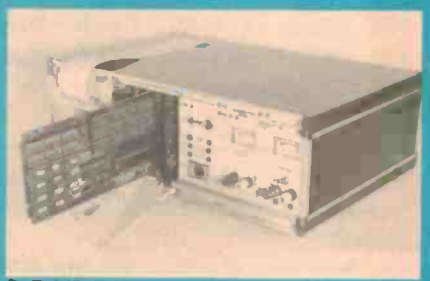



## COVER

Phil Wait looks for a few nuggets in downtown Paddington, Sydney. The search was not successful, but our new metal detector was! Photograph and cover design by Ivy Hansen.

# features







# projects



# news




## sound





## general



# next month

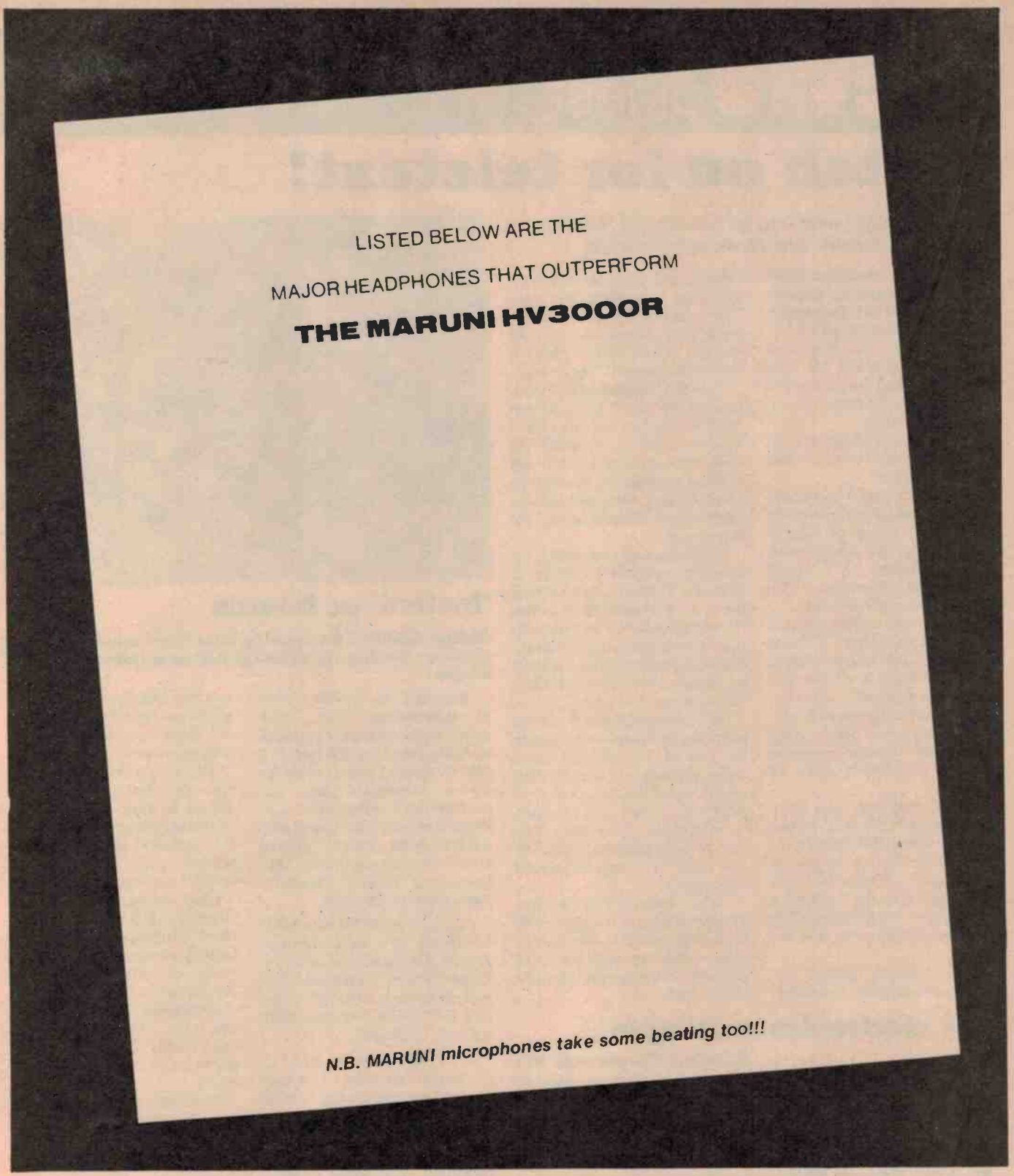
**THE 'VERY LARGE ARRAY'**
The world's largest, most sensitive, highest resolution radio telescope ever to be built, it will provide scientists with the most advanced facilities yet devised.

**PIPE AND CABLE LOCATOR**
Finding ring-pulls, bottle tops and assorted junk is fine with your 'garden variety' metal detector, but if you need to find something larger, deeper — and/or important — like water pipes, phone cables etc, then you need a *proper* instrument. Based on a highly successful commercial design, our Pipe and Cable Locator should prove a very useful device.

**MARANTZ MODEL 2600 AM/FM STEREO RECEIVER**
Featuring 300 watts per channel output and a tuning oscilloscope, Marantz appear to have sacrificed nothing in the way of quality on this unit.

**GEIGER COUNTER**
Sensitive and simple to build, this battery-operated instrument will be very useful to schools, colleges and enthusiasts interested in radiometric measurements.

**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.**




# MARUNI

SUPERLATIVE HEADPHONES AND MICROPHONES

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# NEWS digest

# Switch on for teletext!

Teletext officially went into service around Australia on Monday 4 February, just as we went to press.

**Television stations have been broadcasting experimental Teletext transmissions since March 1977.**

The Minister for Post and Telecommunications, Mr Tony Staley, launched the service at a ceremony in Sydney's Commonwealth Centre.

"This opens a whole new dimension in television in this country," he said.

Channels 7 and 9 in Sydney and Melbourne are transmitting hundreds of 'pages' of Teletext data already, including news, sports, cartoons (!), financial and weather information. The data is continually revised.

About twenty capital city and regional stations have Teletext services on their transmissions.

Philips issued a release immediately following the announcement of the service, saying that they could deliver initial supplies of Teletext-equipped receivers to retailers within 12 weeks.

Philips' chairman and Managing Director, Mr H.D. Huyer, said that some 200 Teletext receivers had been produced at their Clayton, Victoria, factories and supplied to the Australian TV industry over the past three years for experiments with the system.

Whilst add-on Teletext decoders are already available, Philips said they did not contemplate manufacturing one. They estimate a teletext-equipped receiver will be around $300 dearer than a standard colour TV receiver.

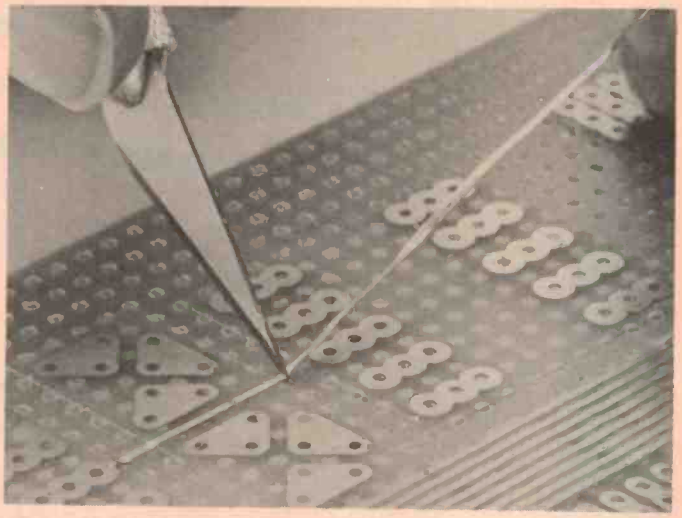
"Initially, Teletext will be confined to the 63 cm (26") screen models and a 54 cm (22") model will follow. We don't believe the nature of Teletext will make it acceptable viewing on small screen sizes, but we are keeping our options open." Mr Huyer said.

Telecom was evaluating 'interactive' systems — such as Britain's Prestel, which allows the individual subscriber to link his television set by telephone to the information computers. Subscribers would have access to virtually unlimited information services, for a fee.

Mr Staley said that it would be left to the marketplace to decide the fate of Teletext and other developments, such as Prestel, which could be introduced in Australia in three or four years.

Australian companies may also provide printers to provide users with hard copy of Teletext information.

"When I was in France I saw the prototypes of a system with hard copy printers which may make a form of electronic mail available in the near future," Mr Staley said.



## 'Instant' pc boards

**Bishop Graphics Inc. recently introduced a new electronic circuit packaging, repair and prototyping system, called E-Z Circuit.**

Designed for a wide range of applications, from solid state, digital and linear systems, to analog circuitry, the new E-Z circuit product line is ideal for home hobbyists and experimenters, electronic students and circuit designers who want to build "instant" printed circuit boards, pc board prototypes, or make pc board repairs right on the spot.

Of particular interest to home hobbyists and experimenters are the fully illustrated, easy-to-follow "how to" techniques, tips, and directions included in the new E-Z Circuit Technical Manual and Catalogue.

With this unique line of pressure-sensitive copper component mounting configurations, donut pads, tape and 'cut-and-peel' copper sheets you can build a pc board prototype or repair pc boards without chemicals, artwork, photography, screening or etching.

The E-Z Circuit copper design products are specially suited to high voltage, high speed applications, including ECL systems, as well as sophisticated applications involving straight analogue circuitry.

Also included in Bishop Graphics' E-Z Circuit line are multi-purpose epoxy glass boards, designed to suit a wide range of breadboarding and prototyping methods, and pre-shaped epoxy glass plug boards which are specially designed for use with E-Z Circuit's pressure-sensitive copper design products.

More information from Circuit Components of Bexley, NSW.

## New electronics catalogue


**Standard Components have released their new 96-page colour catalogue containing over 5000 product lines.**

Standards, renowned for the service they provide to NSW country customers, have previously not had a catalogue of products during their 20 years in the wholesale electronics business. The catalogue is easy to use, cross-referenced, indexed and is available for $3.00 plus 50 cents postage from Standard Components Pty Ltd, 9 Hill Street, Leichhardt NSW 2040. (02) 660-6066.

## Wein or Wien?

**It seems we did the gentleman who invented the bridge named after him a disservice by spelling his name incorrectly in Lab Notes in our December '79 issue.**

Correct spelling of said gent's name is **Wien**. Thanks to Mr Suckau and Mr Mulok-Houwer for pointing out the error of our ways. We did attempt to check the spelling but two separate, well-respected, sources gave opposite spellings. With a 50/50 chance of choosing the wrong one, Mr Murphy (who wrote the law of the same name) did his bit, as usual.

# Peter Sydenham new head of electronics school

**ETI correspondent, Professor Peter Sydenham, commenced the 1980 academic year as Head of the School of Electronic Engineering at the Levels campus of the South Australian Institute of Technology.**

Professor Sydenham is the author of our popular 'Electronics It's Easy' series (now a three-volume book set), and the 'Transducers in Measurement and Control' series published in ETI over 1972/1973, later published as a book by the University of New England Press.

He began his career as an apprentice electrical fitter, qualifying after five years with a 1st Class Trade certificate from the Adelaide Technical College in 1955. In succeeding years he worked with the Nilsen Electric Co, and the S.A.I.T., joining the (then) PMG as a cadet in 1957. During his time with the PMG he undertook university study, gaining a B.E. (Hons) degree in 1965, and in 1967 a master of Electronic Systems degree, from Adelaide University. At Warwick University in the UK he successfully completed a PhD, awarded in 1969, and is currently preparing a submission for a DSc at the same university.

He returned to Australia in 1970 to take a position of Lecturer in Instrumentation at the University of New England. Since his original appointment he was promoted to Senior Lecturer and lately as Associate Professor, which was the position he held immediately prior to his appointment to the Institute.

# Firms gear up for video disc

**Trio-Kenwood late last year became the fourth Japanese company to sign an agreement with Philips Eindhoven to manufacture and market video disc players designed by the Dutch giant.**

Trio-Kenwood followed Pioneer, Sony and Sharp in signing licensing agreements with Philips. Trio have been working on a video disc system for several years but have not announced a product. While they are reported to prefer the optical types (as per Philips) over mechanical types (RCA, Matsushita etc) it seems Trio are attempting to acquire licensing on RCA's capacitive pickup player.

Meanwhile, Magnavox began their third test marketing of the Magnavision optical video disc player in Dallas, Texas late last year. The firm estimates that by 1985 the total US market for video discs will be about US$3 billion annually.

RCA, however, are holding out until 1981 to introduce their Selectavision player. They expect to have demonstrator models to US distributors by December this year and plan a nationwide release in the first quarter of 1981. RCA hope to establish the Selectavision system as the industry standard.

# Briefs

**IBM research scientists have developed an experimental electroplating technique that uses the heat from a laser to enhance the deposition of metal over small areas, offering a potentially simpler means of producing the small metal patterns which form the basis of modern electronic circuitry. The new approach could avoid the need for the overlaid masks employed in conventional photolithographic circuit fabrication.**

According to figures out the US business press, RCA pushed past Sony to become last year's VCR market leader. Sony's Betamax system, launched late in 1975, had the market to itself virtually for two years. RCA hit number two position in December 1977. The top four in the US video cassette recorder market at present are: RCA, Sony, National Panasonic and Zenith. They are followed by JVC, Curtis Mathes, North American Philips' Magnavox, Matsushita's Quasar, then Toshiba and Sanyo. There are eight also-rans.

**Texas Instruments has developed a distributed computing network called TI-Score for the Lake Placid Olympic organizing committee to provide the fastest and most extensive sports results, processing and distribution method ever available at an Olympics.**

**The results are automatically printed on the eight omni 800 model 820 KSR terminals at the press centres and are transmitted to the wire services in New York. In four event categories, official verification of results is made by another TI product, the TI59 programmable calculator, employing a custom module developed to the specs of LPOOC scoring officials, and the PC100C printer. The TI59 will be used by scorers to officially audit times and scores in the Bobsled, Biathlon, Speed Skating, Cross Country Ski-ing, and Cross Country portions of the Nordic combined events.**

A new UHF communication system, designed to cope with the increasing volume of telephone traffic along the rail link between Broadmeadow and Werris Creek in the north west of NSW, will be supplied and installed by Plessey Australia Pty Limited. Referred to as UHF Trunk Radio Relay System, it covers 250 km and is the second such microwave link in the network of the Public Transport Commission of New South Wales installed by Plessey. It will be in operation by the end of 1980.

A similar system between Broadmeadow and South Grafton was designed and installed by Plessey in 1978.

**IBM Scientists (again) have invented an experimental transistor microstructure that could lead to a new form of very-large-scale integrated (VLSI) circuitry. Experimental circuits fabricated with the new structures show high switching speed (0.8 nanoseconds), high packing density and low power consumption. Such features are key goals of research efforts aimed at further miniaturization and integration, say IBM.**

Explosive expansion is the forte of fast food chains, the public service and the money supply — ask any Australian businessman, says Tandy. Tandy Electronics has opened 68 dealerships in Australia since the Australian Tandy Dealer programme was launched in May, 1978 (a rate of one per week). Worldwide, Tandy operate more than 7 000 retail outlets, over half of which are dealerships, and recorded nett sales of $1215 million in 1978/79.

What next? Realistic burgers with all-beef patties, cheese, lettuce, onions, gherkin on Micronta poppy seed buns?

**Japan plans to lead the world in IC components — and therefore in computers and telecommunications — by 1999, according to the New York Times. The plan is apparently the spearhead of a national programme to transform Japanese industry from dependence on heavy industries, such as steel and cars, to advanced computer fields.**

# What should I look for in buying a computer

- Full application software
- Reliable hardware
- Hardware support
- Software support
- Competitive price structure
- State-of-the-art components
- Future expansion capabilities
- A solid company backing
- Australia-wide dealer network

**We've got it all!**

*Dealer inquiries invited.*

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24 Woodfield Blvde., Caringbah. 2229 Sydney, N.S.W. Phone (02) 524-5639 (Telex) Dicker AA70182.

## World times/alarm watch

**GFS Electronic Imports have just announced the release of a solar — world times — alarm watch.**

Known as the Model 1700S, it allows a user to easily read the time anywhere in the world.

The 1700S is also a 12-function six-digit watch. The functions include alarm, day, date, seconds, stop watch, dual-standard time etc.

It has an LCD readout and the watch has a small battery installed which is automatically charged by a built-in solar cell.

The case and band of the 1700S are manufactured from stainless steel and the face is glass. The band is fully adjustable with the watch itself being water resistant.

The 1700S is currently available at $89 plus $2.50 postage. Contact GFS Electronic Imports, 15 McKeon Road, Mitcham Vic 3132. (03) 873-3939.

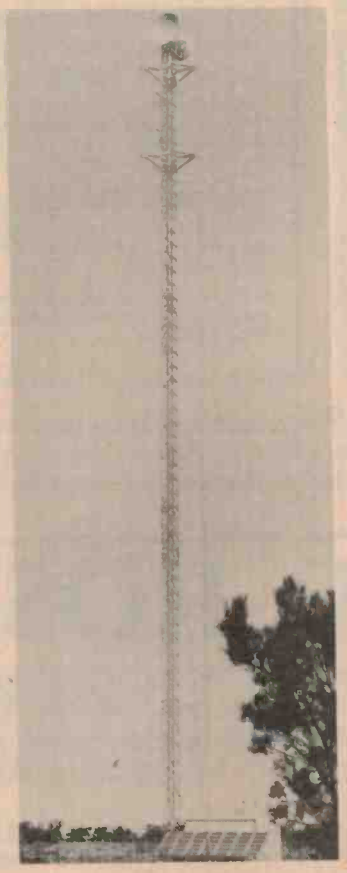
## Australia's largest commercial solar powered communications system installed

**Lucas Industries has completed the installation of Australia's largest commercial application of solar power for the communications system along the new 831 km Tarcoola — Alice Springs' Railway (see News Digest, Dec. 1979 p.8).**

In 1979 the Australian National Railways awarded Lucas the contract to supply solar power for 23 radio repeater stations in the integrated microwave-VHF radio system along the railway.

This communication system will enable train crews and track maintenance gangs to have continuous radio contact with train control centres in Alice Springs, Tarcoola and Port Augusta. The use of solar power for the communications was selected by Australian National Railways to eliminate costly diesel fuelling and maintenance procedures on the new line.

Further information on Lucas Solar Power is available from Arthur Wookey or Richard Collins, Lucas Industries Australia Limited, Battery Division, 1156 Nepean Highway, Cheltenham, Victoria 3192. (03) 93-0311.



## Moves afoot

**National Panasonic (Australia) Pty Ltd are moving their Sydney head office from Kensington to North Ryde this month.**

New address is 95-99 Epping Rd, North Ryde 2113; (02) 888-1188.

Another relocation involves **Bell Instruments**, formerly of The Crescent, Homebush. They moved in January to Garema Circuit, Kingsgrove, 2208 NSW. New postal address is P.O. Box 154, Kingsgrove 2208; phone number is now (02) 750-6000 and telex is AA22540.

## Versatile plug packs

**Two ac adaptor packs released by Dick Smith Electronics offer a very economical way to operate low-power dc equipment from the mains.**

One pack, designated the M-9525, has a switchable 3, 6 or 9 volt output at 200 mA. A "cruciform" connector is fitted to the dc side. This four-way connector contains a 2.5 mm and 3.5 mm plug, and two 'dc' type plugs of different sizes. This combination virtually ensures compatibility with any suitable appliance such as cassette players, AM/FM radios, etc.

Cost of the M-9525 ac adaptor is $6.90 including tax.

The other adaptor (Cat. No. M-9514) is a 9 V dc-only device. Rated at 200 mA it is a very economical unit at only $4.90 including tax. This unit is designed specifically for applications where it will be used with the one appliance all the time.

For further flexibility, both units have a special polarity-reversing plug and clear instructions as to how to use them.

Both units are Electricity Authority Approved and are attractively packaged. Available at Dick Smith stores and dealers.

## The flasher

**A flashing LED indicator, featuring a built-in IC, was announced as available ex-stock from Electronic (distributors) recently.**

The device is ideal as a warning indicator on alarms, control equipment, limit indicators etc. A flashing light draws more attention to itself than a standard indicator.

The flashing LED is a gallium arsenide phosphide type with a diffused, red plastic lens. The built-in IC flashes the lamp on and off at a typical pulse rate of 2.5 Hz and can be driven directly by standard TTL and CMOS circuits — no external switching is required (it would be ideal in January's Fuel Level Alarm project, ETI-321).

The unit is rated to operate at a maximum voltage of 6 Vdc and luminous intensity is typically 1.2 mcd at Vf of 5 V. Emission peak wavelength is 650 nM whilst peak current is typically 20 mA at Vf of 5 V (50% duty cycle).

Free sample and data sheet are available on written request (on company or departmental stationary) from Electronic (distributors) 2-3, 7/10 Joyce St, Pendle Hill 2145 NSW. (02) 636-6222.

# SOFTWARE

## ACCOUNTING PACKAGES

DEBTORS $330
CREDITORS $330
DIRECT MAIL $500
GENERAL LEDGER $330
PAYROLL $500
STOCK/INVOICE $500

Packages are written in CBASIC II in Australia. SOURCE IS AVAILABLE (POA). Packages supplied on 8" or 5¼" disk and need 80 x 24 serial terminal, 48K RAM, 2 x 240K (min) capacity disk drives, 132 column printer. CUSTOMISING AVAILABLE.

## OPERATING SYSTEMS

CP/M VERSION 1.4 $145.
CP/M VERSION 2.0 $175 (Suitable for HARD DISK).
MPM VERSION 1.0 $305 (CP/M 2.0 extended for MULTI-USER).
CPM 374X $200 (transfers between IBM 3741 data sets and CP/M files).

## LANGUAGES

C-BASIC II $110 (Semi compiler).
BASIC-80 $305 (Microsoft Disk Extended Basic).
BASIC COMPILER $355 (down to HEX!).
FORTRAN-80 $405.
COBOL-80 $630.
CIS-COBOL $860 (includes full ISAM).
PASCAL/Z $400 (includes VARIANTS).
APL/Z80 $393.
ALGOL-60 $205.
Full ISAM file utilities are available.

## ASSEMBLERS

MAC (by Digital Research) $95.
SID (Symbolic De-bugger 8080 code) $85.
ZSID (as per SID but Z80) $105.
MACRO-80 (by Microsoft) $155.
XMACRO 86 (8086 cross compiler) $300.
Z80 CROMEMCO relocatable assembler $130.
Z80 Development Package $103.
ZDT (Z80 De-bugger) $55.
DISTEL disassembler $70.
DISILOG disassembler $70.

## EDITORS/WORD PROCESSORS

WORDSTAR (for Serial Terminals) $445.
WORDMASTER $130.
POLY VUE 80 (full screen editor) $140.
POLY TEXT/80 (text formatter) $90.
POSTMASTER $150.
TEXTWRITER II $130.

## UTILITIES

SAVER (Re-constitutes files erased by the CP/M command ERA. Display/Alter information on disk sector by sector independently of file structure!)

**We have much more software (including comprehensive 3D GRAPHICS) and it's all described in our comprehensive catalogue.**

# HARDWARE

## POWER CONTROLLER Model A $460

Controls 6 channels 240 volts x 1.5A, 2 channels 24 volts DC x 3 amps. Requires a computer with an 8-bit latched parallel port.

## 16K STATIC RAM BOARD $400

Fully assembled and tested, 4 MHz, 2114 chips, no wait states, phantom line capability, addressable 4K blocks anywhere in 64K, fully buffered, meets S100 IEEE standards. Ideal for use with Sorcerer.

## 64K DYNAMIC RAM BOARDS $1,400

These S100 boards are completely compatible with Cromemco systems.

## DELTA PRODUCTS S100 CPU BOARD $495

Features: 4MHz Z80; 2 x RS232C serial programmable I/O ports; 1 x 8255 24 bit parallel I/O port; M1 wait state for 450nSec memory chips; conforms to IEEE proposed standard with memory management on A16 and A17.

## DISK CONTROLLER — supplied with CP/M

MICROPOLIS $495 (5½" drives).
MICROMATION $570 (8" double density).
DELTA PRODUCTS $570 (8" double density).

## CROMEMCO D+7a $280

Features 7 channels of 8 bit analog-digital and 7 channels digital-analog.

## VECTOR GRAPHICS BIT STREAMER II $310

3 RS232C serial ports and 2 eight bit parallel ports.

## MATROX ALT 256 $500

Produces 256 x 256 graphics display to Australian standards. Supplied with SUBLOGIC graphics software. 512 x 256 display board and character generator board are available, send for details.

## NDK SERIAL/PARALLEL PRINTERS $3,500

Includes stand, 6 month warranty, 170 cps, bi-directional.

## WORD PROCESSING PRINTER $4,085

Dot matrix printer that produces normal draft copy at up to 200 cps and full wordprocessing quality at 40-50 cps. Can have up to 16 software selectable fonts. At last, a general purpose printer — 16 cpi, 12 cpi, 10 cpi etc. Choose from 18 fonts! Send for details.

## SHUGART SA801R 8" drives (ex-stock) $650

CASE with 2 x Shugart 8" disk drives, power supply, 8 slot S100 motherboard, Delta Products disk controller, CP/M (available for Exidy Sorcerer) $2,870.

**We have systems from Cromemco, Altos, Vector Graphics and our own OMEGA. We build systems to order. SEE OUR CATALOGUE FOR FULL DETAILS.**

To receive our catalogue on hardware, software, systems and components send 3 x 20c stamps and become a member of our mailing list club that will keep you informed on the latest developments in the computer field and entitle you to receive notice of our regular specials.

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*Prices subject to change without notice. All prices include sales tax.*

# Barra Sonobouys: world market

**One of the most significant projects ever undertaken by the Australian Defence industry, the Barra Sonobuoy, is now entering the world export market.**

As well as establishing a world lead in submarine detection, the Barra project has played a vital role in establishing Australia's reputation in the international defence industry.

The Barra Sonobuoy was developed by Australian industry in association with the Department of Defence and is now being manufactured by Amalgamated Wireless (Australasia) Limited as prime contractor.

The Barra Sonobuoy is a device dropped into the sea by anti-submarine aircraft to locate submarines. Operating at selectable depths, and consisting of a surface buoy and a suspended submerged array assembly, the Sonobuoy uses hydrophones to detect acoustic noise emission.

The Sonobuoy is part of a joint Australian/British system, with the UK developing and building an airborne computer-based processor and receiver, which picks up radio signals transmitted from Sonobuoy and processes them into a 'fix' which can be utilised by the aircraft's crew for anti-submarine activities.

In addition, a ground support facility is being developed in Australia for the RAAF's long range maritime patrol aircraft.

The Australian Minister for Defence, Mr Killen, said recently that the Barra Sonobuoy had proved in recent trials that its detection and location performance was superior to that of other Sonobuoys presently available overseas and that the buoy had a good potential for export sales to approved countries. When the Barra Sonobuoy was exhibited at the Paris Air Show in June last year, those countries which showed interest included Japan, France and the Netherlands.

# Teletext decoder chip set

**Philip's Teletext decoder chip set comprises four dedicated LSI circuits which can be used with two standard 1k x 4 static RAMs and four low-power Schottky TTL circuits to build a complete Teletext decoder.**

The four dedicated ICs are: SAA5020 timing chain, SAA5030 video processor, one of the SAA5040 series of acquisition and control circuits, and one of the SAA5050 series of character generators.

The SAA5030 video processor is a monolithic bipolar 24-pin IC which extracts data clock formation from the composite video signal and feeds this to the SAA5043 acquisition and control circuit. A 6 MHz crystal controlled oscillator is incorporated to drive the timing chain. Line and field sync pulses are separated from the input video in the SAA5030.

The SA5040, SAA5040A, SAA5040B, SAA5041, SAA5042, and SAA5043 form the SAA5040 series of N-channel MOS ICs for control, data acquisition and data routing functions of the Teletext system.

The circuits differ in the on-screen that is provided and in the decoding of the remote control demands. The SAA5043 is a 28-pin device which receives serial Teletext data from the SAA5030 video processor and data from the remote control system e.g: SAA5010. The SAA5043 selects the required page information and feeds it in parallel form to the Teletext page memory. The SAA5050 is an N-channel MOS IC with 28-pins and incorporates a fast access ROM that generates 96 alphanumeric and 64 graphic characters. In addition, there are 32 characters that determine the nature of the display. The SAA5050 provides the necessary drive signals for the TV receiver to produce a Teletext display.

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


# Power supply delivers 6 A at 13.8 Vdc.

**The Transwest Mk IV power supply is rated to deliver up to 6 A at a nominal output of 13.8 Vdc at a 50% duty cycle.**

Designed to operate normally battery-powered equipment from the 240 Vac mains, the supply features connection terminals on the rear and is Electricity Authority approved.

It is manufactured in Western Australia by Transwest Pty Ltd and distributed in the eastern states by IFTA Australia Pty Ltd of 1 Greville St, Randwick NSW 2031. (02) 665-8211.

# Reference tome

**As this is the start of the academic year, readers may be interested in a new reference work from the Newnes-Butterworth publishing stable.**

The Electronics Engineers' Reference Book, 4th Edition, edited by L.W. Turner, covers an extremely broad field from basic principles to propagation, valves to ICs, instrumentation and telecommunications, sound and video recording to electronic music, radio astronomy to electronics in education, and more. There are 27 chapters in all. Available now, cost: $75, from Butterworths Pty Ltd, 568 Pacific Hwy, Chatswood NSW 2067.

# Solar powered calculator!

**Dick Smith is offering a solar powered calculator for those hardy types who calculate in the great outdoors.**

It may well be useful for quantity surveyors, architects, geologists etc and has the advantage/disadvantage (depending on your point of view) of requiring no batteries.

Our demonstration unit worked well under normal office fluorescent lighting.

Apart from the usual calculation ability, the device has memory, percent and square root keys plus an eight-digit LCD display. Listed as catalogue No. Q-3050, it is available at Dick Smith stores for about $40.

# LETTERS

**Dear Sir,**

I have recently constructed the Aircraft Band Converter which I feed into my FRG-7 communications receiver. I must say it works very well, but the problem with VHF is that there is a lot of hiss. What I want is a simple squelch circuit to attach to the FRG-7. I have no idea what components to add or where to place them in the audio stage of the receiver. Could you assist? I have written to the manufacturer but they could not help me.

**Hank Dykstra**
**West Ulverstone, Tas.**

*Squelch circuits that you might "add-on" to your FRG-7 may be found in 'FM and Repeaters for the Radio Amateur', published by the American Radio Relay League (ARRL) and available through specialist suppliers such as McGills Authorised Newsagency, Technical Bookshops, Dick Smith Electronics and others. That book has four circuits to choose from. You may find some in 'Amateur Radio Techniques' by Pat Hawker, published by the Radio Society of Great Britain (RSGB), also available from the above-mentioned sources.*

*Incidentally, we are preparing an article, in response to readers' requests, on an IF/audio system for the ETI-721 Aircraft Band Converter which will appear in a forthcoming issue.*

**Dear Sir,**

Your journalistic enthusiasm and urge for the sensational have made you over state the risk to the health of persons using electronic components containing beryllium oxide. You have already succeeded in alarming one technician who thinks he might have scratched a component and your final remark "see your doctor" could terrify others – what is the doctor to do?

Beryllium is a harmful material but had you only read reference 3 in your bibliography you would have gained some idea of the risk to health of persons using electronic components containing beryllium – it pales into insignificance when compared with the normal hazards of life. Your coloured words "deadly cancer-forming agent" and "incredible virulence" might be excused because of your journalistic fervour but your warning to handle heatsinks with plastic gloves is perfectly ludicrous and shows complete ignorance of the literature on the toxicology of beryllium. A little learning is a dangerous thing, far more dangerous than heatsinks.

**G. Major**
**Lecturer in Occupational Health**
**University of Sydney**
**School of Public Health**
**and Tropical Medicine**

*Our article in the October 1979 issue was not occasioned by our "urge for the sensational". In fact, it was prompted by a reader's letter. The title of the article "Beryllium – how dangerous?" is hardly sensational. Notice that the caption above the photographs on page 34 of that issue says "Beryllium compounds are quite safe – providing they're left well alone". Those photographs represent a graphic illustration of the warnings most manufacturers include with their products that contain beryllium oxide.*

*The object was to point out that there was a risk involved with this substance which is widely used in electronics – a risk of which we judged many people were unaware.*

*In the recent past beryllium oxide insulating washers, used to mount power transistors, SCRs and the like, were available and may still possibly be found in manufactured equipment. These washers are superior to mica or other types, particularly in stringent applications. But they are fragile and clearly present a risk. For obvious reasons, with these washers, and electronic devices containing beryllium oxide, warnings cannot be attached. Any person subsequently handling such things may be unaware of any risk. It is apparent to us, from the reaction to the article, that ignorance of the risk was widespread.*

*Many hobbyists, upon destroying a device (albeit, inadvertently), are inclined to 'open it up to see what's inside' out of natural curiosity. This is usually an indelicate operation and it presents a risk if the object contains beryllium oxide. Should not our readers be aware of this risk?*

*Our article did* **not** *advise people to wear gloves while handling heatsinks. It advised readers to wear gloves whilst handling* **heatsink compounds** *that could contain beryllium oxide. Though heatsink compounds containing BeO are rare now, they weren't in the past.*

*Most of the health risks associated with electronics as a hobby or an occupation are readily apparent. However, some risks are insidious – that from beryllium oxide we believe to be in this category. If beryllium oxide is innocuous and our article over emotive and sensational – why do health authorities around the world insist on warning labels?*

*If someone suspects they have had possible harmful contact with the substance, what do* **you** *suggest they do?*

**Dear Roger**

I possess details of experiments which I wish to perform using tunnel diodes. However, I am having great difficulty in obtaining supplies of the components.

I would like to hear from any ETI readers who may have a few tunnel diodes which they would be willing to sell to me. I would be interested in any quantity from 1 – 10 units, either of the same type or of mixed types.

**Terry Day**
**Flat 14, "Marsden"**
**29 Great Western Highway**
**Parramatta**
**NSW 2150**

# NEW KITS
## (and new kit components)

Remember: parts for most kits in most of the electronics magazines are normal stock lines. So even if a kit isn't listed, we may be able to help you anyway. Call in and ask us!

**ETI 300 WATT AMPLIFIER MODULE (See ETI February)**

| | | |
|---|---|---|
| Short Form Kit (F'glass PCB, components, heatsink brackets & instructions | Cat K-3444 | $69.00 |
| Transformer | Cat M-0150 | $32.50 |
| 100 volt fan | Cat D-2865 | $29.00 |
| MJ15003 Transistor | Cat Z-1808 | $5.00 |
| MJ15004 transistors | Cat Z-1810 | $5.00 |
| 2500uF/80V RB electro | Cat R-4572 | $3.95 |
| Heatsink (two rec. per module) | Cat H-3460 | $4.75 |

**PLAYMASTER ANALYSER/LEVEL METER (See EA February)**

| | | |
|---|---|---|
| Complete kit, including instructions | Cat K-3510 | $89.50 |
| Printed circuit boards (set of two) | Cat H-8313 | $8.50 |
| MM5837 IC | Cat Z-6130 | $3.90 |
| UA-4136 IC (10 required) | Cat Z-6105 | $1.88 |

**SUPERBASS FILTER (See EA February)**

| | | |
|---|---|---|
| Printed Circuit Board | Cat H-8370 | $2.40 |

**FLASH EXPOSURE METER (See EA January)**

| | | |
|---|---|---|
| Printed Circuit Board | Cat H-8371 | $2.10 |
| Solar Cell | Cat Z-4820 | $2.50 |
| 100uA panel meter | Cat Q-2070 | $12.50 |
| 5082-2800 diode | Cat Z-3230 | $2.88 |
| CA-3140 IC | Cat Z-5417 | $1.48 |

**GUITAR PRACTICE AMPLIFIER (See ETI January)**

| | | |
|---|---|---|
| Printed Circuit Board | Cat H-8625 | $4.60 |

**PLAYMATE AMPLIFIER (See EA January)**

| | | |
|---|---|---|
| Printed Circuit Board | Cat H-8369 | $4.60 |

**TRANSISTOR ASSISTED IGNITION (See EA December)**

| | | |
|---|---|---|
| Complete kit including instructions | Cat K-3300 | $32.50 |
| Printed circuit board | Cat H-8367 | $2.20 |

**FAN SPEED CONTROL (See EA December)**

| | | |
|---|---|---|
| Short form kit (PCB, components; no h'ware) | Cat K-3090 | $11.50 |
| Printed Circuit Board | Cat H-8368 | $1.60 |
| SC141D Triac | Cat Z-4510 | $1.28 |

(zippy box, etc, normal stock lines – or build it in to appliance.)

**NEW METAL LOCATOR (See EA November)**

| | | |
|---|---|---|
| Complete kit (excluding dowel & former) | Cat K-3504 | $19.50 |
| Printed Circuit Board | Cat H-8366 | $2.40 |

**INFRA-RED REMOTE CONTROLLER (See EA October)**

| | | |
|---|---|---|
| CQY89A infra red diodes | Cat Z-3235 | $1.50 |
| BPW34 photo transistors | Cat Z-1954 | $3.50 |
| Printed circuit boards (pair) | Cat H-8365 | $5.95 |

# JUST RELEASED!

Our fi-nd new up-dated colour kit catalogue is now available
Send for your copy NOW – it is

# FREE!

## MAJOR DICK SMITH RESELLERS

Listed below are re-sellers who stock a large range of our products. However, we cannot guarantee that they will have all items in stock or at the prices we advertise.

**A&M Electronics**
78 High Street, Wodonga, Vic. Ph 244 588
**Advanced Electronics**
5a The Quadrant, Launceston Tas. Ph 317 075
**Aero Electronics,**
123a Bathurst Street, Hobart Tas. Ph 348 232
**Peter Brown Electronics**
9 Doveton Street North, Ballarat Vic. Ph 323 035
**Crystal TV Rentals Pty Ltd**
66 Crystal Street, Broken Hill NSW. Ph 6897.
**Decro Electric**
Cnr Magellan St & Bruxner Hwy, Lismore, NSW. Ph 214 137
**Electrofix**
133 Malop Street, Geelong, Vic. Ph 97 827
**Elektron 2000**
181 Wharf Road, Newcastle NSW. Ph 262 644
**Hitel Hi Fi,**
Shop 12, Venure Arcade, High Street, Penrith. (Also at St Marys)
**Hutchesson's Communications**
5 Elizabeth Street, Mt Gambier SA. Ph 256 404
**Keller Electronics**
218 Adelaide Street, Maryborough, Qld. Ph 214 559
**M&W Electronics**
48 McNamara Street, Orange NSW. Ph 626 491
**Mellor Enterprises**
Shop 2/15 Forsythe St, Whyalla Norrie, SA. Ph 454 764
**Power & Sound**
142 Argyle Street, Traralgon, Vic. Ph 743 638
**Purely Electronics,**
15 East St, Rockhampton Qld. Ph 21 058
**Stevens Electrical**
42 Victoria Street, Mackay, Qld. Ph 511 723
**Sumner Electronics**
95 Mitchell Street, Bendigo, Vic. Ph 431 977
**Sound Components**
78 Brisbane Street, Tamworth NSW. Ph 661 363
**The Silicon Chip,**
Suite 3, 98 Bridge St Muswellbrook, NSW
**Tomorrow's Electronics & Hi Fi**
68 William Street, Gosford NSW. Ph 247 246
**Trilogy Wholesale Electronics**
40 Princes Hwy, Fairy Meadow, Wollongong, NSW. Ph 831 219
**Tropical TV Services**
249 Fulham Rd, Vincent, Townsville Qld. Ph 791 421
**Variety Discounts**
113 Horton Street, Port Macquarie NSW. Ph 835 486
**Viking Electronics**
3108 Gold Coast Hwy, Surfers Paradise, Qld. Ph 388 280
**Wagga Wholesale Electronics Sales**
82 Forsyth Street, Wagga NSW.
**Wellington Electrical Services**
110 Lee Street, Wellington NSW. Ph 325

# COMING NEXT MONTH . . .

The all-new 1980 Dick Smith catalogue is almost here. With loads of new products, a huge new computer section and an up-dated data section, the Dick Smith catalogue is a hobbyist's dream. Don't miss out on your 'New Decade Dick Smith Catalogue': you might regret it for the next ten years!

**IT'S FREE — WITH THE APRIL ISSUE OF BOTH ELECTRONICS AUSTRALIA & ELECTRONICS TODAY!**

## STILL TIME FOR THAT PARTY . . .

***Turn it into a DISCO!***

Not a kit: ready to plug in and go!

**$79.00**

This is our incredible disco colour organ. Cat A-4950
It looks like a speaker box with a perspex panel. Connect it to your favourite music source and watch it light up your life. It won't harm your amplifier, etc, and makes any party come alive. 3 channels and 6 colours for a sparkling effect. Comes complete with audio lead and inst.

## INCREDIBLE VALUE

Compare this superb LCD digital alarm/stop watch with others having similar features – some of the big brand names, for instance. They contain EXACTLY the same large scale integrated circuit and liquid crystal display as ours – yet you would pay up to twice, even three times the price of ours!

This outstanding example of integrated circuit technology offers five different modes of operation:

- Normal hours/minutes/seconds display
- Hours/minutes display plus date
- Split time zones (eg daylight saving & standard time)
- Alarm mode, fully settable
- Lap timing

Each watch comes complete with a comprehensive instruction sheet: use it once and it's child's play!

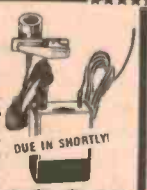
- **Complete with attractive bracelet strap.**
- **Comes in smart gift box for protection!**
- **Compare our price!**

**$49.50**

Cat X-1044

## NEW! FM WIRELESS TIE-CLASP MIC

Here's a brilliant idea: a tiny tie-clasp condenser microphone complete with miniature FM transmitter: receive it on any standard 88 to 108MHz FM receiver. Transmitter section is small enough to slip into shirt pocket; mic comes complete with tie bar. A great idea for entertainers, demonstrators, public address, etc etc etc.




**$29.95**

Cat C-1073

DEAR CUSTOMERS . . .
Quite often, products we advertise are completely sold out within a few days. Or problems may hold up delivery of promised goods so they are not in the stores when the advert appears. Please don't blame the store manager or staff: they are powerless to do anything about it! What we are trying to say is that, if you are about to drive across town to pick up a particular line, give the store a ring first . . . just in case!
***Dick Smith and Staff***

## NEW! 5 WATT, 6 CHAN. HAND-HELD.

For the weekend boating set: take along a bit of security – this handy marine transceiver. Huge 5 watts output (maximum legal power), with 6 channel capacity (comes with one channel fitted on the 27.88MHz boating safety channel). Comes with illustrated case – attractive and durable. Easy to use – and it's handy to find out where the fish are biting!

Approved by the P&T Dept for operation on the 27MHz marine band.

**$89.50**

Cat D-1120

## SAVE ON WELLER!

Here's your chance to grab a famous Weller soldering iron at way under normal price. The popular SP250 mains iron normally sells for $13.95 – while stocks last, they're only

**$9.75!**

Buy now – you reap the benefit of Dick's bulk buying. But hurry: only 1200 at this price. Cat T-1030

## SUPA SAVING!


This liquid crystal display calculator with memory uses no batteries. It operates from either solar power or normal room lights. It was selling for $39.95 – now you save an incredible $14.00! Yes, be quick for this one: stocks won't last long at this price. Cat Q-3060

**$25.95**

***STOP PRESS!*** **NEW REGULATIONS ALLOW 6 CHANNELS ON 27MHz. THIS SET IS READY FOR ALL 6!**

## SPEAKER FADER

High power (25W) control for fading between front and rear speakers. Easy to fit, a delight to use! Cat A-7834

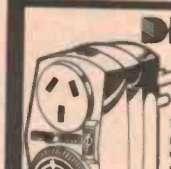
**$9.95**

## CODEMASTER:

Play against the computer: can you beat it. This remarkable thinking game gives you the clues; you have to try to work out the answers. Great for all ages, size approximately that of an 8-track cartridge. Cat X-1150

**$29.50**

## DISCOLITE



- **It's a strobe!**
- **It's a music colour!**
- **It's a light dimmer!**

This is the most incredible device going. It is three in one: a strobe circuit which flashes incandescent globes in a pseudo-strobe effect; plus it's a colour organ which has its own inbuilt mic. to modulate lights in accordance with music or sound received; plus it is a conventional light dimmer. All you do is plug it into the power point, and plug your lights into it. It really is incredible!

**$47.50** Cat X-1105 **JUST PLUG IT IN!**

## PLUG-IN TIME SWITCH

Incredible! Up to 3 on/off actions per 24 hours, fully settable, auto and manual control. Contacts rated at 2400 watts (same rating as your power point); appliances simply plug in! Pool filters, security lights, battery chargers, electric blankets, etc etc etc. Auto or manual control, too.

**24.50** Cat X-1120

## Incredible audio accessories sellout!

Save around 10% and more on these value packed 'BIB' audio accessories. And save even more by keeping your audio gear in tip-top condition!

**Groove kleen:**
It's the modern automatic record cleaner which keeps you records clean while they are being played (the time they collect the most dust!) No liquids, silent operation, has self-adhesive base and counter-weight to ensure proper light tracking. Was $6.95 . .
Now only **$6.25** Cat C-7060

**Deluxe cassette care kit.**
Everything you need to keep your cassettes in top condition. Splicing block, tape, extraction tool/winder, head cleaning tape, labels, etc. A must for the serious recordist. Was $16.25
Now only **$14.60** Cat C-7074

**Stylus balance**
Make sure your stylus is correctly balanced with this easy-to-use balance. You'll get longer record and stylus life. Pays for itself times over. Was $5.80
Now only **$5.20** Cat C-7075

**Static reducer**
The latest in static reduction: Simply point the 'groove stat' at the record, turntable, etc, and squeeze the trigger. A stream of ions neutralises the static charge. Incredibly effective. Was $23.55
Now only **$21.20** Cat C-7079

**Stylus brush**
Keep your stylus clean and ready for use with a brush designed to do the job properly. Was $2.60
Now only **$2.30** Cat C-7081

## COMPUTER CORNER:

Calling computer experimenters: if you like to 'dabble', Dick has the IC's you need. Here are just a few specialised computer ICs – just for experimenters.

ISP-8A/500D – Miniscamp IC. Now less than half price . . . way under cost! Cat Z-9307 Was $19.95; now only **$9.95!!** (limited quantity)

Z-80 Microprocessor IC – one of the most popular (as used in Sorcerer) Cat Z-9100 $19.95

MM5740AAF Encoder – a keyboard to ASCII encoder chip. Cat Z-9202 $15.98

MM5303N/TMS6011/S1883 UART IC – the universal data communicator. Cat Z-9204 $5.25

RAMs:
2102 1K Static RAM Cat Z-9302 $1.30
2112 256 x 4 bit static RAM Cat Z-9304 $2.25
2114 4k static RAM Cat Z-9306 $7.30
4116 16k Dynamic RAM – as used in just about everything! Cat Z-9310 $17.00

## BUDGET KEYBOARD KIT

Cat K-3601


Here's value! 60 key computer keyboard, with keys labled ready for connection. Each key is separately switched, allowing for virtually any usage. Compare other keyboard prices!

**39.95**

## TRS-80 OWNERS:

Save with Dick's TRS-80 16k upgrade kit! Brand new, prime spec components: was half the price of Tandy's equivalent; NOW REDUCED EVEN FURTHER! That's right – save $40.00 on our old price, and a massive $180 on Tandy equiv!

~~$149.50~~

Cat X-1188

NOW ONLY **$109.50**

## BUYING BY MAIL?

It's so easy! Simply list the items you want with their catalogue numbers and post it off with your cheque to our mail order centre (address at right). Don't forget to include post & packing (charges apply to total order value as per table at right).

Then watch your letterbox!

| ORDER VALUE: | P&P |
|---|---|
| $5 (min) to $9.99 | $1.00 |
| $10.00 to $24.99 | $2.00 |
| $25.00 to $49.99 | $3.00 |
| $50.00 to $99.99 | $4.00 |
| $100 or more | $5.50 |

NOTE: These charges apply to goods sent by post in Australia only. Large and bulky items cannot be sent by post.
If you prefer, we will despatch your order by Comet Road Freight to anywhere in Australia for only $6.00 – that's below what it costs us! Large and bulky items are normally sent by Comet unless you specify differently (eg by rail or air – you pay freight on delivery.)

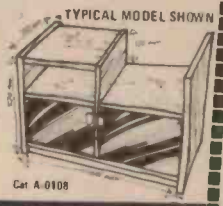
## extra special SCOOP PURCHASE

We've bought the entire stock from a major manufacturer of these superb hi-fi system cabinets and stands. Finished in a deluxe wood-grain look material; some even have smoked doors on record cabinets, etc – really smart. They're selling fast, so some models may already be sold out. Hurry in before they all go! Five models, all one price.

(Sorry, no mail orders available on this item as there are five different models. Personal shoppers only, while stocks last)

5 models to choose from (while stocks last!!!)

**$49.50**




Cat A-0108

# BUYING A COMMUNICATIONS RECEIVER?

## Then consider this:

The 'state-of-the-art' in communications receiver design is the famous 'Wadley Loop' principle. This simply is a special circuit which causes errors and drifting in the receiver to be self-cancelling. The result: a better signal, with virtually no drift and superb quality signals.

Most of the really expensive ($1000-$2000 plus) monitor receivers used by broadcasting authorities throughout the world use the 'Wadley Loop' principle for its inherent reliability. Now Yaesu has brought the Wadley loop into communications receivers in the under-$1000 price range.

Don't be fooled by claims of other receiver manufacturers that their circuits are 'as good as Wadley Loop'. If a receiver hasn't got the real thing – Wadley Loop circuitry – it just isn't in the race. Insist on Wadley Loop!

## FAMOUS FRG-7:

**WADLEY LOOP COMMUNICATIONS RECEIVER**

Without doubt, the world's most popular receiver. 0.5 to 30MHz continuous coverage, readout to 10kHz. The Wadley Loop coupled with a triple conversion superheterodyne system guarantees extremely high sensitivity with excellent stability. Has 3 position RF attenuator, auto noise suppression circuit, 3 position tone selector, and can be operated from 240V AC or 12 volts DC.

Sensitivity: 0.25uV for 10dB S-N/N (SSB & CW) or 0.7uV AM

Selectivity: 3kHz nominal bandwidth at 6dB and 7kHz at 60dB down.

**$395.00** Cat D-2850

## DELUXE FRG-7000

**WADLEY LOOP COMMUNICATIONS RECEIVER WITH DIGITAL DISPLAY**

All the features of the FRG-7 plus! This remarkable receiver has a digital display for highly accurate frequency readout, plus a digital clock displaying either GMT or local time at the flick of a switch. The clock also allows you to turn the receiver on at a later time so you can record a program you might otherwise miss! In addition, this receiver covers all of the MF & HF bands – down to 0.25MHz and up to 29.9MHz. (Note: because of the digital display this receiver needs to be operated from 240V AC – but can be operated from 12V if you wish).

**$625.00** Cat D-2848

## BONUS!

Every purchaser of the FRG-7 or FRG-7000 will receive, as a bonus, a copy of Dick's exclusive booklet, written by world-famous short-wave and broadcasting authority Art Cushen, MBE. This explains all the controls of the receiver in detail, and how to get the most out of your short wave listening. It is available only from Dick Smith.

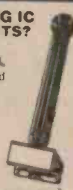
## NEW! INCREDIBLY LOUD AUDIO ALARM

You've got to hear this to believe it! It's ear shattering! Nominally rated at 9 volts, operates from around 5 to 25 volts.

Cat L-7024 **$4.95**

## BUILDING IC PROJECTS?

Use this IC insertion tool. Saves ruined MOS ICs, suits all DIP packages. Plunger action



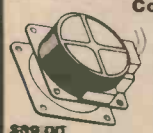
**$4.95** Cat T-4640

## AMATEURS

**Don't forget: Dick Smith will better any genuine Australian advertised price on Yaesu!**

## RUNNING A BIT HOT?

**Cool things down with a quality Yaesu fan**



And you save nearly $10.00! We've dropped the price – you reap the benefit! 100 volt fan (use tap on transceiver transformer, or series C direct off 240 volt), approx. 100mm mounting clearance. Keep your gear running cool – and happy! (This fan is also used in the new ETI466 200/300 watt amplifier modules). Cat D-2865

~~$39.00~~ **$29.50**

## NEED BIGGER FEET?

**YAESU FL2100B LINEAR AMP.**

**$599.00**

This superb Yaesu linear covers all HF bands, and is rated at a massive 1.2kW (so at maximum legal power it's just coasting – no stress, no problems!) Beautifully made for years of reliable service. Finals are rugged 572B's in grounded grid. Features front panel adjustable SWR meter, too. Every ham should have one! Cat D-2546.

## YAESU OPTIONS:

**MEMORY UNIT** Suits 901/101, allows split frequency operation, remembers QSY or other popular frequencies, etc. Very easy to fit. Cat D-2858 **$149.50**

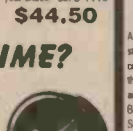
**DC–DC Converter** Suits 101/901; allows operation from 12 volts DC in the field. Very handy for DXing, etc. Cat D-2856 **$75.00**

**YD148 DESK MIC** Dual impedance, suits just about any transceiver. 600 ohms and 50k. Has push-to-talk with lock-down bar for long rag chews. 'Professionalese' your shack! Cat C-1118 **$44.50**

## WHAT'S THE TIME?

You can tell at a glance what the time is in any area in the world with this highly accurate time clock by Yaesu. Rugged 24 hour movement, designed to withstand shock, and will keep correct time mounted at various angles. Uses one UM-21 5V battery with a life of approx. one year.

**$37.50** Cat X-1054

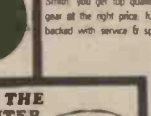


How many times have you been working on a circuit and needed a specific resistor? Our new resistance wheel, dials up the value you want! The handiest thing in your workshop or toolbox!

**IDEAL FOR THE EXPERIMENTER**

5 ohms to 1 megohm in 38 steps

Cat Q-1410 **$5.95**




## 1980 ARRL H'BOOK

The all-new 1980 ARRL 'bible'. The Radio Amateur's Handbook, is now available. With new sections, new data and new features, this is one volume that every amateur and aspiring amateur should have. Cat B-2218

**$15.95**

## ARRL ANTENNA ANTHOLOGY

Cat B-2205

**$6.25**


A collection of the best antenna articles from the ARRL's monthly journal, 'QST'. 151 pages of the latest antenna designs, theory, practices, etc.

A must for the serious amateur operator.

## HERE IT IS!

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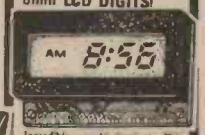


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An artist's impression of an SBS satellite. Note the concentric cylinders of solar cells and the dish reflector which produces the strongest signals in the densely populated east and west regions of the USA, marked in white. (Courtesy Hughes Aircraft Co., California).

# Satellite business systems

**Brian Dance**

Businesses in the USA will shortly have communications facilities unrivalled by any existing system — provided by a satellite system owned and operated by a business consortium.

BY THE EARLY 1980's the United States will have a satellite communications system able to carry signals anywhere across the 48 contiguous states using relatively small antennae mounted on the top of the users' office blocks. The system will cater for high speed data, voice communications, facsimile and even teleconferencing communications, but all signals will be digitised.

Special features of the Satellite Business Systems (SBS) equipment include the use of 12/14 GHz frequency bands (K-bands) and direct access to the satellite by large scale users of the telecommunications services. Initially it is planned that two specially designed satellites will be placed in geosynchronous orbit by late 1980 so that the commercial service can commence in January 1981. A third satellite will act as a spare on the ground. Special techniques will be employed to enable the maximum information carrying capacity to be obtained from the system.

## SBS

Satellite Business Systems was established in December 1975 as a partnership amongst its wholly owned subsidiaries Aetna Life and Casualty, Comsat General Corporation and International Business Machines; it is the successor to the CML Satellite Corporation. The SBS offices are situated at 8003 Westpark Drive, McLean, Virginia, 22102, USA and this organisation will manage the whole system.

Satellites and the associated Earth stations are now big business. Satellite Business Systems awarded the Hughes Aircraft Company a 63 million dollar contract to build the three satellites, whilst the Japanese Nippon Electric Company will share the production contracts for the Earth stations with Hughes Aircraft Company.

## The satellites

The SBS satellites being manufactured by Hughes Aircraft Company are spin-stabilised craft of the same basic design as that used for Canada's Anik C communications satellite. They have been designed to be launched by NASA using either the Space Transportation System (STS – also known as the Space Shuttle) or by a Delta 3910 booster rocket. The first launching is scheduled for mid-1980 using the Shuttle.

The two satellites which will be placed in orbit in late 1980 will provide complete "in-orbit" redundancy and, with the ground based spare ready for launching whenever it is needed, the system will provide complete reliability for US internal communications. The operational satellites will be placed in a geosynchronous orbit about 36,000 km above the surface of the Earth; at this altitude they can be made to rotate around the Earth once every 24 hours. As the Earth itself is rotating at this same rate, the satellite remains almost stationary above the same point on the Earth's surface. Thus the satellite's rate of rotation is synchronised with that of the Earth – hence the name 'geosynchronous orbit'.

In order to permit the use of small, economical Earth stations, it is desirable that the satellite shall transmit signals at relatively high power. This power can only come from the solar cells which transform the energy of the sunlight falling on the cells into electricity. A large array of solar cells is required to provide the relatively high transmitted power. It is very expensive to launch large satellites into a geosynchronous orbit; indeed, the charges for Space Shuttle launching are proportional to the length of the payload bay used to accommodate the satellite.

In order to minimise the space required in the transport vehicle, the SBS satellites will use deployable solar cell arrays. Two concentric cylinders of solar cells are used, one of slightly larger diameter than the other. During the launching phase the one cylinder fits over the other, but they are deployed in orbit so that all of the solar cells can receive the sunlight. In addition, the antenna is a folding type so that it can be folded over the solar cell drums during the launching phase. This technique enables the height during the launching to be reduced to 282 cm, whereas the height of the satellite in orbit is 550.4 cm. The diameter is 216 cm both at launch and in orbit. An improved type of solar cell has been used for this type of satellite so that when the solar cell cylinders are fully deployed in geosynchronous orbit a total of 914 W of power is available.

The weight of an SBS satellite is ▶

about 1057 kg at launching using the Shuttle, whilst with a Delta 3910 launch the spacecraft has this same weight after its injection into the elliptical transfer orbit by the perigee motor which is part of the payload assist module (PAM). After the apogee engine has been fired, the weight of the operational satellite falls to 549.9 kg; of this weight, 96 kg consists of propellant for use in orbit.

## Communications systems

The SBS satellites will operate using an up-link from the Earth in the 14 GHz band and a down-link from the satellite in the 12 GHz band. These frequencies are much higher than the normal ones of 6 GHz and 4 GHz, but the use of the higher frequencies will enable reliable communications to be maintained with the satellites even when the Earth stations are in urban areas, where the use of lower frequencies might cause interference to terrestrial systems or to other spacecraft.

The SBS satellites are spin stabilised so that they remain stabilised like a spinning gyroscope. It is therefore necessary to mount the antenna and reflector on a "de-spun" shelf so that the direction of the transmitted and received beams is always towards the USA. This same technique has been used in the current Intelsat IVA international communications satellites, but the Intelsat V craft will not be 'spinners'.

The communications repeater system on board the SBS satellites employs 20 W multicollector travelling wave tubes in each channel. The antenna gain in the direction of the primary eastern zone coverage area allows a minimum signal strength of 43.7 dBW to be obtained in this region. Each satellite will have ten transponder channels, the bandwidth of each channel being great enough for data rates of up to 43 megabits per second to be employed.

**Table 1. Channel frequencies to be used by the SBS system**

| Channel number | Frequency (GHz) Uplink | Downlink |
|---|---|---|
| 1 | 14.025 | 11.725 |
| 2 | 14.074 | 11.774 |
| 3 | 14.123 | 11.823 |
| 4 | 14.172 | 11.872 |
| 5 | 14.221 | 11.921 |
| 6 | 14.270 | 11.970 |
| 7 | 14.319 | 12.019 |
| 8 | 14.368 | 12.068 |
| 9 | 14.417 | 12.117 |
| 10 | 14.466 | 12.166 |

The receivers used in the satellites will employ gallium arsenide (GaAs) FETs in the input stage which have a 4 dB noise figure. The 20 W multicollector transmitter tubes will be supplied by AEG-Telefunken of Germany.

In order to optimise the satellite's performance, various parameters must be closely monitored. These include its general communications performance, its orientation to the Earth and to the Sun, its thermal condition, its power subsystems, its batteries and other subsystems.

The SBS satellites will carry rechargeable batteries. These batteries will enable the performance to be unaffected by the eclipse of a satellite from the Sun as it passes through the shadow of the Earth.

The costs of manufacturing and launching a satellite are enormous. Therefore great precautions must be taken to ensure that the probability of failure is as small as possible. Each SBS satellite will contain one active receiver and three spare wideband receivers. In addition, it will contain 16 travelling wave tubes, one for each of the down-link centre frequencies shown in Table 1. These tubes are arranged so that it will require the failure of at least four of the tubes before one of the active channels can no longer be operated.

## Earth stations

The main difference between the SBS system and all existing satellite communications systems is the use of relatively small Earth stations which will often be situated on the user's premises. Reliable, unattended operation of SBS Earth stations will be obtained by the use of high quality components and system redundancy which, in the case of component failure, will switch in a correctly working unit.

The components of an SBS Earth station will include:

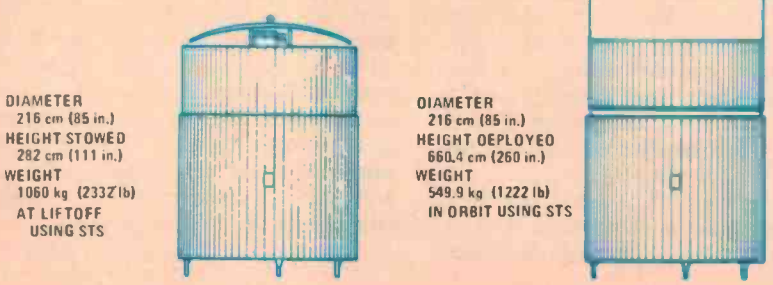
(i) The radio frequency terminal which will provide the transmit and recieve functions and the frequency translations between the 14 GHz and 12 GHz transmit and receive frequencies and the 70 MHz interface with the TDMA Burst Modem.

(ii) The TDMA Burst Modem. Time Division Multiple Access (TDMA) will be employed by the SBS system to enable the available time to be shared between various users. This greatly increases the signal carrying capacity of the system. The TDMA Burst Modem performs the modulation, demodulation and associated functions which enable bursts of digital information to be transmitted through each of the satellite communications channels on a time-shared basis.

(iii) The Satellite Communications Controller (SCC). This is a highly integrated system containing processors, storage units and control programmes. It performs the essential TDMA, Demand Assignment (DA) and other control and processing functions, as well as analogue/digital conversion of voice and any similar signals.

(iv) The Monitor and Command Loop which enables remotely located SBS System Management Facilities (SMF) to determine the status

*Figure 1:* **The solar panels of SBS satellites can be telescoped into each other and the aerial folded over to greatly reduce the height at launch.**



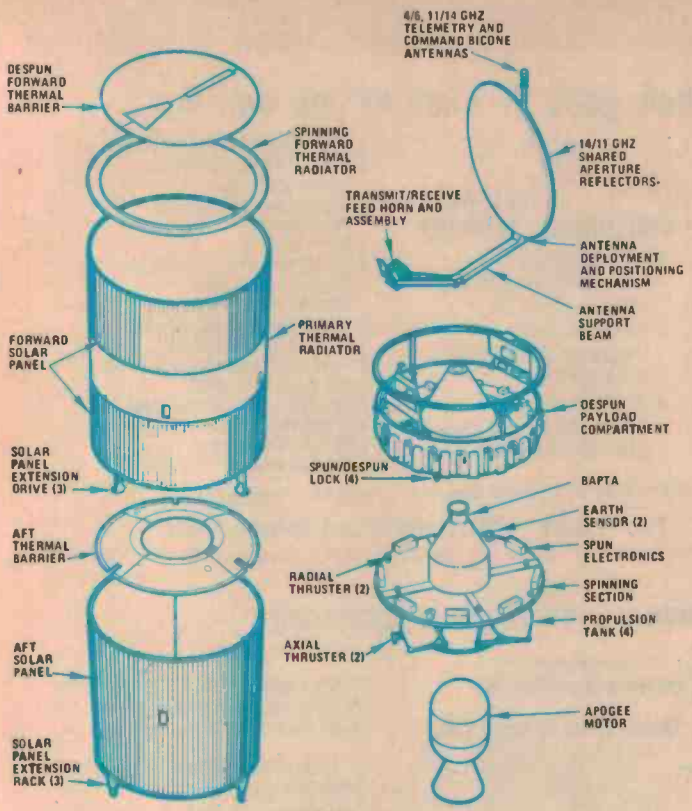



*Figure 2:* The components of an SBS satellite shown separately.

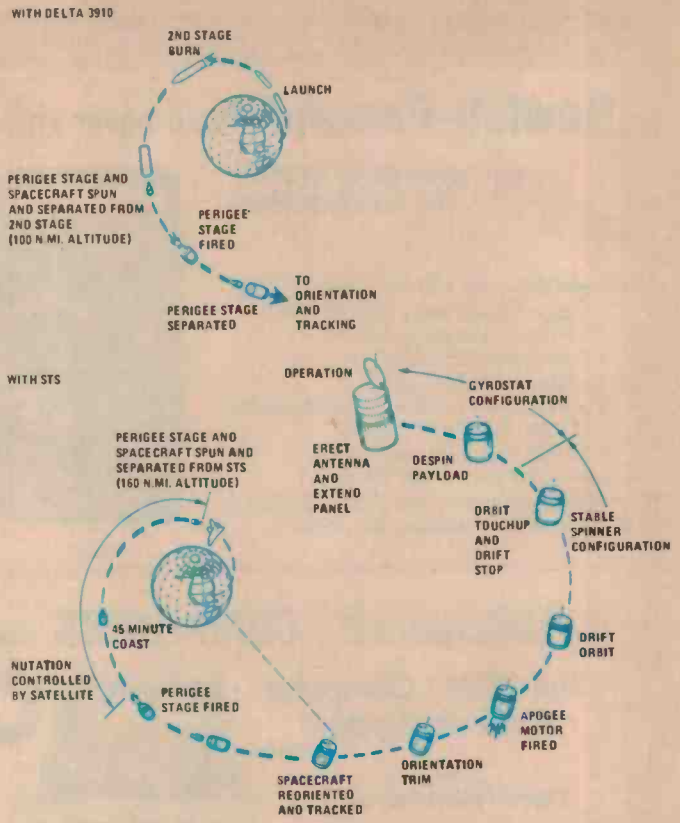



*Figure 3:* It is hoped to launch the SBS craft using the Shuttle, but as the Shuttle may not be available early enough for the first launchings, provision has been made for a rocket launch. In both cases the satellite will take up a geosynchronous orbit.

and health of the Earth station equipment and to issue diagnostic and corrective commands.

(v) The Port Adapter System (PAS) which provides a compatible interface between the SCC and the various customer connecting facilities.

It can thus be seen that the equipment required for each Earth station is quite complex and one can understand why cost estimates of US$313,000 have been made for a five metre station (including $194,000 for the radio frequency equipment) and $392,000 for seven metre stations (including $273,000 for radio frequency equipment).

## General considerations

The SBS system has been specifically designed to meet the requirements of a large community of business users, government organisations and various others who require communications facilities on a regular basis. It is expected that the greatest benefits will be obtained by those customers of SBS who have the need for communications between widely dispersed premises. A typical network for a company might consist of 15 to 25 Earth stations spread throughout the USA.

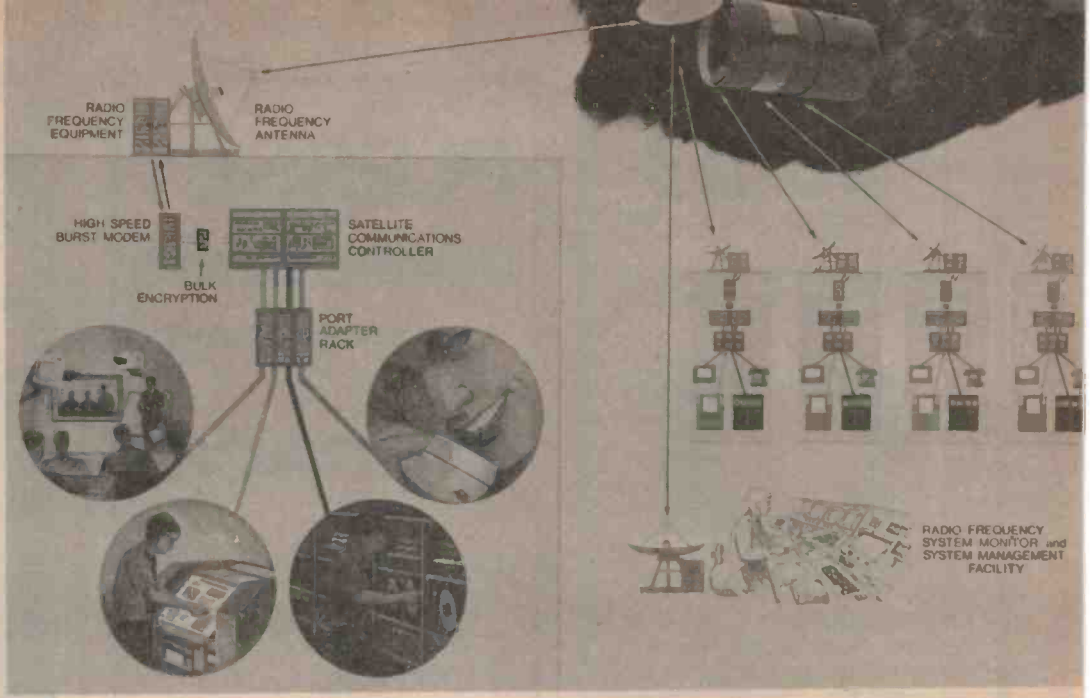
One of the SBS satellites will be ▶

**Table 2. Satellite data**

| Satellite characteristic | Type or value |
|---|---|
| Launch vehicle | Shuttle or Delta 3910 rocket |
| Launch date | 1980 |
| North-South station keeping | ±0.05 degree, maximum |
| East-West station keeping | ±0.05 degree, maximum |
| Eclipse capability | 100% |
| Redundancy | 100% all elements except 60% for travelling wave tubes |
| Total communications r.f. power | 200W |
| Communications EIRP per transponder (Minimum values) | Region 1 43.7 dBW Region 2 41.7 dBW<br>Region 3 40.0 dBW Region 4 37.0 dBW<br>Region 5 38.0 dBW Region 6 39.0 dBW<br>Los Angeles 41.2 dBW San Franscisco 42.0 dBW |
| Communications Receiver G/T (Minimum values) | Region 1 +2 dB/K Region 2 0 dB/K<br>Region 3 −2.5 dB/K Region 4 −5.5 dB/K<br>Region 5 −4.5 dB/K Region 6 −5.5 dB/K<br>Los Angeles −0.3 dB/K San Franscisco +0.5 dB/K |
| Communications polarisation | Transmit: linear horizontally polarised<br>Receive : linear vertically polarised. |

**Table 3. Communication antenna characteristics of earth stations**

| Characteristics | Regions 1 and 2 | Regions 3 to 6 |
|---|---|---|
| Type | Parabolic | Parabolic |
| Nominal size | 5 metre | 7 metre |
| Mid-band gain (dB) | | |
| Receive | 53.8 | 56.7 |
| Transmit | 55.3 | 58.2 |
| Polarisation | | |
| Receive | Horizontal | Horizontal |
| Transmit | Vertical | Vertical |
| Tracking mode | Fixed | Command track |
| G/T | 30.4 dB/K | 33.3 dB/K |
| Mid-band Eirp | | |
| Main beam | 79.8 dBW | 82.7 dBW |




**Overall view of how the SBS system works. Video, facsimile , computer data and speech may all use the communications facility of the SBS satellite. (Courtesy: Satellite Business Systems).**

able to carry information equivalent to about 12,000 simultaneous telephone conversations. In addition, it is very easy to interconnect any number of points using a satellite, whilst the direct interconnection of only 12 cities in a terrestrial network can require 66 separate land-based links.

Earth stations will interface with interconnecting facilities to customer provided PBXs, foreign exchange lines, data terminals and other equipment. Customer locations and equipment which are in the same premises as the Earth station may be connected via internal cables, whilst locations which are remote from any SBS Earth station can be connected by existing terrestrial facilities.

It seems likely that the digital code to be used will be a 32 kbits per second syllabically companded delta modulation system which can provide an excellent performance and which can enable very efficient utilisation of the satellite's communications capability to be obtained. When the SBS system is fully developed, digital data services will be provided at a variety of data rates from 2.4 kbits per second to 6.3 megabits per second.

## Bit error rates

The SBS TDMA Burst Modem has been specified to maintain synchronism up to a bit error rate of at least $1 \times 10^{-2}$, whilst the radio frequency links have been designed to provide a bit error rate of $1 \times 10^{-4}$ or better for 99.5% of the time. (For 95.0% of the time, the bit error rate will not exceed $1 \times 10^{-6}$, whilst a maximum bit error rate of $1 \times 10^{-2}$ will occur 99.9% of the time). The results of subjective testing of a 32 kbits per second delta modulation voice modem indicate that good voice quality will be obtained with bit error rates of $1 \times 10^{-2}$, so it is expected that excellent voice quality will be obtained using the SBS links.

The customer will be able to pay for even lower bit error rates for digital data transmission if he so wishes. The Satellite Communications Controller can apply forward error correction (FEC) coding to the digital information ports for which the customer has exercised the option. This will result in a bit error rate of $1 \times 10^{-7}$ or better for 99.5% of the time using a coding rate of approximately two-thirds.

The capacity of an SBS satellite expressed in terms of the number of voice circuits it can carry is a complex function of the bit rate per voice channel, the effectiveness of the voice activity compression (VAC) algorithm, the overhead of the TDMA frame format, the number and sizes of the Earth stations served by each satellite channel, the traffic characteristics of each customer network and other factors. However, for one set of assumptions which are believed to approximate to actual traffic conditions, it was estimated that a statellite will provide the equivalent useful capacity of 12,000 voice channels at 43 megabits per second or 14,000 voice channels if the full 48 megabits per second is used at some later date.

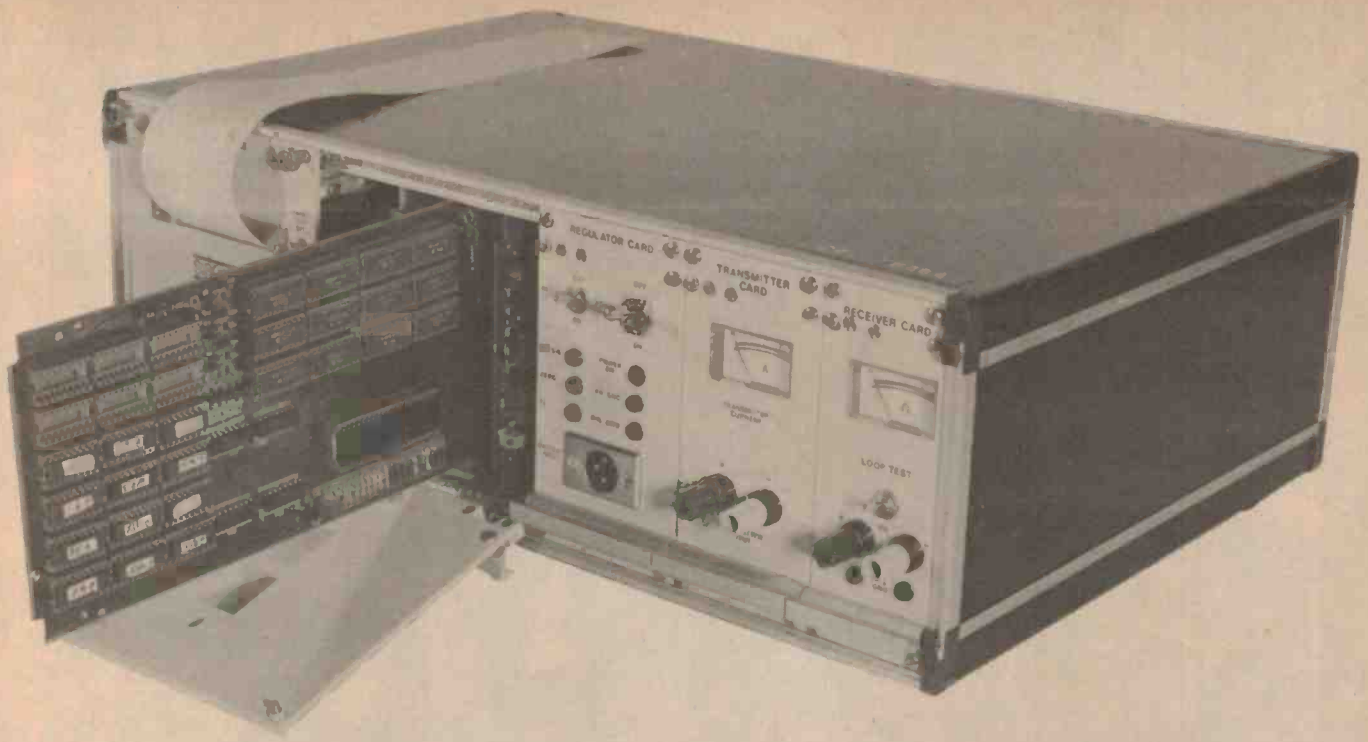
## Conclusions

As long ago as April 1977 SBS began to evaluate equipment performance and to verify system concepts as well as to gain operational experience. Initially SBS operated Earth stations in New York and California sited on IBM premises for test transmissions through the use of an existing domestic communications satellite. Another two Earth stations were then introduced for intra-company communications. Extensive field trials of prototype hardware are now commencing, whilst in 1977 and 1978 SBS carried out tests on the premises of four large firms to evaluate the potential of satellite communications in a business environment.

SBS will offer each company sufficient network capacity to meet its present intra-company communications requirements and sufficient flexibility and capacity to meet future requirements. Normally voice channel traffic will be at a peak during normal business hours, so the channels can be used for any other purposes during off-peak hours.

The estimated costs of the system are divided up in the following way: the developmental costs of the system will be around $96 million on present day values (23.6 % of the whole), the space segment costs including the satellites about $117 million (28.7 %), the smaller five metre Earth stations $105 million (25.9%), the larger seven metre Earth stations some $70 million (17.3%), whilst $8.6 million (2.1%) are required for system management facilities and $9.8 million (2.4%) for spares, etc.

One can only wonder how long it will be before other regions adopt similar communications systems. Europe is likely to follow the USA fairly quickly, but it may be somewhat longer before the more sparsely populated regions such as Australia find that it is economically sensible to invest in such communications systems. ●




# SIROTEM — Australian geophysical instrument wins world market.

Developed by two Australian researchers working in the CSIRO, this geophysical prospecting instrument has rapidly won both acclaim and commercial acceptance within a relatively short period after production prototypes were released.

AUSTRALIAN mineral survey teams have it tough by anyone's standard. Their prospecting is done in the arid inland, in remote areas and in blistering heat. They search for ore bodies which are hundreds of metres below the surface under a crust of ancient salty soil and rock. Virtually all the ore bodies which break the surface have already been found, and this old and weatherbeaten continent is holding her remaining minerals close and deep. On a scale of difficulty, in human and mineral terms, exploration in Australia poses more problems than anywhere else in the world.

Although the modern prospector, or geophysicist, relies heavily on instruments, the instruments themselves pose even more problems. In survey work geophysicists choose from several types of devices to search for ore bodies hidden from view under the ground. One class of instruments are based on the fact that ore bodies are frequently very good conductors of electricity.

A number of imported instruments were used in Australia in the sixties and seventies, but Australia's salty soil and the fact that ore bodies were covered by thick layers of conductive material meant that the performance of the instruments was not good.

One device imported from Russia gave the best performance in Australia, but still left a great deal to be desired. It could not "read through" the conductive overburdens common in Australia. The saline soil and oxidised rocks confused the readings, and it did not perform well in the heat of the Australian outback.

At this point, in 1972, the CSIRO Division of Mineral Physics tackled the problem of coming up with a device which would be better suited to Australian conditions. Dr Jock Buselli and Mr Brian O'Neill took on the task.

Dr Buselli, a former space scientist and Mr O'Neill, a former radar engineer, had a wealth of experience in similar problems and by 1973 had evolved new concepts which dramatically improved performance compared to the Russian instrument.

The only snag was that a small computer was needed to sort out the signals, and computers, even small ones, were not suitable for mining exploration trips. Fortunately, it was about this time that the first reliable microprocessor came on the market, which meant an envelope sized circuit board could replace a 20kg computer.

The next few years were spent in ▶

SIROTEM in the field.

sorting out all the interfering noises which prevented a clear signal being received from the ore body. These problems were eventually solved by Dr Buselli and Mr O'Neill after many months of laboratory bench work and equally demanding field evaluation trips.

During this period the research team received advice and assistance from five mining companies; WMC, BHP, Carpentaria, North Broken Hill and Pacminex, through the Australian Mining Industries Research Association. The assistance was largely financial, but also included practical advice and the provision of test sites for the CSIRO-designed instrument, called SIROTEM.

Exhaustive testing was carried out in Western Australia, the Blue Mountains of NSW, Mt Isa, and at Cobar in NSW as well as other test sites. SIROTEM was also taken to Canada and Russia for field trials and further evaluation.

All told, CSIRO spent 13 man years in the highly complex task of developing and testing SIROTEM, so that it would be equal to the task demanded by mineral exploration conditions in Australia.

Despite its sensitivity and selectivity, the instrument and its batteries weigh only 18 kg and can be carried on a back pack. This means it can be taken into the most inaccessible areas, and there are plenty of them in Australia. It consists of a control box containing a microprocessor and printer. This is attached to a flexible wire loop up to 400 metres in circumference.

SIROTEM operates on the same basic principle as earlier instruments — that ore bodies conduct electricity. An electric current is passed from the control box around the wire loop and then cut off rapidly. If an ore body is under the loop, an electric current is produced in it by induction and this will then decay away in a small fraction of a second. SIROTEM detects the very small magnetic fields from these currents. From these and other readings at adjacent loop positions a "picture" of the ore body below can be built up.

Test drilling based on this interpretation is the next step in the exploration process. Samples are taken from the ore body and the surrounding material for a more accurate assessment of the content of the ore.

The SIROTEM licence was granted to Geoex from CSIRO in October 1977. In that same month Geoex exhibited a prototype version of the instrument at the "Exploration '77" Conference in Ottawa and a considerable amount of interest was generated.

A production prototype instrument was produced in March 1978 and the first two production units were delivered to Geoex from sub-contractors in June. Geoex then took SIROTEM to the United States for demonstration trials and subsequently to the European Association of Exploration Geophysicists Conference and Exhibition in Dublin in June 1978. It was then sent to Djakarta where it was displayed at a mining equipment display in the Australian Trade Commission's showrooms.

In October 1978 another SIROTEM instrument was taken to the United States, where successful field trials were conducted in order to provide case histories of North American situations for display at the Society of Exploration Geophysicists Convention in San Francisco at the end of that month. After display at this exhibition, it was taken to Toronto, Canada and subsequently to Finland where surveys were conducted north of the Arctic Circle in temperatures of −5°C.

Since the granting of the licence, Geoex has operated at least one SIROTEM survey crew continuously on contract work, first with the prototype instrument and subsequently with one of the new production instruments. Recently two production units have been in use.

The first production run of ten units was sold out by March 1979. Two units have been sold to BHP and sales have been made to the Institute of Geological Sciences in Great Britain, the University of Lulea, in Sweden and a private company in Finland. The United States Geological Survey has ordered the first of the new production run and there are many other opportunities for contract work in North America, South Africa and Scandinavia.

To date the marketing program for SIROTEM has concentrated on areas where sales are most likely to be immediate. It is now at the stage of

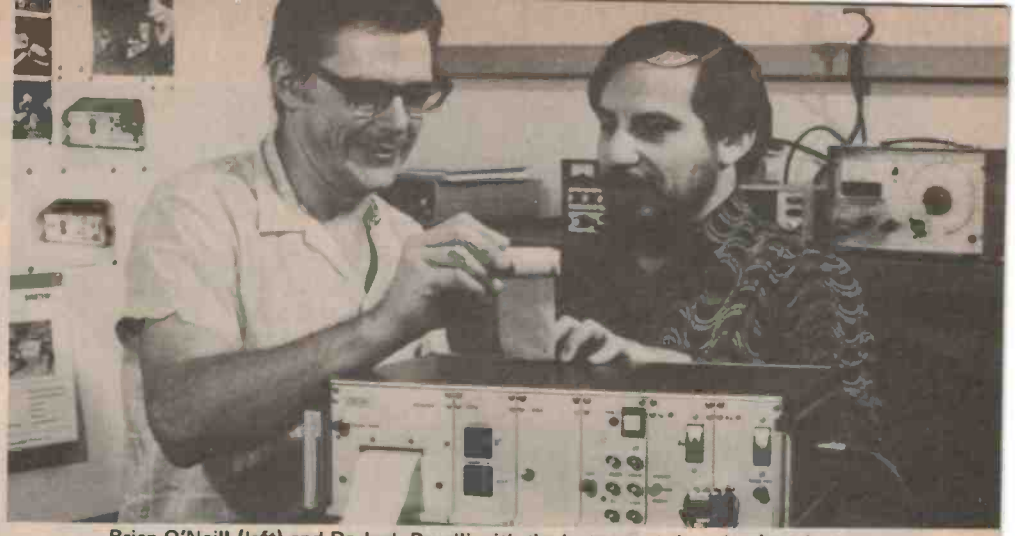
branching into other territories such as South Africa, South East Asia and the Middle East.

Apart from its use in Australia, SIROTEM is now being used to explore for uranium-associated sulphides at a depth of 300 metres in the arctic winters of central Canada. It has also been used in Scandinavia to explore for minerals under the sea during winter, when the equipment can be set up on the sea ice.

SIROTEM is being used in the search for copper, nickel, lead and zinc sulphides, which are now increasing in value, and indirectly for uranium when associated with for example, conductive shales. It has also proved useful in coal and oil shale exploration by defining basin configuration.

According to Geoex it can be used in any case where resistivity mapping is of value, such as detecting geological contacts concealed by other rocks. Artesian and fresh water searches are also possible in much the same way.

Although this instrument can be used for mapping configurations which lead to a better assessment of the possibility of ore deposits, there are some limits on its use. For example, it cannot be used like a metal detector, to find gold or iron ore deposits. Gold occurs in relatively small quantities in its natural state and is quite often heavily insulated by quartz. SIROTEM is designed to find larger bodies, and although the same principle in a scaled down instrument can be used to find small quantities of gold, it works on too large a scale for gold prospecting. The gold nugget would need to be something approaching 10 metres in size in order to be detected! Iron ore in its natural state poses particular conductivity problems and makes a poor target for SIROTEM.



Brian O'Neill (left) and Dr Jock Buselli with the instrument they developed.

According to Geoex, SIROTEM has set new standards in terms of the speed with which the production instruments were accepted by the market – less than nine months after being granted the licence to manufacture, and less than six months from the construction of the first production prototype. It has been named as one of the IR-100 award winners – prestigious awards made by an American publishing company for achievements in science and technology.

SIROTEM has already claimed many national and international firsts, but as the search for minerals steps up in the years ahead it seems certain to continue to enhance its reputation in the highly competitive area of exploration technology. ●

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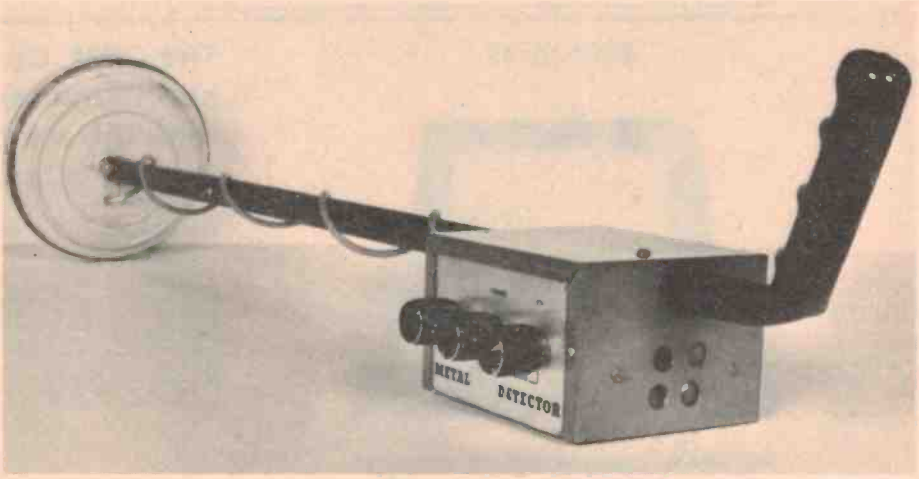
Project 561

# Simple, sensitive metal detector

**Phil Wait**

The metal detecting hobby is enjoying quite a boom at the moment and treasure hunters are not just after gold. Though the price of the precious metal has fallen in recent months, at around $600 an ounce it's worth going after. Old coins and relics fetch high prices too, so there's lots to find out there . . .




METAL DETECTORS depend on detecting one of several effects that can be observed when a metal object influences the magnetic field surrounding a coil of wire carrying an alternating current. The principal effects are: the pattern of the magnetic field surrounding the coil will be altered and the inductance of the coil will change.

The various types of metal detector devised exploit these changes, electronically detecting the alteration induced in the coil by the metallic object. Non-metallic objects or material can also affect the coil in similar ways.

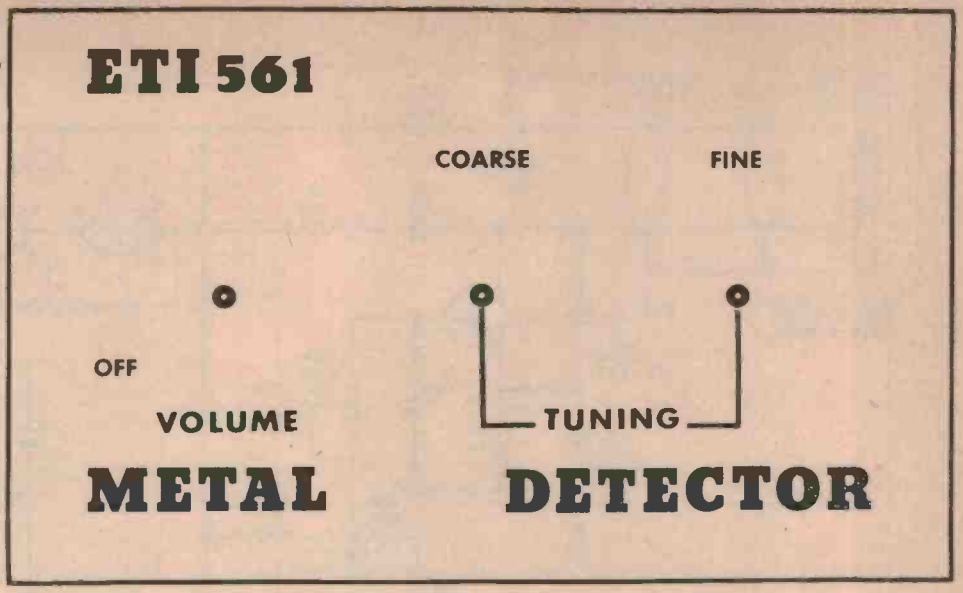
There are three basic methods employed to exploit the above effects. "Induction Balance" (IB) metal detectors employ two coils. One is driven by a modulated oscillator. The other is connected to a detector and amplifier. The two coils are carefully positioned with respect to one another such that the receiver coil picks up very little of the energy radiated by the transmitter coil when no metal or mineral material is nearby. When the coils are brought near a metal object, the field pattern is distorted, greatly increasing the transmitted energy picked up by the receiver coil. The modulated signal is detected and can be indicated by amplifying the recovered modulation to speaker level as well as indicating it on a meter. For obvious reasons, this type of metal detector is often referred to as a "transmit-receive" or TR detector, sometimes as an IB/TR detector. Chief advantages are good pinpointing ability and good depth penetration, and they are not sensitive to small ferrous objects. Sensitivity suffers badly in mineralised or ironstone ground. We described an IB/TR metal detector back in our May 1977 issue (Project 549) and it is still a popular project. The problem for the home constructor lies in correct construction and alignment of the coils.

Most IB detectors operate at a frequency between 85 kHz and 150 kHz. As they are badly affected by mineralised ground a technique was developed using very low frequency to energise the transmit coil. The 'VLF' types operate at frequencies around 4 – 6 kHz, a frequency range which penetrates all types of soil quite well. However, they need to run at a fairly high power to achieve sufficient sensitivity with small objects, hence battery drain is quite high, and pinpointing ability is poor.

"Pulse Induction" detectors employ coils in the search head that are set up in much the same manner as the IB detector. However, the transmitter is pulsed so that high energy bursts are transmitted by the search coil. The receiver then compares the phase of portion of the received pulse with the transmit signal. When a ferrous or magnetic object is brought near the search coils the phase of the received signal is *advanced* with respect to the transmit signal. The *opposite* occurs when a non-magnetic conductor is brought near the search coils. Thus, this type of detector can effectively 'discriminate' between ferrous and non-ferrous metals as well as exclude ground effects – simply by setting the detection circuitry to exclude signals of the unwanted phase characteristics. Thus, a "Ground Exclusion" control is often featured with these detectors. As the strength of the received signal also varies, depending on the 'target' object's characteristics, this effect may also be included in the detection process.

**FEATURES**

- Good sensitivity
- Excellent stability
- Good pinpointing ability
- Loudspeaker output
- Simple construction and set up
- Tuning allows for ground
- Low cost




Full size print of the front panel.

Clearly, an IP detector presents many problems to the home constructor.

The simplest technique detects the change in inductance of a single search coil. If this coil is part of the tuned circuit of an oscillator, then comparing the frequency of the 'search' oscillator with a stable reference oscillator will indicate the presence of a metal object. This detector is called the "Beat Frequency Oscillator" or BFO type. The two oscillators are set such that there is a slight difference in their frequencies and their outputs mixed. The resultant will be a 'beat' frequency which is equal to the difference between the two oscillator frequencies. The main advantages of this type are simple circuitry and setting up along with good pinpointing ability. In the past, most published designs have suffered from a distinct lack of sensitivity as well as poor tuning stability. A cunning mixing technique and a few other fillips can overcome these problems.

Hence, our new metal detector is a BFO type incorporating some modern refinements. It has proved to have similar sensitivity to our IB detector, the ETI-549, but is generally easier to build and set up, there being no critical adjustments.

## Design features

Our new metal detector has three controls: COURSE frequency adjust, FINE frequency adjust and VOLUME on/off. The course frequency control is used to initially set the frequency of the search oscillator, compensating for the various factors affecting any drift in this oscillator (mainly temperature and battery voltage). The fine frequency control is then used to set the note to a low pitch when the detector is placed over the ground, permitting compensation for the effect of the ground on the frequency of the search oscillator. The volume control adjusts the loudness of the output from the speaker.

The two main design problems this type of detector presents are the frequency stability of the two oscillators and the minute frequency change which has to be detected.

The search oscillator we finally used was settled on after some experimentation. Our first try employed an LC oscillator built around a CMOS gate chip. This proved to be not as stable as we required and we found that trying to obtain dc control of the frequency by varying the supply rail voltage had drawbacks. After some experimentation with oscillator configurations we hit on a discrete component oscillator which we found behaved much as we were seeking.

The search coil in the circuit we used is the inductor in a Colpitts oscillator. However, this particular circuit may be a little unfamiliar to many readers. To increase the RF current in the coil, it is placed in the collector circuit of Q1. Feedback is between collector and emitter and the base is effectively at RF ground. The frequency determining capacitance of the tuned circuit is 'tapped' to provide feedback, C2 and C3 performing this function. Careful attention has been paid to the basic frequency stability of this oscillator. Good quality styroseal capacitors have been used for C2 and C3. These have a temperature coefficient roughly opposite to that of other temperature influences on the frequency of the oscillator. In general, the short-term stability of this oscillator is quite good.

The particular circuit configuration of the oscillator gave us a very useful bonus – dc control of the oscillator frequency over a small range. Varying the base bias on a transistor will vary the collector-base capacitance. In this circuit, the c-b capacitance is part of the overall 'stray' capacitance that determines the exact frequency of oscillation. As the base bias is increased the c-b capacitance decreases, increasing the oscillator frequency. In this way, the oscillator frequency can be varied over a range of about ten percent. We have provided two controls, the FINE control providing a variation of about one-tenth that of the COURSE control.

The search oscillator is loosely coupled via a 47p capacitor to a following CMOS Schmitt trigger and two inverters which square the output. The loose coupling isolates the oscillator from the subsequent circuitry, further enchancing the stability of the search oscillator.

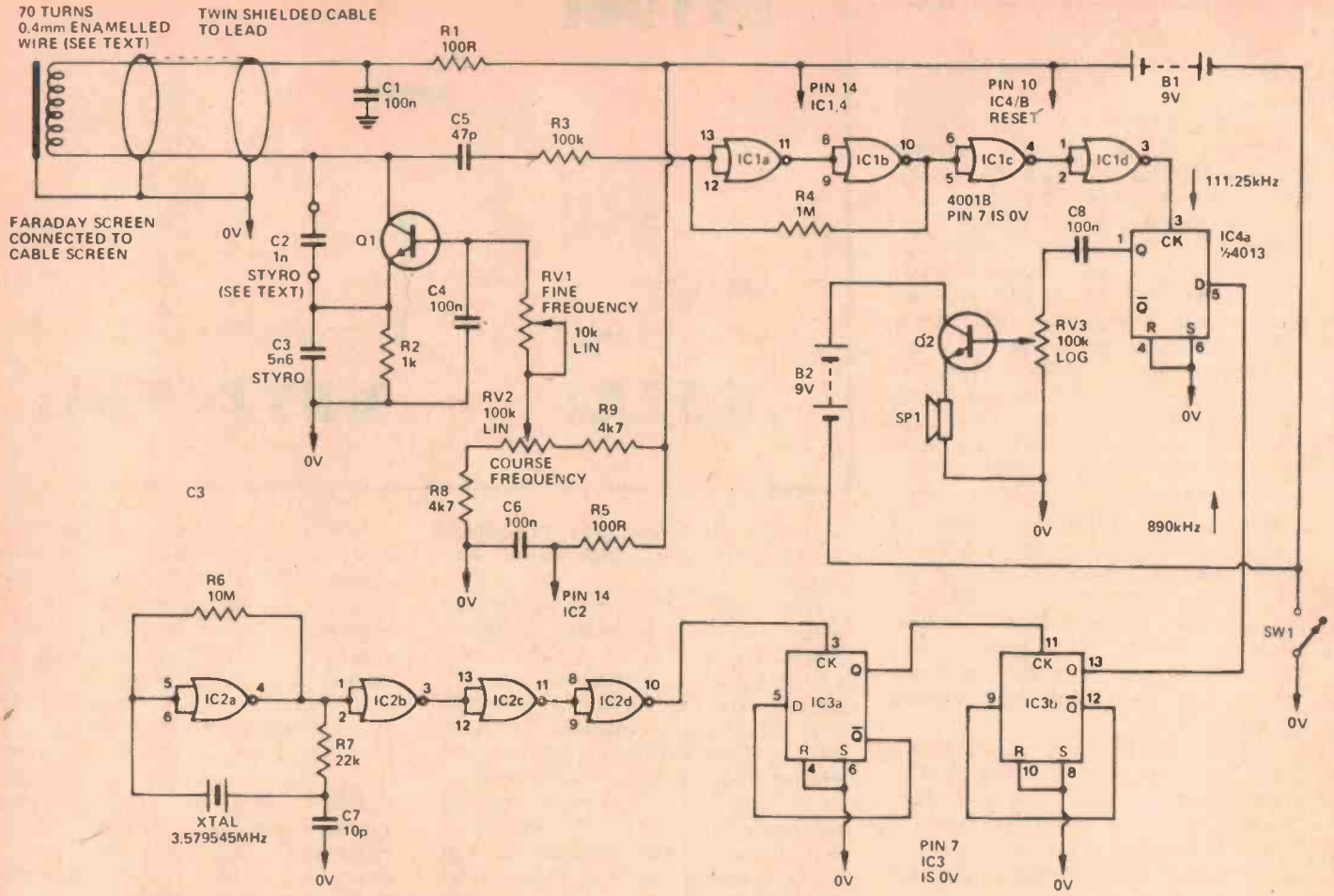
For the reference oscillator, we chose to use a crystal, because of its inherent stability. It has been argued that if an ordinary LC circuit is used for the reference oscillator it will have similar drift characteristics as the search oscillator and the overall drift will be reduced. In fact, the reference oscillator can be made using a standard 455 kHz IF transformer. In practice however, the two tend to drift at markedly different rates. We think the best approach is to make both oscillators as stable as possible. Hence the crystal – which is an easily available type and cheaper than an IF transformer!

The reference oscillator is a simple 'inverter' crystal oscillator built around one gate from a CMOS quad NAND gate, IC2. This has a square wave output and drives a divide-by-four circuit, IC3, via the other three gates in IC2, acting as buffers.

The crystal we used is a 3.579545 MHz type (NTSC chrominance subcarrier frequency) commonly available from a number of suppliers. We used one in our Electronic Tuning Fork (ETI–606) published last November. The output of IC3 is at a frequency of about 890 kHz. The *exact* frequency is unimportant, just so long as it's *stable*.

The search oscillator operates at a little above 100 kHz, about one-eighth of this frequency.

The secret of our metal detector's overall sensitivity lies in the mixer circuit. This employs one section of a 4013 flip-flop. The reference oscillator's divider output (at 890 kHz) is applied to the D input of IC4a and the squared-up search oscillator's output is applied to the clock input. If the clock frequency (i.e: the search oscillator frequency) changes by 1 Hz, the output beat (from the Q output of IC4a) will change by 8 Hz (see 'How it Works'), thus considerably *multiplying* the smallest changes in oscillator frequency. ▶




## HOW IT WORKS · ETI 561 Metal Detector

The beat frequency metal detector employs two oscillators: a very stable reference oscillator and a search oscillator. The search oscillator uses a tuned circuit designed to be influenced by metal or mineral objects which are brought into its field. The two oscillators are adjusted so they are harmonically related and fed to a mixer. When the search frequency is adjusted so the reference frequency fed to the mixer is eight times the search frequency, the output of the mixer is zero. The search frequency is slightly adjusted so that an output appears from the mixer which is the difference between the two input frequencies. This can be adjusted to an audio tone.

When a piece of metal or mineral is brought near the search coil the frequency of the oscillator varies, which in turn varies the output frequency from the mixer. The change in pitch can easily be heard from the speaker.

The reference oscillator employs a crystal in a CMOS oscillator circuit using one gate from IC2a. The resistor R6 biases the gate into its linear region. IC2 b, c and d, are used as buffer stages to prevent oscillator "pulling" and to further square its output waveform. Two flip-flops, IC3a and b, divide the reference signal by four to 890 kHz.

The search oscillator uses a discrete transistor in grounded base configuration, with the search coil in the collector. Using the coil in the collector increases the strength of the field around the coil and hopefully overcomes some of the losses in the ground. Feedback is set by the ratio of C2 to C3 from collector to emitter and their value determins the frequency of the oscillator. The base is grounded at RF by C4.

By varying the bias on the transistor the inter-element capacitances can be varied. This varies the oscillator frequency as the transistor capacitances form part of the 'strays' in the LC circuit. RV1 and RV2 provide fine and course frequency control. The resistors R8 and R9 limit the maximum and minimum voltage on the base to prevent over-dissipation in the transistor or drop-out of the oscillator.

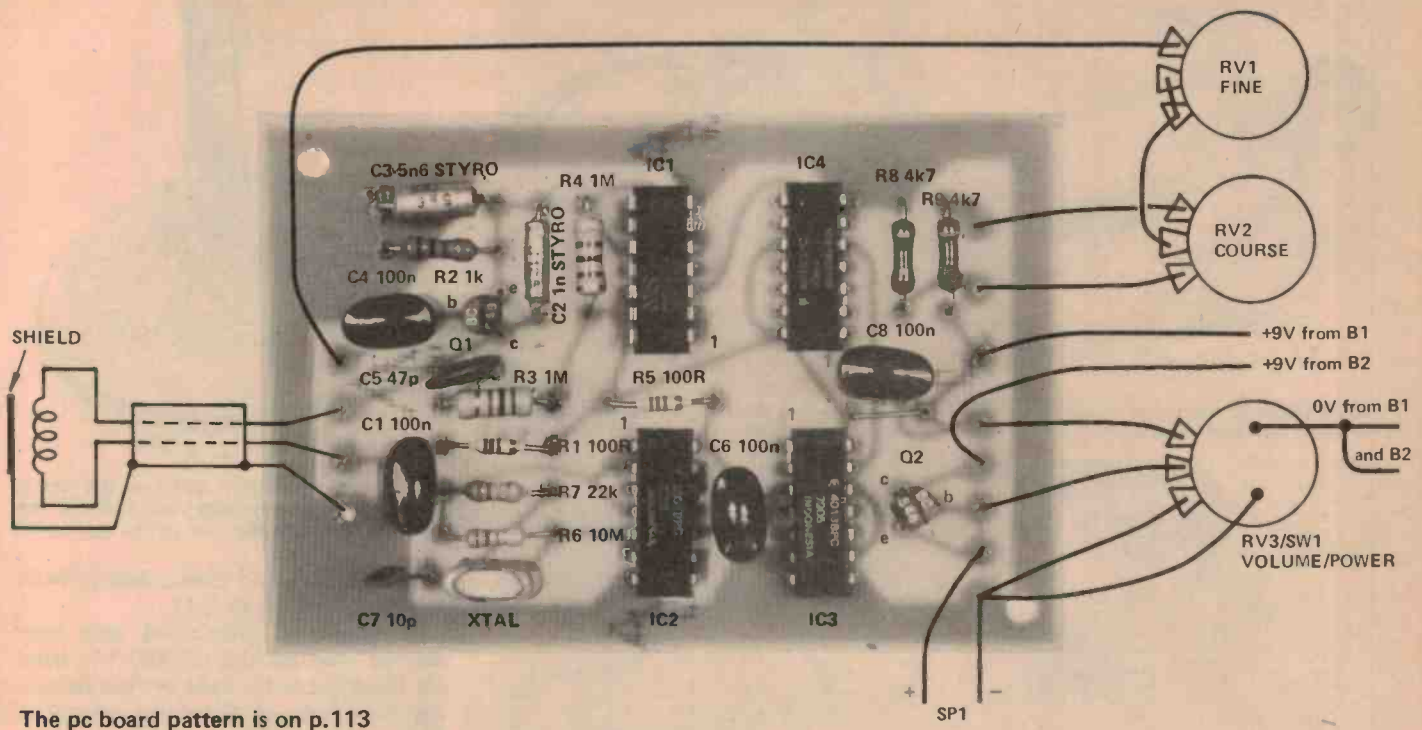
The output of the search oscillator is fed to a Schmitt trigger, consisting of IC1a and b, where it is squared and further buffered by IC1c and d. The search frequency is then fed to the mixer.

Both oscillators are decoupled from each other by supply line decoupling R1–C1 and R5–C6.

The mixer consists of half a dual-D flip-flop. The search and reference frequencies are fed to the clock and D inputs respectively. The flip-flop looks at the reference oscillator (D) on every positive transition of the search oscillator (clock), and transfers this level to the Q output until the next clock transition. If the two oscillators are exactly evenly harmonically related (i.e: 2nd, 4th, 6th, or in our case 8th, harmonic) the D input will always be the same level at each clock pulse. The output from the mixer at the Q pin will always be the same – no pulses.

However, if the search frequency is varied and the D and clock inputs are no longer harmonically related but are changing in phase with respect to each other, after a few clock pulses the D input will no longer be the same – the output will change state. The effect of all this is to produce a chain of square waves at the Q output, the frequency of which is eight times the change in frequency of the search oscillator.

Capacitors C8 and RV2 form a differentiating network which feeds a pulse to the audio amplifier, Q2, for each output transition from the mixer. Each cycle from the mixer produces two pulses in the speaker. If the frequency of the search oscillator is shifted one hertz the output of the mixer changes by eight hertz, producing an output of eight pulses per second in the speaker.




The pc board pattern is on p.113

The output of the mixer is fed to a simple audio amplifier driving a loudspeaker. The search and reference oscillators must be well decoupled from each other and buffered from the mixer stage to prevent 'pulling' of the oscillators, which would result in erratic operation, especially when set for a low frequency output. We have used supply line decoupling as well as buffer stages after each oscillator. We also found it necessary to use a separate battery for the audio stage to prevent the very short, but high current pulses to the audio stage affecting the oscillators.

## The search coil

The most important characteristic of the search coil is its size. Surprisingly enough the actual inductance doesn't seem to have much effect on sensitivity. The greater the coil diameter the greater the penetration depth, but the less sensitive it is to small objects. As a general rule the penetration is about equal to the search coil diameter, while the sensitivity is roughly proportional to the cube of the object diameter (as expressed as a function of the search coil diameter). Sensitivity is also inversely proportional to the sixth power of the distance between the coil and the object.

All this means is that if the object size is halved the sensitivity is reduced to one-eighth. Also, if the depth is doubled the sensitivity is reduced to one sixty-fourth. It's easy to see why all metal detectors which are designed to pick up small objects use small coils, (150 to 300 mm diameter) and really only skim the soil surface. If the search coil is doubled in diameter for greater penetration the sensitivity to small objects falls to one-eighth. You rapidly encounter the law of diminishing returns.

Some of the more expensive metal detectors improve the penetration, while retaining sensitivity, by using a very complex arrangement of coils which modifies the field pattern. This can be done to some extent by making the coil on the BFO detector oval in shape.

We chose a round coil of 150 mm diameter to give good sensitivity to small objects giving about 100–150 mm penetration which is easy to build, but this is open to considerable experimentation. Remember though, that if the coil diameter is increased the number of turns will have to be reduced so that the search oscillator remains at the same frequency (about 110 kHz).

## Faraday shield

If the search coil is moved around, the capacitance between it and the ground ▶

### PARTS LIST - ETI 561

**Resistors** all ½W, 5%
- R1 . . . . . 100R
- R2 . . . . . 1k
- R3 . . . . . 100k
- R4 . . . . . 1M
- R5 . . . . . 100R
- R6 . . . . . 10M
- R7 . . . . . 22k
- R8, R9 . . . . . 4k7

**Potentiometers**
- RV1 . . . . . 10k lin
- RV2 . . . . . 100k lin
- RV3 . . . . . 100k log switch pot

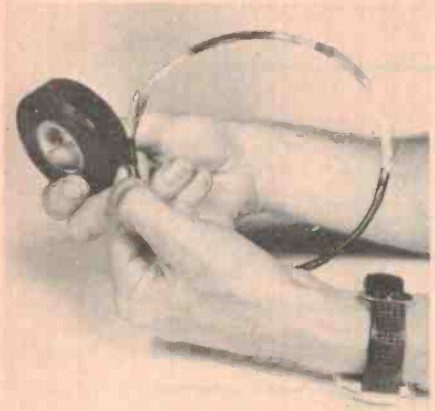
**Capacitors**
- C1. . . . . 100n greencap
- C2. . . . . 1n styroseal
- C3. . . . . 5n6 styroseal
- C4. . . . . 100n greencap
- C5. . . . . 47p ceramic
- C6. . . . . 100n greencap
- C7. . . . . 10p ceramic
- C8 . . . . . 100n greencap

**Semiconductors**
- Q1, Q2 . . . . . BC548, BC108, etc.
- IC1, IC2 . . . . 4001B
- IC3, IC4 . . . . 4013

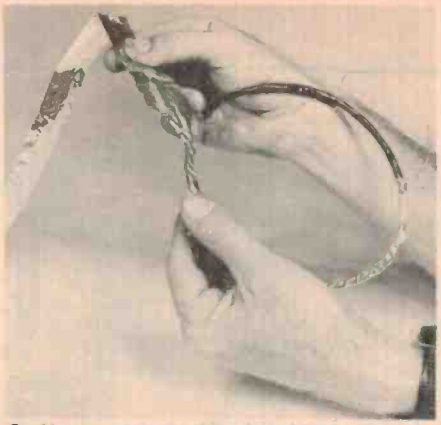
**Miscellaneous**
- SP1 . . . . . 8 ohm speaker
- B1, B2 . . . . . 9 Volt battery (type 216)
- XTAL . . . . . 3.579545 MHz NTSC colour xtal
- ETI-561 . . . . pc board

Length of twin shielded cable, plastic pot stand (approx 150 mm dia), length of steel or aluminium tube (approx 600 mm long, 20 mm dia), length of plastic rod or wood dowel to fit inside pipe (approx 200 mm long), 0.4 mm enamelled wire, aluminium foil, Araldite, box to suit (approx 105 x 125 x 75 mm), three knobs, battery clips, insulation tape, two right angle brackets.

## SEARCH HEAD CONSTRUCTION



1: Having wound the coil as described, wrap it with two layers of insulation tape.



2: Next wind the Faraday shield using two strips of aluminium foil, leaving a break where the coil ends come out.

5: Press the assembled coil into the rim of the pot stand, terminate the wires as described and epoxy the coil to the pot stand.

3: Wind tinned copper wire over the shield, passing the end out where the coil leads pass out.

4: Cover the whole coil assembly with two more layers of insulation tape.

or other objects changes. This changing capacitance 'pulls' the oscillator frequency and can completely swamp out the small change in inductance we are looking for. The coil can be screened from this capacitance effect by using a Faraday Shield around the coil. This consists of a ring of tubing, or in our case – a wrapping of aluminium foil, around the coil but broken at one point so it does not make a shorted turn. This shield is then connected to the common supply rail (OV) on the oscillator.

## Construction

We have deliberately chosen commonly available mechanical and electronic components so that construction of this project is as easy as possible – especially for the newcomer. The search coil is mounted on a 165 mm diameter plastic pot stand which may be purchased at hardware stores and nurseries (if you must know, we used a Decor *497!). The electronics is mounted inside a simple aluminium box attached to a stem made from a length of tube specified for C2 and C3 or performance which extends down to the search coil and serves as the handle. Connection to the search coil is via a length of shielded cable. The controls mount on one side of the box housing the electronics. Which side you mount them depends on whether you are right or left handed. The speaker mounts on the end of the box facing the operator. As can be seen from the picture, the handle was made with an upwards bend at the end which you grip. This balances the instrument reasonably well, avoiding arm strain.

Construction should commence with the electronics. Mount the components on the pc board, taking care with the orientation of the transistor (Q1) and the ICs. Do not substitute another type of capacitor for the styroseal types may suffer. The crystal specified comes with flying leads and may be soldered in place. Don't use too much heat though, solder quickly and you will avoid possible damage to the crystal.

The next step is to make the stem. The easiest way is to take a length of 25 mm diameter electrical conduit about 850 mm long and make a bend about 100 mm from one end for the grip. To do this, heat the point of the bend over a flame (not *in* the flame) until it softens and then carefully bend it about 60° from straight.

A length of aluminium tube may also be used for the handle. The bend for the grip can be made by first flattening the point of the bend somewhat with a hammer then placing the short piece in a vice and carefully making the bend. A section of wood dowel or plastic tube should be placed between the search coil and the end of the metal tube to keep the mass of metal about 200 – 250 mm away from the search coil. A piece of wood dowel of the right size, jammed in the end of the aluminium tube, is generally the easiest way to go about it.

We used a small aluminium box which comes in two pieces. We drilled a hole in either end of the 'bottom' of this box so that it could be slipped over the stem (see accompanying photograph). A nut and bolt was used to secure it to the stem on the side 'below' the grip. The small speaker is mounted in this part of the box, before it is secured to the stem, on the end which faces upward toward the operator. A small hole is drilled in the opposite end and a grommet inserted. This permits entry of the cable to the search coil.

The pc board and controls are mounted to the 'lid' of the box. Position the controls on the side that suits your handedness. Our model was made for right handed operators.

Now for the search coil. This is wound so that it can be tucked inside the rim of the up-turned plastic pot stand. First make a cardboard former of the appropriate diameter. Roll a strip of heavy cardboard around the rim such that it fits loosely and tape or staple it securely (to avoid it popping open at an awkward moment).

Lift the former off the pot stand and

then wind the coil onto this former as per the details given in the parts list. Leave a short length of wire spare on each end to make the connection. Tie the coil up with a few lengths of string at various places and then slide it off the former. Now wind two layers of insulation tape around the coil, leading the two ends out at the same place.

Next, wind the Faraday screen. Cut some aluminium kitchen foil into strips about 15 mm wide and wind this around the coil to make two layers but leaving a small gap about 5 mm to 10 mm wide where the coil ends come out. It is very important that the two ends of the Faraday shield do not connect as this would make a 'shorted turn' and the coil would not work as intended.

To secure the foil tightly around the coil, and to make connection to the shield, wind a length of tinned copper wire around the shield with about a 10 mm pitch (i.e: about 10 mm between successive turns). The end of this wire is taken out at the same place as the coil connections.

Now wind another two layers of insulation tape around the whole assembly. Drill a 3 mm hole in the side of the pot stand and then press the coil down into the rim with the connecting wires adjacent to the hole. Pass the wires through the hole. Pour quick-setting epoxy over the coil to hold it in place.

The search head is mounted to the stem using two right-angle brackets and a bolt passed right through the end of the stem. Small pieces of metal here don't seem to adversely affect the operation of the detector.

Solder the coil connections to the twin shielded cable, the Faraday shield connecting to the cable's shield, and glue the cable and wires underneath the pot stand to hold them rigid. If you wish, the 'underside' of the pot stand may be completely filled with epoxy.

Wind the cable around the stem to keep it mechanically rigid and pass it through a grommeted hole in the box. Terminate the cable to the pc board.

## Using it

When the construction is complete, turn on the detector, advance the volume control and rotate the course frequency knob. You will hear a number of 'heterodynes' or beats, one being very strong. This heterodyne is the one commonly used, the others being odd multiples of the reference signal beating with multiples of the search oscillator. You may find that some of these weaker signals are more sensitive to buried objects than the stronger one.

Set the fine frequency control to mid-range and set the course frequency control to near the strong heterodyne with the search head held away from the ground. Lower the detector to the ground and you will notice a frequency shift. This is the effect of the ground and will vary between different types of soil. Use the fine frequency control to set the beat to a low pitch and sweep across the surface. A metal object will cause a change in the pitch which is clearly audible.

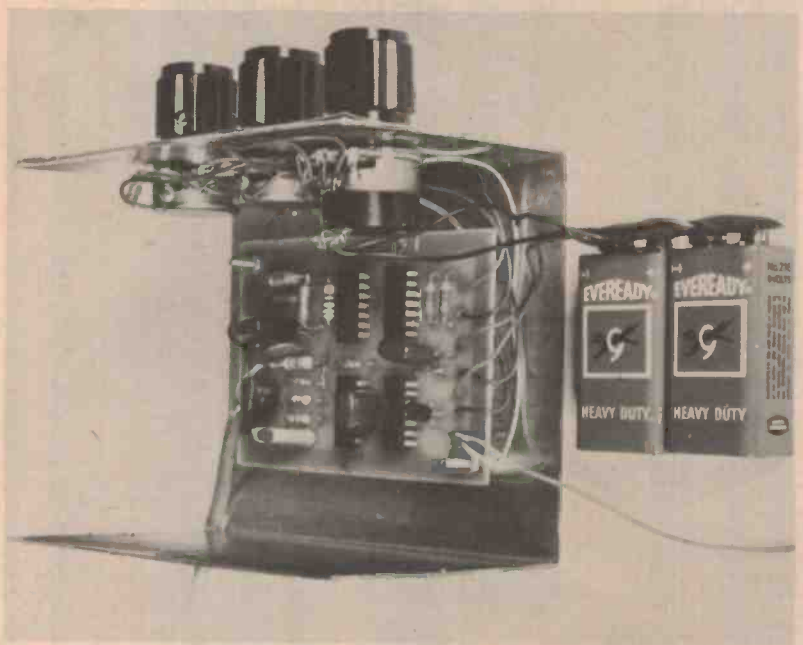
The ear is more sensitive to changes in pitch at low frequencies than at high frequencies and thus it is best to adjust the fine frequency control to a low pitch that can be heard at a comfortable volume from the loudspeaker.

Theoretically, the frequency of the search oscillator should *increase* when a non-ferrous object comes within range of the search coil and *decrease* when a ferrous (or diamagnetic) object is within range. This effect is difficult to detect in practice as eddy currents in ferrous materials swamp the effect and they react much the same as non-ferrous metals. However, minerals such as hematite may show the effect. With the search oscillator set on one side of zero beat, metal objects near the search coil will cause the pitch to *increase*, while magnetic minerals will cause the pitch to *decrease*. With the search oscillator set to the other side of zero beat, the opposite will occur.

You could try a few experiments to show up this effect.

Enough theorising. In general operation, try to keep the search head a constant distance from the ground and sweep from side to side in a regular pattern. The right technique is easily developed with a little practice.

There are a number of books on metal detecting available and these show the sort of techniques the successful treasure hunter employs. ●




**Internal view of the metal detector electronics showing general placement of the major components. We mounted the pc board using some 12 mm spacers, nuts and bolts. The speaker mounts on the box 'lid'.**

| ITEM | TRADE | INC. TAX |
|---|---|---|
| **CMOS** | | |
| 4000 | .20 | .23 |
| 4001B | .18 | .21 |
| 4001A | .18 | .21 |
| 4002 | .19 | .22 |
| 4006 | 1.05 | 1.21 |
| 4007 | .21 | .24 |
| 4008 | .90 | 1.04 |
| 4009 | .41 | .47 |
| 4010 | .42 | .48 |
| 4011 | .25 | .29 |
| 4012 | .19 | .22 |
| 4013 | .32 | .37 |
| 4014 | 1.00 | 1.15 |
| 4015 | .78 | .90 |
| 4016 | .41 | .47 |
| 4017 | .80 | .92 |
| 4018 | 1.00 | 1.15 |
| 4019 | .52 | .60 |
| 4020 | 1.05 | 1.20 |
| 4021 | 1.05 | 1.20 |
| 4022 | .95 | 1.09 |
| 4023 | .18 | .21 |
| 4024 | .64 | .73 |
| 4025 | .19 | .22 |
| 4026 | 1.40 | 1.61 |
| 4027 | .42 | .48 |
| 4028 | .78 | .90 |
| 4029 | 1.11 | 1.28 |
| 4030 | .33 | .38 |
| 4031 | 1.98 | 2.28 |
| 4034 | 3.25 | 3.74 |
| 4035 | 1.16 | 1.33 |
| 4039 | .60 | .69 |
| 4040 | .92 | 1.06 |
| 4041 | .90 | 1.04 |
| 4042 | .64 | .74 |
| 4043 | .64 | .74 |
| 4044 | .61 | .70 |
| 4046 | .98 | 1.13 |
| 4047 | 1.06 | 1.22 |
| 4048 | .45 | .52 |
| 4049 | .33 | .38 |
| 4050 | .37 | .43 |
| 4051 | .71 | .82 |
| 4052 | .70 | .80 |
| 4053 | .72 | .83 |
| 4060 | 1.05 | 1.21 |
| 4066 | .51 | .57 |
| 4068 | .29 | .33 |
| 4069 | .20 | .23 |
| 4070 | .34 | .39 |
| 4071 | .21 | .24 |
| 4072 | .34 | .39 |
| 4073 | .27 | .31 |
| 4075 | .24 | .28 |
| 4076 | 1.05 | 1.21 |
| 4077 | .29 | .34 |
| 4078 | .34 | .39 |
| 4081 | .23 | .27 |
| 4082 | .34 | .39 |
| 4089 | .90 | 1.04 |
| 4093 | .50 | .58 |
| 4503 | .54 | .62 |
| 4507 | .40 | .46 |
| 4510 | .96 | 1.10 |
| 4511 | .92 | 1.05 |
| 4512 | .95 | 1.10 |
| 4514 | 2.20 | 2.53 |
| 4516 | 1.20 | 1.38 |
| 4518 | .95 | 1.09 |
| 4519 | .46 | .53 |
| 4520 | .92 | 1.05 |
| 4522 | 1.12 | 1.29 |
| 4527 | 1.05 | 1.20 |
| 4528 | 1.11 | 1.27 |
| 4529 | 1.45 | 1.67 |
| 4539 | 1.36 | 1.60 |
| 4541 | 1.40 | 1.61 |
| 4543 | 1.82 | 2.09 |
| 4553 | 6.15 | 7.08 |
| 4555 | .90 | 1.04 |
| MC1-4560 | 2.60 | 2.99 |
| 40097 | .85 | .98 |
| 40098 | .85 | .98 |
| 40175 | .95 | 1.07 |
| **74C SERIES** | | |
| 74C00 | .22 | .25 |
| 74C02 | .22 | .25 |
| 74C04 | .22 | .25 |
| 74C08 | .22 | .25 |
| 74C10 | .24 | .28 |
| 74C14 | .40 | .46 |
| 74C20 | .25 | .29 |
| 74C30 | .25 | .29 |
| 74C32 | .25 | .29 |
| 74C42 | .98 | 1.13 |
| 74C48 | 1.34 | 1.54 |
| 74C73 | .64 | .74 |
| 74C74 | .50 | .58 |
| 74C76 | .64 | .74 |
| 74C83 | 1.25 | 1.44 |
| 74C85 | 1.10 | 1.27 |
| 74C86 | .36 | .51 |
| 74C90 | .86 | .59 |
| 74C93 | .85 | 1.44 |
| 74C95 | .55 | .97 |
| 74C107 | .60 | .74 |
| 74C150 | 2.40 | 3.45 |
| 74C151 | 1.50 | 1.02 |
| 74C154 | 2.45 | 2.92 |
| 74C160 | .80 | .97 |
| 74C192 | .84 | .97 |
| 74C164 | 1.00 | 1.15 |
| 74C173 | .95 | 1.09 |
| 74C174 | .75 | .86 |
| 74C175 | .80 | 1.07 |
| 74C192 | 1.10 | 1.29 |
| 74C193 | 1.02 | 1.17 |
| 74C195 | .90 | 1.04 |
| 74C221 | 1.30 | 1.50 |
| 74C373 | 1.60 | 1.84 |
| 74C374 | 1.82 | 2.09 |
| 74C901 | .50 | .58 |
| 74C902 | .50 | .58 |
| 74C905 | 9.80 | 11.27 |
| 74C906 | .48 | .55 |
| 74C907 | .50 | .58 |
| 74C915 | .94 | 1.08 |
| 74C922 | 3.32 | 3.82 |
| 74C923 | 3.50 | 4.03 |
| 74C925 | 4.10 | 4.72 |
| 74C926 | 4.10 | 4.72 |
| 74C927 | 4.10 | 4.72 |
| 74C932 | .95 | 1.19 |
| **80C SERIES** | | |
| MM80C95 | .75 | .86 |
| 80C96 | .75 | .86 |
| MM80C97 | .75 | .86 |
| 80C98 | .75 | .86 |
| **LINEAR** | | |
| LH0002 | 7.50 | 9.56 |
| LH0022CD | 13.00 | 16.58 |
| LH0042CH | 4.43 | 5.65 |
| LH0070 | 10.00 | 12.75 |
| LH0071 | 10.00 | 12.75 |
| REF02CJ | 6.60 | 8.42 |
| TL071 | .68 | .87 |
| TL072 | 1.20 | 1.53 |
| TL082 | .88 | 1.12 |
| LH0091CD | 20.75 | 26.46 |
| LH0094CD | 29.50 | 37.62 |
| SAK140 | 1.79 | 2.28 |
| UAA170 | 2.80 | 3.57 |
| UAA180 | 2.80 | 3.57 |
| TCA220 | 1.80 | 2.30 |
| LM301 | .26 | .33 |
| LM301-H | .38 | .49 |
| LM304-H | 1.40 | 1.79 |
| LM305-H | .65 | .83 |
| LM307-CN | .32 | .41 |
| LM307-H | .75 | .95 |
| LM308 | .60 | .77 |
| LM308H | 1.00 | 1.27 |
| LM310-N | 1.75 | 2.23 |
| LM310-H | 2.10 | 2.68 |
| 311 | .55 | .70 |
| LM311 | .55 | .70 |
| LM311H | 1.00 | 1.27 |
| LM318 | 2.25 | 2.87 |
| LM322 | 3.10 | 3.95 |
| LM324 | .63 | .80 |
| LM325 | 2.50 | 3.19 |
| LM329-DZ | 1.14 | 1.45 |
| LM334Z | 1.10 | 1.40 |
| OM335 | 9.80 | 12.50 |
| LM336Z | 2.54 | 3.24 |
| LM339 | .50 | .64 |
| LM348 | .92 | 1.18 |
| LM349 | 1.45 | 1.85 |
| LF351N | .55 | .71 |
| LF356AN | .90 | 1.15 |
| LF357 | .90 | 1.15 |
| LM358 | .60 | .77 |
| LM373 | 3.30 | 4.20 |
| LM374 | 4.25 | 5.42 |
| LM376 | .56 | .72 |
| LM377 | 2.30 | 2.94 |
| LM379 | 4.50 | 5.74 |
| LM380 8PIN | .80 | 1.02 |
| LM380 14PIN | .95 | 1.22 |
| LM381A-N | 1.95 | 2.40 |
| LM381N | 1.50 | 1.91 |
| LM382N | 1.30 | 1.66 |
| LM383 | 2.15 | 2.74 |
| LM384 | 1.95 | 2.49 |
| LM386 | .84 | 1.07 |
| LM387 | 1.10 | 1.40 |
| LM391 | 1.42 | 1.81 |
| LM393 | .70 | .89 |
| LF398 | 3.95 | 5.04 |
| 456P | 1.29 | 1.64 |
| NE530 | .90 | 1.15 |
| **LINEAR** | | |
| 555 | .25 | .32 |
| 556 | .60 | .77 |
| LM565 | 1.10 | 1.40 |
| LM565CH | 1.65 | 2.10 |
| NE566 | 1.95 | 2.49 |
| LM567 | 1.20 | 1.53 |
| NE571 | 7.50 | 9.56 |
| TBA641BX1 | 2.00 | 2.55 |
| TBA641B11 | 2.00 | 2.55 |
| LM709-LN-8 | .50 | .64 |
| LM709-14PIN | .62 | .78 |
| UA710CA | .54 | .68 |
| LM710-CH | .74 | .94 |
| 711 | .64 | .82 |
| UA711-H | .68 | .88 |
| UA716HC | 4.95 | 6.31 |
| 723 | .38 | .49 |
| LM723CH | .90 | 1.15 |
| LM725 | 3.14 | 4.00 |
| LM733 | .98 | 1.25 |
| UA739 | 1.60 | 2.04 |
| 741 | .20 | .25 |
| LM741-H | .47 | .60 |
| UA747 | .84 | 1.07 |
| UA747HC | 1.76 | 2.24 |
| UA748 | .42 | .54 |
| UA748HC | 1.02 | 1.30 |
| UA753 | 1.45 | 1.85 |
| UA760HC | 3.28 | 4.18 |
| UA777 | 1.95 | 2.49 |
| UA777HC | 2.35 | 2.70 |
| UA796HC | 1.17 | 1.75 |
| OM802 | .94 | 1.20 |
| SAB1048 | 4.20 | 5.36 |
| LM1310N | 1.90 | 2.43 |
| 1408 | 3.90 | 4.97 |
| LM1458 | .50 | .64 |
| UA1488 | .74 | .94 |
| UA1489 | .74 | .94 |
| MC1495 | 5.75 | 7.33 |
| MC1496L | 1.23 | 1.42 |
| LM1558 | 1.23 | 1.57 |
| LM1596 | 1.15 | 1.47 |
| LM1830 | 2.50 | 3.19 |
| 2719 | 3.50 | 4.03 |
| LM2902 | 1.20 | 1.53 |
| LM2917 8PIN | 2.25 | 2.87 |
| LM2917 | 2.45 | 3.12 |
| CA3028 | 1.43 | 1.82 |
| LM3039 | .78 | .99 |
| CA3046 | 1.36 | 1.73 |
| 3065 | .40 | .50 |
| LM3080 | .96 | 1.22 |
| LM3089 | 3.13 | 3.99 |
| CA3130T | 1.05 | 1.40 |
| CA3130E | 1.42 | 1.80 |
| CA3140 | 1.05 | 1.40 |
| 3401 | .60 | .77 |
| 3611 | .92 | 1.17 |
| LM3900 | .65 | .83 |
| LM3909 | .85 | 1.08 |
| LM3914N | 3.10 | 3.95 |
| 4136 | 1.48 | 1.88 |
| LM4250 | 1.45 | 1.80 |
| UA4558TC | 1.08 | 1.42 |
| MM5837 | 1.18 | 1.50 |
| LM7555 | 1.47 | 1.87 |
| MC10116L | .79 | 1.00 |
| LF13741 | .50 | .64 |
| LF13741-H | .61 | .78 |
| DS75452 | .45 | .57 |
| 76477 | 3.53 | 4.50 |
| **TTL (S)** | | |
| 74S00 | .30 | .35 |
| 74S02 | .30 | .35 |
| 74S04 | .74 | .85 |
| 74S10 | .70 | .80 |
| 74S11 | .70 | .80 |
| 74S32 | .70 | .80 |
| 74S51 | .70 | .80 |
| 74S74 | 1.13 | 1.30 |
| 74S86 | 1.17 | 1.45 |
| 74S112 | 1.13 | 1.30 |
| 74S135 | 2.00 | 2.30 |
| 74S138 | 2.87 | 3.30 |
| 74S157 | 2.61 | 3.00 |
| 74S158 | 2.61 | 3.00 |
| 74S182 | 2.87 | 3.30 |
| **7400 SERIES** | | |
| 7400 | .16 | .18 |
| 7401 | .18 | .20 |
| 7402 | .14 | .16 |
| 7403 | .18 | .20 |
| 7404 | .16 | .18 |
| 7405 | .22 | .25 |
| 7406 | .18 | .20 |
| 7407 | .30 | .35 |
| 7408 | .16 | .18 |
| 7409 | .20 | .23 |
| 7410 | .14 | .16 |
| 7411 | .23 | .26 |
| 7412 | .26 | .30 |
| 7413 | .30 | .35 |
| 7414 | .32 | .37 |
| 7416 | .30 | .35 |
| 7417 | .40 | .46 |
| 7420 | .17 | .19 |
| 7421 | .18 | .20 |
| 7423 | .35 | .40 |
| 7425 | .40 | .46 |
| 7426 | .26 | .30 |
| 7427 | .30 | .35 |
| 7430 | .17 | .19 |
| 7432 | .25 | .29 |
| 7437 | .30 | .35 |
| 7438 | .30 | .35 |
| 7440 | .20 | .23 |
| 7441 | .90 | 1.04 |
| 7442 | .40 | .46 |
| 7443 | 1.30 | 1.50 |
| 7444 | 1.20 | 1.38 |
| 7445 | 1.00 | 1.15 |
| 7446 | .84 | .97 |
| 7447 | .64 | .74 |
| 7448 | .83 | .95 |
| 7450 | .18 | .20 |
| 7451 | .18 | .20 |
| 7453 | .20 | .23 |
| 8T26 | .65 | 1.85 |
| 9300 | .60 | .69 |
| 9307 | 1.60 | 1.84 |
| 9308 | 1.12 | 1.29 |
| 7454 | .18 | .20 |
| 7470 | .35 | .40 |
| 7472 | .32 | .37 |
| 7473 | .32 | .37 |
| 7474 | .26 | .30 |
| 7475 | .25 | .29 |
| 7476 | .26 | .30 |
| 7480 | .60 | .69 |
| 7482 | 1.60 | 1.84 |
| 7483 | .74 | .85 |
| 7485 | .75 | .86 |
| 7486 | .36 | .42 |
| 7489 | 1.42 | 1.63 |
| 7490 | .25 | .29 |
| 7491 | .52 | .60 |
| 7492 | .36 | .41 |
| 7493 | .26 | .30 |
| 7494 | .80 | .92 |
| 7495 | .40 | .46 |
| 7496 | .70 | .81 |
| 7497 | 2.20 | 2.53 |
| 74107 | .40 | .46 |
| 74109 | .32 | .37 |
| 74116 | 1.90 | 2.19 |
| 74121 | .40 | .46 |
| 74122 | .60 | .69 |
| 74123 | .58 | .67 |
| 74125 | .52 | .60 |
| 74126 | .55 | .63 |
| 74132 | .75 | .86 |
| 74141 | 1.04 | 1.20 |
| 74145 | .80 | .92 |
| 74147 | 1.78 | 2.05 |
| 74148 | 1.24 | 1.43 |
| 74150 | .65 | .75 |
| 74151 | .36 | .41 |
| 74152 | 4.42 | 5.01 |
| 74153 | .65 | .75 |
| 74154 | .65 | .75 |
| 8T28 | 1.40 | 1.61 |
| 9310 | .60 | .69 |
| 9311 | .90 | 1.03 |
| 9312 | 1.20 | 1.38 |
| 74155 | .86 | .99 |
| 74156 | 1.38 | 1.59 |
| 74157 | .56 | .64 |
| 74160 | .92 | 1.06 |
| 74161 | .95 | 1.09 |
| 74162 | .85 | 1.01 |
| 74163 | .80 | .92 |
| 74164 | .55 | .63 |
| 74165 | .55 | .63 |
| 74166 | 1.28 | 1.47 |
| 74167 | 2.20 | 2.53 |
| 74170 | 1.83 | 2.11 |
| 74173 | 1.45 | 1.67 |
| **7400 SERIES** | | |
| 74174 | .48 | .55 |
| 74175 | .84 | .97 |
| 74176 | 1.04 | 1.20 |
| 74177 | 1.00 | 1.15 |
| 74180 | .84 | .97 |
| 74181 | 2.08 | 2.39 |
| 74182 | .84 | .97 |
| 74184 | 1.90 | 1.29 |
| 74185 | 1.90 | 1.29 |
| 74190 | .90 | 1.04 |
| 74191 | .80 | .92 |
| 74192 | .65 | .75 |
| 74193 | .72 | .83 |
| 74194 | 1.05 | 1.20 |
| 74195 | .60 | .69 |
| 74196 | .80 | .92 |
| 74197 | .99 | 1.13 |
| 74198 | .99 | 1.13 |
| 74199 | 1.20 | 1.38 |
| 74221 | .80 | .92 |
| 74290 | .80 | .92 |
| 74293 | .80 | .92 |
| 74365 | .75 | .86 |
| 74366 | .75 | .87 |
| 74367 | .55 | .63 |
| 74368 | .74 | .85 |
| 8T96 | 1.65 | 1.89 |
| 9314 | 1.20 | 1.38 |
| 9368 | 1.70 | 1.96 |
| 9370 | 1.80 | 2.07 |
| 74LS00 | .16 | .18 |
| 74LS01 | .20 | .23 |
| 74LS02 | .15 | .17 |
| 74LS03 | .19 | .22 |
| 74LS04 | .19 | .22 |
| 74LS05 | .20 | .23 |
| 74LS08 | .18 | .20 |
| 74LS09 | .19 | .22 |
| 74LS10 | .18 | .20 |
| 74LS11 | .20 | .23 |
| 74LS13 | .40 | .46 |
| 74LS14 | .60 | .69 |
| 74LS15 | .25 | .29 |
| 74LS20 | .20 | .23 |
| 74LS21 | .21 | .24 |
| 74LS22 | .22 | .25 |
| 74LS26 | .26 | .30 |
| 74LS27 | .21 | .24 |
| 74LS28 | .30 | .35 |
| 74LS30 | .22 | .25 |
| 74LS32 | .21 | .24 |
| 74LS33 | .32 | .37 |
| 74LS37 | .30 | .35 |
| 74LS38 | .26 | .30 |
| 74LS40 | .20 | .23 |
| 74LS42 | .70 | .81 |
| 74LS47 | .80 | .92 |
| 74LS48 | .96 | 1.10 |
| 74LS49 | .96 | 1.10 |
| 74LS51 | .24 | .28 |
| 74LS54 | .24 | .28 |
| 74LS55 | .50 | .58 |
| 74LS58 | .60 | .69 |
| 74LS73 | .50 | .58 |
| 74LS74 | .31 | .36 |
| 74LS75 | .40 | .46 |
| 74LS76 | .36 | .41 |
| 74LS78 | .36 | .41 |
| 74LS83 | .91 | 1.05 |
| 74LS85 | .90 | 1.04 |
| 74LS86 | .30 | .35 |
| 74LS90 | .44 | .50 |
| 74LS92 | .84 | .96 |
| 74LS93 | .54 | .62 |
| 74LS95 | .62 | .71 |
| 74LS96 | 1.40 | 1.61 |
| 74LS107 | .34 | .39 |
| 74LS109 | .34 | .39 |
| 74LS112 | .34 | .39 |
| 74LS113 | .60 | .69 |
| 74LS114 | .48 | .55 |
| 74LS122 | .42 | .48 |
| 74LS123 | .71 | .82 |
| 74LS125 | .44 | .51 |
| 74LS126 | .65 | .75 |
| 74LS132 | .74 | .85 |
| 74LS133 | .30 | .35 |
| 74LS136 | .34 | .39 |
| 74LS138 | .64 | .74 |
| 74LS139 | .80 | .92 |
| 74LS151 | .68 | .78 |
| 74LS153 | .56 | .64 |
| 74LS154 | 1.32 | 1.52 |
| 74LS155 | .96 | 1.10 |
| 74LS156 | .96 | 1.10 |
| 74LS157 | .86 | .99 |
| 74LS158 | .66 | .76 |
| 74LS160 | .78 | .90 |
| 74LS161 | .78 | .90 |
| 74LS162 | .95 | 1.09 |
| 74LS163 | .78 | .90 |
| 74LS164 | 1.16 | 1.33 |
| 74LS165 | .48 | .55 |
| 74LS168 | 1.70 | 1.96 |
| 74LS169 | 1.70 | 1.96 |
| 74LS170 | 2.46 | 2.83 |
| 74LS173 | .66 | .76 |
| **74LS SERIES** | | |
| 74LS174 | .64 | .74 |
| 74LS175 | .64 | .74 |
| 74LS181 | 2.50 | 2.88 |
| 74LS189 | 3.35 | 3.85 |
| 74LS190 | 1.20 | 1.38 |
| 74LS191 | 1.02 | 1.17 |
| 74LS192 | .82 | .94 |
| 74LS193 | .82 | .94 |
| 74LS194 | .65 | .75 |
| 74LS195 | .75 | .86 |
| 74LS196 | 1.15 | 1.32 |
| 74LS197 | .96 | 1.10 |
| 74LS221 | 1.02 | 1.17 |
| 74LS245 | 2.10 | 2.42 |
| 74LS247 | .80 | .92 |
| 74LS249 | 1.15 | 1.32 |
| 74LS251 | .70 | .81 |
| 74LS253 | .95 | 1.10 |
| 74LS257 | .60 | .69 |
| 74LS258 | .45 | .52 |
| 74LS259 | 2.20 | 2.53 |
| 74LS260 | .35 | .40 |
| 74LS266 | .66 | .76 |
| 74LS273 | 1.70 | 1.96 |
| 74LS279 | .60 | .69 |
| 74LS283 | 1.10 | 1.20 |
| 74LS90 | .99 | 1.13 |
| 74LS293 | 1.05 | 1.21 |
| 74LS295 | 1.50 | 1.70 |
| 74LS298 | .95 | 1.10 |
| 74LS352 | 1.15 | 1.32 |
| 74LS353 | 1.15 | 1.32 |
| 74LS365 | .48 | .55 |
| 74LS366 | .66 | .76 |
| 74LS367 | .53 | .61 |
| 74LS368 | .36 | .41 |
| 74LS373 | 1.30 | 1.50 |
| 74LS374 | 1.50 | 1.73 |
| 74LS386 | .46 | .53 |
| 74LS670 | 2.38 | 2.74 |
| 81LS95 | 2.11 | 2.42 |
| 95H90 | 7.74 | 8.90 |
| 11C90 | 11.44 | 13.15 |
| 81LS96 | 2.11 | 2.42 |
| 81LS97 | 2.11 | 2.42 |
| 81LS98 | 2.11 | 2.42 |
| **TRANSISTORS** | | |
| 2N301 | 1.80 | 2.30 |
| 2N657 | .14 | .18 |
| 2N930 | .51 | .65 |
| 2N1613 | .90 | 1.15 |
| 2N1711 | .45 | .58 |
| 2N1893 | .86 | 1.10 |
| 2N2219A | .35 | .47 |
| PN2222 | .18 | .24 |
| 2N2222 | .25 | .32 |
| 2N2483 | .30 | .39 |
| 2N2484 | .54 | .69 |
| 2N2646 | .55 | .70 |
| 2N2647 | .90 | 1.15 |
| 2N2894 | .68 | .87 |
| 2N2904 | .40 | .51 |
| 2N2905 | .35 | .45 |
| 2N2906 | .30 | .50 |
| PN2907 | .24 | .30 |
| 2N2913 | 1.00 | 1.28 |
| 2N3053 | .35 | .38 |
| 2N3054 | .60 | .77 |
| 2N3055 | .55 | .70 |
| 2N3301 | .25 | .32 |
| 2N3440 | .94 | 1.20 |
| 2N3502 | .60 | .77 |
| 2N3503 | .60 | .77 |
| 2N3563 | .18 | .23 |
| 2N3564 | .23 | .29 |
| PN3565 | .18 | .23 |
| PN3566 | .15 | .20 |
| PN3567 | .18 | .23 |
| PN3568 | .18 | .23 |
| 2N3569 | .18 | .23 |
| 2N3638 | .18 | .23 |
| 2N3639 | .18 | .23 |
| 2N3640 | .18 | .23 |
| 2N3641 | .18 | .23 |
| PN3642 | .14 | .18 |
| PN3643 | .16 | .20 |
| PN3644 | .16 | .20 |
| 2N3645 | .16 | .20 |
| 2N3646 | .16 | .20 |
| 2N3692 | .43 | .55 |
| 2N3693 | .30 | .38 |
| PN3694 | .10 | .13 |
| 2N3702 | .20 | .26 |
| 2N3704 | .25 | .32 |
| 2N3709 | .25 | .32 |
| 2N3713 | 1.66 | 2.22 |
| 2N3771 | 1.50 | 1.91 |
| 2N3772 | 1.50 | 1.91 |
| 2N3819 | .25 | .32 |
| 2N3866 | 1.62 | 2.07 |
| 2N3904 | .18 | .23 |
| 2N3906 | .16 | .20 |
| 2N4030 | .90 | 1.15 |
| 2N4032 | .45 | .57 |

# SEMIS

TERMS: Minimum order $10.00 Aust.
Bankcard accepted. Full line price list
now available, send 50c post.

## ☆☆ SPECIAL ☆☆

| | Trade | Inc. tax |
|---|---|---|
| SYM. T Microprocessor | 195.00 | 224.25 |
| Red LED's, 100 for | 10.00 | 11.50 |
| 14 pin gold L-P IC sockets, 100 for | 12.00 | 13.80 |

| ITEM | TRADE | INC. TAX |
|---|---|---|
| 2N4033 | .78 | .99 |
| 2N4036 | .82 | 1.05 |
| 2N4037 | .73 | .93 |
| PN4121 | .14 | .18 |
| 2N4233 | 1.30 | 1.66 |
| 2N4235 | 1.55 | 1.98 |
| 2N4236 | 1.80 | 2.30 |
| 2N4248 | .16 | .20 |
| PN4249 | .26 | .33 |
| 2N4250 | .12 | .15 |
| 2N4258 | .18 | .23 |
| 2N4292 | .60 | .77 |
| 2N4354 | .20 | .26 |
| 2N4355 | .20 | .26 |
| 2N4356 | .16 | .20 |
| 2N4398 | 4.38 | 5.04 |
| 2N4401 | .14 | .18 |
| 2N4402 | .23 | .29 |
| 2N4403 | .14 | .18 |
| 2N4416 | .80 | 1.02 |
| PN4888 | .30 | .38 |
| 2N4906 | 2.45 | 2.82 |
| 2N5088 | .14 | .18 |
| 2N5089 | .14 | .18 |
| 2N5179 | 1.50 | 1.91 |
| 2N5303 | 2.65 | 3.38 |
| 2N5320 | .68 | .87 |
| 2N5401 | .20 | .26 |
| 2N5458 | .40 | .51 |
| 2N5459 | .40 | .51 |
| 2N5461 | .59 | .75 |
| 2N5484 | .46 | .58 |
| 2N5485 | .38 | .48 |
| 2N5486 | .46 | .59 |
| 2N5769 | .14 | .18 |
| 2N5770 | .20 | .25 |
| 2N5830 | .22 | .29 |
| 2N5831 | .25 | .32 |
| 2N5856 | .27 | .35 |
| 2N5873 | .94 | 1.20 |
| 2N5874 | 1.13 | 1.45 |
| 2N5961 | .14 | .18 |
| 2N5963 | .90 | 1.15 |
| 2N6027 | .38 | .49 |
| 2N6121 | .38 | .48 |
| 2N6122 | .41 | .52 |
| 2N6124 | .33 | .42 |
| 2N6126 | .46 | .59 |
| 2N6129 | .63 | .80 |
| 2N6130 | .70 | .89 |
| 2N6131 | .77 | .88 |
| 2N6132 | .70 | .89 |
| 2N6133 | .77 | .88 |
| 2SA353 | .16 | .20 |
| 2SA354 | .16 | .20 |
| 2SB77 | .16 | .20 |
| 2SB187 | 1.00 | 1.28 |
| 2SC1060 | 1.45 | 1.85 |
| 2SC1061 | 1.45 | 1.85 |
| 2SD200 | .78 | 1.00 |
| 2SF102 | 1.00 | 1.28 |
| 2T73 | .12 | .15 |
| 2N301 | .30 | .38 |
| 9012F | .20 | .25 |
| AC127 | .62 | .79 |
| AC128 | .62 | .79 |
| AC187 | .62 | .79 |
| AC188 | .62 | .79 |
| AD149 | 1.60 | 2.04 |
| AD161 | 1.34 | 1.75 |
| AD162 | 1.34 | 1.75 |
| AX6247 | .35 | .45 |
| AY6102 | .40 | .51 |
| AY6112 | .40 | .51 |
| AY6118 | .40 | .51 |
| AY6119 | .40 | .51 |
| AY6120 | .40 | .51 |
| AY6121 | .40 | .51 |
| AY8110 | .50 | .64 |
| AY8139 | .40 | .51 |
| AY9139 | .40 | .51 |
| BC107 | .18 | .23 |
| BC108 | .18 | .23 |
| BC1080 | .25 | .32 |
| BC109 | .18 | .23 |
| BC109C | .27 | .34 |
| BC147 | .10 | .13 |
| BC159 | .14 | .18 |
| BC177 | .20 | .26 |
| BC178 | .20 | .26 |
| BC179 | .20 | .26 |
| BC204 | .14 | .18 |
| BC205 | .14 | .18 |
| BC206 | .14 | .18 |
| BC208 | .12 | .15 |
| BC209 | .14 | .18 |
| BC287 | .14 | .18 |
| BC309 | .14 | .18 |
| BC317 | .14 | .18 |
| BC318 | .14 | .18 |
| BC319 | .15 | .19 |
| BC321 | .14 | .18 |
| BC322 | .14 | .18 |
| BC327 | .12 | .15 |
| BC328 | .13 | .17 |
| BC337 | .14 | .18 |
| BC338 | .14 | .18 |
| BC547 | .10 | .13 |
| BC547B | .14 | .18 |
| BC548 | .10 | .13 |
| BC548B | .14 | .18 |
| BC549 | .10 | .13 |
| BC549C | .14 | .18 |
| BC557 | .14 | .18 |
| BC558 | .14 | .18 |
| BC559 | .14 | .18 |
| BC637 | .23 | .29 |
| BC638 | .28 | .36 |
| BC639 | .27 | .35 |
| BC640 | .24 | .31 |
| BCY70 | .71 | .90 |
| BCY71 | .71 | .90 |
| BD115 | 1.22 | 1.55 |
| BD135 | .40 | .51 |
| BD136 | .40 | .51 |
| BD137 | .35 | .45 |
| BD138 | .35 | .45 |
| BD139 | .32 | .40 |
| BD140 | .32 | .40 |
| BD235 | .55 | .70 |
| BD234 | .41 | .52 |
| BD237 | .41 | .52 |
| BD262 | .99 | 1.26 |
| BD301 | .60 | .77 |
| BD302 | .60 | .77 |
| BD263 | .99 | 1.26 |
| BD435 | .58 | .74 |
| BD646 | 1.35 | 1.72 |
| BD647 | 1.45 | 1.85 |
| BD675 | .70 | .89 |
| BDV64B | 2.45 | 3.12 |
| BDV65B | 2.45 | 3.12 |
| BF115 | .45 | .57 |
| BF173 | .60 | .76 |
| BF180 | .35 | .45 |
| BF195 | .26 | .33 |
| BF198 | .10 | .13 |
| LF199 | .10 | .13 |
| BF336 | .68 | .87 |
| BF337 | .68 | .87 |
| BF458 | .75 | .95 |
| BF494 | .17 | .22 |
| BFX85 | .63 | .80 |
| BFY50 | .75 | .96 |
| BFY90 | 1.10 | 1.40 |
| BS568 | .24 | .30 |
| BSV17 | .80 | 1.02 |
| BU126 | 2.45 | 3.12 |
| BU208 | 3.75 | 4.78 |
| BUX80 | 6.50 | 8.25 |
| FT50 | .90 | 1.15 |
| FT402 | 3.60 | 4.50 |
| FT430 | 4.16 | 5.40 |
| FT2955 | 1.15 | 1.50 |
| FT3055 | .65 | .80 |
| MEL12 | .76 | .97 |
| BU326A | 2.70 | 3.45 |
| MJ2955 | .60 | .80 |
| MJ4032 | 5.85 | 7.46 |
| MJ802 | 2.94 | 3.75 |
| MJ4035 | 5.46 | 6.96 |
| MJ4502 | 2.94 | 3.75 |
| MJE340 | .72 | .92 |
| MJE350 | 1.00 | 1.28 |
| MJE700 | 1.10 | 1.40 |
| MJE800 | .80 | 1.02 |
| MJE1101 | 1.80 | 2.29 |
| MJE2955 | .72 | .92 |
| MJE3055 | .79 | .92 |
| MJE3521 | .47 | .60 |
| MPF102 | .35 | .45 |
| MPF131 | .95 | 1.22 |
| MPS4356 | .30 | .38 |
| MPSA05 | .18 | .23 |
| MPSA14 | .25 | .32 |
| MRF475 | 3.50 | 4.46 |
| MPSA92 | .50 | .64 |
| MT8020 | .80 | 1.02 |
| OA675 | .08 | .11 |
| OC910 | .47 | .60 |
| OC912 | .47 | .60 |
| OC925 | .08 | .11 |
| OC9308 | .08 | .11 |
| OC9554 | .31 | .40 |
| OC9674 | .31 | .40 |
| SE1010 | .16 | .20 |
| SE9302 | 1.20 | 1.33 |
| ST194 | .12 | .15 |
| TIP29A | .63 | .80 |
| TIP29B | .63 | .80 |
| TIP30A | .63 | .80 |
| TIP30B | .63 | .80 |
| TIP31A | .40 | .51 |
| TIP31B | .63 | .80 |
| TIP31C | .50 | .64 |
| TIP32A | .40 | .51 |
| TIP32B | .63 | .80 |
| TIP32C | .63 | .80 |
| TIP33A | .90 | 1.15 |
| TIP34A | .95 | 1.21 |
| TIP34B | 1.20 | 1.53 |
| TIP42B | .90 | 1.15 |
| TIP110 | 1.10 | 1.40 |
| TIP120 | 1.10 | 1.40 |
| TIP2955 | .70 | .89 |
| TIP3055 | .65 | .83 |
| TT641 | .08 | .11 |

**MICRO CHIPS**

| | | |
|---|---|---|
| ADCD 800 | 10.50 | 12.08 |
| DAC0808 | 2.00 | 2.30 |
| 2102 200NS | 1.75 | 2.02 |
| 2102 350NS | 1.75 | 2.02 |
| 2102 450NS | 1.13 | 1.30 |
| 2102 650NS | 1.13 | 1.30 |
| 2111 | 7.50 | 8.63 |
| 2112 | 1.96 | 2.25 |
| 2114 150NS | 9.75 | 11.21 |
| 2114 300NS | 5.50 | 6.33 |
| 2114 450NS 1to7 | 4.65 | 5.35 |
| 8 to 31 | 4.40 | 5.06 |
| 32up | 4.25 | 4.89 |
| 2513 | 10.85 | 12.48 |
| 2516 | 48.50 | 55.78 |
| 2532 | 66.00 | 75.90 |
| 2650 | 24.00 | 27.60 |
| 2708 | 9.57 | 11.00 |
| 2716 | 18.50 | 21.28 |
| 4116 | 14.00 | 16.10 |
| 5101 | 8.30 | 9.55 |
| 55101 | 5.00 | 5.75 |
| MM5203Q | 12.75 | 14.67 |
| MM5204 | 10.96 | 12.60 |
| MM5220 | 6.60 | 7.59 |
| MM5303N | 3.60 | 4.14 |
| MM5307 | 15.80 | 18.18 |
| MM5309 | 5.85 | 6.73 |
| MM5312 | 8.00 | 9.20 |
| MM5369 | 2.30 | 2.65 |
| 5387 | 7.50 | 8.63 |
| MM5395 | 5.95 | 6.84 |
| MM5740 | 13.89 | 15.98 |
| 6502 | 9.36 | 10.77 |
| 6508 | 5.00 | 5.75 |
| 6520 | 5.00 | 5.75 |
| 6522 | 8.91 | 10.25 |
| 6532 | 15.05 | 17.31 |
| 6551 | 14.90 | 17.14 |
| IM6561 | 4.22 | 4.84 |
| MCM6574 | 17.20 | 19.78 |
| MCM6575 | 8.35 | 9.60 |
| MC6800P | 8.20 | 9.43 |
| MC6802 | 12.00 | 13.80 |
| MC6808 | 11.00 | 12.65 |
| 6810A | 4.30 | 4.95 |
| 6820 | 5.20 | 5.98 |
| 6821 | 5.35 | 6.15 |
| 6850 | 5.20 | 5.98 |
| 6852 | 5.60 | 6.44 |
| 7106 | 12.00 | 13.80 |
| 7107 | 13.50 | 15.53 |
| 7217 | 12.00 | 13.80 |
| LS7220 | 5.26 | 6.05 |
| 8035 | 24.00 | 27.60 |
| INS8050 | 13.90 | 15.98 |
| INS8080 | 8.52 | 9.95 |
| P8085 | 21.96 | 25.25 |
| 8155 | 20.00 | 23.00 |
| 8156 | 19.50 | 22.43 |
| 8205 | 4.35 | 5.00 |
| P8212 | 4.15 | 4.80 |
| 8214 | 8.55 | 9.83 |
| 8224N | 5.17 | 5.95 |
| 8224 | 7.10 | 8.17 |
| 8228 | 9.10 | 10.47 |
| 8238 | 8.00 | 9.20 |
| 8243 | 8.00 | 9.20 |
| 8251 INTEL | 13.90 | 15.90 |
| INS8251 | 6.50 | 7.48 |
| 8253 | 19.50 | 22.50 |
| 8255A | 8.60 | 9.89 |
| 8295 | 25.00 | 28.75 |
| DM8578 | 3.20 | 3.68 |
| AY-5-2376 | 19.56 | 22.50 |
| MM5104N | 9.00 | 11.48 |
| MM55106N | 9.00 | 11.48 |
| MM57160 | 6.77 | 8.63 |

| ITEM | DESCRIPTION | TRADE | INC. TAX |
|---|---|---|---|
| **OPTOCOUPLERS** | | | |
| MCT2 | | .75 | .86 |
| MCT6 | | 2.08 | 3.39 |
| MCT275 | | 1.35 | 1.55 |
| MCC671 | | 2.68 | 3.03 |
| 4N28 | | .85 | .98 |
| 4N26 | | .85 | .98 |
| 4N28 | | .85 | .98 |
| 4N33 | | 1.18 | 1.36 |
| TIL116 | | 1.17 | 1.35 |
| FCD825 | | .90 | 1.15 |
| MCA8 | Opt. Limit Switch | 2.50 | 2.88 |
| Zener Diodes | E23 Range | | |
| 400MW | | .12 | .15 |
| 1 watt | | .24 | .28 |
| **VOLTAGE REGULATORS** | | | |
| 78L05 | +5V 100mA | .35 | .40 |
| LM341P-5 | +5V 500mA | .75 | .86 |
| 7805 | +5V 1A | .90 | 1.03 |
| 7905 | -5V 1A | 1.50 | 1.73 |
| LM309K | +5V 1A | 1.10 | 1.27 |
| 7805K | +5V 1A | 1.88 | 2.16 |
| LM323-K | +5V 3A | 5.53 | 6.36 |
| 78H05KC | +5V 5A | 5.34 | 6.14 |
| 78L06 | +6V 100mA | .35 | .40 |
| 7806 | +6V 1A | .90 | 1.03 |
| 7906 | -6V 1A | 1.57 | 1.80 |
| 78L08 | +8V 100mA | .35 | .40 |
| 79L08 | -8V 100mA | .60 | .69 |
| LM341P-8 | +8V 500mA | .75 | .86 |
| 7808 | +8V 1A | .90 | 1.03 |
| 7908 | -8V 1A | 1.18 | 1.35 |
| 78L10 | +10V 100mA | .35 | .40 |
| LM341P-10 | +10V 500mA | .75 | .86 |
| 7810 | +10V 1A | .90 | 1.03 |
| 78L12CP | +12V 100mA | .35 | .40 |
| 79L12 | -12V 100mA | .60 | .69 |
| LM341P12 | +12V 500mA | .70 | .80 |
| 7812 | +12V 1A | .90 | 1.03 |
| 7912 | -12V 1A | 1.30 | 1.50 |
| 7812KC | +12V 1A | 1.96 | 2.25 |
| 7912KC | -12V 1A | 2.35 | 2.70 |
| 78H12KC | +12V 5A | 5.34 | 6.14 |
| 78CBUC | 13.8V 2A | 2.04 | 2.34 |
| 78CBKC | 13.8V 2A | 2.55 | 2.93 |
| 78L15 | +15V 100mA | .35 | .40 |
| 79L15 | -15V 100mA | .60 | .69 |
| LM341P15 | +15V 500mA | .75 | .86 |
| 7815 | +15V 1A | .90 | 1.03 |
| 7915CT | -15V 1A | 1.30 | 1.50 |
| 7915KC | -15V 71A | 2.35 | 2.70 |
| 78H15KC | +15V 5A | 5.34 | 6.14 |
| 78L18 | +18V 100mA | .35 | .40 |
| 7818 | +18V 1A | 1.25 | 1.43 |
| 78L24 | +24V 100mA | .35 | .40 |
| 79L24 | -24V 100mA | .60 | .69 |
| 7824 | +24V 1A | 1.00 | 1.15 |
| LM317T | +ADJ. 1A | 2.10 | 2.42 |
| LM337T | -ADJ. 1A | 3.35 | 3.85 |
| LM317K | +ADJ. 2A | 3.02 | 3.47 |
| LM337K | -ADJ. 2A | 4.43 | 5.09 |
| LM350K | +ADJ. 3A | 7.34 | 8.44 |
| 78HCKC | +ADJ. 5A | 6.20 | 7.13 |
| 78P05 | +5V 10A | 6.90 | 7.94 |
| **BRIDGES** | | | |
| 16F | 25V 600mA | .39 | .50 |
| VM48 | 400V 1A DIL | .91 | 1.05 |
| W02 | 200V 1.5A | .56 | .64 |
| W04 | 400V 1.5A | .58 | .67 |
| W06 | 600V 1.5A | .60 | .69 |
| KHPC02 | 200V 3A | 1.20 | 1.38 |
| KBP602 | 200V 6A | 1.44 | 1.65 |
| KBP604 | 400V 6A | 2.10 | 1.95 |
| KBP606 | 600V 6A | 2.10 | 2.42 |
| KHPC1002 | 200V 10A | 2.33 | 2.68 |
| KBPC1004 | 400V 10A | 2.83 | 3.25 |
| KBPC1006 | 600V 10A | 2.91 | 3.35 |
| VK148 | 100V 30A | 2.90 | 3.34 |
| MDA3501 | 100V 35A | 2.83 | 3.25 |
| MDA3502 | 200V 35A | 2.83 | 3.25 |
| MDA3504 | 400V 35A | 3.04 | 3.50 |
| **DISPLAYS** | | | |
| MAN2A | .3" Red Alpha Num | 5.50 | 6.33 |
| MAN72A | .3" CA Red | 1.96 | 2.25 |
| MAN74A | .3" CC Red | 1.96 | 2.25 |
| MAN52A | .3" CA Green | 3.04 | 3.50 |
| MAN82A | .3" CC Green | 3.04 | 3.50 |
| MAN82A | .3" CA Yellow | 3.04 | 3.50 |
| MAN84A | .3" CC Yellow | 3.04 | 3.50 |
| MAN6740 | .56" 2 Digit CC Red | 3.17 | 3.65 |
| MAN8610 | Red | 2.95 | 3.40 |
| MAN8640 | Red | 2.95 | 3.40 |
| TIL306 | | 10.65 | 12.25 |
| DL704 | .3" CC Red | 2.00 | 2.30 |
| DL707 | .3" CA Red | 2.09 | 2.40 |

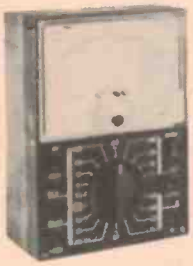
| ITEM | DESCRIPTION | TRADE | INC. TAX |
|---|---|---|---|
| DL747 | .63" CA Red | 3.03 | 3.48 |
| DL750 | .63" CC Red | 3.61 | 4.15 |
| FND357 | .362" CC Red | 1.15 | 1.40 |
| FND500 | .5" CC Red | 1.17 | 1.35 |
| FND507 | .5" CA Red | 1.39 | 1.60 |
| FND800 | .8" CC Red | 2.65 | 3.05 |
| FND807 | .8" CA Red | 3.04 | 3.50 |
| SEL521 | CC Red | 2.48 | 2.85 |
| NSB7881 | CC 4 Digit MUX Red | 9.26 | 10.65 |
| NSN781 | CC 2 Digit MUX Red | 4.30 | 4.95 |
| LT656-12 | CC 3½ Digit Red | 4.78 | 5.30 |
| FNA5220 | CC 2 Digit MUX Red | 3.00 | 3.45 |
| LD462 | 2 LED Array (Red) | .74 | .85 |
| LD465 | 5 LED Array (Red) | 2.04 | 2.35 |
| LD472 | 2 LED Array (Green) | .83 | .95 |
| LD475 | 5 LED Array (Green) | 2.30 | 2.65 |
| LD482 | 2 LED Array (Yellow) | .87 | 1.00 |
| LD485 | 5 LED Array (Yellow) | 2.30 | 2.65 |
| **S.C.R.'s** | | | |
| TIC 46 | 100V 600mA | .59 | .68 |
| EC103B | 200V 800mA | .45 | .52 |
| EC103D | 400V 800mA | .50 | .58 |
| S2003L52 | 200V 3A | .52 | .60 |
| TIC106T | 30V 4A | .30 | .35 |
| C106A | 100V 4A | .60 | .77 |
| T106B1 | 200V 4A | .64 | .73 |
| C106B | 200V 4A | .65 | .82 |
| BT100A | 300V 4A | .50 | .58 |
| C106D1 | 400V 4A | .50 | .58 |
| Q4004L4 | 400V 4A | 1.05 | 1.21 |
| C106E | 500V 4A | .91 | 1.05 |
| Q2006L4 | 200V 6A | .95 | 1.10 |
| S4006LS2 | 400V 6A | 1.08 | 1.25 |
| C122D1 | 400V 8A | 1.11 | 1.28 |
| C122E | 500V 8A | 1.37 | 1.58 |
| S4010LS2 | 400V 10A | 1.25 | 1.44 |
| S2015L | 200V 15A | 1.73 | 1.99 |
| S4015L | 400V 15A | 1.98 | 2.28 |
| S6015L | 600V 15A | 3.43 | 3.95 |
| S2025H | 200V 25A | 2.81 | 3.23 |
| S4025H | 400V 25A | 3.00 | 3.45 |
| S2035H | 200V 35A | 4.10 | 4.71 |
| S4035H | 400V 35A | 4.70 | 5.40 |
| S6035H | 600V 35A | 6.25 | 7.19 |
| **TRIACS & DIACS** | | | |
| AC02DT | 400V 2A | .44 | .50 |
| 2N6073 | 400V 4A | 1.30 | 1.50 |
| Q4006L4 | 400V 6A | 1.40 | 1.61 |
| SC141D | 400V 6A | 1.11 | 1.28 |
| SC146D | 400V 10A | 1.78 | 2.04 |
| BT138 | 600V 10A | 2.04 | 2.35 |
| Q2015L5 | 200V 15A | 1.98 | 2.28 |
| GT40 | | .22 | .28 |
| ST2 | | .22 | .28 |
| Q4015L5 | 400V 15A | 2.20 | 2.53 |
| Q6015L5 | 600V 15A | 3.90 | 4.49 |
| Q4025H | 400V 25A | 4.70 | 5.40 |
| Q6025H | 600V 25A | 6.42 | 7.32 |
| Q4040D | 400V 40A | 7.80 | 8.97 |
| Q6040D | 600V 40A | 13.50 | 15.50 |
| ST4 | | .44 | .50 |
| **OPTO LEDS** | | | |
| LED | Red Rectangle | .21 | .24 |
| LED | Green Rectangle | .30 | .35 |
| LED | Yellow Rectangle | .26 | .30 |
| SEL301G | Green | .26 | .30 |
| SEL302E | Green | .26 | .30 |
| SEL303E | Green | .26 | .30 |
| SEL308E | Green | .30 | .35 |
| SEL101R | Red | .26 | .30 |
| SEL103S | Red | .26 | .30 |
| SEL102S | Red | .26 | .30 |
| SEL108R | Red | .30 | .35 |
| MV53124 | Yellow Square | .70 | .80 |
| MV57124 | Red Square | .70 | .80 |
| MV52124 | Green Square | .70 | .80 |
| 133 | Red Chrome | 1.09 | 1.25 |
| 133 | Amber Chrome | 1.30 | 1.50 |
| 133 | Green Chrome | 1.30 | 1.50 |
| ME7161 | Infrared Led | .83 | .95 |
| MV5752 | Red High Intensity | .54 | .62 |
| MV5152 | Orange " | .54 | .62 |
| MV5252 | Green " | .54 | .62 |
| MV5352 | Yellow " | .54 | .62 |
| MV5353 | Yellow Wide Beam | .54 | .62 |
| MV5491 | Red/Green Dual LED | 3.00 | 3.45 |
| LED | Red Standard | .12 | .14 |
| LED | Green Standard | .18 | .21 |
| LED | Yellow Standard | .18 | .21 |
| SAR3431 | Red Miniture | .15 | .17 |
| CS205 | Green Miniture | .23 | .26 |
| ME7111 | Infrared | .83 | .95 |
| LD599 | Led Flasher | 1.70 | 1.95 |
| MV5153 | Amber Wide Beam | .54 | .62 |
| MV5253 | Green Wide Beam | .54 | .62 |
| MV5353 | Yellow Wide Beam | .54 | .62 |

We specialise in fast service with total customer satisfaction. All items are guaranteed 30 days from date of shipment — user damage excepted. Postage and handling: add $1.50, orders over $50 add $3. All orders sent certified mail. Prices valid 2 months from date of issue. School and govt. orders accepted.

# HIOKI TESTERS

## all with the backing of

## H. ROWE & CO.



**3003** A high sensitivity meter with fuse protection, taut band movement and mirror scale. A.C. current measurement up to 10A, and output terminal for dB readings.

**D.C. VOLTAGE**
Full Scale Value 0.25/2.5/10/50/250/1000V.
Accuracy ± 3% of rated value.
Internal Resistance 30,000Ω/V

**D.C. AMPERAGE**
Full Scale Value 50μA/2.5/25/250mA/10A
Accuracy ± 3% of rated value.

**A.C. VOLTAGE**
Full Scale Value 10/50/250/1000V.
Accuracy ± 3% of rated value.
Internal Resistance 13,500Ω/V

**A.C. AMPERAGE**
Full Scale Value 10A.
Accuracy ± 4% of rated value.

**RESISTANCE (OHMS)**
Full Scale Value 5k/50k/500k/5m Ω (Rc50Ω)
Accuracy ± 3% of scale length.

**LOW FREQUENCY OUTPUT (DECIBELS)**
Full Scale Value −20 + 36 dB.
Accuracy ± 4% of rated value.

**DIMENSIONS**
150 mm H. x 109 mm W. x 60 mm D. Weight 380g.

**ACCESSORIES INCLUDED**
Carry case, test leads, spare fuse, alligator clip.

**3205 DIGITAL MULTIMETER**
A "Field Effect" liquid crystal display ensures good contrast. Approx. 40 hours continuous use with alkaline batteries. Features include– automatic and fuse overload protection and semi-automatic range selection.

**D.C. VOLTAGE** 5 ranges. With auto facility.
200 & 2000 mV ranges: acc. ± 0.3%rdg ± 0.1%f.s. ± 1dgt.
20-200 Volts range: acc. ± 0.5%rdg ± 0.1%f.s ± 1dgt.
200 & 1000 V ranges: acc. ± 1.5%rdg ± 0.1%f.s ± 1dgt.
**D.C. AMPERAGE** 4 ranges. With auto facility.
200 & 2000 μA ranges: acc. ± 1.0%rdg ± 0.1%f.s. ± 1dgt.
20 & 200 mA ranges: acc. ± 1.0%rdg ± 0.1%f.s. ± 1dgt.
**A.C. VOLTAGE** 5 ranges. With auto facility.
2000 mV range: acc. ± 0.3%rdg ± 0.2%f.s. ± 1dgt.
20-200 Volts range: acc. ± 0.8%rdg ± 0.7%f.s. ± 1dgt.
200 Volts range: acc. ± 1.7%rdg ± 0.8%f.s. ± 1dgt.
1000 Volts range: acc. ± 1.7%rdg ± 0.3%f.s. ± 1dgt.
**A.C. AMPERAGE** 4 ranges. With auto facility.
200 μA acc. ± 1.3%rdg ± 1.0%f.s. ± 1dgt.
2000 μA acc. ± 1.3%rdg ± 0.2%f.s. ± 1dgt.
20 & 200 mA ranges: acc. ± 1.3%rdg ± 0.7%f.s. ± 1dgt.
**RESISTANCE (OHMS)** 6 ranges. With auto facility.
200 & 2000Ω ranges: acc. ± 0.5%rdg ± 0.1%f.s. ± 1dgt.
20 & 2000kΩ ranges: acc. ± 0.5%rdg ± 0.1%f.s. ± 1dgt.
2-20mΩ acc. ± 0.7%rdg ± 0.2%f.s. ± 1dgt.
**DIMENSIONS (Approx)**
151 mm H. x 100 mm W. x 56 mm D. Weight 470g.

## MULTIMETERS

**3001** A competitive meter with fuse protection, and an additional Battery Test Calibration facility for speedy checking of small batteries (calculators etc.). A temperature probe is available as an optional extra with a range of −50°C to +200°C.

**D.C. VOLTAGE**
Full Scale Value 0.25/2.5/10/50/250/1000V.
Accuracy ± 3% of rated value.
Internal Resistance 2000Ω/V.

**D.C. AMPERAGE**
Full Scale Value 0.5/10/250mA.
Accuracy ± 3% of rated value.
Voltage Drop 250mV.

**A.C. VOLTAGE**
Full Scale Value 10/50/250/1000V.

**RESISTANCE (OHMS)**
Full Scale Value 3k/30k/300kΩ (Rc 26Ω)

**DIMENSIONS**
130 mm H. x 90 mm W. x 53 mm D. Weight 305g.

**ACCESSORIES**
Carry case, test leads, spare fuse.

**3010** An ultra sensitive meter−100,000Ω/V. (Max). Includes D.C. polarity selector switch, relay and fuse protection, a taut band movement plus an output terminal for dB readings.

**D.C. VOLTAGE**
Full Scale Value 0.1/1/2.5/10/50/250/1000V.
Accuracy ± 3% of rated value.
Internal Resistance 100,000Ω/V.

**D.C. AMPERAGE**
Full Scale Value 10μ/100μ/1/10/100/500 mA /10A
Accuracy ± 3% of rated value.
Voltage Drop 100 mV, 250 mV.

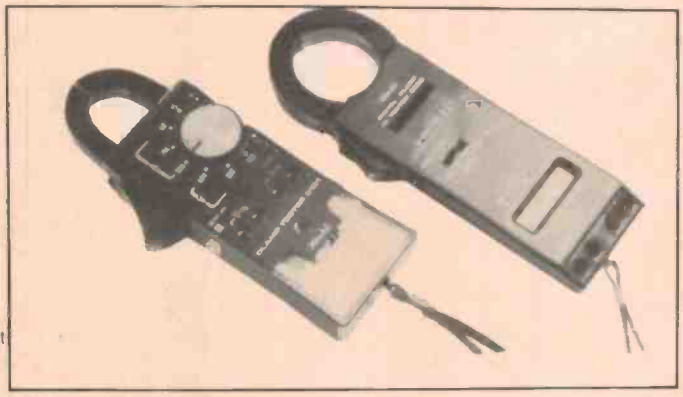
**A.C. VOLTAGE**
Full Scale Value 10/50/250/500/1000V.
Accuracy ± 3% of rated value.
Internal Resistance 10,000Ω/V.

**A.C. AMPERAGE**
Full Scale Value 10A.
Accuracy ± 4% of rated value.

**RESISTANCE (OHMS)**
Full Scale Value 2k/200k/2m/20mΩ (Rc 20Ω)
Accuracy ± 3% of scale length.

**LOW FREQUENCY OUTPUT (DECIBELS)**
−20 +36 dB.

**DIMENSIONS**
170 mm H. x 126 mm W. x 70 mm D. Weight −690g.



## CLAMPTESTERS

**3101** Dustproof case, circuit protection fuse and convenient meter lock. Incorporates the advanced, shock-resisting core magnet taut band movement.

**A.C. AMPERAGE**
6/15/60/150/300A
Accuracy ±3% of rated value.

**A.C. VOLTAGE**
150/300/600 V
Accuracy ±3% of rated value.

**RESISTANCE (OHMS)**
0-1 k Ω (Centre 30 Ω)
Accuracy ±3% of scale length.

**DIMENSIONS**
210 mm H. 86 mm W. 42 mm D. Weight 400 g.

**ACCESSORIES INCLUDED**
Carry case, test leads, spare fuses, alligator clip.

**3206 DIGITAL CLAMP TESTER** A "Field Effect" type liquid crystal display ensures good contrast for low power consumption–approx. 100 hours continuous use with alkaline batteries. Features include auto range selection, peak hold and display hold facilities.

**READING RANGE**
A.C. AMPERAGE
0-20 amp range, 200 and 1000 amps max.
A.C. VOLTAGE
0-1000 volts.
**RESISTANCE (OHMS)** 0-2000Ω
**DIMENSIONS (Approx)**
230 mm H. x 80 mm W. x 38 mm D. Weight 450g.
**ACCESSORIES INCLUDED**
Carry case, test leads, spare fuse, alligator clip.

H.ROWE & CO PTY LTD

**H. ROWE & CO. PTY. LTD.**

54 Racecourse Road, North Melbourne. Ph. 329 6511

SOLE AUSTRALIAN AGENTS

**adelaide brisbane melbourne perth sydney**

# Speaker protection unit saves a saddening experience

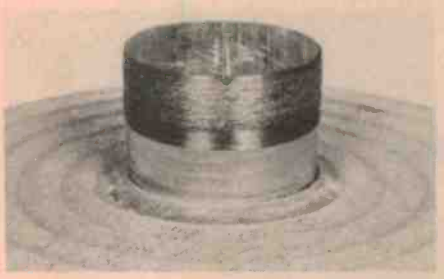
An expensive speaker system can be readily destroyed by a 20 watt amplifier. Carelessness with a high power amplifier (like the ETI-466 for example) can melt voice coils like cheese on toast. We know . . .

**David Tilbrook**

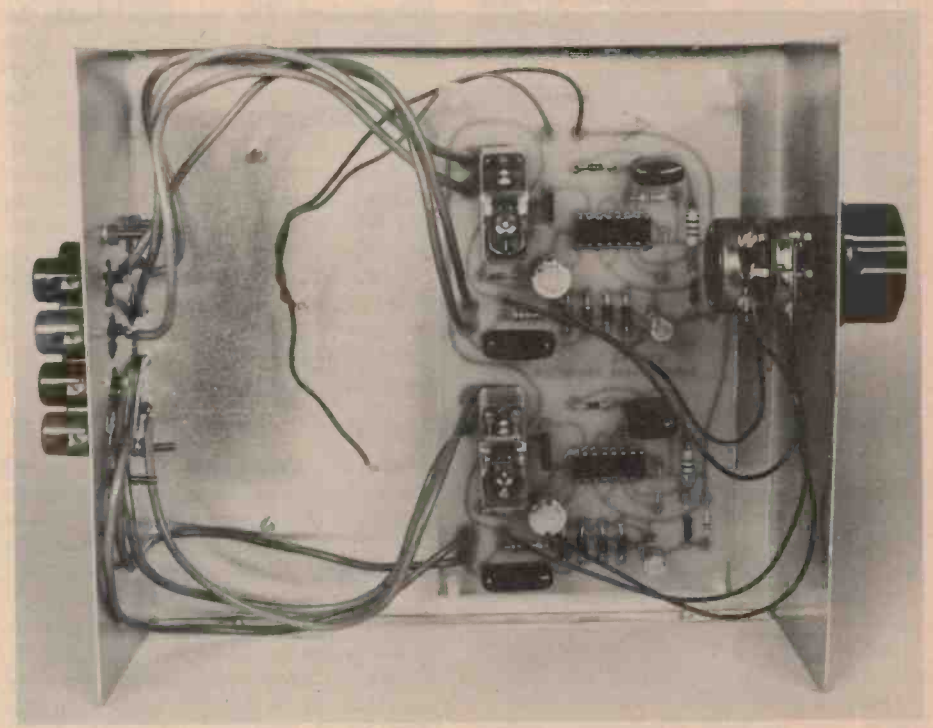
MODERN TRANSISTOR power amplifiers use the technique of dc coupling between the low level amplifier stages and between the output stages and the loudspeaker. This has the advantage of removing coupling capacitors from the signal path, decreasing parts count and improving performance at low frequencies.

Older transistor amplifiers used a single supply rail so the transistors operated between the supply voltage and ground. Since an ac signal has both negative and positive excursions the power amp was designed so that a dc voltage was present on the output stage. Positive excursions would cause an increase of this dc voltage while negative excursions decrease the voltage. Since dc cannot be applied directly to a loudspeaker it was necessary to insert a capacitor, called a blocking or output capacitor, between the output stage and the loudspeaker. The load impedance of the loudspeaker is around eight ohms so the capacitor has to be 5000 $\mu$F to 10 000 $\mu$F before an acceptable low end performance can be obtained.

The solution to these problems was dc coupling. The power amp is run from a 'split supply' so that the output transistors are supplied from a positive and negative supply voltage. The average of these supply rails is zero volts, so the output can be connected directly to the loudspeaker. Both positive and negative excursions are possible due to the split power supply.



What happens *without* the speaker protector.



Internal view of the speaker protector. We mounted the unit in a 'Deluxe Metal Cabinet" from Dick Smith measuring 184 x 160 x 70 mm, but you can choose any similar size cabinet to suit your equipment or even mount single units in your loudspeaker enclosures with preset controls.

Unfortunately, dc coupling also has its disadvantages. The biggest of these is the possibility of damage to the loudspeakers in the case of power amp failure. Since all the stages are dc coupled, a fault anywhere in the power amp can cause the output stage to swing hard against one of the supply rails. The most common power amp fault is a condition in which one or several of the output or driver transistors is destroyed, and this almost always causes the full dc voltage from one of the supply rails to be applied directly to the loudspeaker. The loudspeaker cone is slammed against the suspension and the power dissipation in the voice coil causes a rapid increase of voice coil temperature. In this condition most woofers will survive for only a few seconds. The most dramatic example of this fault I have seen was in a very expensive pair of three-way loudspeakers. They had been connected to a high power tuner-amplifier (150 W/channel) when the output stage had gone faulty. The entire inside of the speaker was one charcoal mass (much to the horror of the owner). The temperature increase in some of the crossover components had set fire to the stuffing inside the box, totally destroying the crossover and drivers.

This type of fault is all too common and is the most expensive fault likely to ▶

occur in a modern hi-fi system. Some top line amplifiers have built in protection circuits with relays that disconnect the loudspeakers should this condition occur, but these are the minority.

This project is an attempt to remedy this situation. The circuit 'looks' at the loudspeaker wires and protects the loudspeakers in two ways. The presence of any dc automatically trips the relay and disconnects the loudspeaker. The protector also looks at the amount of power applied to the loudspeaker. It allows high power transients but will disconnect the loudspeaker if the applied power exceed the loudspeaker rating form more than about 50 milliseconds. In this way the advantage of the improved high power amplifiers is not lost but the loudspeaker is still protected. The circuit includes a two-second monostable delay circuit so that the loudspeaker is automatically reconnected approximately two seconds after the 'fault condition' has been removed.

The project is designed around two standard CMOS ICs. This ensures a very low current consumption and obviates the need for a power switch. This is important since a fault with an amplifier could well occur at the moment of turn-on and it is essential that the loudspeaker protector is already on. When the relay trips, the circuit pulls around 50 mA for each relay so it is important that battery is capable of supplying 100 mA during relay operation. For this reason, the battery specified for this project is an Eveready 276-P or equivalent. There should be no problem with the battery lasting for its shelf life, providing the relays are not tripped more than very occasionally.

## Construction

Start construction with the pc board. Solder the resistors capacitors, diodes and relay first. The diodes and electrolytic capacitors must be inserted the right way round as shown on the pc board overlay. Lastly, solder the transistors and ICs on the board. Again, these devices must be oriented correctly.

The prototype was constructed in a general purpose steel box but this is not critical. The front panel is fitted with a stereo 100k potentiometer. This sets the trip point of the protector so that it can be adjusted for your particular loudspeakers. The rear panel holds the terminals for the wires from the amplifier and loudspeakers. I used two four-way spring terminals. The wiring to the rear panel and to the front potentiometer is shown in the wiring diagram.

Finally, make the connection to the battery. Probably the best way to do this is to screw two self-tapping screws into the battery terminals and solder the wires between these and the pc board. The pc board should be mounted on spacers in the case. Plastic pc board stand-offs are ideally suited for this project as the pc board is small.

## Testing

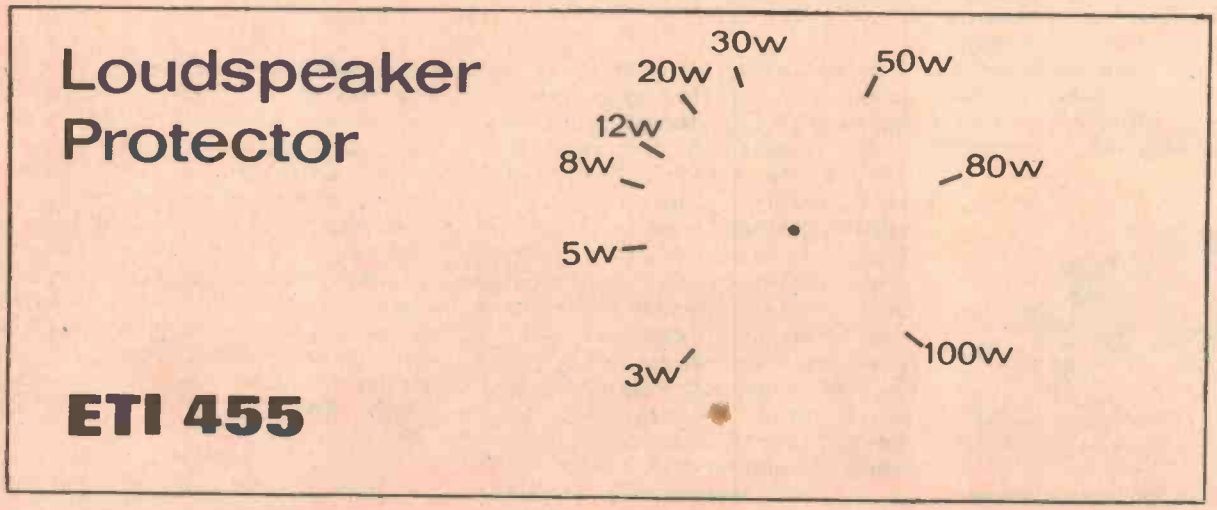
Check the orientation of all polarised components including the transistors and ICs. If all is well cut two short lengths of speaker cable and connect the output of the amplifier to the input of the loudspeaker protector. Connect the speaker cables to the output of the protector. Now switch on the hi-fi system. Choose music with reasonably even amplitude for this test. Turn the front panel level control on the loudspeaker protector for the lowest power and slowly increase the amplifier volume. When the power to the loudspeakers exceeds that set by the potentiometer the protector should trip in and disconnect the loudspeakers.

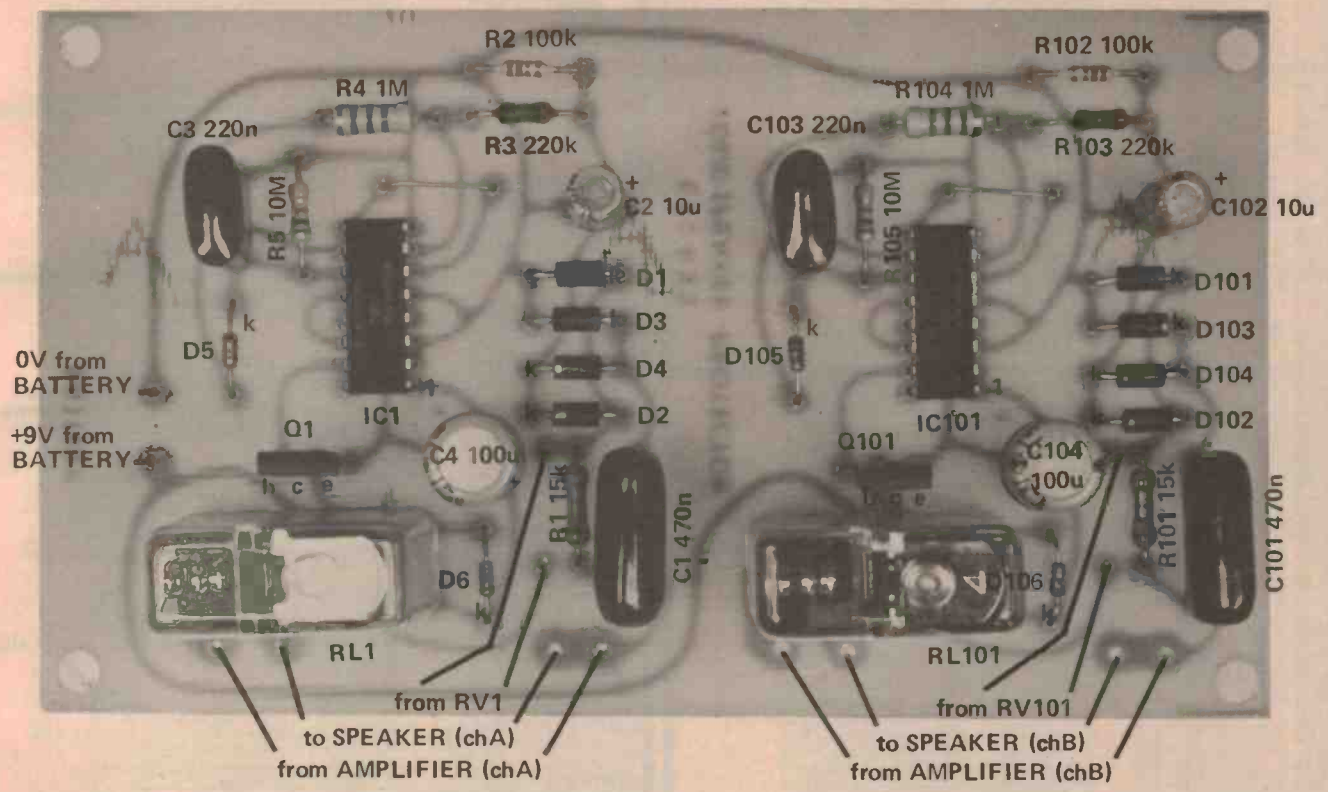
Turn the amplifier down, and the loudspeakers should be reconnected after about two seconds. Since loudspeaker power figures are a rather dubious quantity, it is probably best to establish the correct setting for the

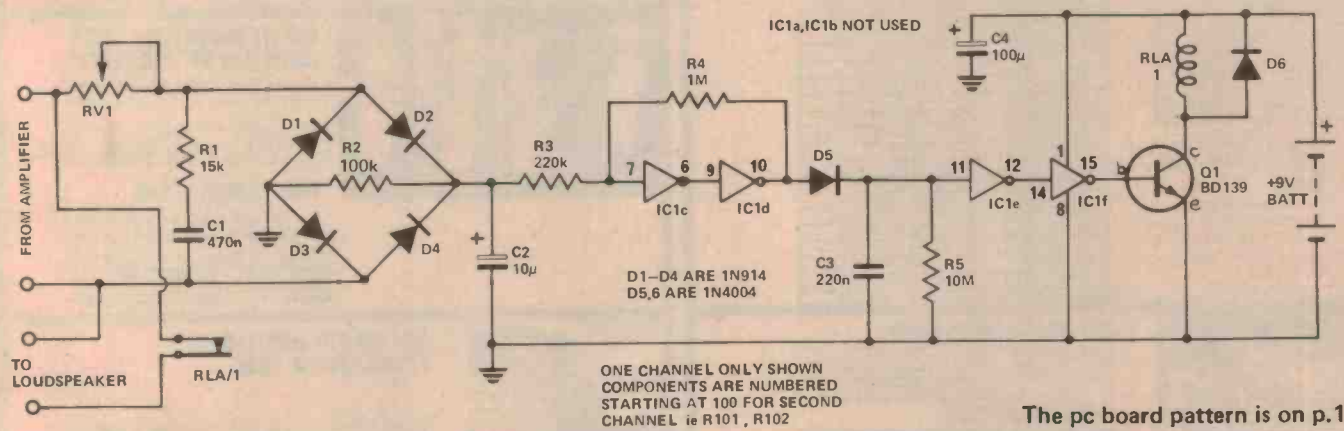
### HOW IT WORKS – ETI 455

The signal voltage from the amplifier is rectified by a full-wave bridge consisting of diodes D1, D2, D3 and D4. The potentiometer RV1 and the resistor R1 and capacitor C1 form a potential divider that determines the sensitivity of the circuit. At normal signal frequencies C1 has a relatively low impedance and the resistance across the diode bridge becomes that of resistor R1, i.e: 15 k. As the frequency approaches dc however, the impedance of this capacitor increases, increasing the sensitivity of the circuit. If a dc voltage is presented to the input C1 acts as an open circuit and the protector is therefore at its most sensitive.

Signal voltges from the full wave rectifier are averaged by the capacitor C2 and R2, and then applied to a Schmitt trigger. The Schmitt trigger is formed from the resistors R3, R4, IC1c and IC1d. This circuit will only respond to a voltage level greater than a preset amount. When this voltage is exceeded (around 6.5 V in this case) the output goes positive charging C3 through diode D5. This diode prevents C3 from being discharged by the Schmitt trigger when its output goes low again so the capacitor can only be discharged by the 10 M resistor R5. This takes about two seconds so this circuit is in reality a simple and effective monostable. Another two stages of the IC drive the transistor which is in series with the relay coil. Diode D6 protects the transistor from large back-EMF voltage spikes produced when the relay is turned off.






The pc board pattern is on p.113

loudspeaker protector experimentally rather than just setting it to the rated power handling of your loudspeakers. Your ears are the best indication that the system is being strained. Set the loudspeaker protector so that it trips just below that volume where distortion starts to occur.

We have done extended tests on the protector, even to the point of connecting expensive loudspeakers and inducing power amp faults that would otherwise destroy a loudspeaker in seconds. In all of these tests the loudspeaker protector has performed well and it is a comforting thought that should a power amp fault occur, it will not take your loudspeakers with it. ●

## PARTS LIST - ETI 455

**Two of each of the following is required for stereo.**

**Resistors** all ½W, 5%
- R1 . . . . . 15k
- R2 . . . . . 100k
- R3 . . . . . 220k
- R4 . . . . . 1M
- R5 . . . . . 10M

**Potentiometers**
- RV1 . . . . .100k lin. (dual for stereo)

**Capacitors**
- C1. . . . . 470n greencap
- C2. . . . . 10µ 25V electrolytic
- C3. . . . . 220n greencap
- C4. . . . . 100µ 25V electrolytic

**Semiconductors**
- Q1 . . . . . BD139
- D1–D4. . . . IN4002, EM402 or similar
- D5, D6 . . . . IN914 or similar
- IC1 . . . . . 4049B Hex inverter

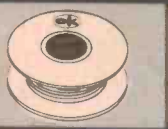
**Miscellaneous**
Only one of each of the following is required.

ETI 455 . . . pc board
12V relay with one C/O, Pye 265/12/C2, four terminals, case - Dick Smith H-2744, knob(s), screws, nuts, pc board spacers.

## JUST WRAP™ WIRE WRAPPING TOOL

WHY CUT? WHY STRIP? WHY SLIT? WHY NOT JUST WRAP?

| | |
|---|---|
| JW-1-B | BLUE WIRE |
| JW-1-W | WHITE WIRE |
| JW-1-Y | YELLOW WIRE |
| JW-1-R | RED WIRE |



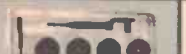
## JUST WRAP REPLACEMENT ROLLS

| | | |
|---|---|---|
| R-JW-B | BLUE WIRE | 50 ft. Roll |
| R-JW-W | WHITE WIRE | 50 ft. Roll |
| R-JW-Y | YELLOW WIRE | 50 ft. Roll |
| R-JW-R | RED WIRE | 50 ft. Roll |



## UNWRAP TOOL FOR JUST WRAP

| | |
|---|---|
| JUW-1 | UNWRAPPING TOOL |



## JUST WRAP KIT

| | |
|---|---|
| JWK-6 | JUST WRAP KIT |

## "HOBBY" WIRE WRAPPING TOOL BATTERY POWERED

| | |
|---|---|
| BW-2630 | FOR AWG 26-30 |

Use "C" size NICAD Batteries, not Included. Bits not included.

| | |
|---|---|
| BT-30 | BIT FOR AWG 30 |
| BT-2628 | BIT FOR AWG 26-28 |


## HOBBY WRAP TOOLS

| | |
|---|---|
| WSU-30 | REGULAR WRAP |
| WSU-30M | MODIFIED WRAP |

## PRE-STRIPPED WIRE WRAPPING WIRE

Wire for wire-wrapping, AWG-30 (0.25mm) KYNAR® wire, 50 wires per package stripped 1" both ends.

® KYNAR PENNWALT

| | |
|---|---|
| 30-B-50-010 | 30 AWG blue Wire, 1" Long |
| 30-Y-50-010 | 30 AWG Yellow Wire, 1" Long |
| 30-W-50-010 | 30 AWG White Wire, 1" Long |
| 30-R-50-010 | 30 AWG Red Wire, 1" Long |
| 30-B-50-020 | 30 AWG Blue Wire, 2" Long |
| 30-Y-50-020 | 30 AWG Yellow Wire, 2" Long |
| 30-W-50-020 | 30 AWG White Wire, 2" Long |
| 30-R-50-020 | 30 AWG Red Wire, 2" Long |
| 30-B-50-030 | 30 AWG Blue Wire, 3" Long |
| 30-Y-50-030 | 30 AWG Yellow Wire, 3" Long |
| 30-W-50-030 | 30 AWG White Wire, 3" Long |
| 30-R-50-030 | 30 AWG Red Wire, 3" Long |
| 30-B-50-040 | 30 AWG Blue Wire, 4" Long |
| 30-Y-50-040 | 30 AWG Yellow Wire, 4" Long |
| 30-W-50-040 | 30 AWG White Wire, 4" Long |
| 30-R-50-040 | 30 AWG Red Wire, 4" Long |
| 30-B-50-050 | 30 AWG Blue Wire, 5" Long |
| 30-Y-50-050 | 30 AWG Yellow Wire, 5" Long |
| 30-W-50-050 | 30 AWG White Wire, 5" Long |
| 30-R-50-050 | 30 AWG Red Wire, 5" Long |
| 30-B-50-060 | 30 AWG Blue Wire, 6" Long |
| 30-Y-50-060 | 30 AWG Yellow Wire, 6" Long |
| 30-W-50-060 | 30 AWG White Wire, 6" Long |
| 30-R-50-060 | 30 AWG Red Wire, 6" Long |

## TRI-COLOR DISPENSER

| | |
|---|---|
| WD-30-TRI | TRI-COLOR DISPENSER |
| R-30-TRI | REPLACEMENT ROLLS |

## WIRE DISPENSER

| | |
|---|---|
| WD-30-B | BLUE WIRE |
| WD-30-Y | YELLOW WIRE |
| WD-30-W | WHITE WIRE |
| WD-30-R | RED WIRE |

## DISPENSER REPLACEMENT ROLLS

| | |
|---|---|
| R-30B-0050 | 30-AWG BLUE 50 FT. ROLL |
| R-30Y-0050 | 30-AWG YELLOW 50 FT. ROLL |
| R-30W-0050 | 30-AWG WHITE 50 FT. ROLL |
| R-30R-0050 | 30-AWG RED 50 FT. ROLL |

®KYNAR PENNWALT

## HOOK-UP WIRE

| | | | |
|---|---|---|---|
| HK-18 | 18 AWG | 25 FT. | SOLID CONDUCTOR |
| HK-20 | 20 AWG | 25 FT. | SOLID CONDUCTOR |
| HK-22 | 22 AWG | 50 FT. | SOLID CONDUCTOR |
| HK-24 | 24 AWG | 50 FT. | SOLID CONDUCTOR |
| HK-26 | 26 AWG | 50 FT. | SOLID CONDUCTOR |
| SHK-18 | 18 AWG | 25 FT. | STRANDED CONDUCTOR |
| SHK-20 | 20 AWG | 25 FT. | STRANDED CONDUCTOR |
| SHK-22 | 22 AWG | 50 FT. | STRANDED CONDUCTOR |
| SHK-24 | 24 AWG | 50 FT. | STRANDED CONDUCTOR |
| SHK-26 | 26 AWG | 50 FT. | STRANDED CONDUCTOR |

## PRB-1 DIGITAL LOGIC PROBE

- DC to > 50 MHZ
- 10 Nsec. pulse response
- 120 K Ω Impedance
- Automatic pulse stretching to 50 Msec.
- Automatic resetting memory
- Open circuit detection
- Automatic threshold resetting
- Compatible with all logic families 4-15 VDC
- Range extended to 15-25 VDC with optional PA-1 adapter
- Supply O.V.P. to ± 70 VDC
- No switches/ no calibration

| | |
|---|---|
| PRB-1 | DIGITAL LOGIC PROBE |

## PROTOTYPE BOARD CM-100

TERMINALS: 1,020 TEST POINTS. 188 separate 5 point terminals, plus 2 horizontal bus lines of 40 common test points each.

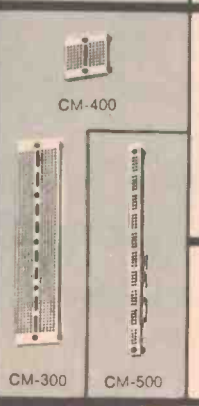
SIZE: 6½" Wide, 5" Long.

| | |
|---|---|
| CM-100 | MODULAR PROTOTYPE BOARD |

## PROTOTYPE BOARD CM-200

TERMINALS: 630 TEST POINTS. 94 separate 5 point terminals, plus 4 bus lines of 40 common test points each. SIZE: 6" Wide, 3½" Long.

| | |
|---|---|
| CM-200 | MODULAR PROTOTYPE BOARD |




## PROTOTYPE BOARD CM-300, CM-400

CM-300 and CM-400 have two separated rows of five interconnected contacts each. Each pin of a DIP inserted in the strip will have four additional tie-points per pin to insert connecting wires. They accept leads and components up to .032 in. diameter. Interconnections are readily made with RW-50 Jumper Wire. All contact sockets are on a .100 in. square grid (1⅜ in. wide).

| | |
|---|---|
| CM-300 | MODULAR PROTOTYPE BOARD |
| CM-400 | MODULAR PROTOTYPE BOARD |

## MODULAR BUS STRIP

CM-500 is a bus strip to be used in conjunction with CM-300 and CM-400 for distribution of power and common signed lines. Two separate rows of common terminals, grouped into clusters of five. All contact sockets are on a .100 in. square grid.

| | |
|---|---|
| CM-500 | MODULAR BUS STRIP |


## DIP IC INSERTION TOOLS WITH PIN STRAIGHTNER

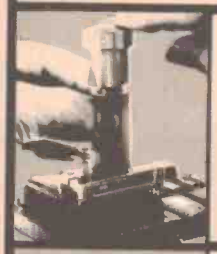
Narrow profile. Pin straightener built into tool. Automatic ejector.

| | |
|---|---|
| INS-1416 | 14-16 PIN DIP/IC INSERTER |

## MOS, CMOS-SAFE

GROUND STRAP NOT INCLUDED

| | |
|---|---|
| MOS-1416 | 14-16 PIN, MOS CMOS SAFE INSERTER |
| MOS-2428 | 24-28 PIN, MOS CMOS SAFE INSERTER |



## 36-40 PIN CMOS-SAFE IC INSERTION TOOL

Aligns bent out pins. Includes terminal lug for attachment of ground strap.

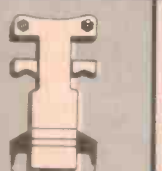
GROUND STRAP NOT INCLUDED

| | |
|---|---|
| MOS-40 | 36-40 PIN CMOS SAFE INSERTION TOOL |

## DIP IC EXTRACTOR TOOL

Extracts all LSI, MSI and SSI devices of from 8 to 24 pins.

| | |
|---|---|
| EX-1 | EXTRACTOR TOOL |



## 24-40 CMOS-SAFE EXTRACTOR TOOL

Removes 24-40 pin IC's, .600" centers. C-MOS safe. Includes terminal lug for attachment of ground strap.

GROUND STRAP NOT INCLUDED

| | |
|---|---|
| EX-2 | CMOS SAFE EXTRACTOR TOOL |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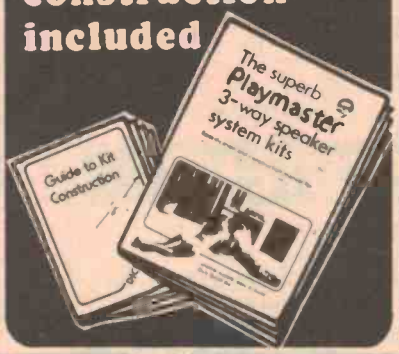


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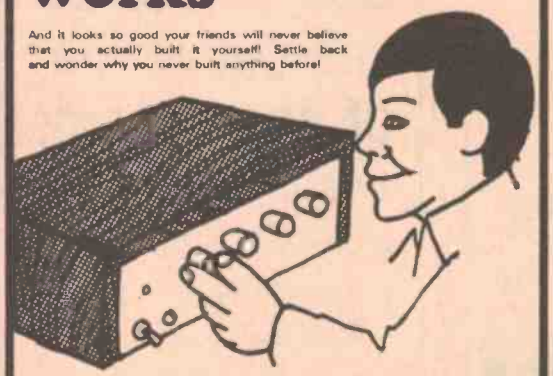

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# DICK SMITH ELECTRONICS

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# This over-rev alarm could save you money!

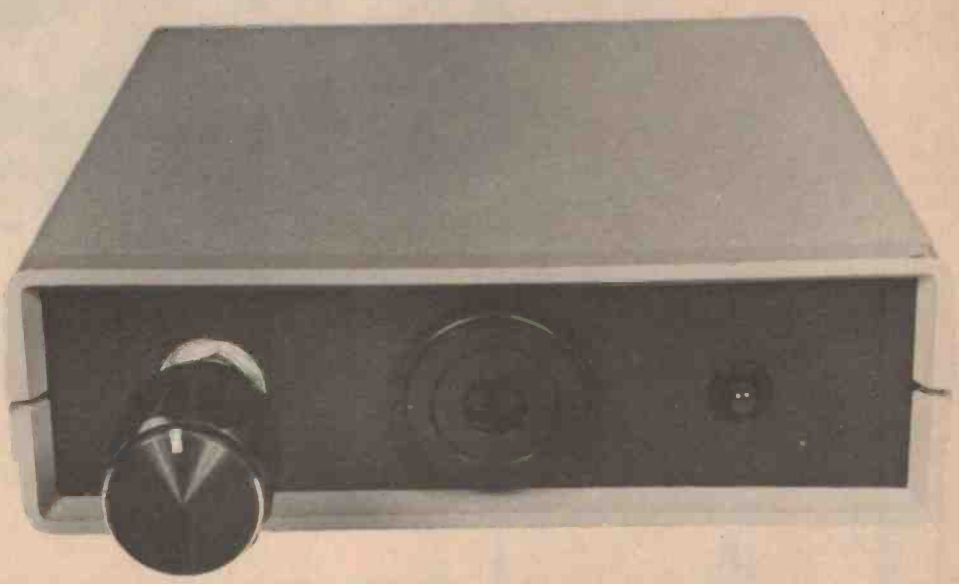
This versatile little project will let you know that you're about to blow up your engine as well as when you're exceeding the speed limit.

IT IS EASY to exceed the rev limit of a vehicle's engine when changing gears at highway speeds, courting danger from an engine failure. This alarm will let you know, in no uncertain fashion, *before* you approach the danger point (i.e: the red line on your tacho – if your vehicle has one). Most tachometers, owing to their construction, have a lag between the actual engine RPM and the RPM they indicate, so that, even if you keep an eye on your tacho you could dangerously exceed the indicated maximum RPM of your engine.

This alarm has no lag problem. When set to sound at an engine speed below the manufacturer's limit, you'll get plenty of warning.

Apart from its usefulness as an over-rev alarm, this project can let you know when you have exceeded a set road speed . . . and it's cheaper than a radar detector and can never be fooled!

The alarm specified is loud enough to be heard in even the noisiest of vehicle cabins.



## The circuit

This alarm is designed for vehicles fitted with a 12 volt electrical system and is driven from the ignition system's contact breaker points. The alarm can be used to indicate when one of four pre-set speeds have been exceeded or when the engine speed exceeds a pre-set rev limit – much the same as a red line on a tacho, but this unit gives an indication you can't ignore!

When used as a speed limit alarm the four pre-sets can be set to different speed limits, say 60 km/h, 100 km/h, 110 km/h and 120 km/h. Of course these speeds will only be accurate in top gear, so the unit should be provided with a switch to turn it off when driving around town. Its main use will be on country trips and on expressways.

When used as an over-rev alarm only one range will be necessary so the switch and three unused trim pots can be left out. The unit can be set to any rev limit, say 6000 revs, to indicate when you're coming close to over-revving the engine. The actual limit depends on the particular engine in your vehicle.

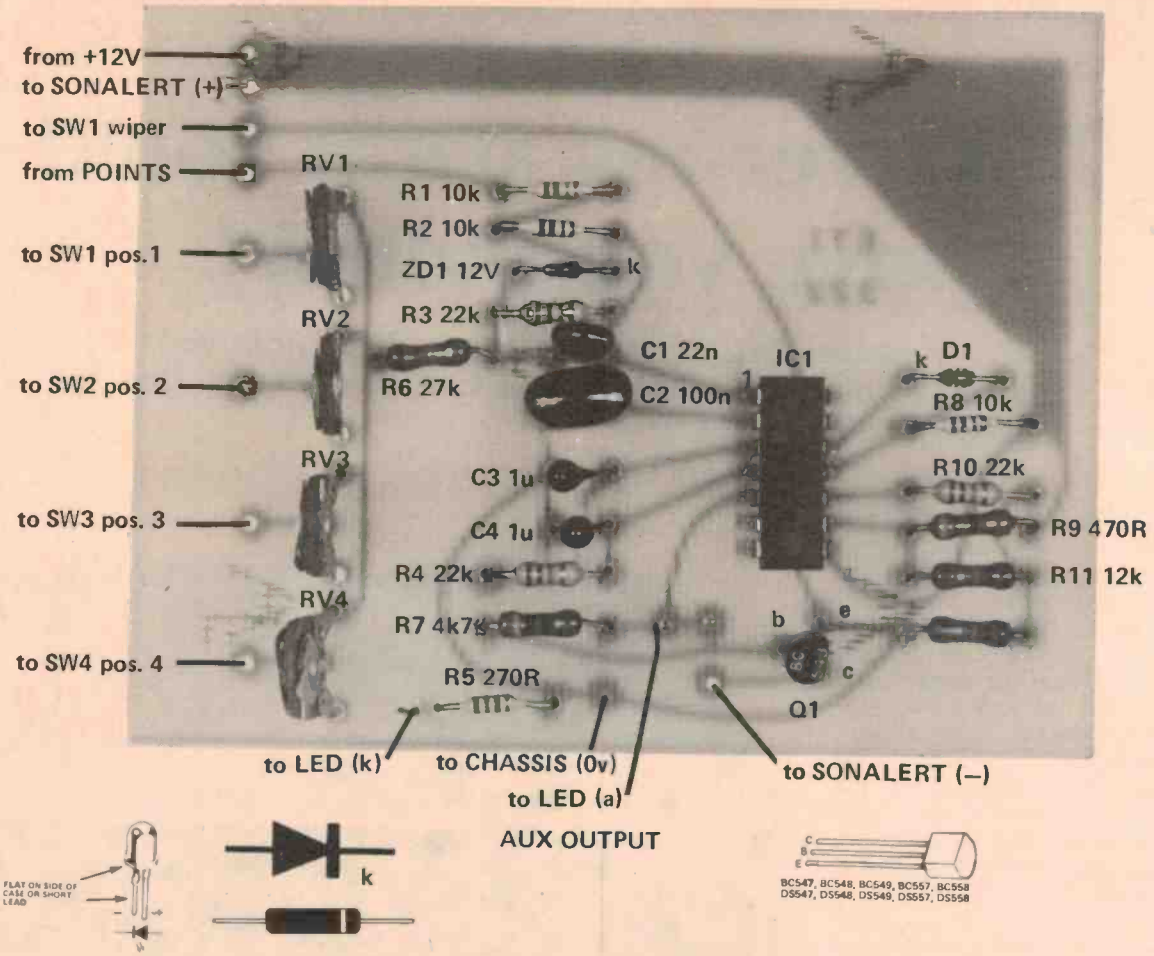
The unit could be used as both an over-rev alarm and a speed alarm by using one switch position as a rev alarm and the other three set to speed limits in top gear. For city driving it would be left in the over-rev position and switched over in the country.

When the engine speed reaches the pre-set limit the LED lights, (we used a flashing LED) and the Sonalert alarm sounds. The Sonalert is very loud and can be left off or reduced in level with a series resistor. A relay can be used in place of the Sonalert, to control an external circuit, but never use it to turn off the ignition. You are likely to need the full power of the engine to avoid a collision!

The circuit employs an LM2917 frequency-to-voltage converter recently released by National. The input waveform from the points switches a comparator and charges a capacitor, C3, from a charge pump. The charge on the capacitor is proportional to the frequency and is set by the values of C3 and the trim pots. When the voltage rises to a pre-set limit the second comparator switches and an output from the chip, on pin 5, lights the LED and drives Q1.

## Construction

The over-rev alarm can either be incorporated into the car under the dash, with the switches and LED mounted on ▶










The pc board pattern is on p.113

## PARTS LIST - ETI 322

**Resistors** all ½W, 5%
- R1, R2 . . . . . 10k
- R3, R4 . . . . . 22k
- R5 . . . . . 270R
- R6 . . . . . 27k
- R7 . . . . . 4k7
- R8 . . . . . 10k
- R9 . . . . . 470R
- R10. . . . . 22k
- R11, R12 . . . 12k

**Potentiometers**
- RV1–RV4. . . 100k min vert mounting trim pots

**Capacitors**
- C1. . . . . 22n greencap
- C2. . . . . 100n greencap - see text
- C3, C4 . . . . . 1µ 33V tantalum

**Semiconductors**
- D1 . . . . . 1N914 or similar
- ZD1. . . . . 12V, 400 mW zener diode
- LED1. . . . . TIL220R LED or similar OR flashing LED (see text)
- Q1 . . . . . BC558, BC108 or similar
- IC1 . . . . . LM2917N

**Miscellaneous**
- ETI 322 . . . . pc board
- SW1. . . . . one pole four position rotary switch

Sonalert alarm or similar, case to suit (see Shoparound on page 73.)

## HOW IT WORKS – ETI 322

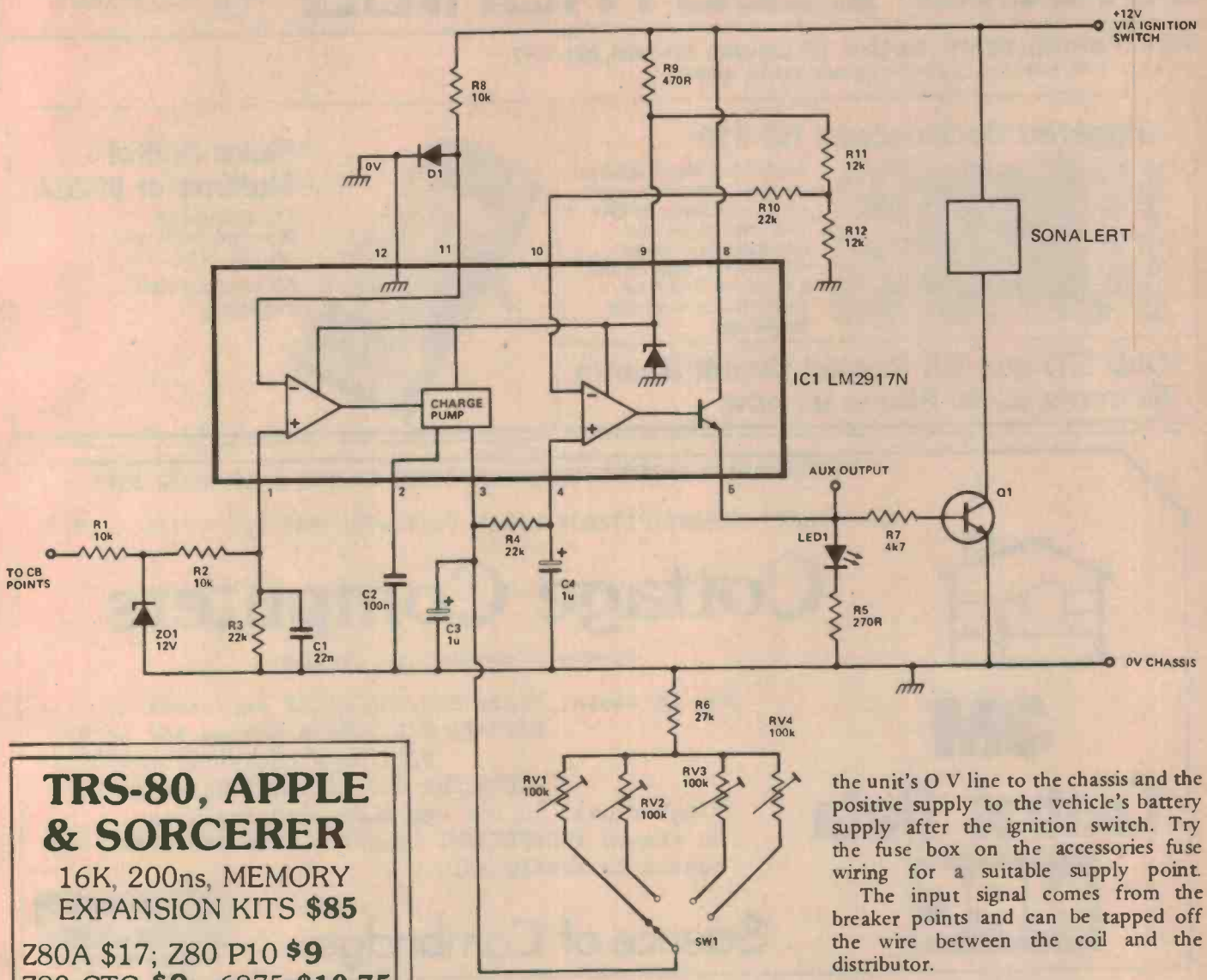
The alarm detects the engine RPM by looking at the pulses from the contact breaker points. These pulses are used to charge a capacitor, so the voltage on that capacitor is linear with respect to pulse frequency. When the voltage across the capacitor reaches a pre-set value a comparator switches over, lights the LED and turns on the Sonalert alarm.

When in top gear, the engine speed is proportional to road speed. The frequency of the pulses from the points is therefore also proportional to road speed. The pulses are fed through a current limit resistor, R1, and to a zener diode ZD1. This insures that no damaging high voltage spikes reach the IC. The pulses are then differentiated by C1 and fed to the non-inverting input of a comparator. The inverting input is clamped by D1 to about 0.6 V. The comparator switches when the input pulse is greater than 0.6 V. This avoids triggering of the comparator on noise.

The charge pump is controlled by the output of the comparator which puts a constant current pulse into the charge capacitor C3. The length of this pulse is determined by the value of C2. The voltage across C3 then rises linearly with frequency as the pulse repetition rate increases. The range resistors vary the discharge time of the charging capacitor, thus varying the voltage across it for a given frequency.

The voltage across the timing capacitor is monitored by a second comparator. The switching point for this comparator is set by the voltage divider R11 and R12 on its inverting input. When the voltage on the charging capacitor reaches this fixed voltage the comparator switches and the output on pin 5 goes high.

The LED lights and Q1 switches on, turning on the Sonalert alarm. The supply for the IC and the reference voltage for the second comparator come from an internal, zener-regulated supply, the output of this being connected to pin 9.






a small bracket or it can be built into a small plastic box, as we have done (see Shoparound).

Mount all the components on the pc board being careful with the orientation of the IC and tantalum capacitors. The value of C2 must be chosen to provide a suitable rev range for your vehicle. A value of 100n enables a rev span of 1500 to 6000 revs to be covered on a four cylinder, four stroke engine. If your engine is an eight cylinder four stroke or a four cylinder two stroke use 47n to get the same rev range. For six cylinder four stroke engines use a value of 68n. If you have a motor bike or racing car, decreasing the value of C2 will increase the maximum rev setting.

Once the unit is constructed, mount it in a convenient position in the car within easy reach of the driver. Connect the unit's O V line to the chassis and the positive supply to the vehicle's battery supply after the ignition switch. Try the fuse box on the accessories fuse wiring for a suitable supply point.

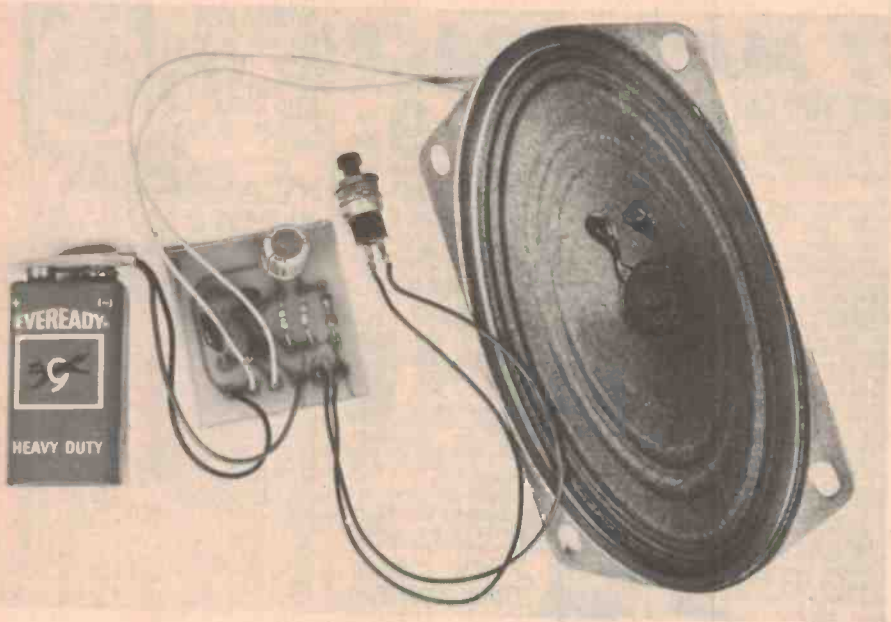
The input signal comes from the breaker points and can be tapped off the wire between the coil and the distributor.

## Calibration

This is a two-man job with one person driving the car to the required speed while the other adjusts one of the trim pots. This has to be done for each speed setting. Adjusting the rev limit is a little more difficult since few cars will reach their top revs in top gear. In any case, they would be doing well over 160 km/h. A little fast. If you have a friend with a tacho this is the easiest way. If not, the unit can be set from the manufacturer's data. Information is available for each car showing the speed per thousand revs in each gear. Simply choose a suitable gear, say second, and multiply the number of thousand revs you want to set the limit to by the speed per thousand revs in that gear. Drive the car up to that speed in the gear and set the trim pot so the alarm just sounds. Once set, the unit should not require attention. ●

# Simple siren is fun to build and interesting to play with

You can simulate an air raid siren, or that of a fire engine, with this simple project. Learn while you build, too.




ELECTRONIC CIRCUITS that simulate everyday sounds are always popular with beginners. We receive many requests, and quite a few circuit suggestions, for such things. This project comes from a circuit idea sent in by Mr. W.T. Geary of Rossmoyne in Perth, W.A.

The circuit employs a cunning, yet simple oscillator, the frequency of which is made to rise and fall in pitch by charging and discharging a capacitor.

## How it works

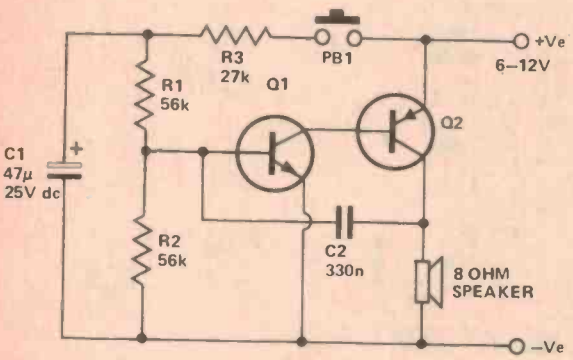
For the moment, let's ignore what C1 does and look at the circuitry around Q1 and Q2. These two transistors, an NPN and a PNP type respectively, are connected as a non-inverting amplifier. That is, a rising voltage (positive-going) on the base of Q1 will cause the voltage across the speaker to rise towards the positive rail. Conversely, a falling voltage (negative-going) on the base of Q1 will result in a falling voltage across the speaker.

This circuit has been arranged to have positive feedback applied via the capacitor C2. This means that some of the output signal is fed back to the input in the same phase. The amplifier must have sufficient gain to overcome any losses in the feedback components. That's no problem in this circuit. As the input and output are in phase, the feedback (i.e: C2) is simply connected between the collector of Q2 and the base of Q1.

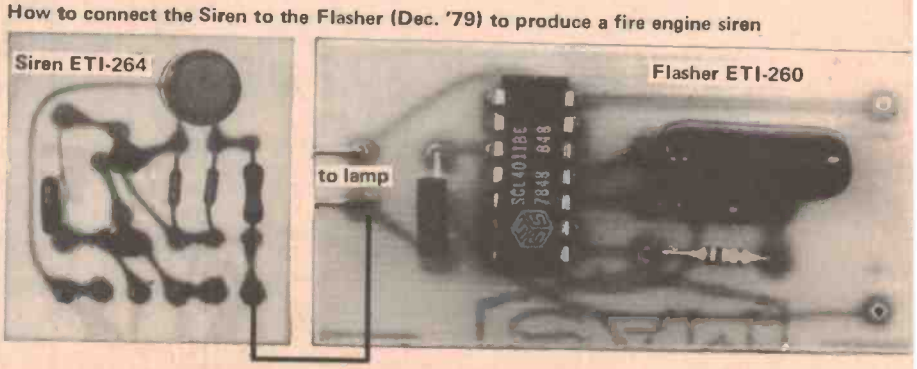
When the pushbutton, PB1, is pushed (still remembering that C1 is 'not there'), Q1 will be forward biased and collector current will start to flow. It must flow via the base-emitter junction of Q2, thus Q2 will start to turn on. The voltage across the loudspeaker will start to rise. The feedback capacitor, C2, will start to charge then causing Q1, and thus Q2, to 'turn on' harder. The voltage across the loudspeaker will rise more . . . and so on until both Q1 and Q2 are 'hard on' and the voltage across the loudspeaker is pretty much that of the supply. All this occurs very rapidly.

The amplifier now has no gain and Q1 will commence to turn off, causing Q2 to turn off. As the voltage across the speaker will then begin to fall, the feedback via C2 will cause the voltage on the base of Q1 to fall, turning it off further, along with Q2. This proceeds until Q1 and Q2 both turn off. C2 will discharge via R2 and the speaker, removing the feedback.

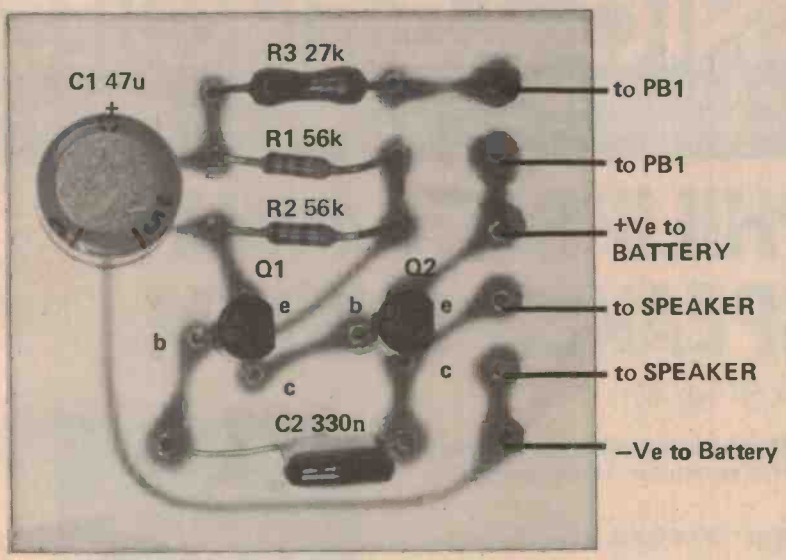
Now Q1 will start to turn on again, and the whole cycle will repeat. In fact, it repeats at many thousands of cycles per second, the frequency of oscillation being largely determined by C2, the resistor values and the supply voltage. Increasing the value of C2 will decrease the frequency of oscillation and vice versa. The operation of this circuit, simple though it appears, is quite




How to connect the Siren to the Flasher (Dec. '79) to produce a fire engine siren




The pc board pattern is on page 113




complex, requiring some fancy mathematics to understand it properly. The above explanation should be clear enough for most purposes.

Now, let's see what C1 does. When the pushbutton is operated, C1 will initially appear as a short circuit and the oscillator will not work. However, C1 will begin to charge via R3 until the voltage across it is sufficient to forward bias Q1, starting the oscillator. But, it will start at a low frequency, increasing as the voltage across R1/R2 increases. When the pushbutton is released, C1 will discharge via R1 and R2 and the oscillator frequency will fall. As the pushbutton is alternately pressed and released, the pitch of the sound from the loudspeaker will rise and fall in sympathy.

## Construction

This is fairly straightforward as there is nothing critical about placement of the components. However, take care with the orientation of the electrolytic capacitor (C1) and the two transistors. Although this circuit can be readily assembled on a piece of matrix board (as per the actual circuit diagram!) we elected to use a pc board. The speaker, battery and pushbutton are all attached via flying leads as shown in the photograph. Note that the pushbutton is a momentary-contact, push-to-make type and that a 10 ohm speaker will also work in this circuit.

When connecting the battery or supply, make sure you have the leads the right way round as reverse connection could destroy the transistors.

## Try these changes

If you increase the value of capacitor C1 you can make this circuit sound like an air raid siren. Swap the pushbutton for a toggle switch. When you turn it on, the pitch will rise slowly over some seconds until it reaches a maximum frequency. Try a value of 470u or 1000u for C1. You can increase the maximum pitch of the sound by decreasing the value of C2. Try a 270n. For a lower maximum pitch, increase the value of C1 to say 470n or even 680n.

To make a continuous 'fire engine' siren you'll need to build up the flasher, Project 260, described in our December 1979 issue (page 58). The pushbutton will not be needed, instead, connect R3 of this siren to the emitter of Q1 in the flasher as shown in the accompanying diagram. The two projects should share the same supply, of course. You can omit the lamp in the flasher if you wish.

Now, as the flasher cycles on and off, the siren will operate, rising and falling in pitch in sympathy . . . and you have a fire engine siren. ●

### PARTS LIST - ETI 264

| | |
|---|---|
| **Resistors** | all ½W, 5% |
| R1, R2 | 56k |
| R3 | 27k |
| **Capacitors** | |
| C1 | 47μ, 25V electrolytic |
| C2 | 330n greencap |
| **Semiconductors** | |
| Q1 | BC108, BC548, DS548 or similar |
| Q2 | BC178, BC558, DS558 or similar |
| **Miscellaneous** | |
| PB1 | momentary pushbutton, push-to-make type, eight ohm speaker, ETI 264 pc board |

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|---|---|
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| AD162 | 2.20 |
| BC107 | .35 |
| BC108 | .35 |
| BC108C | .39 |
| BC109 | .35 |
| BC109C | .40 |
| BC177 | .35 |
| BC177B | .65 |
| BC178 | .35 |
| BC179 | .40 |
| BC318 | .22 |
| BC319 | .22 |
| BC320 | .22 |
| BC182B | .20 |
| BC286 | .16 |
| BC287 | .16 |
| BC327 | .30 |
| BC337 | .30 |
| BC338 | .30 |
| BC547 | .19 |
| BC548 | .19 |
| BC549 | .19 |
| BC549C | .20 |
| BC557 | .20 |
| BC558 | .20 |
| BC559 | .20 |
| BC639 | .40 |
| BC640 | .40 |
| BCY71 | .69 |
| BD131 | .65 |
| BD139 | .59 |
| BD140 | .59 |
| BD262 | 1.20 |
| BD263 | 1.20 |
| BD647 | 1.90 |
| BD648 | 1.90 |
| BDV64B | 3.19 |
| BDV65B | 3.19 |
| BF115 | .65 |
| BF338 | .90 |
| BFW10 | 1.40 |
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| BFY50 | .85 |
| BFY51 | .85 |
| BFY90 | 1.50 |
| BU126 | 3.90 |
| BUX80 | 9.95 |
| MJ802 | 4.20 |
| MJ2955 | .90 |
| MJ4502 | 4.20 |
| MJE340 | 1.30 |
| MJE2955 | 1.50 |
| MPF102 | .60 |
| MPS3565 | .18 |
| MPS3538 | .18 |
| MPSA05 | .30 |
| MPSA06 | .30 |
| MPSA12 | .50 |
| MPSA14 | .45 |
| MPSA55 | .30 |
| MPSA92 | .40 |
| MPSA93 | .55 |
| PN3564 | .24 |
| PN3565 | .18 |
| PN3566 | .18 |
| PN3567 | .18 |
| PN3568 | .18 |
| PN3569 | .18 |
| PN3638 | .18 |
| PN3638A | .22 |
| PN3641 | .20 |
| PN3642 | .20 |
| PN3643 | .20 |
| PN3644 | .22 |
| PN3645 | .22 |
| PN3646 | .22 |
| PN3693 | .29 |
| PN3694 | .29 |
| PN4121 | .35 |
| PN4248 | .22 |
| PN4250 | .29 |
| PN4355 | .29 |
| TIP31A | .65 |
| TIP31C | .85 |
| TIP32C | .85 |
| TIP2955 | 1.60 |
| TIP3055 | 1.00 |
| TT800 | 1.20 |
| TT801 | 1.20 |
| 2N697 | .60 |
| 2N918 | .65 |
| 2N2102 | .82 |
| 2N2219 | .50 |
| 2N2219A | .65 |
| 2N2222A | .35 |
| 2N2368 | .25 |
| 2N2484 | .55 |
| 2N2646 | 1.00 |
| 2N2647 | 1.20 |
| 2N2904 | .50 |
| 2N2905 | .50 |
| 2N2905A | .50 |
| 2N2906A | .50 |
| 2N2907 | .50 |
| 2N2907A | .50 |
| 2N3053 | .55 |
| 2N3054 | .90 |
| 2N3055 | .75 |
| 2N3107 | 1.20 |
| 2N3300 | .85 |
| 2N3302 | .60 |
| 2N3638 | .55 |
| 2N3638A | .59 |
| 2N3642 | .59 |
| 2N3702 | .20 |
| 2N3703 | .30 |
| 2N3704 | .30 |
| 2N3740 | 1.60 |
| 2N3819 | .40 |
| 2N3904 | .25 |
| 2N3906 | .20 |
| 2N4030 | 1.00 |
| 2N4032 | .80 |
| 2N4033 | 1.00 |
| 2N4036 | 1.20 |
| 2N4037 | 1.30 |
| 2N4231 | 1.20 |
| 2N4234 | 2.10 |
| 2N4235 | 1.70 |
| 2N4238 | 1.90 |
| 2N4401 | .20 |
| 2N4403 | .20 |
| 2N5086 | .25 |
| 2N5087 | .25 |
| 2N5088 | .30 |
| 2N5089 | .25 |
| 2N5210 | .50 |
| 2N5458 | .50 |
| 2N5459 | .55 |
| 2N5461 | .90 |
| 2N5462 | .90 |
| 2N5485 | .65 |
| 2N5871 | 1.70 |
| 2N5872 | 2.25 |
| 2N5873 | 1.70 |
| 2N5874 | 1.85 |
| 2N6027 | 1.00 |
| 2N6124 | 1.20 |
| 2N6126 | 1.30 |
| 2N6129 | 1.40 |
| 2N6130 | 1.30 |
| 2N6132 | 1.60 |
| 2N6134 | 1.70 |
| 3N140 | 1.70 |
| 3N201 | 1.60 |
| 3N210 | 1.70 |
| 40673 | 1.40 |

**DIODES**

| | |
|---|---|
| AAY30 | .40 |
| BA244 | .22 |
| BP104 | 2.80 |
| BYX71 | 1.20 |
| HP5082 | |
| 2800 | 2.50 |
| OA47 | .40 |
| OA90 | .20 |
| OA91 | .20 |
| OA636 | .70 |
| P600G | .90 |
| 1N3493 | 1.70 |
| 1N3493R | 1.70 |
| 1N4001 | .08 |
| 1N4002 | .10 |
| 1N4004 | .10 |
| 1N4007 | .20 |
| 1N4148 | .06 |
| 1N5404 | .40 |
| 1N5408 | .80 |

**BRID. RECT.**

| | |
|---|---|
| 400V,1A | 1.50 |
| 400V6A | 3.60 |
| 200V1½A | .75 |
| 100V 2A | .95 |
| 100V35A | 3.40 |

**VOLT. REG.**

| | |
|---|---|
| 309K | 1.90 |
| 317T | 2.90 |
| 317K | 2.90 |
| 323K | 8.95 |
| 723 | .55 |
| 7805 | 1.00 |
| 7805K | 2.10 |
| 7812 | 1.00 |
| 7812K | 2.40 |
| 7815 | 1.00 |
| 7818 | 1.00 |
| 7824 | 1.00 |
| 78H05 | 7.50 |
| 78H12 | 7.50 |
| 78HG | 7.95 |
| 78P05 | 8.00 |
| 78L05 | .40 |
| 78L09 | .40 |
| 78L12 | .40 |
| 78L15 | .40 |
| 78L18 | .40 |
| 78L24 | .40 |
| 78CB | 2.40 |
| 7905 | 1.85 |
| 7905K | 2.95 |
| 7906 | 1.85 |
| 7908 | 1.85 |
| 7912 | 1.85 |
| 7912K | 2.95 |
| 7915 | 1.85 |
| 7918 | 1.85 |
| 7924 | 1.85 |
| 79HG | 10.80 |
| 79L03 | .95 |
| 79L05 | .95 |
| 79L12 | .95 |
| 79L15 | .95 |
| 79L18 | .95 |
| 79L24 | .95 |
| 78MGT2C | 1.80 |
| 79MGT2C | 1.80 |

**LINEAR**

| | |
|---|---|
| 301 | .40 |
| 307 | .70 |
| 308 | 1.20 |
| 310 | 2.60 |
| 311 | .70 |
| 318 | 3.20 |
| 324 | 1.00 |
| 339 | .90 |
| 358 | .70 |
| 377 | 2.70 |
| 378 | 4.20 |
| 379S | 6.90 |
| 380-8 | 1.50 |
| 380N14 | 1.50 |
| 381 | 2.30 |
| 381AN | 3.96 |
| 382 | 2.00 |
| 388 | 1.38 |
| 555 | .35 |
| 556 | 1.20 |
| 565CH | 3.30 |
| 566 | 3.10 |
| 567CH | 3.00 |
| 709 | .80 |
| 710 | .80 |
| 711 | .80 |
| 741 | .30 |
| 747 | 1.00 |
| 748 | .60 |
| 771 | .50 |
| 1458 | .60 |
| 1558 | 1.90 |
| 2917 | 3.20 |
| 3089 | 4.20 |
| 3914 | 4.50 |
| 7392 | 3.30 |
| CA3046 | 1.65 |
| CA3086 | .65 |
| CA3130 | 1.50 |
| CA3140 | 1.50 |
| CA3302 | .70 |
| CA3401 | .80 |
| MC1494L | 6.65 |
| OM350 | 7.90 |
| RC4136 | 1.45 |

**PROMS**

| | |
|---|---|
| 93448 | 10.50 |
| 2708 | 12.00 |

**INTERFACE**

| | |
|---|---|
| 1488 | 1.00 |
| 9368 | 2.30 |
| 8T24 | 2.20 |

**RAMS**

| | |
|---|---|
| 2102A-4 | 1.90 |
| 2114-N | 6.50 |
| 2114-3 | 8.00 |
| 2102 | 1.60 |

**74LS**

| | |
|---|---|
| 74LS00 | .30 |
| 74LS01 | .30 |
| 74LS02 | .30 |
| 74LS03 | .30 |
| 74LS04 | .30 |
| 74LS05 | .30 |
| 74LS08 | .30 |
| 74LS09 | .30 |
| 74LS10 | .30 |
| 74LS11 | .35 |
| 74LS12 | .30 |
| 74LS14 | .80 |
| 74LS15 | .75 |
| 74LS16 | .60 |
| 74LS20 | .30 |
| 74LS21 | .35 |
| 74LS27 | .30 |
| 74LS28 | .35 |
| 74LS30 | .30 |
| 74LS32 | .30 |
| 74LS37 | .40 |
| 74LS38 | .40 |
| 74LS40 | .30 |
| 74LS42 | .45 |
| 74LS73 | .60 |
| 74LS74 | .40 |
| 74LS75 | .50 |
| 74LS78 | .65 |
| 74LS85 | 1.40 |
| 74LS86 | .60 |
| 74LS90 | .60 |
| 74LS92 | 1.00 |
| 74LS93 | .85 |
| 74LS95 | 1.00 |
| 74LS107 | .65 |
| 74LS109 | .50 |
| 74LS113 | .50 |
| 74LS114 | .55 |
| 74LS125 | .70 |
| 74LS133 | .30 |
| 74LS138 | 1.10 |
| 74LS151 | 1.00 |
| 74LS157 | .75 |
| 74LS160 | .70 |
| 74LS163 | .80 |
| 74LS164 | 1.40 |
| 74LS165 | 1.40 |
| 74LS169 | 1.90 |
| 74LS174 | .65 |
| 74LS175 | .90 |
| 74LS190 | 1.60 |
| 74LS191 | 1.30 |
| 74LS192 | 1.15 |
| 74LS193 | 1.00 |
| 74LS194 | 1.20 |
| 74LS195 | 1.00 |
| 74LS196 | 1.60 |
| 74LS197 | 1.60 |
| 74LS221 | 1.50 |
| 74LS247 | 1.95 |
| 74LS251 | .85 |
| 74LS253 | .85 |
| 74LS257 | .75 |
| 74LS259 | 2.20 |
| 74LS279 | .70 |
| 74LS290 | 1.30 |
| 74LS365 | .80 |
| 74LS366 | .80 |
| 74LS367 | .90 |
| 74LS368 | .65 |

**7400 TTL**

| | |
|---|---|
| 7400 | .30 |
| 7401 | .30 |
| 7402 | .30 |
| 7403 | .30 |
| 7404 | .30 |
| 7405 | .30 |
| 7406 | .60 |
| 7407 | .45 |
| 7408 | .30 |
| 7409 | .30 |
| 7410 | .30 |
| 7413 | .55 |
| 7414 | .60 |
| 7416 | .60 |
| 7417 | .65 |
| 7420 | .30 |
| 7421 | .30 |
| 7422 | .35 |
| 7426 | .40 |
| 7427 | .40 |
| 7430 | .30 |
| 7432 | .30 |
| 7437 | .40 |
| 7438 | .40 |
| 7439 | .50 |
| 7440 | .30 |
| 7442 | .80 |
| 7447 | 1.10 |
| 7448 | 1.10 |
| 7450 | .30 |
| 7451 | .30 |
| 7453 | .30 |
| 7454 | .30 |
| 7460 | .30 |
| 7470 | .50 |
| 7472 | .55 |
| 7473 | .55 |
| 7474 | .35 |
| 7475 | .45 |
| 7476 | .40 |
| 7480 | 1.00 |
| 7483 | 1.40 |
| 7486 | .55 |
| 7489 | 2.90 |
| 7490 | .40 |
| 7491 | 1.00 |
| 7492 | .80 |
| 7493 | .50 |
| 7494 | 1.15 |
| 7495 | 1.00 |
| 7496 | 1.10 |
| 74100 | 2.00 |
| 74107 | .70 |
| 74121 | .70 |
| 74123 | .85 |
| 74132 | 1.30 |
| 74145 | 1.50 |
| 74150 | 1.50 |
| 74151 | 1.40 |
| 74153 | 1.40 |
| 74154 | 1.40 |
| 74157 | 1.40 |
| 74160 | 1.70 |
| 74165 | 1.70 |
| 74172 | 1.40 |
| 74173 | 2.60 |
| 74175 | 1.20 |
| 74180 | 1.50 |
| 74188 | 3.00 |
| 74192 | 1.80 |
| 74193 | 1.80 |
| 74367 | .90 |

**CMOS**

| | |
|---|---|
| 4000 | .30 |
| 4001 | .38 |
| 4002 | .40 |
| 4007 | .30 |
| 4008 | 1.20 |
| 4011 | .38 |
| 4012 | .30 |
| 4013 | .65 |
| 4014 | 1.40 |
| 4015 | 1.20 |
| 4016 | .60 |
| 4017 | 1.30 |
| 4018 | 1.30 |
| 4020 | 1.40 |
| 4021 | 1.30 |
| 4022 | 1.30 |
| 4023 | .30 |
| 4024 | 1.00 |
| 4025 | .30 |
| 4027 | .70 |
| 4028 | 1.00 |
| 4029 | 1.60 |
| 4035 | 1.20 |
| 4040 | 1.40 |
| 4042 | 1.20 |
| 4043 | 1.00 |
| 4044 | 1.00 |
| 4046 | 2.20 |
| 4049 | .70 |
| 4050 | .75 |
| 4051 | 1.20 |
| 4052 | 1.20 |
| 4053 | 1.20 |
| 4060 | 1.50 |
| 4066 | .90 |
| 4068 | .45 |
| 4069 | .30 |
| 4070 | .30 |
| 4071 | .30 |
| 4072 | .30 |
| 4076 | 1.75 |
| 4077 | .30 |
| 4078 | .60 |
| 4081 | .30 |
| 4082 | .30 |
| 4093 | .70 |
| 4441 | .95 |
| 4502 | 1.40 |
| 4506 | .70 |
| 4510 | 1.50 |
| 4511 | 1.30 |
| 4518 | 1.80 |
| 4520 | 1.40 |
| 4528 | 1.40 |
| 4553 | 6.90 |
| 4555 | 1.00 |
| 4581 | 3.50 |
| 4582 | 1.40 |
| 4584 | 1.00 |
| 40014 | .90 |
| 40097 | 1.00 |
| 40098 | 1.20 |
| 74C02 | .35 |
| 74C04 | .35 |
| 74C08 | .35 |
| 74C10 | .35 |
| 74C20 | .35 |
| 74C48 | 2.50 |
| 74C73 | 1.10 |
| 74C76 | .95 |
| 74C90 | 1.40 |
| 74C93 | 1.40 |
| 74C175 | 1.70 |
| 74C192 | 1.90 |
| 74C193 | 2.70 |

**DISPLAYS**

| | |
|---|---|
| FND357 | 1.40 |
| FND500 | 1.40 |
| DL747 | 3.50 |

**OPTO COUPLER**

| | |
|---|---|
| MCT2 | .75 |

**SCR's**

| | |
|---|---|
| C103YY | .80 |
| C106Y | .65 |
| C106D | .90 |
| C106E | .70 |
| C122D | 1.30 |
| S4015L | 1.90 |
| S2025H | 3.75 |

**TRIACS**

| | |
|---|---|
| SC141D | 1.30 |
| O4015L5 | 2.80 |
| BT139 | 2.80 |

**TRIGGER DIODES**

| | |
|---|---|
| ST2 | .55 |
| ST4 | .80 |

**LED's**

| | |
|---|---|
| RED | .18 |
| GREEN | .30 |
| YELLOW | .30 |
| CLEAR | .25 |
| TIL209 | .18 |
| FRD(fl) | 2.30 |
| SEL102S | .30 |
| SEL103S | .30 |
| SEL302E | .40 |
| SEL303E | .40 |
| SKNR | 1.20 |
| SKNG | 1.70 |
| SKNY | 1.80 |
| SEL351 | 1.10 |
| LD271A | .80 |

**ZENERS**

| | |
|---|---|
| ½ WATT | .19 |
| 1 WATT | .30 |
| 2½ WATT | .65 |
| 5 WATT | 1.20 |

**MICROS**

| | |
|---|---|
| 6800P | 11.50 |
| 6821 | 6.50 |
| 6850 | 6.50 |
| TMS1000 | 7.95 |

**TANTALUM**

35v

| | |
|---|---|
| u1-u68 | .25 |
| 1u-10u | .30 |
| 15uF | .55 |
| 22uF | .74 |
| 10uF/25V | .25 |

**16V**

| | |
|---|---|
| 4u7 | .20 |
| 22uF | .30 |
| 47uF | 1.30 |

**6.3V**

| | |
|---|---|
| 47uF | .40 |
| 100uF | 1.10 |

**CERAMICS**

| | |
|---|---|
| 1P-u01 | .06 |
| .0056uF | .10 |
| .0068uF | .12 |
| .0082uF | .20 |
| .047uF | .08 |
| .1uF | .12 |
| .22uF | .22 |
| .47uF | .25 |

**GREENCAPS**

**100V**

| | |
|---|---|
| .001uF to .027uF | .10 |
| .033uF to .056uF | .12 |
| .068uF to .1uF | .16 |
| .12uF to .22uF | .30 |

**250V**

| | |
|---|---|
| .27uF | .30 |
| .33uF | .34 |
| .39uF | .48 |
| .47uF | .50 |
| .56uF to .82uF | .60 |
| 1uF to 1.5uF | 1.00 |
| 1.8uF | 1.20 |
| 2.2uF | 1.40 |
| 3.3uF | 2.10 |
| 4.7uF | 3.50 |

**630V**

| | |
|---|---|
| .001uF to .0082uF | .20 |
| .01uF to .015uF | .25 |
| .022uF to .033uF | .30 |
| .047uF to .1uF | .40 |
| .22uF | .60 |
| .33uF | .80 |
| .47uF | .85 |

**TRIM CAP**

| | |
|---|---|
| —5.5pf | .30 |
| —22pf | .40 |
| —40pf | .40 |
| —65pf | .30 |

**ELECTRO. RT.**

**16V**

| | |
|---|---|
| 33uf | .15 |
| 330uf | .40 |

**25V**

| | |
|---|---|
| 100uf | .25 |
| 330uf | .45 |
| 2500uf | 1.00 |

**50V**

| | |
|---|---|
| 2500uf | 2.15 |

**63V**

| | |
|---|---|
| 10uf | .16 |
| 47uf | .30 |
| 100uf | .40 |
| 220uf | .65 |
| 470uf | .75 |
| 1000uf | 1.65 |

**RB. (PCB)**

**6.3V**

| | |
|---|---|
| 470uf | .20 |
| 1000uf | .30 |

**10V**

| | |
|---|---|
| 4.7uf | .10 |
| 100uf | .10 |

**16V**

| | |
|---|---|
| 10uf | .08 |
| 22uf | .10 |
| 33/47uf | .10 |
| 100uf | .15 |
| 220uf | .20 |
| 330uf | .20 |
| 470uf | .25 |
| 640uf | .45 |
| 1000uf | .40 |
| 2500uf | .65 |

**25V**

| | |
|---|---|
| 2u2/3u3 | .10 |
| 4u7/10u | .10 |
| 25u/33u | .12 |
| 47uf | .13 |
| 100uf | .15 |
| 220uf | .20 |
| 330uf | .25 |
| 470uf | .35 |
| 1000uf | .50 |
| 2200uf | .90 |

**35V**

| | |
|---|---|
| 2u2/3u3 | .10 |
| 10uf | .15 |
| 100uf | .20 |
| 220uf | .30 |
| 1000uf | .70 |
| 2000uf | .90 |
| 2200uf | 1.10 |

**50V**

| | |
|---|---|
| 0.47uf | .08 |
| 1u/2u2 | .08 |
| 3.3uf | .15 |
| 4.7uf | .15 |
| 10uf | .15 |
| 22u/33u | .20 |
| 47u/100u | .20 |
| 220uf | .50 |
| 470uf | .60 |

**63V**

| | |
|---|---|
| 0.47uf | .10 |
| 1u/2u2 | .10 |
| 3u3/4u7 | .10 |
| 10u/25u | .15 |
| 47uf | .20 |
| 100uf | .25 |
| 220uf | .40 |
| 330uf | .45 |
| 470uf | .80 |

**160V**

| | |
|---|---|
| 2.2uf | .20 |
| 10uf | .30 |
| 22uf | .50 |

**250V**

| | |
|---|---|
| 2.2uf | .25 |

**350V**

| | |
|---|---|
| 1uf | .20 |

**CAN TYPE**

**35V**

| | |
|---|---|
| 2500uf | 1.60 |
| 2500uf | 1.95 |

**40V**

| | |
|---|---|
| 5600uf | 2.40 |

**50V**

| | |
|---|---|
| 6800uf | 5.20 |

**63V**

| | |
|---|---|
| 2500uf | 3.25 |

**75V**

| | |
|---|---|
| 3300uf | 5.90 |

**BIPOLAR 50V**

| | |
|---|---|
| 1u/2u2 | .25 |
| 3u3/4u7 | .30 |
| 6.8uf | .30 |
| 10/22uf | .40 |
| 33uf | .50 |
| 47uf | .69 |
| 100uf | .80 |

**POLYSTYRENE**

**125V**

| | |
|---|---|
| 10pf to 680pf | .45 |
| 1000pf to 10,000p | .55 |

**RESISTORS**

| | |
|---|---|
| .33W | .03 |
| 1 W | .07 |
| 5 W W/W | .30 |
| .4W 2p.c. | .10 |

**MINIATURE TRIMPOTS**

| | |
|---|---|
| 100 to 1M OHM | .20 |

**MINIATURE MULTITURN**

| | |
|---|---|
| 10 to 2M OHM | 1.45 |

**POTENTIOMET.**

| | |
|---|---|
| SINGLE | .70 |
| DUAL | 1.60 |
| + switch | 1.80 |
| SLIDER | 1.10 |

**CERMET TRIMPOT**

| | |
|---|---|
| 100 to 1M OHM | .52 |

**FUSEHOLDERS**

**3AG**

| | |
|---|---|
| 502 | .99 |
| 504 (box) | .58 |
| 830 line | .28 |
| PCB CLIPS | .06 |

**2AG**

| | |
|---|---|
| 506 | .75 |

**FUSES**

**3AG**

| | |
|---|---|
| .25-.75A | .20 |
| 1-5A | .15 |

**2AG**

| | |
|---|---|
| .25-.5A | .30 |
| .63-4A | .20 |

**WINDING WIRE (B&S)**

| | |
|---|---|
| 16,23 | 2.00 |
| 21,29 | 3.60 |
| 36,37 | 3.60 |
| 38,39 | 3.60 |
| 40 | 3.60 |
| 22 | 3.80 |
| 26 | 3.90 |
| 20,24 | 4.50 |
| 28 | 4.90 |
| 18,30 | 6.50 |
| 31,32 | 6.60 |
| 33,34 | 6.60 |

**IC SOCKETS**

| | |
|---|---|
| 8 pin | .20 |
| 14 pin | .25 |
| 16 pin | .28 |
| 18 pin | .65 |
| 24 pin | .80 |
| 8 W/W | .33 |
| 16 W/W | .90 |

**EDGE CONN.**

| | |
|---|---|
| 8 WAY | 1.10 |
| 16 WAY | 1.85 |
| 24 WAY | 2.95 |
| 32 WAY | 3.80 |

**AUDIO MOD.**

| | |
|---|---|
| SI-1010 | 10.80 |
| SI-1020 | 21.90 |
| SI-1030 | 27.75 |
| SI-1050 | 42.38 |
| HY5 | 33.00 |
| HY50 | 42.00 |
| HY120 | 95.00 |
| HY200 | 133.00 |
| HY400 | 188.00 |

**JOSTY KITS** as per JOSTY adverts.

**CABLE TIES**

| | |
|---|---|
| 3½ inch | .06 |
| 5½ inch | .07 |

**SWITCHES**

**C&K**

| | |
|---|---|
| 7101 | 1.40 |
| 7201 | 1.90 |
| 7301 | 2.95 |
| 7401 | 3.75 |
| 7201L40 | 2.15 |
| 7203 | 2.30 |
| 7301R | 2.45 |
| 8531 | 1.06 |
| SB4011 | 1.52 |
| L40 paddle | .12 |

**LORLIN ROT. ADJ. STOP**

1P12W, 2p6W, 3P4W, 4P3W all 1.95

**THERMISTERS**

15,47,150, 470,1K,4K7

| | |
|---|---|
| 33K OHM | .50 |
| 47K OHM | .55 |

**PLUS**

Computer grade electros.
Polypropolene capacitors.
Car radio suppressors.
CB accessories etc, etc,

# Improved performance and added convenience for your RTTY set up

These add-on accessories will aid performance of the radioteletype transmitting / receiving system, described last August and September, and improve operating convenience.

**Tom Moffat**
**VK7TM**
39 Pillinger Drive, Fern Tree, Tas. 7101

HAVING COVERED a basic RTTY transceiving system in the previous two articles, let's get on with refining the system. You can add any of the accessories/refinements described here, or leave them out, depending on the level of refinement you wish to attain. The idea is to take it in stages, and that's how the article progresses.

No details of pc board layouts have been given, actual construction being left up to the individual. You may lay out your own pc boards or build the various items on matrix board. In general, layout is not critical.

During normal reception of RTTY the receiver is tuned so as to present the receiving converter with two audio tones, 2125 Hz and 2295 Hz for 170 Hz shift standard. Everything works nicely if these are the only tones present. But, consider the case of a full-blown RTTY contest on 20 metres ... there are hundreds of stations all over the world, all trying to communicate at once in something like 30 kHz of band space. Assuming your receiver has a decent filter for SSB voice, for any frequency tuned there will be the two tones you want plus lots of other tones both higher and lower. In theory there could be about 15 stations, each using 170 Hz shift, all making it through your audio system at once. And the strongest one, no matter what his audio frequency, will capture the converter's limiter, making it quite insensitive to anything else. The only way to overcome this problem is to get rid of all the tones except those between 2125 and 2295 Hz.

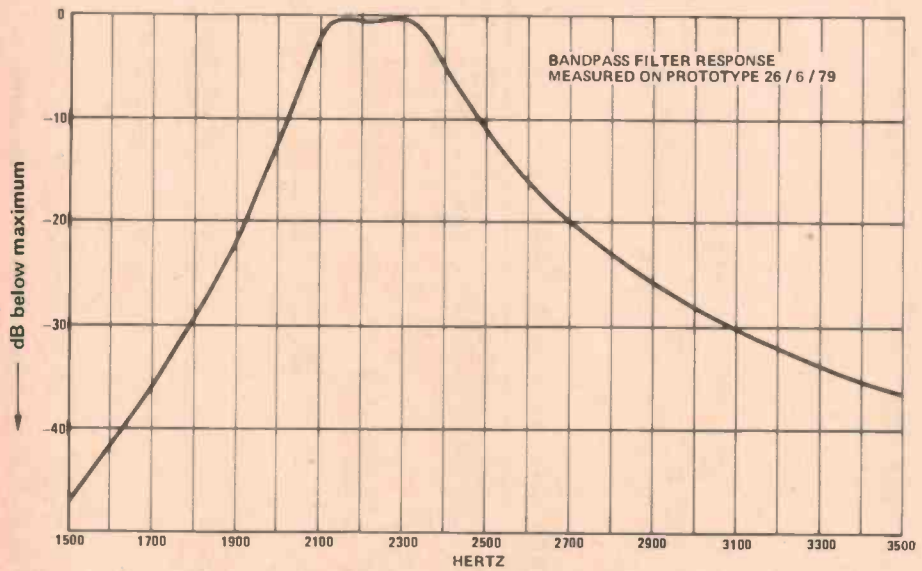



*Figure 1:* Response of the bandpass filter for the RTTY decoder (ETI-730).

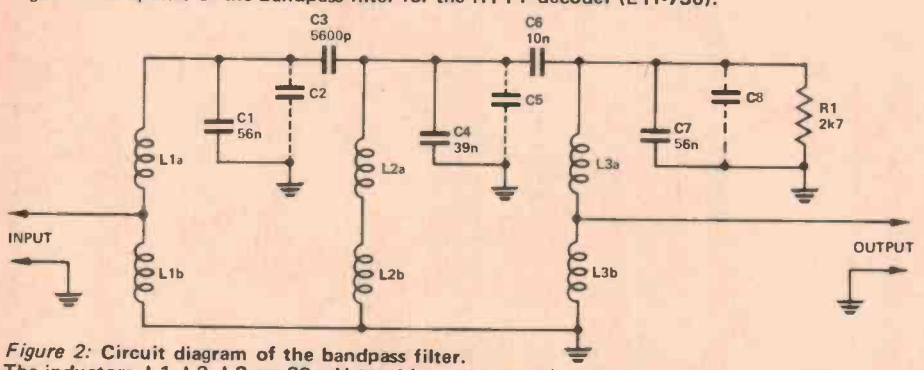



*Figure 2:* Circuit diagram of the bandpass filter. The inductors, L1, L2, L3 are 88 mH toroids or pot cores (see text). Refer to text for C2, C5 and C8.

## Filter

This filter is designed to do precisely that. It has a fairly flat response between 2125 Hz and 2295 Hz but cuts off sharply outside that area (see Figure 1). This is accomplished with three filter sections, each made up of an 88 mH inductor and a high quality capacitor to resonate each section. See the circuit in Figure 2. You may ask why inductors were used when modern practice would indicate that the same thing could be done with one IC. Well, in theory it could, if you could buy such things as 2.347k resistors. An IC filter was tried, and it worked, but the LC filter worked much better.

## Filter construction

Your first problem will be getting the toroids specified. They're not a stock item at electronic suppliers. However it should be possible to get onto a source of toroids by contacting one of the state RTTY groups ... 88mH toroids are very common in RTTY circuits. Alternatively, you can wind an 88mH inductor on a Philips pot core – the 26mm dia. x 16mm high type having 150-200$\mu$e and an adjustable slug is suitable. Wind the bobbin with 264 turns bifilar (two wires) with the windings connected in series. These pot cores are available through the ANARTS. The capacitors specified are the tubular styrene types popular back in the valve days. They are used here because they are extremely stable. If you can't get these, Greencaps should do.

When mounting the toroids on a circuit board, make up some little pads or cushions of plastic to prevent the wires being rubbed or crushed against the board. These can be made up from soft plastic bottle caps, such as those found on hair conditioner or shampoo bottles. Punch holes through the centre of the pads and insert screws through them and the toroid, sandwich style. Then mount the 'sandwich' to the

board. The screws must be brass, as steel ones might affect the tuning of the toroids. Note that each toroid has two windings, which are connected in 'series aiding'. The pot cores suggested are supplied with a mounting clip.

When laying out the filter, keep the input well away from the output.

## Signal conditioner

The filter inserts into the system between the receiver output and the receiving converter input. To do its job properly it needs an 'interface'. A simple voltage follower and impedance converter would probably suffice but a bit of signal conditioning wouldn't go astray either. I've used a limiter and a voltage follower consisting of two 741 op-amps as shown in the circuit in Figure 5. The switch permits switching the filter in and out whilst maintaining the signal conditioner.

This piece of circuitry may be built onto the same board as the filter or put on a separate board. Layout is not critical. Make sure though, that the filter input and output leads are well away from one another else tuning and rejection may be affected. Keep leads short.

The bandpass filter is a three section Butterworth type with each section capacity coupled to the next, and input and output connected to the 'half way' points on L1 and L3. Because all three sections interact the response curve would be 'all over the place' unless tamed by R1. R1 serves to 'squash' and broaden the response until a critical point is reached where the filter begins showing two peaks, evenly displaced about its centre frequency. The input and output impedances also add to the effect of R1, so they are somewhat critical. It's interesting to sweep the filter trying various values for R1; you'll see for yourself how dramatic the effect is.

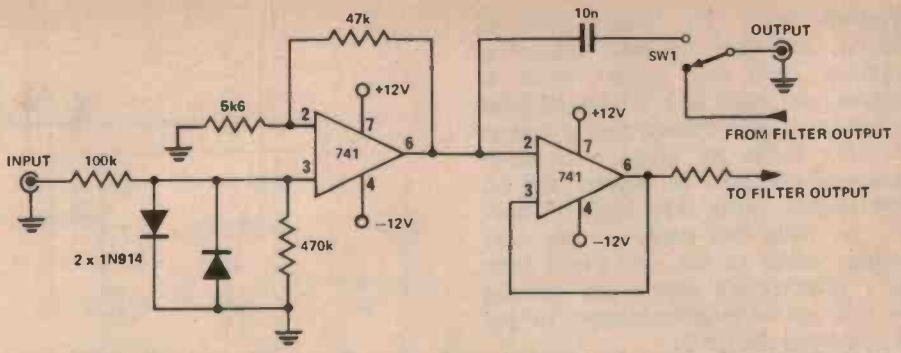



*Figure 5:* Circuit of the signal conditioner which is inserted in the system between the receiver output and filter input.

## The oscilloscope

By now you've experienced the time-consuming process of tuning in signals by moving a CRO or VTVM back and forth between the outputs of the mark and space filters. This special purpose CRO monitors them both at once, and presents an easily interpreted display that enables you to tell all kinds of interesting things about the quality and tuning of a teletype signal. The display is the classic 'cross' type, in which the mark tone is presented to one set of deflection plates and the space tone to the other. When tuning is correct the display is a '+' with each of the legs at maximum length. During selective fades one of the legs will shorten, with interference both will shorten, and with noise on the signal both legs will be surrounded by squiggles. Multipath distortion results in a fleeting multiple image, and a really nasty signal can have all these effects together. Whether the vertical or horizontal leg is arranged to represent mark or space is entirely up to you.

During tuning, the receiver is ▶

### TUNING THE FILTER

During tuning, each section is isolated and treated separately by shortening the sections adjacent to it. This puts the coupling capacitors C3 and C6 in parallel with the filter sections they connect to, so they enter into the tuning process. An audio oscillator and an AC VTVM are necessary, and a frequency counter is definetely required.

Prepare the test set-up shown in Figure 3. With the test equipment connected to section 1, tune the oscillator until the VTVM indicates a sharp peak, and note the frequency. The idea is to tune each section to precisely 2210 Hz, half way between 2125 and 2295 Hz. If the frequency at the peak is below 2210 Hz, remove one turn from each winding of L1 and try again. Continue removing turns until the frequency is slightly above 2210 and then try various capacitors at C2 until the section resonates at 2210, plus or minus a few Hz. Some time spent here is worth the trouble because the more precise the adjustment of the individual sections, the better the filter will work. If you are using the pot cores, the adjustable slug sure helps.

When you're satisfied that section 1 is as close as you can get it, go to section 3 and repeat the procedure, first removing turns from L3 and then adding capacity at C8. Now remove the short from L2, apply shorts to L1 and L3, and connect the equipment to section 2, removing turns and then added the needed capacity at C5. Once all three sections are tuned remove all shorts and install R1. The filter is now ready for testing.

Prepare the test set-up in Figure 4. The input resistor should be selected so that, in combination with the oscillator's output impedence, it totals about 1000 ohms. The 10k resistor across the output simulates the receiving converter's input impedance. Tune the oscillator around until the VTVM reads its highest, and then adjust the output level for a reading representing zero dB. Now, without changing the oscillator output, move the frequency down to 1500 Hz and begin recording meter readings as the frequency is increased in 25 Hz steps. The frequency should be set within 1 Hz at each step, all the way to 3500 Hz. When the readings are plotted on graph paper the result should look like Figure 1. The top of the curve should be fairly flat with a very small dip in the centre. If R1 is too low the dip will be too pronounced, if too high there will be a hump. If the curve is not symmetrically placed about 2125 and 2295 Hz, or if the top of the curve is lopsided, C2, C5, and C8 can be fiddled to 'fine tune' it. Capacity changes should be very small, on the order of a few hundred pF. Tuning the filter is like tuning a pipe organ in that the more time you spend the better it will become. If you don't want to go to all the extra trouble of fine tuning, you'll probably find the filter is quite satisfactory after simply tuning each section to 2210 Hz.

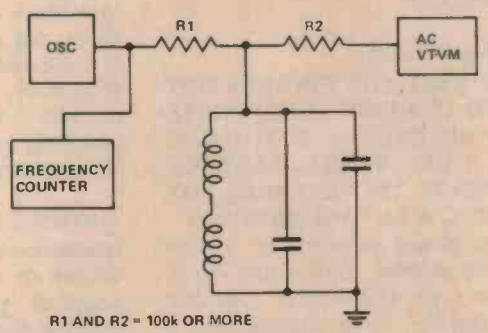



*Figure 3:* Set-up to test each section of the filter.

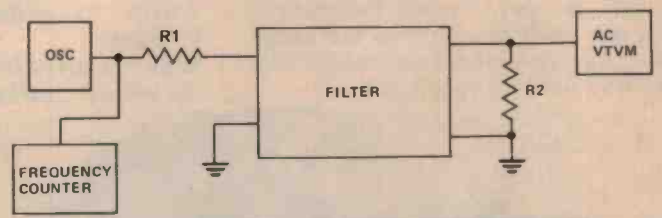



*Figure 4:* Set-up required to plot overall response of the filter.

adjusted until the 'mark' trace is longest, and then the shift control is adjusted until the 'space' trace is longest, and more or less perpendicular to the mark trace. You'll notice that as narrower shifts are tuned, each trace broadens out into an ellipse, and on very narrow shifts they begin to look like footballs. It's really a very easy tuning system to use, and you'll soon learn whether it's even worth turning the teletype on to attempt copy, simply by observing the CRO.

## CRO construction

Although the circuit in Figure 6 shows the use of a type 913 CRO tube, a one-inch metal type, virtually any tube up to three inches in diameter will work with the circuit given. If the 913 tube is used, it can be mounted on a pc board with plastic electrician's saddles of the proper size (see the photograph). You'll have to cut a small slot in the board to allow the tube flange to protrude through. Do not let the metal shell of the tube touch anything conductive as it's hot to the tune of 600 volts. As a safety measure it's a good idea to wrap some heat-proof insulating material around the tube to prevent painful moments during accidental contact. When wiring up the CRT socket, leave enough wire so the tube can be rotated 90 degrees or so. Be sure to use some good heatsinks on the two transistors; they dissipate about a watt each and can become quite hot.

## CRO alignment

**DANGER: KEEP THE FINGERS OUT OF IT AND USE INSULATED TOOLS FOR ALL ADJUSTMENTS. YOU CAN ASSUME THAT EVERY PART OF THE CIRCUIT IS CAPABLE OF DELIVERING A LETHAL SHOCK.**

With the power switched on, rotate the intensity control until a dim fuzzy spot appears on the screen. Use the focus control to bring the spot to a sharp point, backing off on the intensity to keep the spot very dim. Failure to do this can result in a burn on the screen. Now, with an insulated tool, adjust RV3 and RV4 until the spot is centred.

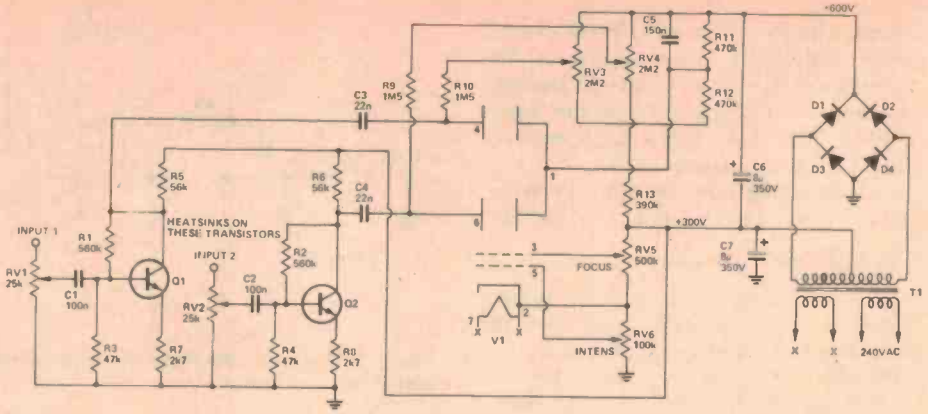



*Figure 6:* **Circuit diagram of the tuning oscilloscope. V1 is a 913 25 mm (1") CRT obtained from surplus sources. Many an amateur junk box will contain one – ask around. Virtually any tube up to 75 mm diameter will suffice.**

Next, connect the CRO inputs to the outputs of the receiving converter mark and space filters. With a good RTTY signal being received, adjust RV1 and RV2 for equal vertical and horizontal traces on the screen. You'll notice one set of plates is more sensitive than the other. This is normal. Finally, use a felt tip pen to mark on the face of the tube the position of the trace you'll call 'vertical'.

Turn off the CRO (remember the tube has 600 volts on it) and rotate the tube in its mounts until the pen mark is vertical. Then erase the pen mark.

Because of its short length, you'll find that the 913 tube is very insensitive to deflection voltages. The deflection amplifiers are working at their hardest to achieve a full sized trace, and one of them may clip if pushed too hard. This is indicated by bright spots at the ends of a trace. If this happens back off on the gain for that channel until the spots disappear, then back off on the other channel to match it.

## Adding a UART

this section describes the most complex circuit in the series, the UART (pronounced you-art). This item, when interconnected with the others, becomes the control centre for the whole system. It performs the following functions:

**SPEED CONVERSION:** From now on the teletype machine may be left set to 50 bauds. Both 45 and 50 baud signals can be sent and received, with the speed conversion taking place electronically. As well, a tape transmitter running at 45 bauds can be switched in to transmit straight through, while allowing the 50 baud printer to provide local copy.

**REGENERATION:** The circuit extends the range over which the teletype machine can operate, so in theory it can accept and decode signals with up to 50 percent distortion. Signals from the keyboard are also cleaned up and transmitted with zero distortion.

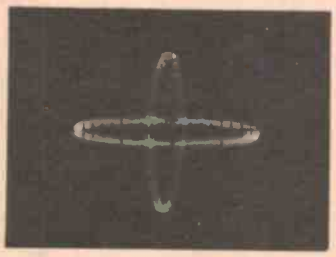
The principles of the UART's operation are explained in the accompanying box. Here's how these principles are put to use in our circuit:

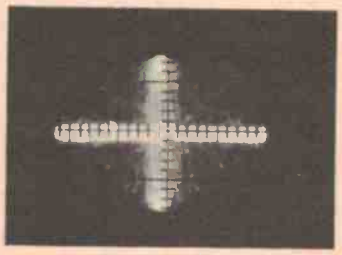
**50 BAUD RECEIVE:** Both input and output sections are fed from the 50 baud clock, so only regeneration occurs within the UART.

**45 BAUD RECEIVE:** Input section fed from 45 baud clock, output section from 50 baud clock, so output is at 50 bauds. There are pauses between the output characters so although each character on its own is at 50 bauds, the character rate is 45 bauds.

**50 BAUD TRANSMIT:** Both sections at 50 bauds, so regeneration only.

**45 BAUD TRANSMIT:** Input section on 50 bauds, output on 45. To prevent characters piling up in the UART the operator must space out his characters so they're coming at less than the 45 baud rate (you probably can't type this





**Above: CRO tuning patterns; mark - V, space - H. On the left is a clean signal, properly tuned. Right is a noisy signal, but good copy. Selective fading is affecting the mark tone. Left: Inside the tuning CRO I constructed. The transformer (T1) was from an old valve radio and has a 200 or 250 V-per-side HT and a 6.3 V filament winding.**

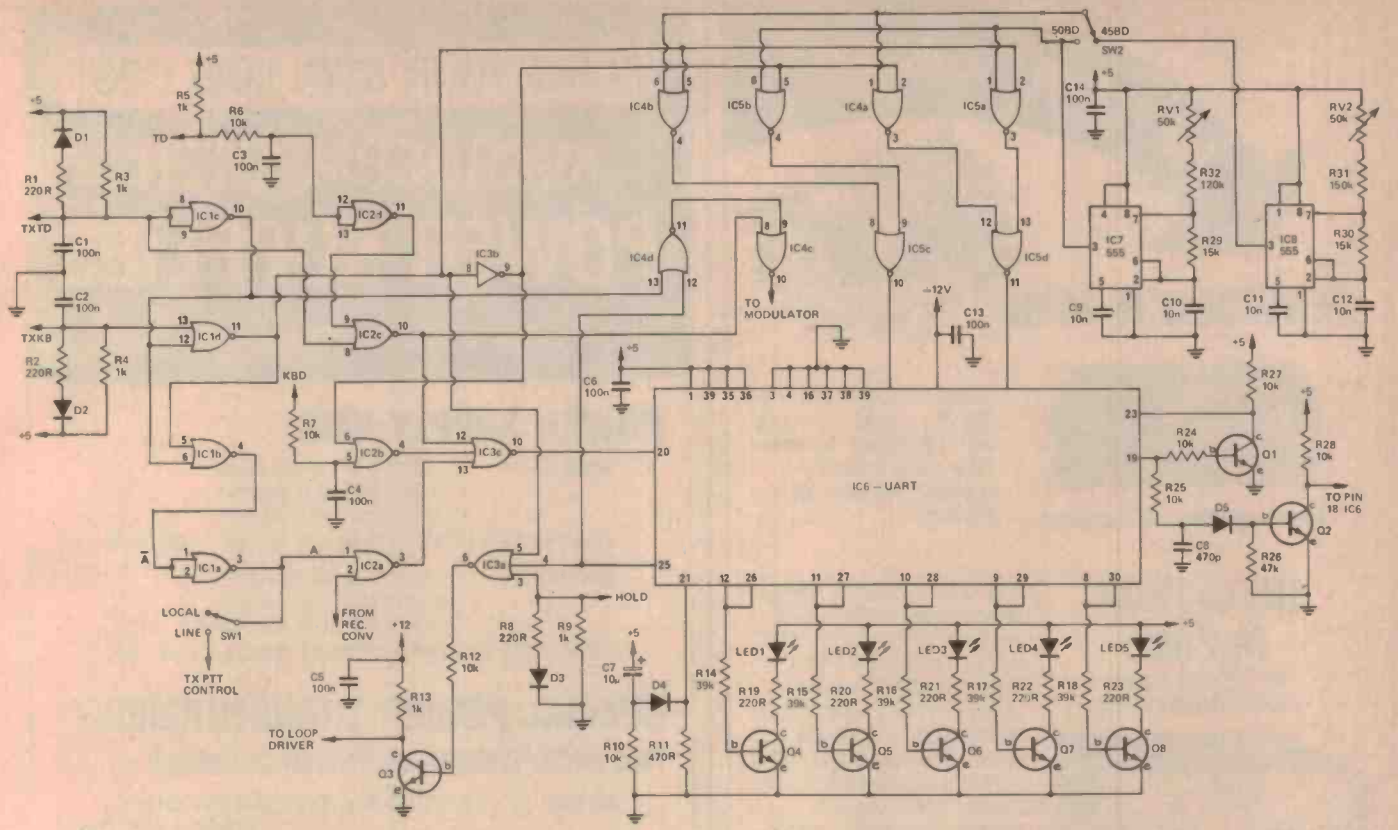



*Figure 7:* **Complete circuit diagram of the UART board for speed conversion and signal regeneration.**

fast anyhow).

**45 BAUD TAPE TRANSMISSION:** The transmitter, running at 45 bauds, is routed straight through to the modulator. The signal is sampled and converted to 50 bauds in the UART so the teleprinter gives local copy of what is being sent. There is no registration of tape transmitter signals, except for the sample going to the local teleprinter.

The complete circuit is shown in Figure 7.

All the clock and source switching to make this happen takes place in a series of NOR gates, under the control of two mechanical switches. (KBD Transmit and Tape Transmit). In the prototype system the send-receive key on the teleprinter is used as the KBD TX switch. The TAPE TX switch is a relay installed within the tape transmitter that operates the instant the tape starts moving. moving.

Another switch is required to select whether the modulator is fed from the system output or from the input to the UART. On the input all modulator signals represent RTTY signals as received (no speed conversion or regeneration). This is handy for recording demonstration signals on cassette tape. Yet another switch is required to select whether the system input/output is at 45 or 50 bauds. There is also a 'HOLD' switch to prevent the teleprinter chattering on no-signal noise, and a LOCAL/LINE switch to prevent the transmitter keying when preparing punched tapes.

## LED display

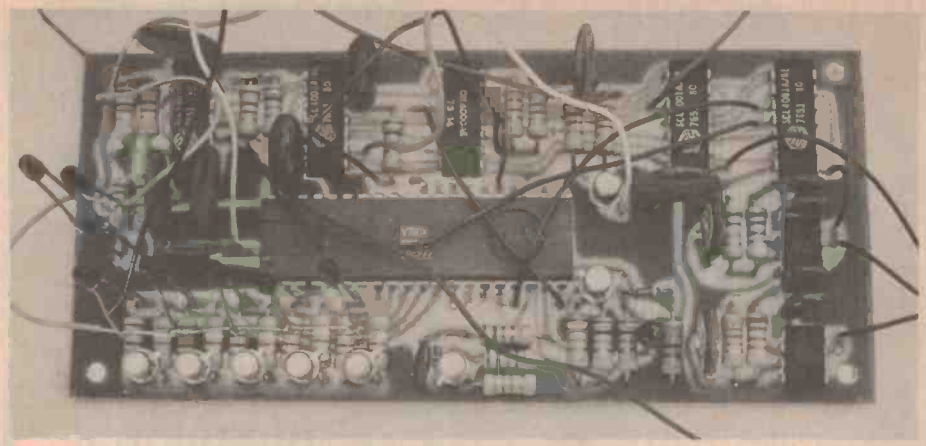
Five LEDs are included to display the code currently in the UART. A lit LED indicates mark. The character displayed is the last one received, and it will not change until a new one comes along to replace it. Other LEDs indicate KBD TX, TAPE TX, and HOLD. The +5V line to all the LEDs can be disabled by a ▶

### How the UART works

UART stands for Universal Asynchronous Receiver-Transmitter. It's a 40-pin CMOS chip that is commonly used in computer circuitry to take several lines of parallel data and send them out as serial (one after another) or it can take serial in and send parallel out. It's possible to do both at the same time, and at different speeds. In this application we've hooked the UART up so that all parallel data lines are connected straight through from input to input. Teletype data comes in through the receive serial port, is processed, and then goes out through the transmit serial port.

If that sounds a little confusing consider this analogy: Assume that there are two lines of five men each, standing facing each other across a ditch filled with sand. Each man can hand buckets of sand across the ditch to his partner on the other side. There is an assistant handing the buckets to the first man in line 'A', who hands them on down the line. There is another assistant who can accept buckets from the last man in line 'B'. There is also a supervisor who can whip the handing-in assistant and the men in line 'A' into action at a given speed, and another supervisor who controls the speed at which the men in line 'B' and the handing-out assistant work. The handing-in assistant is rather sloppy and keeps spilling sand from the bucket to bicket and onto the ground. But the five men in line 'A' have been trained to inspect each bucket they receive, and reach into the ditch to fill all the buckets which are more than half full, all the way to the top. Those less than half full they empty out completely. As the buckets come in they're handed down the line until each of the five men has one. After he's emptied it or filled it completely he hands it across to his partner o on the other side. The men in line 'B' then hand full or empty buckets out the end of their line to the handing-in assistant.

In the UART the handing-in man and the handing-out man are the serial ports. Serial-to-parallel conversion occurs when the men in line 'A' hand the buckets across in groups of five. Regeneration of mangled signals (part full buckets) occurs when the men in the line fill the buckets all the way, or totally empty them. Start and stop pulses are automatically added to the signals before they're sent out of the UART. The supervisor (the clock) for line 'A' lets his men work at an easy pace, but the supervisor for line 'B' makes his men shoot the buckets out quickly, as soon as they're handed across. This is speed conversion. Obviously the men in the input line can't hand in buckets faster than they're handed out the other side, or there would be a big pile up of buckets in the ditch. So only upward speed conversion can take place at normal machine speeds. For downward conversion, the buckets must be somehow delayed and spaced out before they reach the serial input line.



A view of my UART board. I have provided extra pads on the board to provide access to the spare UART pins for future use.

switch if there's nobody around to watch them (such as during long-term monitoring). Or if you don't like to watch the flashing lights you can leave out this part of the circuit altogether.

## UART board

All ICs, except IC7 and IC8, are CMOS types so they should be left in their foil or conductive foam until installation. When soldering them into the circuit, observe the usual precautions. Install wire jumpers from the UART clock and input/output ports to the appropriate points in the switching circuitry. The jumpers allow the UART to be isolated from the rest of the circuit if required.

## UART alignment

The only adjustments required are the clock frequencies, which are set to 16 times the baud rate (the frequencies are divided by 16 in the UART). With a frequency counter connected to pin 3 of IC7, set RV1 for 800 Hz. Go to pin 3 of IC8 and set RV2 for 727.2 Hz. If, during 50 baud reception the system drops occasional characters, it means the sending station is transmitting at a fraction above 50 bauds. If this is the case raise the 50 baud clock's frequency slightly (just a few Hz) and leave it there; it won't affect normal speed operation to any extent.

## How it works

UART operation was explained earlier; if you're interested in what all the pins do, refer to the computer terminal article in ETI for March, 1977. It contains a complete pin-out list and a chart of how the UART is programmed for various data codes.

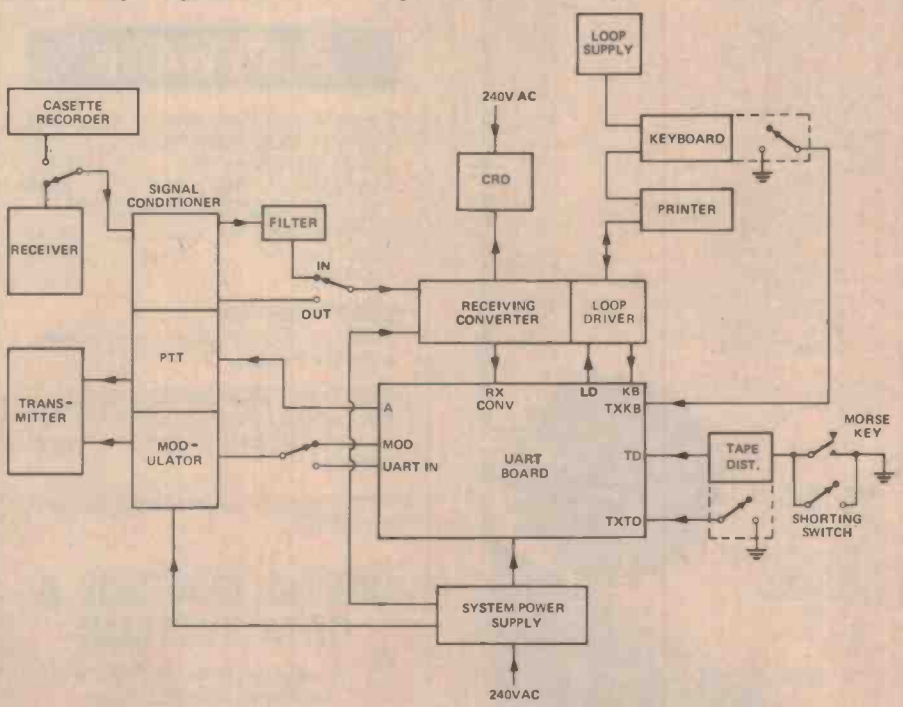
The components associated with pins 18, 19 and 23 inform the output side of the UART that the input side has a character available for sending, and they tell the input when it has been sent. Capacitor C8 provides a slight delay so the UART will have time to hand the signal across. The components connected to pin 21 reset the UART to a 'clear' condition when the power is switched on. Without this pulse the UART latches up and does nothing. IC7 and IC8 are the clocks – 555's connected as free-running multivabrators.

Although there are some rather elegant ICs in the data books that would simplify matters, all pulse switching functions in this circuit are done with NOR gates because they're easy to get. The NOR gates are used in the 'negative logic' sense as upside-down NAND gates. In other words a low on each of a gate's inputs gives a high output, any other combination gives a low.

Consider a gate with pulses going to one input. With the other input held high the output stays low. When the second input goes low the output follows the pulses on the first input, although they are inverted. So one input of each gate becomes a control line that either stops pulses, or lets them through. Since the output stays low when no pulses are going through, it becomes the 'enable' signal for any following gate.

In this way, IC4 A and B, and all of IC5, form a double-pole-double-throw switch. When enable line 'B' is low, it switches 50 baud pulses to the UART 'input clock' port, and 45 baud pulses to the 'output clock' port (this occurs during KBD TX only). When the B (not B) line is low, 45 bauds go to the input and 50 to the output. Since B is formed by inverting $\overline{B}$, they cannot be low at the same time. In the case of IC3 A and B, which are three-input gates, the logic circuitry ensures that pulses can only appear on one input at the same time, the others being held low.

The gate enable signals are formed in IC1 and IC3 B. Earthing TXTD or TXKB starts the process. If both are earthed together, TXTD (tape transmit) takes precedence. If neither are earthed, A is generated, enabling the receiving converter (A is low). When A goes high it becomes the transmitter keying signal, on the grounds that if the system isn't receiving, it must be transmitting. TXTD and TXTB are heavily bypassed, and should be run to the switches in shielded cable to prevent RF getting into the system. The signal lines KB and TD are de-bounced, since the signals are generated by mechanical contacts. The RX CONV signal line needs no debouncing since the signal is generated electronically. ●

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# Lab Notes

An occasional series in which we discuss interesting circuit techniques, circuits we have tried in our own laboratory but not developed as a project, practical notes on projects, measurement techniques for hobbyists etc.

# The LM3914 — a versatile LED bargraph driver chip

This recently-released chip should proye popular with hobbyists and professionals alike. It has a wide variety of potential applications and is easy to use.

Ray Marston

THE LM3914 is a highly versatile IC designed to sense an analogue input voltage and drive a line of 10 LEDs to give a visual analogue display in either a 'Dot' or 'Bar' format.

Figure 1 illustrates the appearance of the two alternative display modes when used to indicate 5 volts on a 10 volt scale. The unit acts as an inexpensive alternative to the conventional-indicating moving-coil meter. It does not suffer from 'sticking' problems, is unaffected by vibration and can be used in any attitude. However, intermediate values are not indicated.

The LM3914 can readily be used as the basis of a wide variety of 'indicator' and instrumentation projects in the home, the car, the workshop and miscellaneous audio and musical projects. One of the great attractions of the device is that it is very easy to understand and use. You don't need to be a BA or MSc to be able to fully comprehend its operating principle and learn

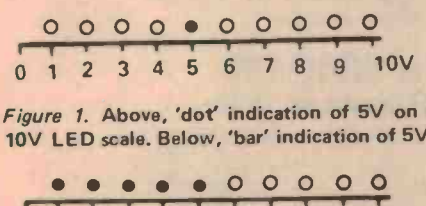


*Figure 1.* Above, 'dot' indication of 5V on a 10V LED scale. Below, 'bar' indication of 5V.

to adapt it to suit your own particular circuit requirement. This article explains the essential details of the device and shows several practical ways of using it in the next few pages.

## Basic principles

Figure 2 shows the equivalent internal circuit of the LM3914 together with the connections for making it act as a 10-LED voltmeter with a full-scale sensitivity of 1.2 volts.

The first point to note about the IC is that it contains a 10-resistor potential divider, wired between pins 4 and 6. The IC also contains ten voltage comparator circuits, each with its non-inverting (+) terminal taken to its own particular tap on the potential divider, but with all inverting (-) terminals of the comparators joined together and taken to the output of an input buffer amplifier. This buffer amplifier gives an output that is, for all practical purposes, identical to the voltage applied to input terminal 5 of the IC. The output of each one of the ten voltage comparators is individually available on one of the pins of the IC (pin 1 and pins 10 to 18) and is capable of 'sinking' a current of up to 30 mA.

The next point to notice is that the IC contains a built-in reference voltage source that provides a highly stable potential of 1.2 volts between pins 7 and 8. This source is of the 'floating' type, so that 1.2 volts is developed between pins 7 and 8 irrespective of whether pin 8 is tied to ground or held at some voltage above ground. In the diagram of Figure 2 we've shown pins 7 and 8 externally connected to potential divider pins 6 and 4 respectively, so in this particular case 1.2 volts is developed across the 10-resistor potential divider network of the IC.

The final point to notice about the IC is that it contains an internal logic network that can be externally programmed to give either a 'dot' or a 'bar' display or action from the outputs of the ten voltage comparators. In the 'dot' mode, only one of the ten outputs is enabled at any one time. In the 'bar' mode all outputs below and including the highest 'energised' output are enabled at any one time.

At this point, let's put together the ▶

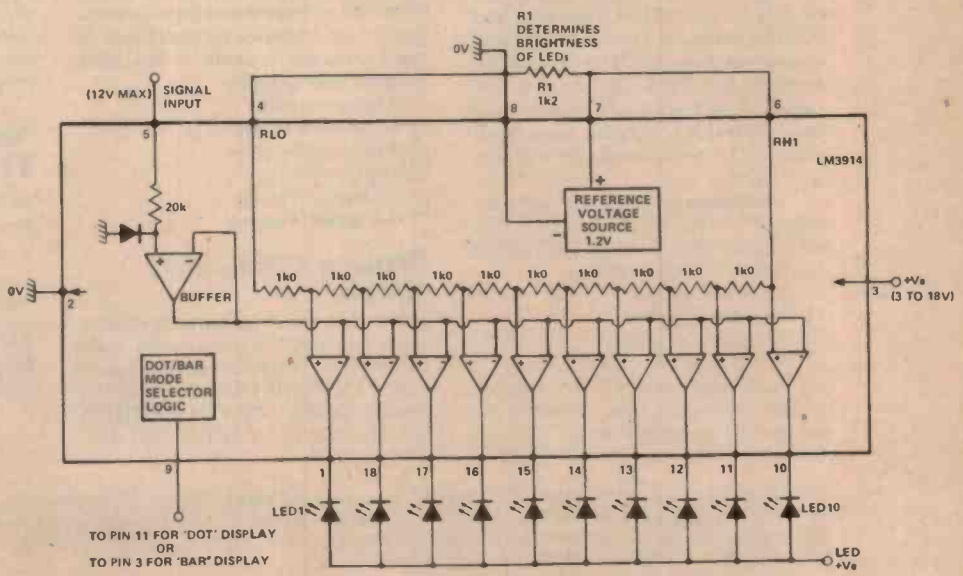


*Figure 2,* Equivalent internal circuit of the LM3914 dot/bar LED indicator. This is the linear indicator chip in a series of three — the '15 is a log type, the '16 a VU type.

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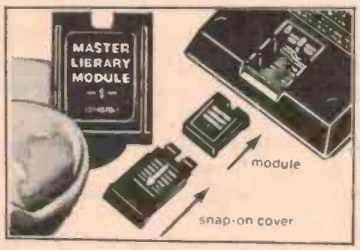


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# Lab Notes

basic information that we have already learned about the LM3914 and the circuit of Figure 2, and see how the entire circuit functions. Let's assume that the logic is set for 'bar' mode operation.

We already know that a reference of 1.2 volts has been set up across the 10-resistor divider, with the low (pin 4) end of the divider tied to ground (zero) volts. Consequently, 0.12 V is applied to the '+' input of the lowest voltage comparator, 0.24V to the next, 0.36 V to the next and so on. If we now apply a slowly rising voltage to input pin 5 of the IC, the following sequence of events takes place:

When the input voltage is zero, the outputs of all ten voltage comparators are high and none of the external LEDs are turned on. As the input voltage is slowly increased it eventually reaches and then rises above the 'reference' 0.12 volts value of the first comparator, which then turns on (it's output conducts) and energises LED 1. As the input is further increased it eventually reaches the 0.24 V of the second comparator, which then also turns on and energises LED 2. At this stage both LED 1 and LED 2 are on. As the input voltage is progressively increased, more and more comparators and LEDs are turned on until eventually, when the input rises to and then exceeds 1.2 volts, the last comparator and LED 10 turn on, at which stage all ten LEDs are illuminated.

A similar kind of action is obtained when the LM3914 logic is set for 'dot' mode operation, except that only one LED turns on at any given time. At zero volts, none of the LEDs are on. At voltages above 1.2 (or whatever reference value is applied to the last comparator) only LED 10 is turned on.

At this stage, then, you can see that the LM3914 is a reasonably easy device to understand. Let's move on and look at some of the finer details of its operation.

## A closer look

There is one component in Figure 2 that we have not yet mentioned and that is R1. This resistor is wired between the pin 7 and pin 8 output terminals of the reference voltage source and determines or 'programmes' the ON currents of the LEDs. The current of each LED in fact approximates ten times the output current of the reference voltage source. The reference

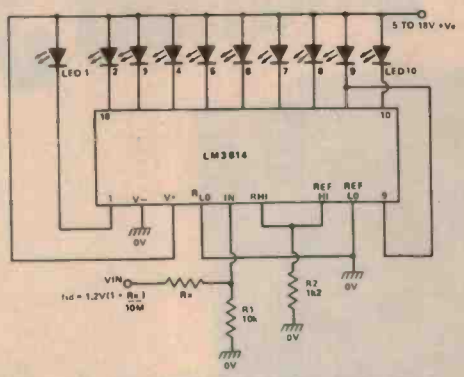


*Figure 3.* **Dot mode voltmeter. Rx may be switched to provide fsd reading from 1.2V to 1000V dc.**

can supply up to 3 mA of current, so the LEDs can be programmed to pass currents up to 30 mA.

Remembering that the reference develops 1.2 V, you can see that if a total resistance of 1 k2 is placed across the pin 7 – pin 8 terminals the reference will pass 1 mA and each LED will pass 10 mA in the ON mode. In Figure 2 the total resistance across the reference terminals is equal to the 1k2 of R1 shunted by the 10k of the IC's internal potential divider, so the reference actually passes about 1.1 mA and the LEDs conduct 11 mA. If R1 were removed from the circuit the LEDs would still pass 1.2mA due to the resistance loading of the internal potential divider on pins 7 and 8.

You'll notice from the above description that the IC can pass total currents up to 300 mA when it is used in the 'bar' mode with all ten LEDs on. The IC has a maximum power rating of only 660 mW, so there is a danger of exceeding this rating when the IC is used in the 'bar' mode. We'll return to this point later.

The IC can be powered from a dc supply in the range 3 to 25 volts. The LEDs can use the same supply as the IC or can be independently powered from supplies with voltages up to a maximum of 25 V. The voltage across the internal potential divider can have any value up to 25 volts maximum.

The internal reference amplifier produces a basic nominal output of 1.28 volts (limits are 1.2 V to 1.32 V), but can be externally 'programmed' to produce effective reference values up to 12 V (we'll show how later).

The input buffer of the IC has integral overload protection and can withstand inputs of up to plus or minus 35 V without damage.

The IC can be made to give either a 'dot' display by wiring pin 9 to pin 11, or a 'bar' display by wiring pin 9 to positive-supply pin 3.

## Practical ciruits: Simple dot mode voltmeters

The basic circuit of Figure 2 acts as a voltmeter that reads full-scale at an input of 1.2 volts. The range of the circuit can be changed in a variety of ways. The sensitivity can be increased, for example, by either interposing a dc amplifier between the input signal and pin 5 of the IC, or by reducing the reference voltage that is applied to the pin 4 – pin 6 terminals of the IC: in this latter case the IC will operate quite well with a reference voltage down to a couple of hundred millivolts.

The easiest and best way to reduce the sensitivity of the meter is to use the connections shown in Figure 3. Here, the basic circuit is that of a 1.2 V meter, but the input signal is applied to the IC via a potential divider formed by Rx and R1. Thus, the circuit can be made to read 12 volts full scale by giving Rx a value of 90k, so that Rx-R1 act as a 10:1 divider. This circuit can be used to read full scale voltages from 1.2 V up to about 1000 V.

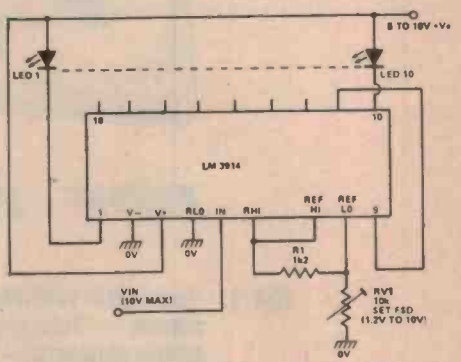


*Figure 4.* **An alternative 1.2V to 10V fsd dot mode voltmeter.**

An alternative connection is shown in Figure 4. In this case the input voltage is applied directly to pin 5 of the IC, but the reference voltage on the internal divider is made variable from 1.2 V to 10 V via RV1. You'll remember that the 'reference voltage' develops 1.2 V between pins 7 and 8, but this voltage is fully floating. By wiring RV1 between pin 8 and ground we can ensure that the output current of the reference flows to ground via RV1, thus providing a voltage that raises the pin 8 (and also pin 7) value considerably above zero volts. This increased voltage is applied to the top ▶

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— Lab Notes, from page 63.

(pin 6) end of the internal potential divider, which has its low end (pin 4) grounded and determines the full scale sensitivity of the circuit. This circuit has a useful voltage range of only 1.2 to 10 volts. The IC supply voltage must be greater than the required full scale voltage.

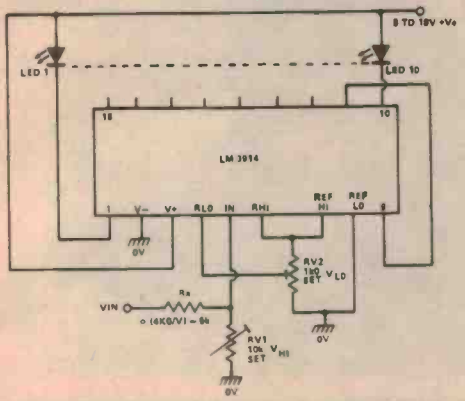


*Figure 5.* **Expanded scale dot mode voltmeter for the 10 - 15 V range.**

Figure 5 shows how the LM3914 can be used as an expanded scale voltmeter that reads (say) 10 V at minimum scale but 15 V at full scale. The secret of this circuit is that both the top and bottom ends of the internal potential divider (pins 6 and 4) of the IC are externally available, so the top and bottom limits of the scale can be individually set. In the diagram the top of the divider is fed from the 1.2 V reference, but the bottom is fed from the slider of RV2. The external input signal is applied to the IC via the Rx-RV1 potential divider. Thus, if 1.2V is set to the top of the divider and 0.8 V is set to the bottom and the input divider has a ratio of 20:1, the circuit will read 24 V at full scale and 16 V at minimum scale.

## Bar mode operation

The three basic voltmeter circuits of Figures 3 to 5 can be used with the IC connected in either the 'dot' or the 'bar' mode. When using the bar mode, however, it must be remembered that the power rating of the IC can easily be exceeded when all ten LEDs are on if an excessive voltage is allowed to develop across the output terminals of the IC. LEDs normally 'drop' about 2 volts when they are conducting, so one way around this problem is to power the LEDs from their own low-voltage (3 to 5 V) supply, as shown in Figure 6.

An alternative solution is to power the IC and the LEDs from the same source but to wire a current-limiting resistor in series with each LED, as shown in Figure 7, so that the output

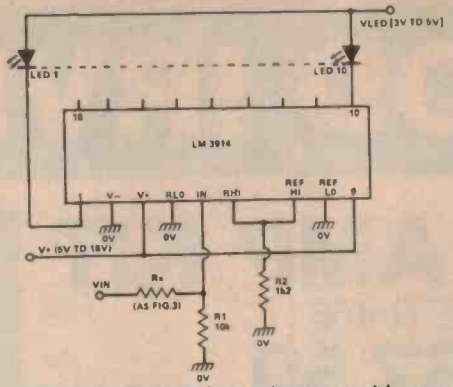


*Figure 6.* **Bar display voltmeter with separate supply for the LEDs. Rx may be switched to provide various fsd ranges as per figure 3.**

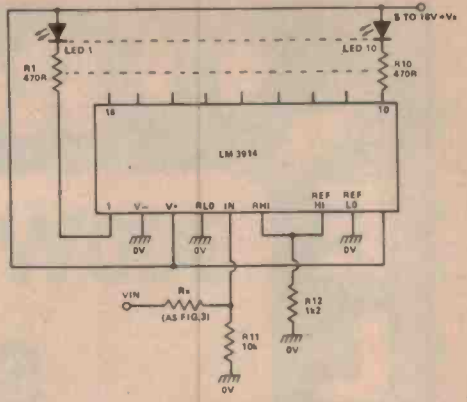


*Figure 7.* **Bar display voltmeter with common LED supply.**

terminals of the IC saturate when the LEDs are on.

## 20-LED voltmeters

Figure 8 shows how two LM3914s can be interconnected to make a 20-LED dot-mode voltmeter. Here, the input terminals of the two ICs are wired in parallel, but IC1 is configured so that it reads 0 to 1.2 volts and IC2 is configured so that it reads 1.2 volts to 2.4 volts. In the latter case, the low end of the IC2 internal potential divider is coupled to the 1.2 V reference of IC1 and the top of the divider is taken to the 'top' of the 1.2 V reference of IC2, which is raised 1.2 V above that of IC1.

The circuit of Figure 8 is wired for 'dot' mode operation. In this case pin 9 of IC1 is wired to pin 1 of IC2 and pin 9 of IC2 is wired to pin 11 of IC2. Note that a 22k resistor is wired in parallel with LED 9 of IC1 in this mode.

Figure 9 shows the connections for making a 20-LED 'bar' mode voltmeter. The connections are similar to those of Figure 8, except that pin 9 is taken to pin 3 on each IC, and a 470 ohm current limiting resistor is wired in series with each LED to reduce the power dissipation of the ICs. ●

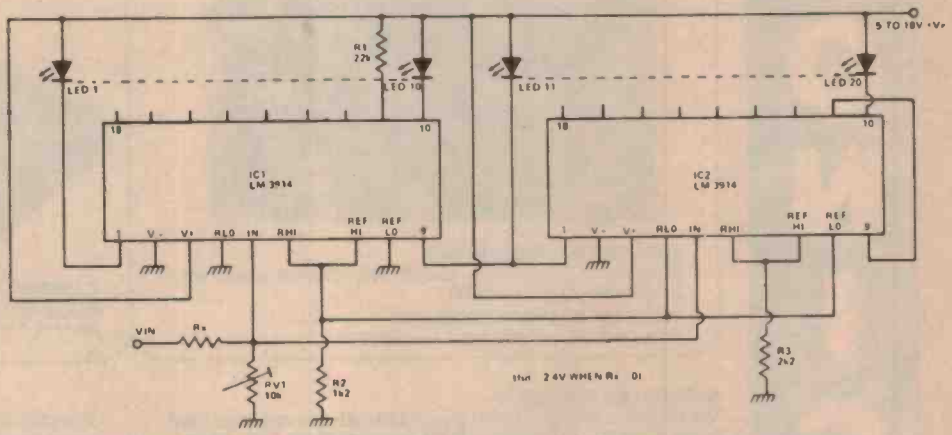


*Figure 8.* **Dot mode voltmeter with 20 LEDs. Full scale is 2.4 V when Rx is zero.**

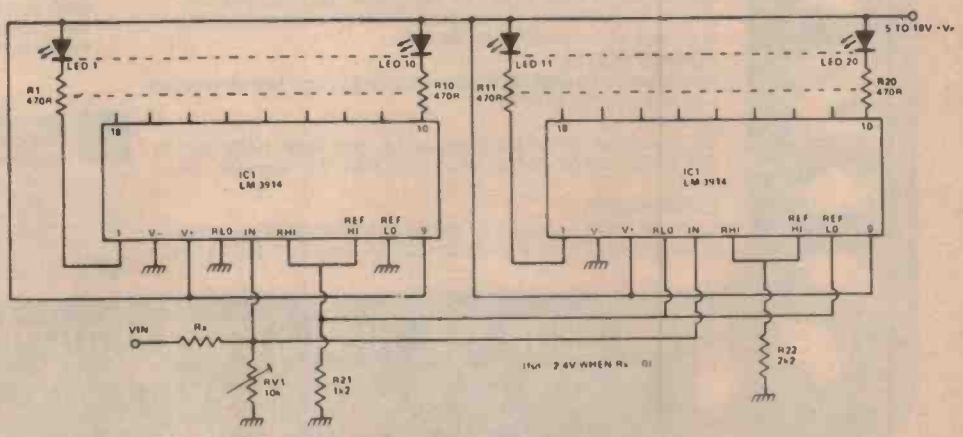


*Figure 9.* **Bar mode voltmeter version of above.**

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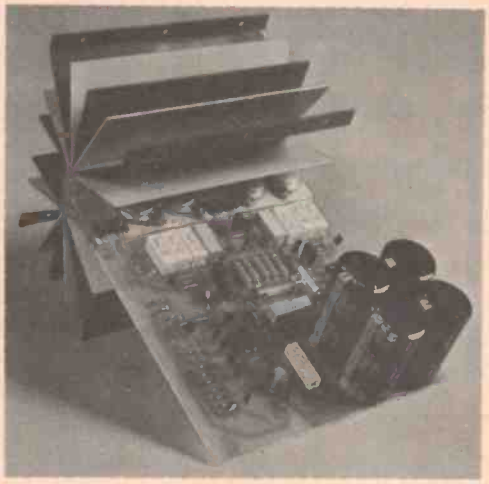

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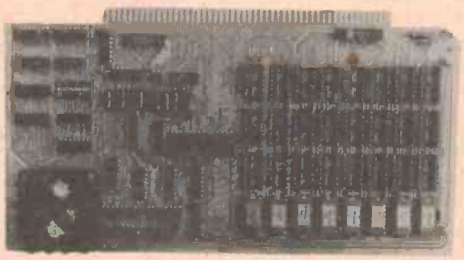

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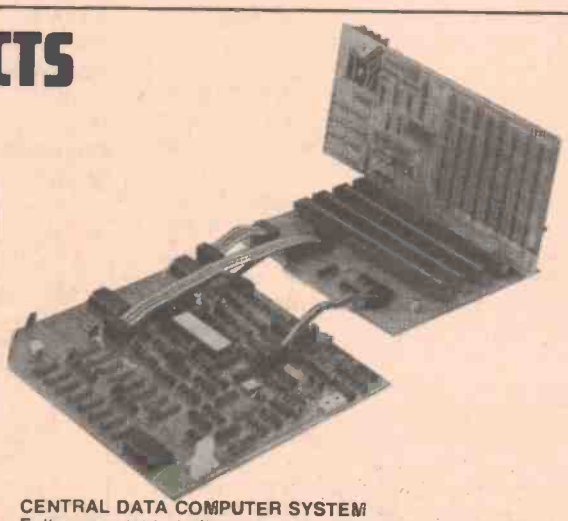

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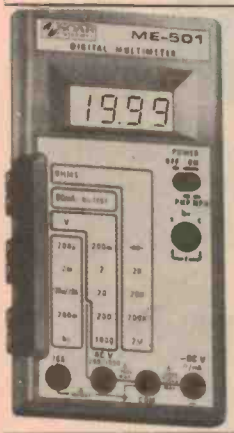


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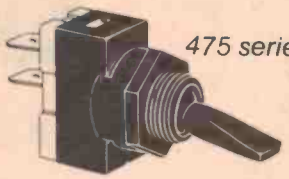
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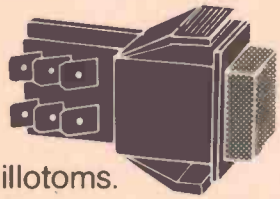

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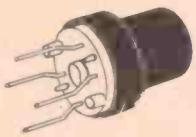

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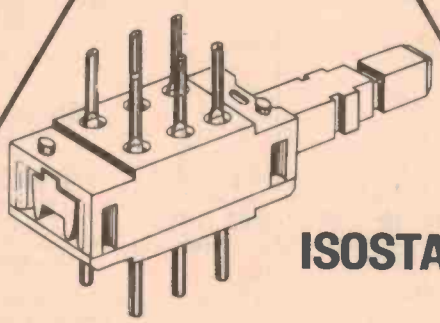

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# Ideas for Experimenters

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.

## Simple voltage reference

This circuit, from R. Gibson of Shortland NSW, uses a 741 op-amp and a zener diode to produce a stable reference voltage, which can be used in regulated power supplies or for calibration applications.

An unusual feature of this circuit is that the zener voltage is used by the op-amp to define a constant current in the zener and thus stabilise it's own voltage. To keep the temperature coefficient of the output low, an EM401 is connected in series with the 6.2 V zener. At 5 mA the BZX79C6V2 has a temperature coefficient of +2.3 mV/°C while the EM401 has a temperature coefficient of -2.2 mV/°C approx. The two cancel each other giving a low temperature stable output. The output voltage, Eo2, is determined by the values of R2 and R3 while the zener current is set by R1. R4 is included to equalise the impedance at the imputs of the 741 and thus minimize the effect of input off-set current drift. The component values shown give Eo1 = 6.8 V, Eo2 = 9 V, zener current = 5 mA.

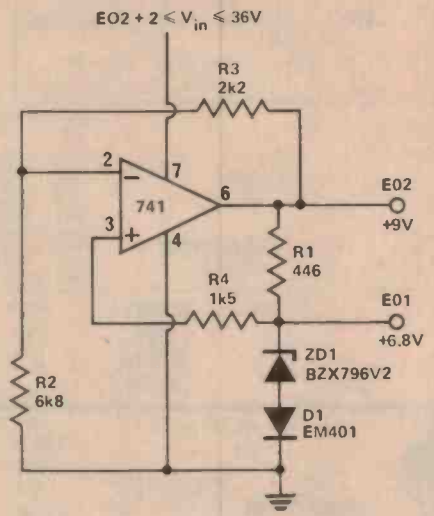
The maximum current drawn from Eo2 should be no more than 2 mA. If a slight variation of the output with temperature can be tolerated, then R4 and D1 can be omitted and R1 and R3 changed to 560 ohm and 3070 ohm, respectively.

For different output voltages and zener currents, the component values are given by:—

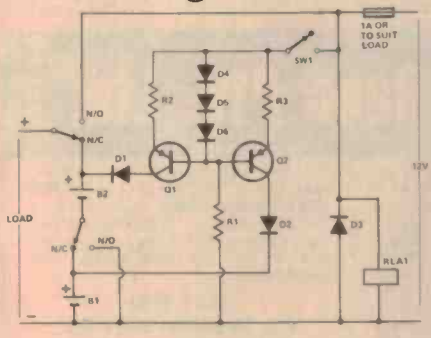
Eo2 = Eo1 (R2 + R3)/R2

R1 = (Eo2 - Eo1). Izener

R4 = R2. R3/(R2 + R3), approx.




## Nicad charger




Quite a number of portable appliances use battery supplies for which NiCad batteries are ideally suited. This circuit, from Ron Smith of Rockhampton QLD, charges two sets of 6 V NiCads from a 12 V source. This allows a 12 V NiCad battery supply to be charged from the 12 V supply in a car or boat, and used as an emergency power source. It would be useful for charging NiCad batteries used in handheld transceivers.

The circuit splits the NiCads into two 6.25 V groups and charges from two current regulators with a common voltage divider on their bases. The output normally comes directly from the vehicle's battery supply until the voltage falls and the relay drops out. The values shown provide about 100 mA charge which is suitable for NiCads of 1 AH capacity or larger. The charge rate may be varied by changing the value of R2 and R3.

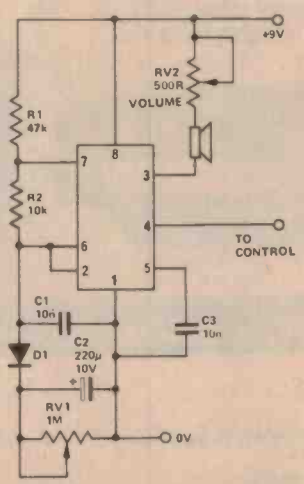
| | |
|---|---|
| Q1, Q2 | MJ2955 |
| D1 – D6 | 1N4004 |
| R1 | 330R, 1 W |
| R2, R3 | 15R, ½ W |
| RLA1 | 12 V relay, DPDT |

## Warbling alarm

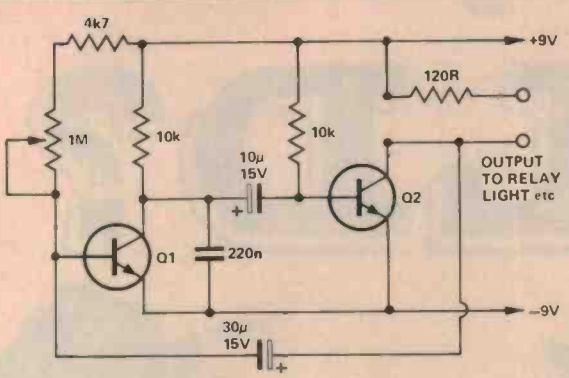
A warbling alarm has a certain attractiveness compared to the usual nerve-wracking attention getters. This circuit, rescued from deep within our files, is quite simple and may be activated in a number of ways. Centred on a 555 timer IC, the alarm works as follows: the CONTROL pin activates the oscillator when it is taken high (to the supply rail). Capacitor C2 will charge up via R1, R2 and D1. When the voltage across C2 reaches 2/3 of the supply voltage (i.e: 6 V), pin 7 of the 555 goes low (to zero volts). This reverse biases D1 and C2 is effectively taken out of circuit. The 555 then operates as an astable oscillator, the frequency being determined principally by R2 and C1. Meanwhile, C2 will discharge via RV1 until the voltage across it is low enough that D1 again becomes forward biased. The whole cycle then repeats. The charging cycle of C2 causes a frequency variation in the oscillation of the 555, giving the warbling sound. Output is via pin 3 of the 555 and either a 16 ohm or higher impedance speaker is recommended.

The alarm is controlled via pin 4 of the 555. When held low (connected to zero volts) the circuit is inactive. Connecting this pin to the positive supply rail will activate the oscillator after a short delay. Either logic circuitry or a simple switch may be used.

Diode D1 may be any silicon switching diode (1N4148, 1N914, 1N916 etc) and C2 may be either a standard electrolytic type or a tantalum capacitor.



# Ideas for Experimenters




## Flip-Flop flasher

This simple flip-flop circuit from **Paul Taylor**, of Eltham Vic, can be used to operate a relay or flash a lightbulb on and off at a rate that may be varied between three flashes per second to one flash every five seconds. The speed is altered by the 1M potentiometer. Component values are not critical and most general purpose NPN transistors will work. A relay with a coil resistance between 50 and 180 ohms should work well (delete 120 ohm resistor).

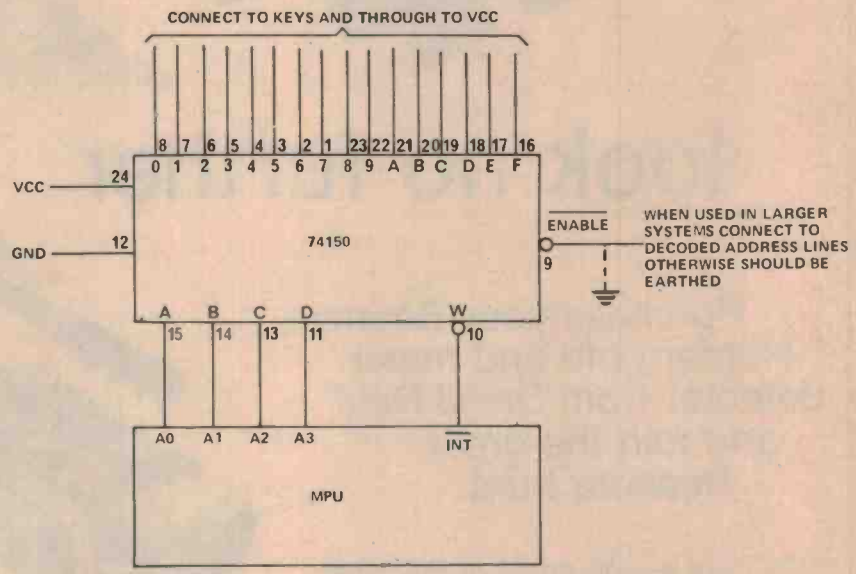
## Simple software-controlled keyboard encoder

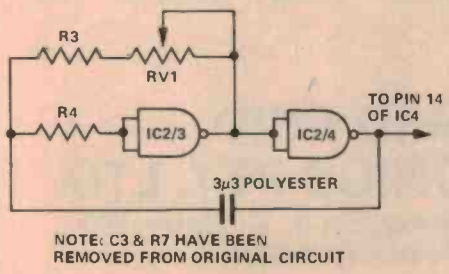
This circuit, sent in by **J. Hardy** from Cheltenham in Victoria is suitable for encoding hexadecimal and can be adapted for baudot or even ASCII. The encoder is based on an inexpensive 74150 16:1 line multiplexer which is connected to the MPU address lines and is controlled by a simple program which could reside in the microcomputer ROM or RAM.

The MPU utilizes an internal 16-bit data counter to address the multiplexer and is incremented if no response is received. The address is cycled through over and over until an interrupt is received from the keyboard. This indicates that a key has been pressed and that the address in the MPU data counter is the binary equivalent for that key (least significant bits).

The interrupt service routine could transfer the four least significant bits of the data counter to the user program area and then loop back to collect the next keypressings.

The encoder can also be adapted to longer codes by using more multiplexers, 16 lines each and using more address lines to enable each multiplexer one at a time (i.e. short form ASCII-6 bits can be encoded by four multiplexers, four lines address all multiplexers and the other two lines select only out of four multiplexers to be enabled).




## ETI 551 oscillator

**Ian Beagrie** of Auckland has had a few problems with the oscillator in the ETI 551 Light Chaser. He found that it would only give an output with some 'digital' help — touching part of the circuit with his finger! The circuit here proved somewhat more reliable, he found.

## Any ideas?

Have you had a bright idea lately, or discovered an interesting circuit modification? We are always looking for items for these pages so naturally, we'd like to hear from you.

We pay between $5 and $10 per item — depending on how much work we have to do on it before we publish it.

The sort of items we are seeking, and the ones which other readers would like to see, are novel applications of existing devices, new ways of tackling old problems, hints and tips.

# Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. It also serves to bring new, special or hard to get components to the attention of the reader. If you are looking for a particular component or project from this month's issue – check with our advertisers if it is not mentioned here. Also, for a list of suppliers who stock the ETI projects published over the last few years, our "Kits for Projects" page may generally be found on the pages immediately preceeding the DREGS page (inside the back cover).

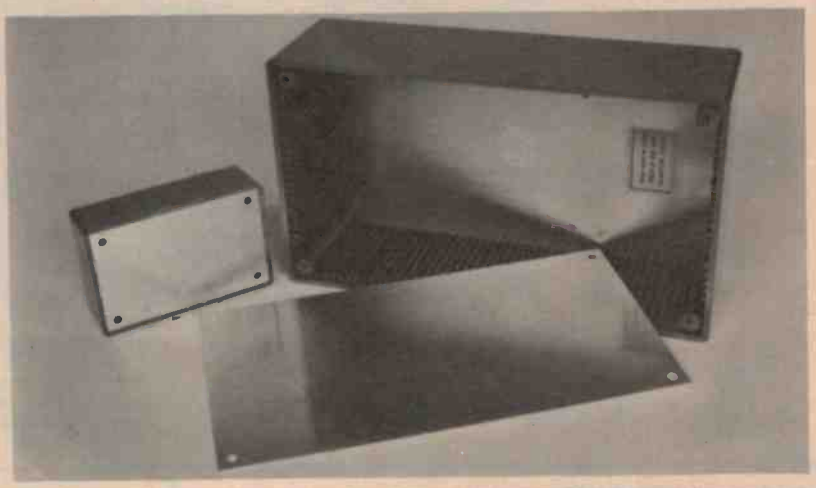
Most of the well-kown kit and component suppliers we contacted indicated they would be stocking pc boards and components or complete kits for this month's projects.

We promised price estimates for projects as of this issue, so here goes. The price ranges given here have been estimated from typical retail prices, but you can expect some variations – especially with pre-packaged kits.

ETI-561 Metal Detector
(less hardware) $14 - $18
(with hardware) $25 - $30

ETI-455 Speaker Protector
stereo (with case) $30 - $35
mono (less case) $15 - $20

ETI-322 Over-rev Alarm
(less case) $20 - $25



'Zippy' boxes are widely popular for housing electronic projects. Dick Smith has recently changed the design of his popular range so that they now include slots around the case walls, making it easier to insert and secure a pc board. Available in a range of sizes at all Dick Smith stores.

ETI-264 Simple Siren $5 - $8

The case we used with the Over-rev Alarm is a PacTec type number CM5-125, distributed by Associated Controls, Padstow NSW.

A recent spate of enquiries about kits for the Series 4000 Stereo Amp prompts us, once again, to list those suppliers stocking complete kits (including cases, panels etc). In Sydney:–

Electronic Agencies
115 Parramatta Rd
Concord.

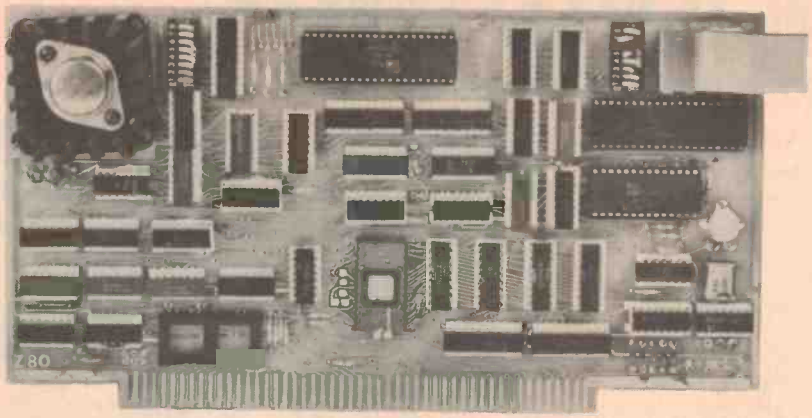
In Melbourne:–

All Electronic Components
118 Lonsdale St
Melbourne.

Rod Irving Electronics
499 High St
Northcote.

Tasman Electronics
12 Victoria St
Coburg.

# ROBOTS: HOME COMPUTERS



**Z80 / S100 = TOTAL FLEXIBILITY . . .**

Described in ETI starting November 1979 the DGZ80 is totally Australian designed and supported and represents a world scoop for ETI. Built around the powerful Z80 chipset (CPU, P10, CTC) the DGZ80 is a complete computer on one board and as such can be used as a freestanding controller or as part of a complete micrcomputer system. Articles soon to be published in ETI will describe a series of experiments using the DGZ80 as a robot/controller which will stimulate considerable interest in this new technology.

## EXPERIMENT WITH Z80 ROBOTICS — CONTROLLERS

Now is the time to start experimenting with ROBOTICS AND MICROPROCESSOR CONTROLLERS. The ETI/DGZ80 is ideally suited as it features:

- 8 dedicated INPUT channels.
- 16 dedicated OUTPUT channels.
- 4 programmable TIME channels.
- On board 1K RAM (expandable to 2K).
- Provision for on board ROM (System Monitor).
- POWER ON JUMP facility.
- S100 Bus for system expansion.

We have designed a low cost experimenter's kit which when connected to the DGZ80 enables you to connect various input stimulli such as switches, photocells, thermistors, microphones and produce various output functions into motors, relays, LEDS and loudspeakers.
The control software is provided in the MATTLOC monitor ROM and the manual enables you to program your DGZ80 to play music output answers onto LEDS, control relays, build a burglar alarm etc. With external S100 boards speech synthesis and recognition is already possible and we hope to produce a super low cost speech unit later this year.

### DGZ80 Robot Kit

DGZ80 1K RAM, MATTLOC monitor, I/O experimenters board with full manuals, **$249.50** tax paid, $222.60 tax exempt.

### For owners of DGZ80 Robot/Controller option

MATTLOC monitor, I/O experimenters board with manuals, **$89.50** tax paid, $79.40 tax exempt.

## Z80 BUDGET HOME COMPUTER ON S100.

Build your own Z80 based home computer using the ETI/DGZ80 described ETI November 1979. Designed by David Griffiths, this is probably the most powerful S100 Z80 project described in the world to date. Features include on board P10 (dual 8 bit I/O) CTC (4 channel programmable counter (timer), power on jump, software write protect option, provision for 2K ROM on board, 1K RAM for stack, scratchpad (expandable to 2K) top quality solder masked, plated through PCB and comprehensive owners manual.

**DGZ80:** Kit **$199.25** tax paid, $175.00 tax exempt.
Assembled **$240.00** tax paid, $215.00 tax exempt.
**DGOS Monitor ROM 2716:** Optional but strongly recommended, $48.00.

### DG640 — S100 VDU

Described in ETI March 1978 the DG640 features 16 lines of 64 characters, upper and lower case with graphics, crystal locked self-contained TV scan circuits, top quality plated through PCB sockets for all IC's and comprehensive owner's manual.

**DG640:** Kit **$139.50** tax paid, $125.70 tax exempt.
Assembled **$149.50** tax paid, $134.25 tax exempt.

### TCT 16K (2114) S100 RAM

The TCT 16K is an Australian designed and supported static RAM card on the S100 bus. Features include 4 independently addressable 4K blocks each with write protect and disable. In addition the board has bank select and phantom capability. Directly compatible with DG Z80, DG 640 the TCT 16K use a top quality plated through, solder masked PCB with comprehensive owners manual. Sockets included for all IC's.

**TCT 16K:** Kit less RAMS **$1.80** tax paid, $95.00 tax exempt.

### PCB's WITH MANUALS

DGZ80 CPU $45.00.
DG640 VDU $35.00.
TCT 16K RAM $45.00.

### SYSTEM SUPPORT COMPONENTS

S100 Protoboard (flow soldered) $19.75.
S100 Sockets $7.95.
S100 Motherboard $27.75.
SECI Cassette Interface $24.50.
KB05 Keyboard $89.50.

**STOP PRESS:** See magazines for details of S100 TCT PCG (Programmable Character Generator plus Joystick for DG640), and also MICROWORLD — Z80 BASIC ON TAPE for the DGZ80.

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- Huge comprehensive user manual
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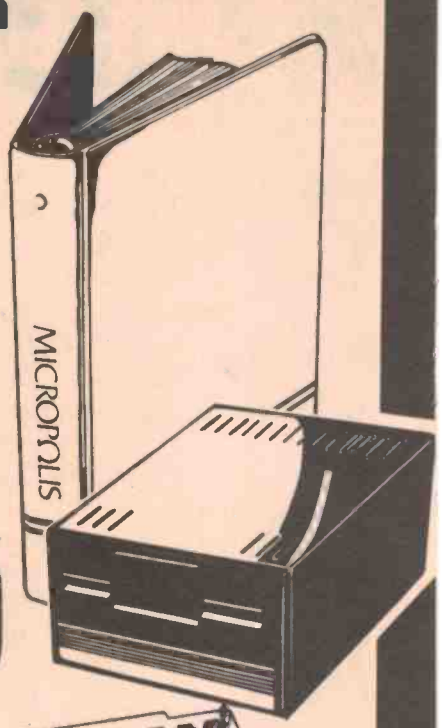


And remember, it is made by Micropolis – pioneers and acknowledged world leaders in high density floppy disk technology.

Of course, this superb storage system is ideally suited to the world's best microcomputer: the Sorcerer.

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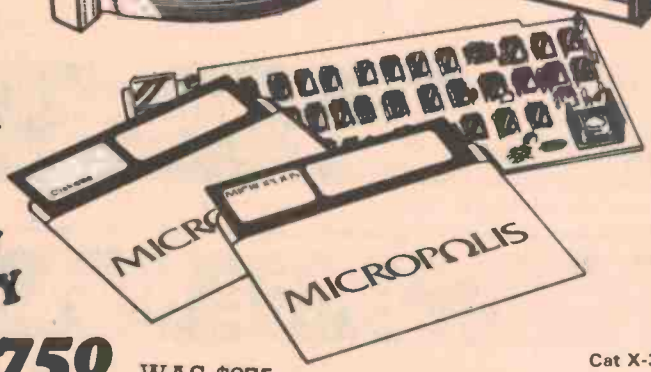


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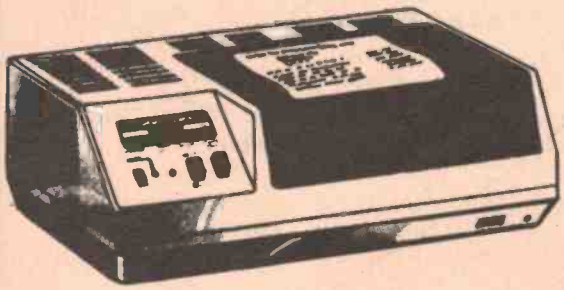

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# Print-out

# The HP-85, Hewlett Packard's 'personal computer for professionals'

Hewlett Packard's low-cost, stand-alone, personal computer system with built-in, interactive graphics was placed on the market on 1 February.

The HP-85 features a powerful central processor, typewriter-like keyboard, 130 mm cathode ray tube display, printer, tape cartridge, and graphics capability in a fully integrated system the size of a portable electric typewriter.

English-like BASIC language programming makes the new system easy to use for those without previous computer experience. A 20-key numeric pad makes data entry or performance of routine arithmetic operations simple.

The HP-85 is designed for personal use in business and industry by professionals such as engineers, scientists, accountants and investment analysts. It will also appeal to serious hobbyists and instructors in secondary schools, colleges and universities. Manufactured and marketed by HP's Corvallis (Oregon, USA) Division, it is an offspring of HP's Capricorn Project.

"This new computer is aimed at users who need computing power in dedicated applications at a reasonable price," said David Booker, general marketing manager of HP Australia.

"This could be an engineer sharing time on a large computer system, or a business professional seeking to improve decision-making.

"The HP-85 is reliable and easy to use because all parts — computer, CRT, keyboard, tape cartridge, and printer — are in one self-contained unit. Yet it is as powerful as some computers costing much more, and it can be put to work immediately on many sophisticated technical, industrial and business applications. We believe this product is indicative of HP's commitment to building advanced, personal computing products," Booker concluded.

In addition to its advanced computation and graphics capability, the HP-85 is equipped with four input/output ports to hold a wide range of optional Interface modules, giving it powerful capabilities in data acquisition and control applications. Furthermore, the I/O ports allow expansion of the system to include plotters, printers, disc drives and other peripherals as they become available.

The HP-85 comes with 16K of read/write memory, with 14.5K available to the user. The read/write memory can be expanded to 32K (30.5 available) simply by plugging an optional memory module into one of the input/output ports on the back of the machine.

The HP-85's BASIC interpretive language (ANSI standard) features 12-digit accuracy, versatile string operations, convenient editing, 42 predefined functions, four levels of programme security and flexible output formatting, according to HP.

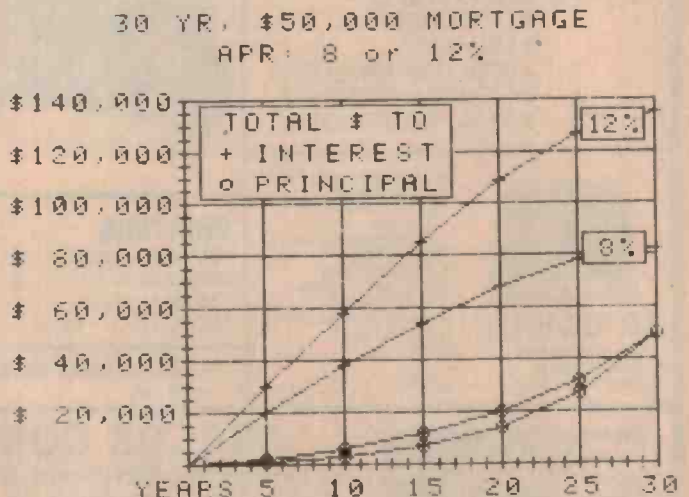
The built-in, interactive graphics allow the user to plot data on the display to clarify complex information in easy-to-understand pictorial form. For example, technical users can check test results and calculations by doing curve fitting and distribution analysis on the screen; business users can see trends in business operations by looking at a chart or curve instead of long lists of numbers. Further, any graphics display on the CRT can be preserved by using the built-in printer.

For user convenience the keyboard is logically divided into four sets of functions: typewriter keyboard for entering alpha data; numeric pad for entering numbers and doing the arithmetic operations of addition, subtraction, multiplication, division, exponentiation and integer division; "soft keys" which are assigned a function by the user during programme development; and display, editing and system control keys which permit the user to control the CRT, operating system, tape drive and printer.

The CRT can display up to 16 lines of data at a time, with up to 32 characters per line. The HP-85 "remembers" up to 64 lines of data, any of which can be viewed by 'rolling' the display on the CRT up or down.

In the graphics mode the display is broken down to a 256 (wide) by 192 (high) dot field giving 49/152 distinct points for high-resolution plotting. Further, the HP-85 stores both the last alphanumeric display and the last graphics display allowing the user to freely switch from one mode to the other without losing data from either.

The quiet thermal printer operates in both alpha-numeric and graphic modes, prints two, 32-character lines per second. In the alphanumeric mode it ▶




An example of the graphics plot available on the HP-85.

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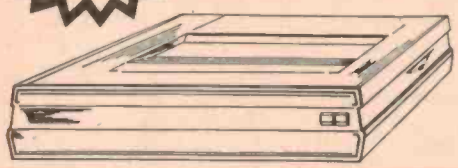

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**SPECIFICATIONS**
**OPTIONS:** "M" — 2K RAM buffer, "S" — high speed paper advance and graphics "T" — tractor feed.
**PRINTING METHOD:** 7 Wire dot matrix, bi-directional, impact
**PRINT AREA:** 8.0 inches (203mm)
**THROUGHPUT SPEED:** 60 lines per minute
**LINE SPACING:** 6 lines per inch
**COLUMN CAPACITY:** 72,80,96,120 or 132. Switch or program selectable
**CHARACTER HEIGHT:** .104 inches (2.6mm)
**CHARACTER WIDTH:** .08 inches (2.0mm) at 80 col
**PAPER WIDTH:** 9.5 inches maximum
**RIBBON:** .5 inch (13mm) cartridge (5M chars)
**INPUT/OUTPUT PROVISIONS:** a) RS-232, b) 20 ma current loop, c) IEEE — 488 type, d) Centronics parallel.
**SIZE:** 3 inches high (75.2mm), 10 inches deep (254mm), 14 inches wide (355.6mm).
**WEIGHT:** 9 pounds (4.1 kg.)
**OPERATING CONDITIONS:** 40 to 120 degrees F (4-49C), 10 to 90 percent relative humidity
**POWER:** 115 VAC or 230 VAC (switch select) 50 or 60 Hz
**EXTERNAL CONTROLS:** Power on-off, self-test, baud-rate, line buffer length, 10 mode select.
**BAUD RATES:** Fifteen rates from 110 to 19,200
**CHARACTER FONT:** 5 X 7 96 character ASCII
**LINE BUFFER:** Two lines plus space for second character font

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can print the full 128 ASCII character set which consists of upper and lower-case letters, numerals and special symbols. Additionally, the full character set can be underlined, giving the HP-85 printer a 256 character-set capability.

In the graphics mode the printer can reproduce any plot on the CRT under programme control or by simply pressing a button. When plotting, the printer 'rotates' the display 90 degrees, permitting virtually endless strip chart printing.

The HP-85 tape drive uses HP Data Cartridges, which have a capacity if 217K. The HP-85 automatically sets up a tape directory at the beginning of each tape. Using this "table of contents", the system can automatically find exact tape locations of recorded programmes and data.

Nine HP-85 application software packages are immediately available on pre-recorded cartridges, and packages combining a number of other commonly used programmes are under development. Other programmes will be available in written form from a users' library, and BASIC programmes developed for HP's desktop computer systems can be adapted for use on the HP-85. Additionally, most existing software comlying with the ANSI standard can be adapted for HP-85 use.

The HP-85 application software now available on pre-recorded cartridges includes BASIC training, general statistics, mathematics, electrical engineering, finance, linear programming and regression analysis.

The HP-85 measures 406 mm wide, 457 mm long by 152 mm high and weighs under 9 kg. A 350-page owner's manual describing operation and programming comes with the new machine. Also included is a standard application software package which contains fifteen useful HP-85 programmes.

Price of the HP-85 is $3550 (less S/T), the optional 16K byte memory expansion module is priced at $430 and the application software packages sell for $104 each. An optional HP-85 carrying case is available for $131 (all less S/T). All items are available immediately through selected authorised HP dealers. For more information, contact Hewlett Packard Australia Pty Ltd, 31-41 Joseph St, Blackburn 3130 Vic. (03) 89-6351.

# For bargain hunters

**Surplus computer hardware at a bargain basement price is available from a Melbourne dealer.**

They have available a large number of incomplete computer terminal units which they suggest could be used to mount a micro plus peripherals in a professional manner.

Each unit contains: one cabinet measuring 1 m high by 500 mm wide by 830mm deep with attractive, lift-off panels; one keyboard in typewriter format with additional function keys: various racks and circuit boards; Muffin fan; draw slides and many Cannon connectors along with various sundries.

Unfortunately, circuits aren't available. However, the cards in the units contain goodies like 74H series chips, MC1488s and MC1489s, Mostek 2407 and 2496 chips, 4.9 MHz and 19.7 Mhz crystals etc, etc.

The equipment may be inspected by appointment at Sharon Youth Camp, Dandenong Hastings Rd, Pearcedale Vic 3192. Phone (059) 78-6278 first.

# New club

**The Darth Amateur Computer (and electronics) Society has been formed to enable Tasmanian computer and electronics enthusiasts to exchange programs, circuits and thoughts on or in computing and electronics.**

The Club welcomes the newly-initiated and experienced hobbyist alike. Membership costs $1.

Prospective members may call in at, or write to, DACS, 4 Mellinga Place, Taroona, Tasmania 7006.

# New line printer from Anadex

**Bell & Howell have released a full size line "super printer" from Anadex Inc.**

Known as the DP9500 series it follows the successful concepts of the smaller DP8000 80 column dot matrix printer released in Australia early in 1979.


A spokesman from Bell & Howell said that the release of the DP9500 would coincide with the US product launch and that it earned its title "super printer" by virtue of its many standard features not previously available in a line printer for under $2000.

A standard feature of the DP9500 series is dual character fonts of either 9 x 9 and 7 x 9 allowing column widths of 132 or 175 with print speeds of 150 or 200 cps (Model DP9500) or fonts or either 11 x 9 and 7 x 9 with column widths of 132 or 220 and print speeds of 120 or 200 cps (Model CP9501). Industry standard 132 columns are printed with true lower case descenders.

An on-board microprocessor ensures high throughput with shortest distance sensing logic and built-in self-test diagnostics to ensure trouble free operation.

Complete communications control is another standard feature which allows the printer to act as an intelligent device. As with the smaller DP8000 all three interfaces (RS232C, current input and parallel) are in-built and switch selectable as is full width adjustable tractor paper feed.

Full service and spares support is provided through their network of branch offices and authorized service centres currently being established in regional centres.

# Signetics interface reduces software overhead

**A new programmable communications interface designed to simplify and expand the capability of microcumputer-controlled data communication systems and significantly reduce "software overhead" has been introduced by Signetics.**

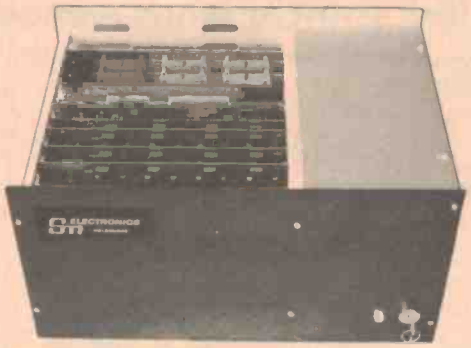
The new device, available from Philips Electronic Components and Materials, is the Signetics 2661 Enhanced Programmable Communications Interface (EPCI).

The 2661, which is pin and register bit-compatible with Signetics' previously released 2651 PCI, provides binary serial interface for asynchronous or character-oriented synchronous data systems. It interfaces directly to all 8-bit microprocessors and can be used in polled or interrupt-driven system environments.

The new circuit incorporates a number of features that otherwise would be ac-▶

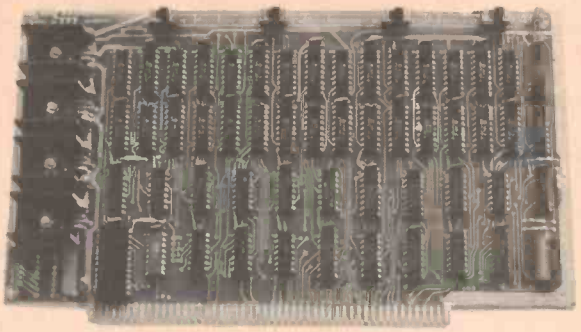
# 'THE S100 BUS STOP'™

## S-100 & 6800 CHASSIS



11 slot backplane, fully card guided. 15 amp power supply, fan, key switch, bench mount, rack mount, annodised aluminium. 5 edge connectors standard. S-100 Bench Kit $345. S-100 Rack Kit $306. 6800 Bench Kit $370. 6800 Rack Kit $330. Assembled prices add $100.

## ETI 642 S-100 16K STATIC RAM



Features:- 2114 low power static RAM's, 4K addressing, 4K write protect, bank select, wait state gen., plated through hole, solder resist mask, 300 or 450 nS speed, ETI 642.
Kit $315. Ass. $380. Add $32 for 300 nS.

### 2708/2716 EPROM CARD
Features:- holds up to 16 2708 or 2716 (single supply) EPROMS, on board wait state gen. Unused locations may be blanked. Plated through holes, solder resist mask.
PRICE:- Kit $115. Ass $155.

### EPROM PROGRAMMING CARD
Features:- ability to programme triple supply 2708's and single supply 2508, 2716, 2732 etc. Zif. Socket. On board 26V generator. Port driven.
Price:- Kit $175. Ass $205.

### Z-80 CPU CARD
Features:- 4 MHz operation, power on jump, wait state generators, provision for on board 1K EPROM, front panel socket for reset, and data lines etc.
Price:- Kit $156. Ass $196.

### Z-80 SINGLE BOARD COMPUTER
Features:- 4 MHz operation, 1K static RAM, 8K/16K EPROM, serial/parallel ports, power on jump, timer, vectored interrupts, software selectable buad rates. With 2716 EPROM. Price:- Kit $295. Ass $370.

### 80 X 24 VIDEO DISPLAY CARD.
Features:- on board Z-80 and CRT 5027 controller chips, parallel keyboard interface, 2708 driver chip, and 2708 character generator chip, special effects and extended character set available.
Price:- Kit $290. Ass $370.

### 64 X 16 VIDEO DISPLAY CARD
Features:- memory mapped 1K board, with reverse video and cursor control. RCA video connector, plated through holes and solder resist mask.
PRICE:- Kit $155. Ass. $180.

### FLOPPY DISK CONTROLLER CARD
Features:- single density, mini or full size disk drives with FD 1771 controller chip, can be interrupt driven, syncs with CPU in data transfer, Shugart/Remex compatable.
Price:- Kit $195 Ass $235

### DD FLOPPY DISK CONTROLLER CARD
Features:- controls mini and full size, single/double sided single/double density and all combinations of each. Crystal locked, PLL data recovery. Shugart/Remex compatible software (CP/M / SDOS) for above controllers available.
Price:- Kit $285. Ass $345

### STANDARD EXTENDER CARD
Features:- double sided f/glass board, numbered test points reflow soldered.
Price:- Kit $33. Ass. $48

### WIRE WRAP CARD
Features:- double side f/glass board, ground plane and supply rails run on both sides, 3M type connector patterns on top of board, provisions for regulators on all rails, holes are on .3" pitch, by .1" pitch.
Price:- Bare board $28.50

### 6800 PRODUCTS
6800 Extender Board $33. 6800 11-slot backplane $36. 6800 11-slot chassis, rack mount $330. 6800 Extender Terminator Board, Kit $80. Ass $105.

### EPROMS AND RAM CHIPS
2708 450nS guaranteed $12. 2716 450nS single supply ex-stock $47.50. Hitachi 2114 low power 450nS $7.50. Hitachi 2114 low power 300nS $8.50.

### DISK DRIVES
Shugart SA400 $410. Shugart SA801 $710. Remex 8-inch double sided $795.

### DUAL 8" DRIVE PACKAGE
Features:- contains dual 8" single or double sided disk drives either Remex or Shugart. Inbuilt power supply, cooling fan, modular construction, keyswitch, fused on mains, all aluminium 19" rack mount (10-½" high).
Price:- single sided $1750. Double sided $1950.

### EPROM SOFTWARE
1. Z-80 monitor in 2708 EPROM, has 16 functions, three versions available to drive TTY, TTY/VDU, KBD/VDU. Price $25. 2. ETI 640 video driver EPROM, makes the memory mapped video card look like a terminal, has XY cursor addressing, home clear screen. Price $25.
3. 6.25K Basic interpreter, in seven 2708 EPROMS, has trig functions, dimensions, command level input ability. EPROM resident at OC000 hex. Price $180.
4. Disk control EPROMS, contain I/O routines to handle our disk controller with CP/M, 2 EPROM set with second EPROM containing inbuilt video driver and I/O routines for all external devices like printers, terminals etc. Price $50.
Customised version available (I/O and relocation) for an additional charge depending on the programme.

### DISK SOFTWARE
CP/M version 1.4, customised for our controller, $130. CBASICII $100. Wordmaster, word processing package $140. TEX writer, letter and text formatter $50. CP/M user group library (33 volts) at $12 per volt. RAM Diagnostic, reports errors and likely causes $25. Available on 8" and 5-¼" single or double density. Above prices are for 8" disks.

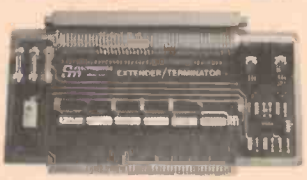
### S-100 I/O PORT BOARD


DUAL SERIAL I/O CARD Features:- dual independantly controlled serial ports with TTY and RS232 outputs and inputs. Nine programmable parallel ports, crystal controlled baud rates fully buffered and address decoded. Plated through holes & solder resist mask.
Price:- Kit $189. Ass. $225.

### UV EPROM ERASER

New product range. Model LEE/T 15W tube, 120 min timer, up to 40 EPROMS will erase in 10/15 mins. Model MEE/T 8W tube 120 min timer, up to 10 EPROMS will erase in 20/30 mins. Model MEE is same as MEE/T but with no timer. All erasers are fully assembled and have a safety switch. LEE/T $105. MEE/T $93.50. MEE $74.

### S-100 EXTENDER/TERMINATOR



EXTENDER TERMINATOR CARD — features:- true active termination of the bus with inbuilt extender connector on top of board, fused rails to extended board. Test points numbered, solder resist, plated through. Price:- Kit $70. Ass. $90.

**SM ELECTRONICS**
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complished in software, reducing performance and available memory requirements in microcomputer systems.

Applications include character-oriented data link control; terminals or terminal controllers; smart communications multiplexers/concentrators; front end or network processors; and interfaces to serial peripherals such as printers, CRTs, etc.

For synchronous service, the 2661 EPCI offers 5- to 8-bit (plus parity) characters; single or double SYN operation with the same or different SYN characters; internal or external character synchronization; transparent mode DLE stuffing (transmit) and detection (receive); automatic SYN or DLE-SYN insertion during transmitter underrun; programmable SYN, DLE and DEL-SYN stripping; odd, even or no parity; partly and overrun detection, local or remote maintenance loopback mode, and baud rates from DC to 1 Mbps (1 x clock).

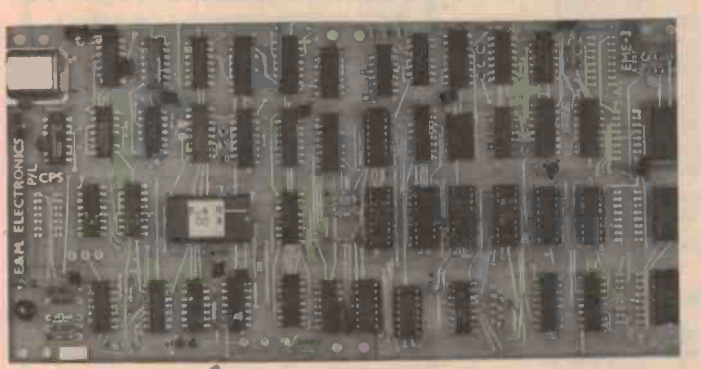
The 2661 can provide strong support to a BISYNC system when combined with Signetics' recently introduced 2653 PGC (polynomial generator checker), supplying an all hardware solution to the usual hardware-software trade-off problems encountered with BISYNC.

Programmed selection of internal clock provides a choice of 16 crystal-controlled baud rates for each of the three versions of the 2661 EPCI. Rates range from 45.5 to 38 400 baud; on external clock, the 2661 can operate at speeds up to 1 Mbps, fast enough to enable a DMA interface to handle character transfers without CPU intervention.

The 2661 EPCI is available in a 28-pin ceramic package. For more information, contact Philips Electronic Components & Materials, 67 Mars Road, Lane Cove, NSW.

## Video RAM board

**The EME-3 Video RAM is designed to interface directly with a micro to display 80 or 64 characters by 24 lines and is supplied as a complete module ready to operate.**




Two versions are available:
(1) EMI-3A: 64x16. Upgrading to 80x24 is possible by the addition of extra components.

(2) EME-3B: 80x24.

High quality 3M type dual-in-line flat cable connectors are available separately and supplied with one plug (single-ended), or a plug at each end (double-ended). Unless specified, the cable lengths are 250 mm. The number of connectors required should be specified in the order.

The alternative power input socket connector is also available separately. This is a four-way pin socket assembly terminated with 300 mm long flying leads.

Prices are as follows: EME-3A $249.00; EME-3B $275.00; DIL connectors, single-ended $3.50; double-ended $6.50 (any length to 250 mm may be specified). Alternative power socket $1.50. Sales tax, where applicable, must be added. The rate is currently 15 percent. $4.50 covers packing and certified airmail anywhere in Australia.

Contact E. & M. Electronics Pty. Ltd., 136 Marrickville Rd, Marrickville, NSW.

## Brief bytes

**Strong rumours have it that Texas Instruments will have their TM990/306 synthetic speech module available soon, if not already. Designed to suit their family of 16-bit processors, the 306 will make use of solid-state linear predictive encoding techniques employed in their earlier consumer products (the Speak and Spell and 99/4 home computer).**

If it isn't enough that TI's gone talkative, Japan's Nippon Telegraph and Telephone Public Corp. and Hitachi have teamed up to produce a commercial speech synthesizer chip. It seems Hitachi will market some imaginative (not to mention, gimmicky) products like a talking soroban — the Japanese version of the abacus, and a talking clock-radio — the clock talks. Operation is based on a technique similar to TI's chip, called Parcor (partial autocorrelation). The Japanese chip has one-up on the US device though — it can synthesize a female voice!

**Motorola will be second-sourcing Intel's 2147 fast static RAM. They have produced the chip in limited numbers through last year and are now able to get good yields of devices meeting the 55 ns access time spec. Next comes a second-source version of Intel's 2115A, according to our sources.**

US television manufacturer Zenith is to diversify into personal computers since buying the famous Heath Company — well known for their enormous range of kits. Reportedly, Zenith paid Schlumberger Ltd US $64.5 million for Heath. Zenith plan to supply the small business market with computers and peripherals.

**Having trouble debugging you minis? Hewlett Packard have an application note available entitled "Minicomputer Analysis Techniques Using Logic Analysers". The 16 page booklet covers theory and examples of procedures for software evaluation, code optimization, performance analysis and troubleshooting complex digital systems. Ten applications illustrate the use of logic analysers with system crashes, complex program tracing, asynchronous buses and turn-on failures. Ask HP for Application Note 292 (publication number 5953-2704). It's free.**

National Semiconductor is developing an even faster version of its Shottky-coupled-logic IDM2901A 4-bit slice microprocessor. The IDM2901A-2 is capable of microrcycle times as low as 60 ns! The new device can perform a simple add as quickly as 67 ns and a more complex add and mutiply in only 78 ns, according to NS, beating previous devices by as much as 60%. The company plans to offer the IDM2901A-2 in plastic and hermetic packages for both military and commercial applications.

**SORD Computer Systems Inc. of Japan have announced receipt of an order from the Swedish Government for 165 SORD M200 MKIII Series Computers for use in Swedish National Hospitals. This is the first large order for any Japanese Microcomputers from Sweden. The 165 Computers are part of a proposed 2000 units expected to be ordered within the next year. The computers will be used at 16 hospitals for stock control of blood, medicine, medical equipment, and also food control. They will be used as intelligent terminals in conjunction with mainframe computers.**

A new floppy-disk controller, compatible with the TM990 series of microcomputer board products, has been announced by Texas Instruments Incorporated. Designated YM990/303, it supports up to four double-sided drives and has the ability to interface to single-density drives of either of the two most popular dual-density drives (FM or MFM). The controller is compatible with IBM 3740 and TI disk formats. Data transfer format and steppermotor rates are both programmable.

**Motorola have released an application note on "Modifications to the Motorola MEK6800D2 Evaluation Kit II, enabling the system to be based on the MC6809 Microprocessor". It is available from Silicon Valley Stores in Sydney, Melbourne, Adelaide and Brisbane. Ask for publication number 79-S3 if the title is a bit of a mouthful or overflows your memory.**

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## NOW EVEN BETTER!

## Sorcerer Mk II

As part of their on-going research and development, Exidy have made some changes giving the Sorcerer on-board capability of up to 48K RAM – plus greater reliability. You still get the interchangeable ROM PAC™ feature, high resolution graphics of 122,880 pixels (nearly twice that of any rival computer), both upper and lower case characters, graphics, I/O ports as standard, S-100 expansion capability, 2 cassette player interface plus many more outstanding features.

Mk II

Cat. X-3000 8K ONLY **$1095**

Cat. X-3001 16K ONLY **$1250**

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The Micropolis Metafloppy™ gives you more than four times the capacity of anyone else's 133mm floppy. Because it uses 77 tracks instead of the usual 35. The Metafloppy™ model 1053 comes with 630,000 bytes on-line and is designed for use with S-100/8080/Z80 bus. Comes complete with controller board, inbuilt power supply, cables, a new BASIC software package, DOS with assembler and editor, even an inbuilt ROM to eliminate tiresome button pushing.

For a superb disc system see Dick Smith – the Micropolis has more bytes in store for you!

Cat. X-3210..... **$1950**

## ROM PACs

### Word Processor PAC™

Add to your Sorcerer for a system that is more powerful than other available systems. It includes instruction manual and features auto text wrap, auto checking drastic commands, powerful search functions auto commands and macro programming, single key commands plus much more.

Cat. X-3085.... **$199.00**

### Development PAC™

Turns your Sorcerer into a dedicated development tool. Includes instructions and features designer's debugging tool, text editor, Z80 assembler, linking loader, I/O driver routines.

Cat. X-3090.... **$139.50**

### EPROM PAC™

Write your own program. This PAC comes complete with special PCB, ancillary components and case and is ready for insertion of your EPROM IC.

Cat. X-3095..... **$75.00**


## Cassette Recorder

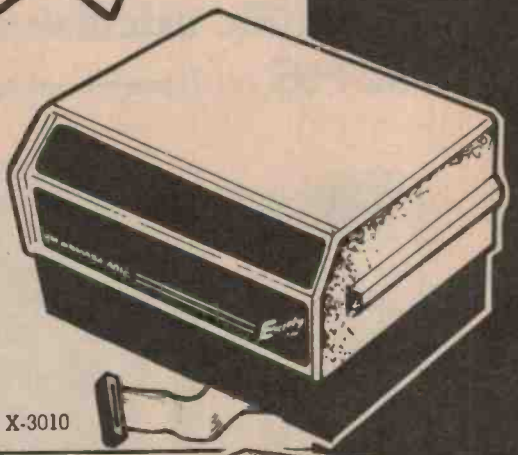
**$39.95** Cat. A-4092

A good quality cassette recorder for use with your computer. If using the Sorcerer you simply interface with serial cable (Cat. X-3110 @ $34.50), which can handle two cassette recorders, and the computer will stop and start your program tape. This unit works on 240V AC or 6V DC and measures 260x140x65mm. Ideal for use with the Tandy TRS-80.

# system for your dollar on quality!

## Exidy S-100 Expansion Unit

The Exidy S-100 expansion unit opens the way to almost unlimited expansion of your Sorcerer system, because more than 100 manufacturers world wide produce plug-in PCB card modules designed for the S-100 bus system. There are S-100 plug-ins available for almost every conceivable avenue of system expansion. Memory cards, floppy disc and hard disc controllers, EPROM programmers, special I/O interfaces and power control cards, colour video graphics controllers, D-to-A and A-to-D converters, music and speech synthesis cards, even speech recognition cards plus more being announced all the time. Supplied complete with inbuilt power supply, ribbon cable and connector.

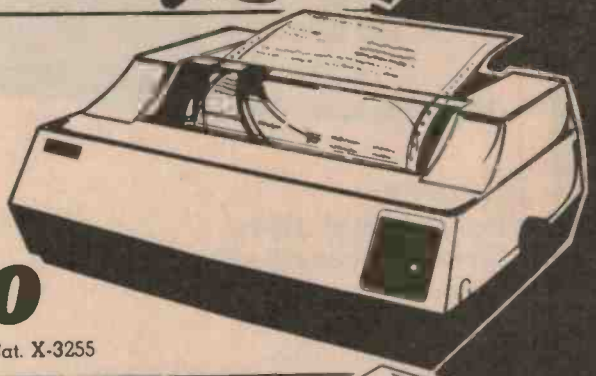


***Use other manufacturers peripherals with your SORCERER***

**$499.00** Cat. X-3010

## ECONOMICAL PRINTER

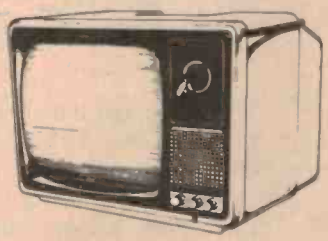
The C.ITOH model 8300 dot matrix printer is a high performance unit that incorporates the latest micro processor technology. This unit is priced below many printers offered by other companies but if you want a no-nonsense printer that can churn out the full 96-character ASCII at a brisk 125 characters per second on standard fan-fold paper, then you can't do better. Character spacing of 80 and 40 columns – software selectable with inbuilt 80 byte character buffer and self testing string generation. Interface 7-bit parallel Centronics type, this is available as Cat. X-3112 @ $49.50.



**$970** Cat. X-3255

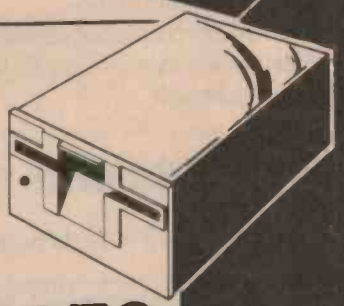
## Universal Monitor
### WHY PAY MORE?

Suits virtually all systems including The Sorcerer, Tandy TRS-80, Apple, System 80 etc. Compare our prices to theirs! Large screen (30cm) with jitter free, distortion free characters. Simple connection plus dual power – 240V AC or 12V DC.



**$149.50** Cat. X-1196

## TANDY OWNERS – DON'T MISS OUT



This superb Dick Smith Mini Disc Drive provides 228% the storage capacity of the Tandy drives yet costs far less! Check these features – ● 133.4mm minifloppy diskette ● 40 tracks instead of 35 – 14% more storage per side ● soft sectored ● dual sensors for reading on both sides – doubles the storage capacity ● recording density (inside track) 2768bpi ● 100K bytes per side ● drive number is switch selectable ● use as first drive or add-on drives for TRS-80. (SAVE $1000 plus on the latest Tandy price - Jan 1980)

**$379** Cat. X-3230

### Power Supply
Cat. X-3234 **$60.00**

Especially suited to the Dick Smith mini disc drive. The unit has dual voltage and will power TWO drives.

### Connecting Cable
Cat. X-3232 **$49.50**

34 way daisy-chain cable for controlling 4 disc drives to your TRS-80.

# DICK SMITH ELECTRONICS

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| | 656 Bridge Road, | RICHMOND. | Phone 428 1614 | | |
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| SA | 283 Wright Street, | ADELAIDE. | Phone 212 1962 | | |
| WA | 414 William Street, | PERTH. | Phone 328 6944 | | |

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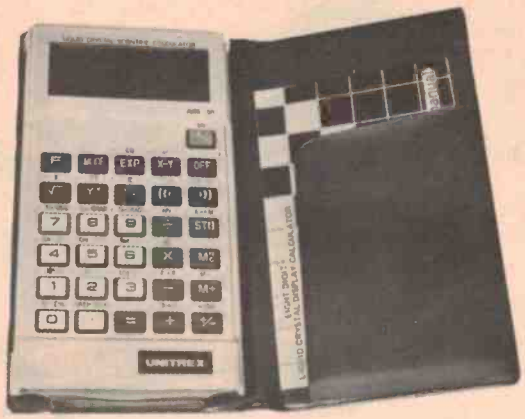
# SUPER CALCULATOR OFFER

## 1) Scientific calculator

**$24·95** + $1.95 post and packing



### Features:

- Full eight-digit display
- Three level parenthesis
- Memory
- Power root operation
- Factorial calculation
- Statistical mode operation
- Permutation/combination keys
- Auto turn-off

### SPECIFICATIONS

**Number of digits operated:**

Entry: 8-digit display — 8 significant digits
Exponent display — Mantissa 5 digits
Exponent 2 digits

Result: Mantissa — 8 significant digits (indicated by CN key)
Exponent — 2 digits

**Number of digits displayed:**

Mantissa and algebraic display: Maximum 8 digits (8 significant digits)
Exponent display: Upper 5 digits (mantissa) + 2 digits (exponent)

**Types of operation:**

Four fundamental arithmetic calculations, Memory calculations, Functional calculations (Root, Pi, Reciprocal, Square, Factorial, Trigonometric/Inverse trigonometric, Exponential, Logarithm, Permutation and Combination calculations), Statistical calculations and Transformation calculations (Display change notation, Coordinate system transformation, Degree-Minute-Second transformation and Transformation among DEG, RAD and GRAD).

**Decimal point:**

Entry: Integral part — Floating (equal or less than 8 digits)
— Exponent method

Result: $10^{-2} \sim 10^{7}$ — Floating
$10^{-103} \sim 10^{-3}$, $10^{8} \sim 10^{103}$ — Exponent method

**Operation range:** $(\pm 0.0001 \times 10^{-99}) \sim (\pm 99999 \times 10^{99}), 0$

**Power source:** DC 2 x 1.5 V Silver Oxide Battery or Equivalent

**Power consumption:** 0.0003 W

**Operating temperature:** 0°C ~ 40°C (32°F ~ 104°F)

**Dimensions:** 64 mm (W) x 121 mm (D) x 7.8 mm (H)

**Weight:** 68 g (with batteries)

## 2) Conversion calculator

**$19·95** + $1.95 post and packing


### Features:

- Metric-Imperial-Metric conversions
- Centigrade-Fahrenheit-Centigrade conv.
- US gallon-to-litre conversions
- US oz.-to-cc conversions
- Four function calculator plus percent and square root.

**• KEY DESCRIPTION**

| | |
|---|---|
| ⊡ ⊡ | Conversion keys<br>Convert the contents of a display register into the arrow units. |
| In ↔ cm | Inch ↔ Centimeter |
| ft ↔ m | Foot ↔ Meter |
| mile ↔ km | Mile ↔ Kilometer |
| $in^2 \leftrightarrow cm^2$ | Square inch ↔ Square centimeter |
| $ft^2 \leftrightarrow m^2$ | Square foot ↔ Square meter |
| US oz ↔ cc | U.S.Ounce ↔ Cubic centimeter (Liquid measurement) |
| UK oz ↔ cc | U.K. Ounce ↔ Cubic centimeter (Liquid measurement) |
| $in^3 \leftrightarrow cm^3$ | Cubic inch ↔ Cubic centimeter |
| $ft^3 \leftrightarrow m^3$ | Cubic foot ↔ Cubic meter |
| US gal ↔ l | U.S. gallon ↔ Liter |
| UK gal ↔ l | U.K. gallon ↔ Liter |
| oz ↔ g | Ounce ↔ Gram |
| lb ↔ kg | Pound ↔ Kilogram |
| °F ↔ °C | Fahrenheit ↔ Centigrade(Celsius) |

### SPECIFICATIONS

1. **Display:** 8 digits + 1 (Signs of Minus and Overflow)
Liquid Crystal Display

2. **Function:** Addition & Subtraction, Multiplication, Division, Automatic Constant Calculation, Percentage, Add on & Discount, Power & Reciprocal Calculation, Square Root Calculation, Inverse Calculation, Mixed Calculation, Conversion Calculations

3. **Decimal Point:** Full Floating Decimal Point System

4. **Zero:** Leading Zero Suppression

5. **Rounding:** Truncation

6. **Capacity:** Full 8 digit capacity with minus and overflow indications

7. **Power Source:** DC; 2 x 1.5V Silver Oxide Battery (G10) or equivalent

8. **Operating Voltage:** 3V

9. **Power Consumption:** 0.00008W

10. **Operating Temperature:** 0°C ~ 40°C (32°F ~ 104°F)

11. **Dimensions:** 55mm(W) x 91mm(D) x 3.5mm(H)

12. **Weight:** 36g (with batteries)

## COUPON →

NOTE: This offer is made by Caldor Pty Ltd and ETI is acting as a clearing house for orders only. Cheques should be made out to UNITREX CALCULATOR OFFER and sent, together with the order, to:

**Unitrex offer**
**Electronics Today International**
**15 Boundary St, Rushcutters Bay NSW 2011**

ETI will process the orders and send them on to Caldor who will then send out goods by certified mail. Please allow up to four weeks for delivery.

### UNITREX CALCULATOR OFFER

Send to: Electronics Today International
15 Boundary St, Rushcutters Bay, NSW 2011

Please supply:
Scientific calculators at $24.95 each . . . . . $
plus $1.95 post and packing per unit . . . . . $

Conversion calculators at $19.95 each . . . . . $
plus $1.95 post and packing per unit . . . . . $

TOTAL $

Please make cheques/money orders payable to 'Unitrex Calculator Offer'.
Offer closes 16 April 1980

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. . . . . POSTCODE . . . . . .

Facts from Fluke on low-cost DMM's

# Investigator for hire: Powerful. Professional. Portable.

Sometimes it takes both hands, both feet and your undivided attention to get a job done right.

For balancing acts like this you need the new 8024A Investigator from Fluke – the first DMM you can both see *and* hear. So you can use it with confidence. Even behind your back.

With nine functions, the 8024A is the most versatile 3½-digit multimeter you can buy. Special skills give the Investigator powers you won't find in any other handheld DMM.

The Investigator's level detector provides an instant visual (⬍) and audible signal for continuity checking, logic pulse detection, and timing measurements. You can make rapid circuit checks with both eyes on the test points while the Investigator's "beep" guides you.

Another exclusive among low-cost DMM's is the Investigator's ability to deliver fully compensated direct temperature readings with any K-type thermocouple.

The 8024A also has a peak hold feature that locks onto and retains transient signals, such as motor starting currents. And with conductance (measures leakage and high resistance), 0.1% basic accuracy, custom accessories and all the excellence you expect from Fluke.

For all the facts on the new 8024A Investigator, use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

FLUKE®


☐ *Please send data on Fluke DMMs.*
☐ *Please have a representative call me.*

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**ELMEASCO**
**Instruments Pty. Ltd.**

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13-15 McDonald Street, Mortlake, 2137
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21-23 Anthony Drive, Mt.Waverley. 3149
Tel: (03) 233-4044 Telex: AA36206
Adelaide: 51-3521 Brisbane: 229-3161
Perth: 398-3362

# COMMUNICATIONS

## Morse and RTTY the microprocessor way

Sydney-based amateur equipment and instrument dealer, Emtronics, has been quietly promoting the Info-Tech line of digital code communications equipment over the last year.

**There are six units in the Info-Tech range: the M-100E tri-mode converter that converts morse, baudot and ASCII codes to video; the M-200E — a more sophisticated version of the M-100E using Fairchild's F8 microprocessor technology; the M-300C tri-mode keyboard — an 'electronic' typewriter that puts out morse, RTTY and ASCII codes from a standard keyboard; the M-150 which is an earlier keyboard designed just for RTTY operation; the M-75 RTTY to video converter, and the Professional Monitor.**

Proprietor, Rudi Breznik VK2A0T, loaned us an M-200E, M-300C and Monitor late last year for us to fiddle with and we thought the system quite amazing.

All units operate from the 240 Vac mains and are internally well constructed and housed in attractive all-metal cases. The M-200E simply requires audio input from your receiver phones output and will accept and decode all the generally-used RTTY shifts and speeds. It provides composite video output at 2.5 V p-p with negative sync.

The video characters it generates are standard 5 x 7 dot matrix, positive video (white or black) and you can get 32 characters by 16 lines, with scrolling. The M-200E accepts morse speeds between five and 60 wpm and has a single ASCII speed of 110 baud (100 wpm). The device works as smooth as silk, once set up. It just sits there and does what it should!

The M-300C tri-mode keyboard is a microprocessor controlled device with a standard QWERTY keyboard featuring a 700 character running buffer. This allows you to 'type ahead' of what the keyboard is actually transmitting. You can 'pre-load' the buffer with a suitable response, while still receiving another station. It also has 11 recallable, user programmable message memories (RAM) of 120 characters each. These may be used separately or linked together for longer messages.

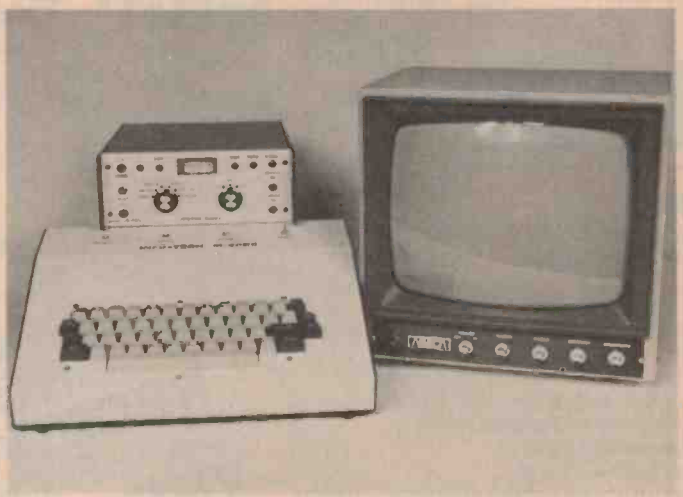
In addition, there is a special message memory with 120 character capacity for storing station ID or the mandatory morse ID required for RTTY contacts.

The M-300C can be easily interfaced with most transmitters. Again, operation is silky smooth.

The monitor is a delight. The display was stable — rock steady — and there was plenty of brightness for good viewing under bright light conditions. We found it worked excellently with a computer system too!

The Into-Tech system copied morse off-air as if from some electronic sender, but we found setting up was a bit of an art — new chum's finger troubles, no doubt. RTTY reception was no problem, even with noisy signals. Both morse and RTTY transmission from the system was 'copybook'. The buffer memory sure smooths things out.

The system is not for those light-on in the pocketbook but certainly appears good value for money. Full details from Emtronics, 649 George St, Sydney 2000 NSW. (02) 211-0531. Ask for their new catalogue while you're at it.



## VHF linear amplifiers

**Vicom recently announced the availability of a new line of VHF linear amplifiers produced by the Tono Corporation, manufacturer of the RTTY/CW Theta-7000 terminal keyboard.**

The company produce linears for 146, 435 and 28 MHz with output powers ranging from 30 to 130 watts.

Initially, the 146 MHz units will be available: the MR-1300E and the MR-900E. Both units accept a driving power of 10-15 watts and will handle FM, SSB, CW and RTTY.

The MR1300E has an output power of 130 watts when driven with 15 watts and the MR900E 90 watts under the same conditions. Both units employ a receiving RF amplifier which gives a gain of 13 dB.

Further details can be obtained from Vicom, 68 Eastern Road, South Melbourne Vic 3205. (03) 699-6700.

## New man for Vicom in NSW

**Vicom International Pty Ltd has appointed Mr Laurie Wade as Branch Manager of their NSW operations.**

He is responsible for all sales and marketing functions of Vicom's professional and amateur divisions in their recently established NSW office.

Mr Wade, a chartered electronic engineer, is well known around the Australian electronics industry, and is a respected member of the amateur radio fraternity. He holds the callsign VK2AQW.

He brings with him many years of experience in the communications and test equipment fields. You'll find him at the Vicom offices at 339 Pacific Hwy, Crows Nest NSW 2065. (02) 436-2766.

## 70 W 6/10 m booster amp

**As the low frequency gain of the DX542CF, used in the ETI-726, is uncharacterised some amps may show HF instability.**

This problem is easily cured by damping RFC1 with a resistor, around 5 ohms in value, connected in parallel.

If you like to play it safe with regard to TVI, the filter described for use with ETI-715 6m amp, published on p.52 of the January 1978 issue of ETI, will serve very well.

# Check out these sophisticated kits from Denmark

JostyKits ... Denmark's finest, offer the kind of innovative design inside and outside that you'd expect from Scandinavia. Created by qualified electronic engineers, they feature solid-state space age technology advanced enough for the most demanding kit builder. Each comes with a comprehensive instruction booklet. Whether you're a novice or experienced builder — JostyKits will give you hours of satisfaction in construction and performance!

## Audio

AF300 AUDIO AMPLIFIER
A real work-horse, this universal power amp has a wide range of applications such as car radio, record players and small receivers. Due to its well designed electronic circuit, the AF300 can be used over wide voltage ranges without deterioration of the specification parameters.
Kit AF300 — $25.00

AF340 40 WATT AUDIO AMPLIFIER MODULE
High quality 20-20,000 Hz, 37w RMS with low distortion.
Kit AG340 — $35.00

## FM Tuners

HF325-2 QUALITY FM TUNER MODULE
The HF325 is a complete high quality FM tuner of professional standing. The tuner unit is ready-made and pretrimmed, making it child's play to assemble. Tuning range 88-108 MHz, operating voltage 12-55 ac. Kit HF325 — $79.00
Stereo decoder HF 310

HF310 FM RECEIVER
The HF310 is a very reasonable priced HF FM tuner. Fully trimmed, the sensitivity according to IHF standards is better than 10uV. Features 60 dB S/N radio and low harmonic distortion.
Kit HF310 — $49.00

HF330 STEREO DECODER
Gives 40-45 dB channel separation, just add to a good quality FM receiver. Kit HF330 — $24.00

## Pre-amps (RF)

HF395 RF PREAMPLIFIER
Gain 30dB to 20 MHz, 10 dB to 100 MHz and 5 dB to 226 MHz. Ideal to boost reception on short-wave receivers. Kit HF 395 — $6.00

HF385 VHF/UHF ANTENNA PREAMP
Superb quality with two acrial inputs and one down lead which simultaneously supplies current from the power supply. Frequency range 40-250 MHz and 400-820 MHz. Gain 9-18 dB, depending on frequency. Kit 385 — $30.00. Box B850 — $6.00.

**VHF (FM) TRANSMITTER**
60-148 MHz. Cat HF65.
Only **$9.00!**

**SHORT WAVE RECEIVER PREAMP**
Cat HF 395. Only **$6.00!**

**VHF/UHF RECEIVER PREAMP**
Cat HF 385. Only **$6.00!**

## Light Shows

AT465 LIGHT SHOW
Turn your music into light. Simply connect this 3 channel light show to the audio terminals of your amplifier and this quality kit does the rest for you!
Kit AT465 — $64.00
Attractive box and knobs B6065 — $25.00

AT468 4 CHANNEL LIGHT SHOW
This superb kit drives 4 lights (400w per channel) from the audio amplifier output. Kit AT468 — $75.00. Attractive box and knobs B3265 — $48.00

AT365 LIGHT SHOW
This quality kit uses microphone input instead of connection to the audio output. 1599w max.
Kit AT365 — $69.00
Box and knobs B3265 — $48.00

## FM Transmitter

HF65 FM TRANSMITTER 60-148 MHz
Will run 5w output with heat sink. Ideal for signal testing of for a miniature transmitter which could be received on a standard FM receiver. Kit HF65 — $9.00.

## Receiver Converter

HF305 VHF CONVERTER
Converts FM 105-148 MHz to 105 MHz.
Kit HF305 — $28.00
Box B3405 attractive chassis kit — $24.00

## AM Receiver

HF61 MEDIUM WAVE RECEIVER 540-1600 KHz receiver complete with ferrite coil antenna. Kit HF61 - $19.00

## Power Supplies

NT415 LAB POWER SUPPLY
0-30V 1 amp well-regulated supply for professional use. Complete with box and transformer.
Kit NT415 — $128.00

NT300 LABORATORY POWER SUPPLY
2-30V High quality supply, regulated 2-30V dc at 2 amps with overload protection. Complete with box and transformer. Kit NT300 — $110.00

## Quick assembly kits

| | | |
|---|---|---|
| JK01 | GENERAL PURPOSE AMP 0.5w | $18.00 |
| JK02 | MICROPHONE AMPLIFIER | $18.00 |
| JK03 | SINE WAVE GENERATOR 20-20,000 Hz | $30.00 |
| JK04 | FM TUNER 88-108 MHz | $30.00 |
| JK05 | 27 MHz RECEIVER | $33.00 |
| JK06 | 27 MHz TRANSMITTER | $29.00 |
| JK07 | DUAL TONE DECODER FOR R/C MODELS | $43.00 |
| JK08 | 330Vac LIGHT OPERATED RELAY | $19.00 |
| JK09 | SIREN KIT inc. SPEAKER | $19.00 |
| JK10 | PHOTOGRAPHIC TIMER 240 Vac | $23.00 |
| JK101 | CAR BURGLAR ALARM KIT | $55.00 |

## New Kits

| | | |
|---|---|---|
| AT347 | Electronic Roulette | $54.00 |
| AT350 | 2 amp triac light controller | $12.00 |
| AT357 | Touch-control light dimmer | $33.00 |
| AT356 | 6 amp AC regulator | $27.00 |
| MI-360 | Multivibrator, sq. wave to 10MHz | $6.00 |
| SY-310 | 15w stereo amplifier kit | $230.00 |
| SY-340 | 37W stereo amplifier kit | $289.00 |

VICOM

JostyKits are now available from:

**Sydney:** Vicom,
339 Pacific Hwy, Crows Nest
Ph 436 2766
Radio Despatch Service,
869 George St, Sydney.
Ph 211 0816
Customs Communications,
Parramatta. Ph 635 6399

**Adelaide:** Hamtronics,
Goodwood Rd, Kingspark.
Ph 272 8417

**Melbourne:** Eastern Communications,
898 Riversdale Rd.,
Camberwell. Ph 836 8635
Tasman Electronics,
12 Victoria St, Coburg.
Ph 354 5062
Magraths, 208 Lt Lonsdale St,
Melbourne. Ph 663 3736.

**Brisbane:** Delsound,
1 Wickham Tce,
Ph 229 6155.
CW Electronics,
Marshall Rd, Tarrgindi.
Ph 48 6601.

**Perth:** Willis Electronics,
993 Hay St,
Ph 321 7609

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Wagga 21 2125
Hobart 43 6337
Cairns 54 1035
Launceston 44 3882

Launceston 31 7075
Launceston 31 5815
Brisbane 38 4480
Wellington (N.Z) 28 7946

**Mail Orders:** Direct to VICOM, 68 Eastern Rd., Sth. Melbourne, Vic. 3205. **Enclose $1 extra** for handling and postage costs.

# COMMUNICATIONS

## Communications monitor

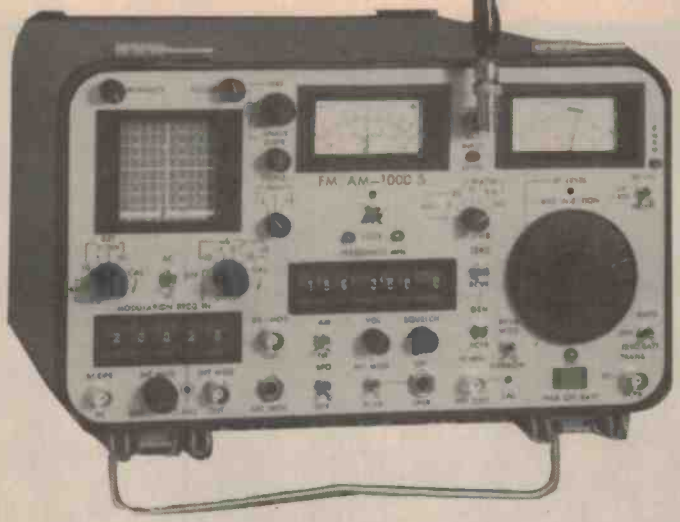
**Communications monitors have been recognised by the industry as a cost efficient test instrument for two-way radio servicing.**

Until now, service managers have been confused by a bewildering selection of plug-in modules available from the existing suppliers of communication service monitors, say Vicom.

Instrument Flight Research (IFR Inc) released communications monitors Models FM-AM 1000A and FM-AM 1000S recently. The instrument covers all functions as standard, and this includes spectrum analysis (S model), audio synthesis, two tone generation, BFO for single side-band measurement, power measuring to 100 watts and field strength measurements as well. All modes of measurement are available at the flick of a switch. The units cover to 1000 MHz from the generator and on reception, with spectrum analysis from 1 MHz to 10 MHz.

The instrument is powered by mains voltages or its own built-in NiCad battery pack. As the instrument is smaller and lighter than others in its class, it is well suited for field operation.

IFR Inc manufacture the monitors to specifications traceable to the National Bureau of Standards. In addition, they comply to FCC and FAA regulations for servicing of avionics. (Part 15 sub-part C FCC Rules and Regulations).



Vicom International, Professional Products Division, is the proud authorised Australian agent for the IFR range of test equipment. The people at Vicom are only too pleased to help you handle any enquiries on instruments and demonstration units are available now. Vicom's address is 68 Eastern Road, South Melbourne, telephone: 699-6700; Sydney, 339 Pacific Highway, Crows Nest, telephone 436-2766.

## Active SSB/CW filter

**GFS Electronic Imports of Mitcham, Victoria recently released a new "signal enhancer" — the MFJ-752 dual tunable filter.**

The unit consists of two separate active filters that have both bandwidth and centre frequency fully adjustable. Either filter may be set up individually as peak, notch, low pass or high pass networks.

Price of the MFJ-752 is $139. For more information contact GFS Electronic Imports, 15 McKeon Road, Mitcham, Vic 3132. (03) 873-3939.

## Repeater struck by lightning

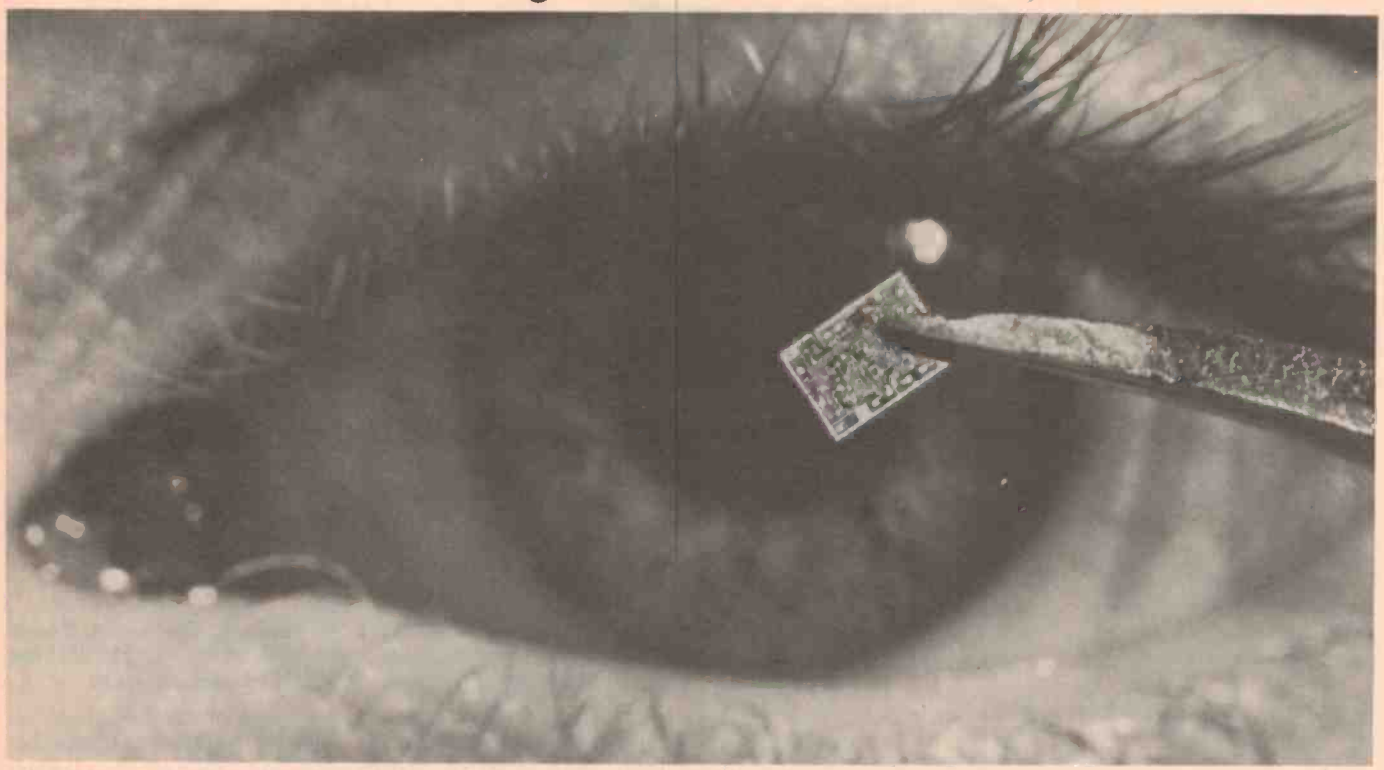
**In the early hours of 14th December, the Gold Coast Amateur Radio Society's repeater VK4RGC (VHF/UHF) was struck by lightning during a violent electrical storm.**

As a result, the mains power lead earth wire vapourized, the mains plug blew out of the wall and the transistors in the power amplifier melted and their caps were blown off!

The repeater is not expected to be operational until February/March, when a new repeater is completed.

Any donations towards the construction of a new repeater would be greatly appreciated. Donations to: GCARS Secretary, P.O. Box 588, Southport 4215 Qld. Cheques payable to "Gold Coast Amateur Radio Society."

# Set your sights on a space age career in Today's Air Force.



It takes hundreds of skilled people to keep our aircraft fully operational. To maintain the sophisticated electronic equipment carried on the planes, and on the ground.
Right now we're looking for more fit young people — including Apprentices — to work on some of the most advanced aeronautical and communications systems in the world. Could you be one of them?

## The work is stimulating, rewarding and vital.

The atmosphere throughout the Air Force is one of high professionalism in a unique and exciting environment.
You'll be required to maintain the high technological standards that make today's Air Force the efficient force it is.

## Great Times. New friends.

Today's Air Force also offers great comradeship, excellent sports facilities and an active social life.

## Necessary qualifications.

You'll need to be aged between 17 and 43 years. (17 and 34 if training is required), an Australian citizen or meet our nationality requirements. (Apprenticeships are also available for those aged between 15 and 17 years.)

## Start on full adult pay.

From the first day, you'll be on full adult pay. After you've completed your initial training, we'll pay you even more.
Then there's four weeks annual leave with a salary bonus and the opportunity to continue studying for higher qualifications.

## Interested?

Walk into the Air Force Recruiting Office nearest you and have a chat with a Careers Officer. The address is in the phone book.

Alternatively send the coupon or 'phone for details:

| | | | |
|---|---|---|---|
| Brisbane: 226 2626 | Townsville: 71 3191 | Sydney: 212 1011 | Newcastle: 2 5476 |
| Wollongong: 28 6492 | Wagga: 21 1100 | Canberra: 82 2333 | Melbourne: 61 3731 |
| Hobart: 34 7077 | Adelaide: 223 2891 | Perth: 325 6222 | |

To:
AIR FORCE CAREERS
OFFICER, G.P.O. Box XYZ
in the capital city nearest you.
Yes! I am interested in an Air Force career. Please send me full details.

Name:
Mr./Miss: _____

Address: _____

_____

State: _____ Postcode: _____

Date of Birth: __/__/__

RG203

# You're somebody in Today's Air Force

Authorised by Director-General Recruiting Dept. Defence

RG203.FP.129

# More space for broadcasters

Shortwave broadcasting has gained a brand new band as a result of the Geneva World Administrative Radio Conference which concluded in December.

**The new band will be from 13 600 to 13800 kHz, for the exclusive use of broadcasting stations.**

Another bonus for shortwave broadcasters and DXers alike is the expansion of all bands above 9 MHz, apart from the little used 11 metre band which has been contracted.

Altogether, the proposals of the Geneva conference have added some 840 kilohertz of spectrum space for international shortwave broadcasting. These proposals should go a long way towards relieving the congestion now apparent on the broadcasting bands.

Here is a run-down on the recommendations of the World Administrative Radio Conference, as they affect the shortwave broadcasting bands:

**120, 90 and 60 metre tropical bands:** No changes will be made to these bands. The proposals of some European countries that the 60 metre band be opened up for short distance international broadcasting were the targets of coordinated opposition from countries in tropical regions.

This opposition ensured that 60 metres will continue to be used for broadcasting only in tropical regions to reach a domestic audience. This news will please many DXers who mounted a vigorous campaign to keep the high-powered international stations out of the 60 metre band, so preserving 60 metres as a rich source of DX exotica.

**49 and 41 metre bands:** The Geneva Conference decided there would be no expansion of either of these bands and the present shared arrangements between broadcasting and amateur operations will continue on 7 MHz.

This is a major disappointment to DXers who are familiar with the tremendous over-use of both these bands. For example, 49 metres between 5950 and 6200 is currently used daily for more than twice the number of broadcasting hours per frequency than the number of broadcast hours recommended as the maximum capacity by the International Telecommunications Union. The situation on 41 metres between 7100 and 7300 is even worse, with this band being over-loaded above the ITU-recommended capacity per frequency by more than 2.5 to 1.

**31 metres:** This band has had its limits pushed upwards from 9775 to 9900, and will now cover 9500-9900. Considering that the band, by ITU figures is already overloaded by a factor of more than 2.5 to 1, these proposals will probably only bring slight relief to the congestion. Also, it must be remembered that much of the new spectrum space up to 9900 is already well used by many broadcasters who have moved in as fixed services and other facilities have vacated this region.

This will make for even less scope for international stations hoping to find vacant channels on 31 metres.

**25 metres:** This band has been recommended for expansion at both extremities, with the bottom end extending down to 11 650 (formerly 11 700), the upper end extending to 12 050 (instead of 11 975).

This is probably the most over-loaded broadcasting band at present, used to almost three times the ITU-recommended capacity. The new spectrum space allocated to the 25 metre band is already well used by broadcasters, particularly the region from 11 700 to 11 650, with stations such as Israel, India, China, USSR, Kuwait, Algeria and many others making for few vacant channels on this "new" spectrum space!

**23 metres:** This will be a completely new band for international broadcasting and may help to relieve some of the over-use on both 25 and 19 metres.

**19 metres:** The 19 metre band will be extended upwards to 15 600 (from 15 540), providing an extra 150 kHz of spectrum space for broadcasting. Unfortunately, this only formalises a current trend, with many channels above 15 450 already occupied by broadcasters in anticipation of just such a decision of the Geneva Conference.

**16 metres:** A further 150 kilohertz has also been added to this band, extending down from 17 700 to 17 550. China, Egypt and Israel are already major uses of this extra spectrum space.

**13 metres:** This band has been extended by a further 100 kHz, with the upper limit at 21 850 instead of at 21 750. It was the least congested broadcasting band according to ITU figures compiled at the end of 1978, but has recently come into greater use during the present high sunspot activity. Basically a band for day-time reception, this extra 100 kHz will become less useful for long-distance international broadcasting as the expected decline in sunspot activity occurs later this year.

**11 metres:** Broadcasting loses some 70 kHz in this band, with the frequencies from 25 600 to 25 670 now allocated to the exclusive use of radio astronomy.

Broadcasting could certainly afford to lose this spectrum space, for even during the present solar peak, when conditions are at their most favourable for international broadcasting on this band, 11 metres is still very much under-used.

The Geneva World Administrative Radio Conference was attended by more than 2000 delegates from 142 member countries, and the resolutions and regulations adopted cover more than 1150 pages.

The new radio regulations adopted at the conference are due to come into effect on January 1st, 1982. DXers should not expect any immediate changes to frequencies used by broadcasters as a further conference is to be held to work out the details of shortwave broadcasting services and band allocations.

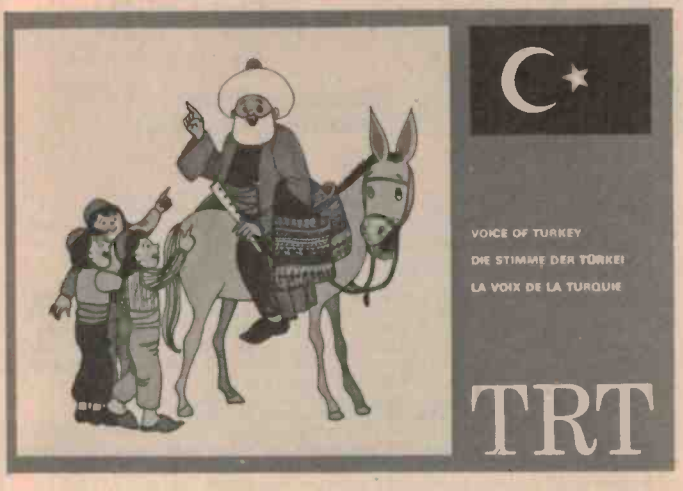
The new allocations will not come into effect until 1985, with the present services operating in the new parts of the spectrum to be given over to shortwave broadcasting having those five years to vacate the frequencies.

Overall, DXers must feel somewhat disappointed in the results of the Geneva Conference. Back in 1959 when the last conference was held, there were only some 300 shortwave transmitters in operation world wide. When the 1979 Conference met, there were about 1500 transmitters in operation. Over-loading of the broadcasting bands has therefore become acute. A major problem of a bank up of transmissions on the 49 and 41 metre bands has not been tackled at all at Geneva. With new transmitters coming into use every year and with another World Administrative Radio Conference many years away, this overloading of 6 MHz and 7 MHz will become acute, especially in periods of lower sunspot activity. This will inevitably force more stations to use frequencies outside the designated bands.

**Here is a listing of the new shortwave broadcasting bands decided upon by the WARC 1979 meeting in Geneva:**

120 metres: 2300-2495 (unchanged)
90 metres: 3200-3400 (unchanged)
75 metres: 3900-4000 (unchanged)
60 metres: 4750-5060 (unchanged)
49 metres: 5950-6200 (unchanged)
41 metres: 7100-7300 (unchanged)
31 metres: 9500-9900 (extra 125 kHz)
25 metres: 11 650-12 050 (extra 125 kHz)
23 metres: 13 600-13 800 (NEW BAND, extra 200 kHz)
19 metres: 15 100-15 600 (extra 150 kHz)
16 metres: 17 550-17 900 (extra 150 kHz)
13 metres: 21 450-21 850 (extra 100 kHz)
11 metres: 25 670-26 100 (loss of 70 kHz)

# shortwave loggings




## Turkey for overseas

**A new outlet has recently been added by the Voice of Turkey for the programmes in Turkish for Turks abroad.**

New is 15 225, replacing a 25 metre outlet. with Turkish programmes giving very good reception between 0500 and 0800.

Voice of Turkey has also extensively re-arranged services in foreign languages.

Programmes in English are now broadcast 1200-1300 on 11 800 and 17 820; from 1330-1430 on 17 820; Turkey's morning programmes in English are at 2030-2130 on 11 955 and 9550, and between 2200 and 2255 on 11 955, 9550, 9515 and 7215.

This schedule means Turkey has increased services in English considerably, with an extra hour of English in both the morning and evening transmissions.

## Greenland heard

**A rare DX catch at the best of times, Radio Greenland has recently been noted by several Melbourne DXers.**

**The Godthaab station was received on 9575, from sign-on at 1000 until signals faded out at about 1050 due to advancing daylight in Greenland.**

**Signals were able to be received from Godthaab on 9575 due to this frequency being clear of co-channel interference and the favourable propagation conditions during our southern hemisphere summer months.**

## Delhi well heard on high frequencies

**The General Overseas Service of All India Radio, directed for Australia listeners, is beamed daily from 1000 until 1100.**

Well heard at present carrying this service is 21 695. Other frequencies for the programme directed our way are 17 875, 15 205 and 11 935. The station welcomes reports and comments from listeners which can be sent to: Box 500 New Delhi, 110001.

## Malta Calling

**The Maltese state radio has again been heard with the weekly English programme from the relay facilities at Cyclops, near Valetta.**

"Malta Calling" is on air each Saturday 0700 to 0800 on 9670. A good roundup of local and overseas news is given at 0713-0720. "Malta Calling" gives good reception currently, although the station had not been traced on the bands during the last few months of 1979. It is believed the station was inactive on shortwave in that period, but has returned in the familiar format and on the old frequency.

Reports of Malta Calling may be sent to Box 82, Valetta.

## Zimbabwe guerillas from Madagascar

**The Patriotic Front guerilla alliance has recently been noted in eastern Australia during their newly introduced broadcasts via Radio Madagascar.**

Identifying as the "Zimbabwe People's Revolutionary Voice", the Patriotic Front programme is heard currently on 5010 at 1715, in English and African languages.

## Daily from Andorra

**The tiny principality of Andorra, located in the Pyrenees between France and Spain, now broadcasts daily programmes produced by Adventist World Radio.**

The AWR programmes begin each day with English at 2000, with various languages filling the 2030-2100 block each day. Andorra's frequency is 6215, just above the 49 metre band. They use a transmitter rated at only 3 kilowatts, so making their shortwave broadcasts a real challenge for the DXer to hunt out.

More should be heard from Andorra in the future however, as the station has plans for acquiring a 20 kilowatt unit to operate on shortwave. When installed, the new transmitter should make for regular reception of Radio Andorra here in Australia.

## Clandestine radio

**An interesting clandestine broadcaster currently providing good signals is Bizim Radio (meaning "Our Radio") which is the Voice of the Turkish Communist Party.**

The station can be heard on weekdays on 9585, with programmes in Turkish from 0600 to 0650, and again between 0700 and 0750. The station has been operating for some years and is well heard all over Europe.

There is still uncertainty as to the location of the shortwave transmitter used by Bizim Radio. European observers are of the opinion that the transmitter is located in either East Germany or Romania. Bizim Radio broadcasts political talks and typical Turkish music. The station is not heard in Australia on weekends, as 9585 is occupied by Radio Budapest with a special service in Turkish and Greek.

## Philippines news round-up

**An interesting service for those seeking a good roundup of Asian news is that provided by the Philippines News Agency, broadcast daily via the transmitters of the Far East Broadcasting Company in Manila.**

The Philippines News Agency has English news read at dictation speed every day via FEBC on 9720, between 0830 and 0900.

## Brazil in English

**Radio Nacional de Brasilia's International Service has recently begun use of the new outlet of 15 125 for the English programme broadcast daily 2000-2100.**

This programme includes short features on Brazilian events, history and culture together with selections of local music which are always a highlight.

**NOTE! All times are given in Greenwich Mean Time (GMT). To convert to Australian Eastern Standard Time, add 10 hours (11 hours for Daylight Saving Time). To convert to Central Time, add 9.5 hours and for Western Time add 8 hours. All frequencies are in kHz.**

**Shortwave Loggings is compiled by Peter Bunn on behalf of the Australian Radio DX Club (ARDXC). Further information on DXing or the activities of ARDXC may be obtained from either PO Box 67, Highett Vic 3190, or from PO Box 79, Narrabeen NSW 2101, for a 30c stamp.**

# PREDICTIONS APRIL 1980

Covering 3 to 40 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.**


These GRAFEX style computer generated predictions are provided courtesy of the Australian Ionospheric Prediction Service.

KEY TO SYMBOLS

A blank area means no normal propagation is possible.

% . . . . . path open 50 - 90% of days in month.

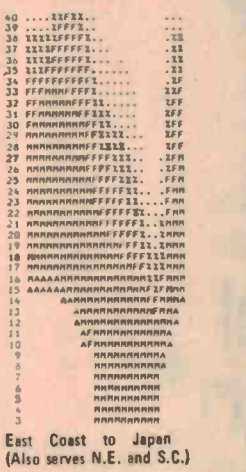
F . . . . . path open at least 90% of days in month.

B . . . . . propagation possible via E and F layers over 90% of days. Overrides 'F'.

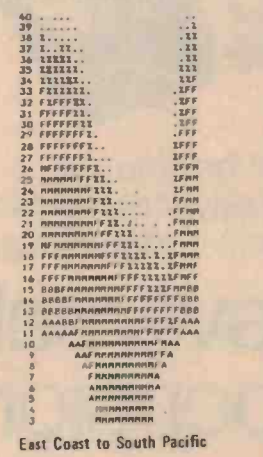
M . . . . . propagation possible by both 1st and 2nd F-layer modes. Expect strong fading.

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.

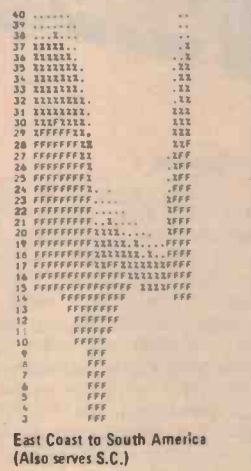


East Coast to Japan (Also serves N.E. and S.C.)

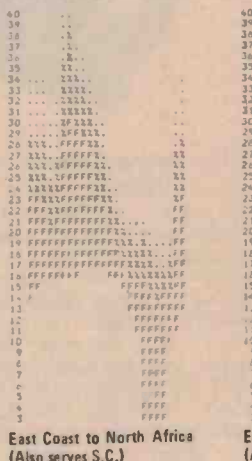


East Coast to South Pacific

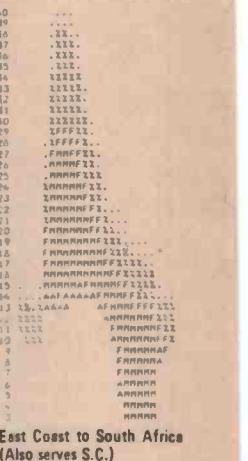
East Coast to North America (Also serves N.E. and S.C.)



East Coast to South America (Also serves S.C.)

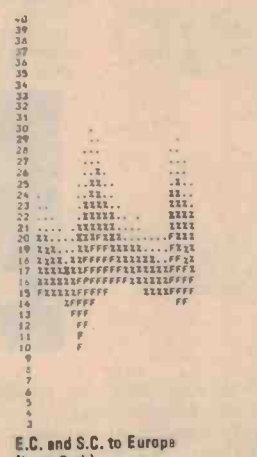


East Coast to North Africa (Also serves S.C.)

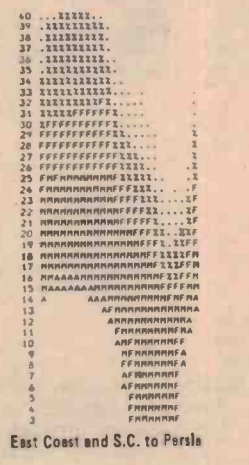


East Coast to South Africa (Also serves S.C.)

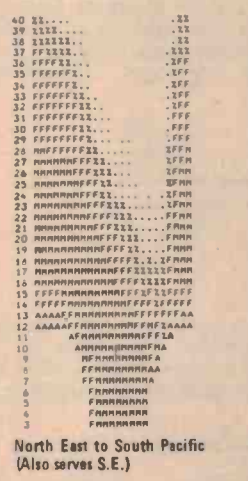
East Coast to Europe (Short Path)



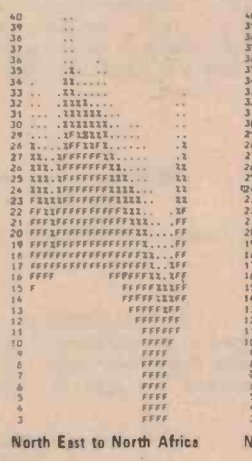
E.C. and S.C. to Europe (Long Path)



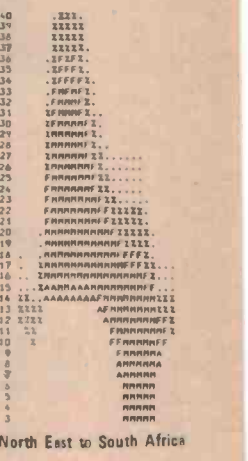
East Coast and S.C. to Persia



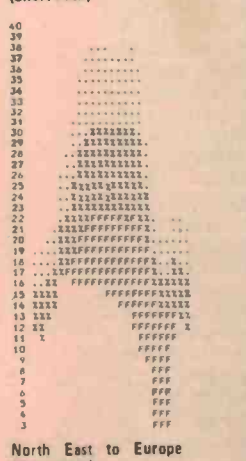
North East to South Pacific (Also serves S.E.)



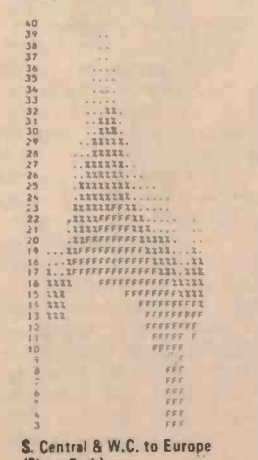
North East to North Africa



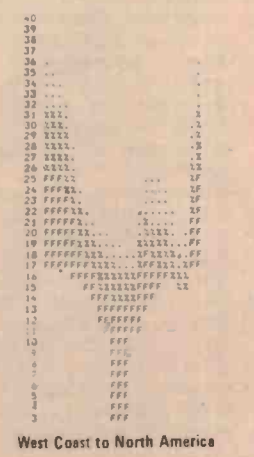
North East to South Africa



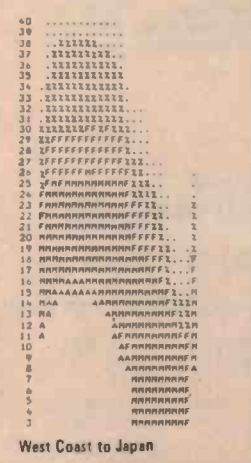
North East to Europe (Short Path)



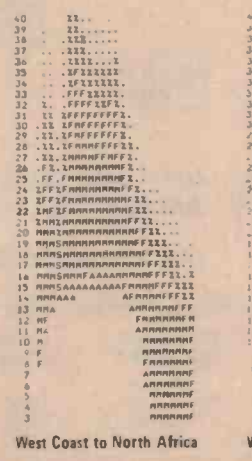
S. Central & W.C. to Europe (Short Path)



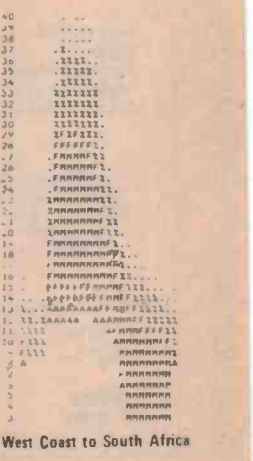
West Coast to North America



West Coast to Japan



West Coast to North Africa



West Coast to South Africa

# SONICS —out now

SONICS is a magazine for musicians and road crews, for sound engineers, lighting operators and recording engineers, for service technicians and venue managers, and for anyone at all who has an interest in or an involvement with music or musical electronics.

SONICS covers every aspect of sound production and presentation, from pick-ups, guitars and amplifiers to microphones, mixers and multitrack recorders.

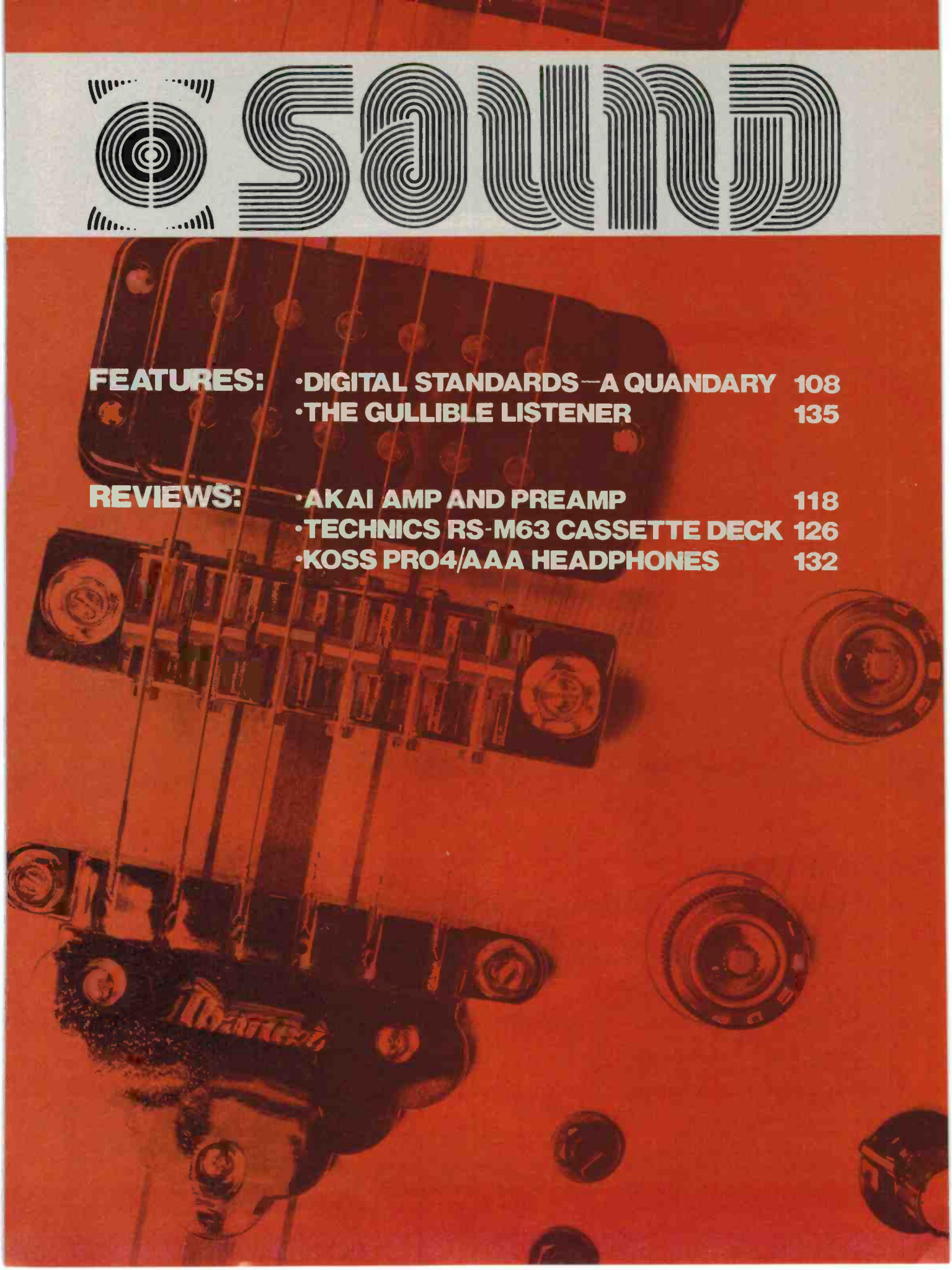


The first edition of SONICS contains feature articles on a variety of topics, plus a comprehensive Directory — a guide to the "tools of the trade" in the form of a survey of every electric/electronic instrument or piece of equipment SONICS could track down: what it is, where to get it, and what it will cost.

SONICS is a music magazine with a difference — a magazine about the marriage of music and technology.

## RENDEZVOUS WITH SONICS AT YOUR NEWSAGENT

# sound



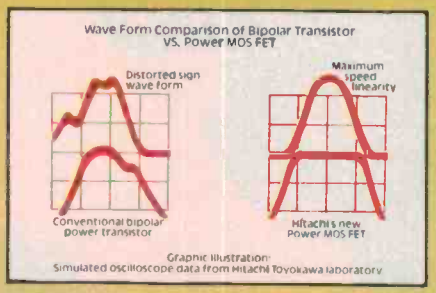
HITACHI

High fidelity. Natural sound

## A super system based on the power MOS FET Amplifier HA 5700.

The high fidelity and natural sound concept together give pure performance in this super system from Hitachi–examples of Hitachi's advanced HI Fi technology. The amplifier incorporates power MOS FET devices–another Hitachi world first. MOS FET (Metal Oxide Semi Conductor) is a new development which enables superior performance to conventional bipolar transistors giving the lowest possible distortion over the widest possible frequency range.

The turntable features the revolutionary Hitachi Unitorque motor system which delivers smooth unfluctuating torque for extremely low wow and flutter and high signal to noise ratios. With unitorque there is none of the cogging or pulsations associated with conventional DC motors used in most direct drive turntables.




Other features and Hitachi developments include the power assisted soft touch mechanism and digital fluorescent metering of the cassette deck and of course a dynamic responsive 3 way speaker system and the precise reception of the solid state tuner.

And what does all this add up to? Performance. Pure and simple.

**The facts and figures may look impressive but the real judge is you. Listen to Hitachi soon.**

HITACHI

Quality comes first at Hitachi

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Sydney 6692200 Adelaide 2121300
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H&T HSA010

# sound news

## Australia's first comprehensive guide to electronic musical instruments and equipment!

Sonics, Australia's first specialised and authoritative magazine on musical electronics, has just been published by the ETI division of Modern Magazines.

**It's a music magazine with a difference — about electronic music and about electronics in music; about the application of technology to music.**

Electronic methods have been used for the amplification and recording of instruments and voices and to create new instruments for more than 50 years. In the last 20 years the level of technology, and our reliance upon it, has increased dramatically. Contemporary music — and the multi-million dollar music industry, could not exist without it.

Sonics is a magazine for musicians and roadies, for sound engineers, lighting operators and recording engineers, for service technicians and venue managers — anyone who has an interest or involvement in music or musical electronics.

The first edition, published as the 1980 yearbook, contains ten features on everything from keyboards to microphones to lighting, plus thirteen directories listing all the instruments and equipment currently available in Australia. Future editions will be published quarterly.

Ron Keeley, who was the drummer with acclaimed rock group Radio Birdman and latterly The Visitors and The Other Side, edited this first issue. It is on sale now at newsagents and selected specialist outlets, $4.35.


## Tiny motional feedback speakers deliver big sound

**Philips' AH 587 motional feedback box has an internal volume of only 19 litres yet delivers an SPL of 109 dB at one metre and has a frequency response from 27 Hz to 20 kHz, according to its specifications.**

Measuring an overall 300 x 487 x 237 mm, the AH 587 incorporates a special Philips 'combi dome squawker/tweeter' and a 200 mm motional feedback (MFB) woofer. The woofer has a built-in accelerometer which provides information to the servo feedback loop electronics included in the box.

Each driver is powered by its own associated amplifier from an electronic crossover unit. This crossover has three separate, accurately-scaled filters which can be switched in to nullify the effects of bass colouration wherever a unit is placed.

The speaker input is protected against overload from excessive input levels. Input sensitivity can be varied over the range of 1 V to 25 V. Input impedance is quoted as 100 k up to 3 V input, 1 k above that. Overall distortion is quoted as less than 0.1%, at the rated power for each driver.

More information available from your local Philips dealer.

## New man for Hagemeyer

**Mr K.K. Tan was appointed new National Sales Manager of Hagemeyer (Australasia) B.V. late last year by the company's Division Director Oceania, Mr C.W. Rakers.**

Mr Tan was formerly the General Manager of Hagemeyer Trading Co. (Singapore) Sdn. Bhd.

☆ ☆ ☆

## Lightweight phones from Koss

**Renowned in the audio industry for quality headphones for many years, Koss' new HV/1A stereophones should gain ready acceptance.**

Featuring lightweight construction, the 'phones have a new, low-mass Decilite (TM) driver diaphragm giving a wide frequency response — quoted as 15 Hz to 30 kHz.

The headband is extendable with self-adjusting, pivoting yokes and soft-padded, vinyl cover. The ear cushions are made of soft acoustical sponge.

Sensitivity is quoted as 500 mV (pink noise) for 100 dB SPL, 900 mV for a 1 kHz sine wave. Soundpressure level produced at 1% THD at 1 kHz is quoted as 108 dB. The specifications give the impedance as 157 ohms at 1 kHz and the HV/1A is designed to operate from outputs with a source impedance between 3.2 and 600 ohms.

Koss headphones are distributed in Australia by Audio Engineers P/L, 342 Kent St, Sydney 2000 NSW, offices in Victoria, QLD and W.A.


# Record Ecology in DiscKit form

## — you'll Save more than money

DiscKit is a crafted walnut tray and dustcover that saves you 20% with the Discwasher products in the kit. ($55 versus $69 separately) DiscKit includes: 1) The Discwasher System Record Cleaner with D3 Fluid, 2) the Zerostat anti-static pistol and test light, and 3) the SC-1 Stylus Cleaner.

But you'll save more than money. You'll save your records from imbedded micro-dust, your cartridge stylus from abrasion and your ears from a lot of static.
It's your choice, disposable records or Discwasher. (Walnut tray and dust cover are available separately as the Discorganizer, $15)

Cartridge and Disc Traker (pictured) not included in Kit, ask your nearest dealer for details.

**Now includes free, DC1 pad maintenance brush.**

Sole Australian Agents

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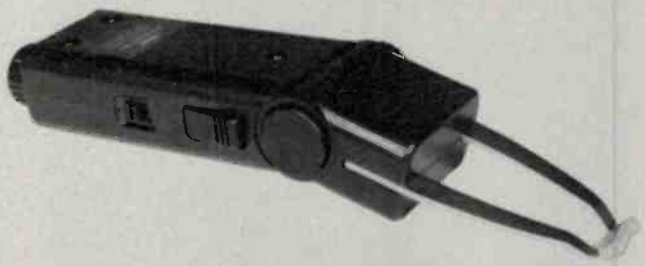
**DISCWASHER, INC.**



## Flexible head demagnetizer

**The new tape head demagnetizer from TDK, model HD-11, features an adjustable yoke angle and rapid operation.**

The unit is battery-operated and fully self-contained and suits both open-reel and cassette recorders of all types.

The unit will produce a flux density of 640 Gauss, according to TDK and has a decaying oscillation so that the unit is simply held with the yoke against the recorder head and the demagnetizing push-button operated. The heads are demagnetized in about 0.7 seconds.

The HD-11 head demagnetizer is available through hi-fi dealers throughout Australia. For more information, contact TDK (Australia), 4 Dowling St, Wooloomooloo NSW 2111; (02) 358-2088.

## Mics for the musician — from AKG

**To release the new range of AKG microphones, Dr Fritz Sippl of AKG presented a lecture and demonstration on psychoacoustics, reverberation and microphones in Sydney late last year.**

The three new microphones in the 'D300' series have been given an inherent 'presence' characteristic — a slight rise in the response between 2 kHz and 12 kHz, peaking by 6 dB around 5 kHz. Each mic incorporates a newly-developed dynamic capsule.

Model D310 is a cardiod mic while the D320B and D330BT are hypercardiod mics. The polar pattern is claimed to be virtually independent of frequency and uniform about the axis. Thus, susceptibility to feedback is extremely low. The D320B and D330BT each have a hum compensation coil to reduce pickup from stray fields.

The D330BT incorporates a special elastic suspension system for the transducer which AKG claim protects it against most structure-borne vibrations, greatly reducing mic stand and handling noise.

The D320B and D330BT have "contour" switches to vary the presence characteristics of the mic. The D320B has a small three-position switch designed to adjust the bass response to reduce 'proximity' effect. The D330BT, in addition to a low frequency contour switch, includes a high frequency switch designed to add brilliance and presence.

All microphones in the series are designed to withstand considerable abuse.

Dr Sippl has been a company director with AKG since 1959. He was born in Vienna, Austria, in 1922 and has a Dipl. Ing. in Applied Mathematics and Phsycis from the Vienna Technical University. He has also studied Psychology in Vienna and Berlin. He helped develop the first tape recorders in 1941. Dr Sippl has lectured all over the world and written many articles in the fields of audio and psychoacoustics.

AKG is represented in Australia by AWA Engineering Products Division, 422 Lane Cove Rd, North Ryde NSW 2113. (02) 888-8111.

## Fosgate speakers for car sound systems

**To complement their range of car hi-fi systems, Fosgate have a range of speaker systems to provide 'full range' sound in your vehicle.**

Two systems are offered: the PRS-690, a two-way stereo set and the PRS-694, a three-way system.

The PRS-690 consists of two 150 x 230 mm woofers which feature 567 gram (20 oz.) magnets, plus two 25 mm dome tweeters. Frequency response of the system is quoted as 25 Hz to 20 kHz. The system includes all grilles, wires and mounting equipment.

The PRS-694 system has the same woofer and tweeter set as the PRS-690 but includes a pair of mid-range drivers measuring 50 x 114 mm, having 284 gram magnets.

Further information can be obtained from the importers: CPI (Australia) Pty Ltd, P.O. Box 246, Double Bay NSW 2028. (02) 36-3703 TLX AA23381.


## Stylish portable with AM/FM

**Sanyo's latest ac/dc portable, model RP5445, is stylishly finished in grey and black. It covers the full medium-frequency broadcast band and the international FM band.**

Its 77 mm speaker provides good sound level from the half watt audio output stage. Tuning is by a slide rule dial. It has a high/low switched tone control and is powered by internal batteries or ac mains. Recommended retail price is $40. Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02) 436-1122.

## Moving-coil from Piezo

**Piezo, well-known for their induced-magnet and moving-magnet cartridges, released their new moving-coil cartridge, model GM-500, late last year.**

Distributed here by the Melbourne-based Maruni Corporation, the GM500 comes complete with headshell and features a frequency response of 10 Hz to 50 kHz, according to the literature. It comes with an elliptical stylus and has a quoted compliance of 90 nm per dyne (at 100 Hz). Recommended tracking force is 1.6 — 2.0g and overall cartridge weight (with headshell) is 15.4g.

For more information on the GM500, contact The Maruni Corporation, 297 Williamstown Rd, Port Melbourne 3207 Vic. (03) 645-2079.

# FREE HI-FI ADVICE

Before you buy any Hi-Fi, know the answers to these questions.

Is the system really good value for money, and will it sound as good in my home?

Will I have to lug it home and put it together, or will a factory trained technician come and set it up to perfection?

If something goes wrong... will I have the back-up of a three year warranty... and can I be sure I'll have it serviced within 48 hours?

Will my system be set up by factory specialists to get the very best from my room, using equalizers, Real time analyzers, and pink noise generators?

Will my system let me shape the music, to hear it exactly the way I want to hear it... to emphasize the instruments I enjoy?

When you buy Audio Reflex equipment, those kind of questions don't bother you. If you're buying another pretty face from a discount king, well, try and enjoy it, anyway.

For free Hi-Fi advice anytime... drop in on your Audio Reflex Dealer

INSTALLATION & EQUALIZATION SERVICE IN CAPITAL CITIES ONLY

**AUDIO REFLEX**


## MC head amp from Accuphase

**A recent release from Arena Distributors was the Accuphase moving coil head amp, model C-7.**

Featuring a direct-coupled Class A push-pull amplifier design, Accuphase claim a hum and noise figure of -72 dB (IHF-A/RIAA with respect to 100 nV input), gain of 26 dB, THD less than 0.002% across the spectrum at maximum input and a max. input voltage of 35 mV RMS. Input and output impedance is quoted as 100 ohms.

The C-7 head amp measures 102 mm wide, 61 mm high by 350 mm deep and is powered from the 240 Vac mains. More information is available from Arena Distributors, 642 Albany Highway, Perth W.A. 6000. (09) 361-5422.

## New speaker from British designer

**British speaker designer, Jim Rogers launched a 'twin-bass' speaker system recently, housed in an unusual 'tensioned aluminium' cylindrical enclosure.**

Called the JR150, it uses two long-throw 130 mm diameter Bextrene cone bass drivers which are said to be electrically and acoustically in parallel. Rogers claims his design increases radiation, reduces distortion and provides superior transient response.

Claimed performance figures are certainly impressive — frequency response 40 Hz to 40 kHz; power handling to 100 watts on programme. The JR150 is recommended for use with amplifiers delivering from 15 to 100 watts.

The Australian agents, International Dynamics, are confident the system will emulate the success of the smaller JR149s which readers may know, on which the new speaker is based.

As with the JR149, the JR150 is available in a variety of wood and leather finished tops and has an acoustically transparent foam cover which can be removed for cleaning. An optional stand is available if floor-standing operation is envisaged.

International Dynamics are at 23 Elma Rd, Cheltenham 3192 Vic., (03) 95-0366.

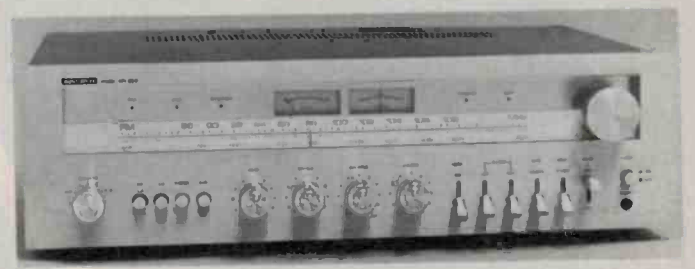
## Sound Engineering certificate course

**The South Australian Music and Audio Education Centre has been granted a licence by the S.A. Department of Technical and Further Education (TAFE) to operate a 'Private Technical College'.**

They have received the licence, No. 333, after running the Sound Engineering Certificate course for the past two years. The licence also incorporates the Advanced Sound Engineering Diploma programme of study and the Live Sound course.

Under the terms of the licence, the Centre's lecturing techniques, notes, references, premises, fees and administrative structure are reviewed by the Department of TAFE. This provides protection for students and a close liaison between the Education Department and the Centre.

Enrolments are now open for the 1980 Sound Engineering Certificate course and persons interested should contact the S.A. Music and Audio Education Centre in Adelaide on (08) 212-5955. They are located at 212 Hindley St, Adelaide S.A. 5000.



## New receiver from Audio Reflex

**The AR650 is an attractively designed AM/FM receiver incorporating both a highly flexible and sophisticated preamp section with the latest in circuit technology.**

At 50 W RMS per channel, total harmonic distortion is quoted as 0.9%; frequency response, 10 Hz-30 kHz and the power bandwidth 20 Hz-20 kHz with 8 ohm load.

The FM tuner's sensitivity at 1 mV gives excellent clarity and offers in addition highly accurate and easy tuning of all stations, according to Audio Reflex.

Recommended retail price is $399.

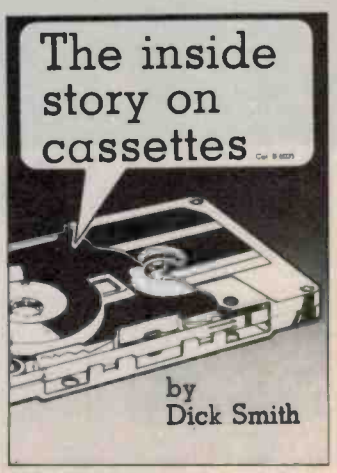
For further information, contact Audio Reflex (Australia) Pty Ltd, 7 Orchard Road, Brookvale NSW 2100. (02) 938-4188.

## Cassette book

**Dick Smith's "Inside Story on Cassettes" is a booklet describing all the useful things you need to know about cassette recorders and cassettes.**

It covers 'Choosing a Cassette Recorder', 'Choosing a Cassette', 'Maintenance' and 'Recording'.

It is listed as catalogue number B-6035 and is available at all Dick Smith stores — free with any purchase of any ten cassettes.



# Pack it. Wrap it. Seal it. Tie it.

TN1054


## Or bag it.

The best ideas are always simple. Like TNT Courier Overnight Satchels. For $8.75 you can send anything that fits inside, to almost anywhere in Australia door to door. Overnight. Just call before 6 p.m. and we'll get it there, usually by 10 a.m. the next morning.

Don't be fooled by appearances. The bag is tough, waterproof and tear resistant.

Get TNT Courier Overnight Satchels from TNT Courier offices around Australia. Or from most newsagents.

**TNT Courier Overnight Satchels.*Anything, anywhere, overnight.**

TNT COURIER

A Speedy Communications product. *Anything which fits inside the satchel may be sent almost anywhere in Australia, overnight.

# Digital standards—a quandary

In our October 1979 issue we gave readers an insight into the developments in digital recording which will eventually revolutionise our hi-fi systems and video recorders. We now look a little further into this fascinating subject, but no one (not even the staff of ETI!) can hope to forecast when we shall be able to derive the full benefits of domestic digital audio recordings.

THE MAIN ADVANTAGES of digital recording systems are the greatly improved signal-to-noise ratio, the improved quality of reproduction and the ability to copy repeatedly (including the making of copies from each succeeding copy) without any degradation of the signal quality. The advantages and disadvantages are summarised in Table 1.

It is perhaps rather remarkable that digital audio equipment was first investigated not for possible use in hi-fi equipment, but rather in the communications field. Here, the only requirement is that of intelligibility, not whether the audio output sounds clear and pleasant. The audio bandwidth in communications equipment can be very restricted and therefore the system could be relatively simple.

## Standards

In high fidelity digital audio systems, one can select the performance to match one's own particular requirements. Unfortunately, systems using one standard are not normally compatible with those using another digital standard. A standardised system is essential if one is to be able to purchase digitally recorded audio tapes or discs or play items recorded by others. Although the need for a standardised system of digital recording is so vital, it is also important that the standards should not be selected too early as users may suffer for many years to come if they have to work with equipment which is not using the optimum standards.

In order to appreciate the vital importance of the proper standardisation of digital audio equipment let us consider some of the trade-offs involved. Last October we saw that the analogue signal to be recorded had to be sampled at regular times; that is, the amplitude of the waveform was measured. What sampling rate should we choose for our future digital recorders? If one chooses a low sampling rate, the audio bandwidth can be restricted so that quality of the reproduced sound is less than optimum. On the other hand, if we select a higher sampling rate than is really required, the complexity and cost of the recording and reproducing equipment is greatly increased. We must not make the mistake of demanding cheap digital recording equipment and hence poor equipment operating on those standards for ever and anon. Equally the cost of the equipment must not be allowed to rise to an excessive figure.

One of the factors which must be considered in the choice of sampling rate is that of the word length. Each digital word represents a certain signal level and one wishes to be able to specify the signal level at any time accurately by having a suitably long digital word, but not an excessively long word which would result in unnecessarily costly equipment.

Table 2 shows how the number of bits per word (the word length) is related to the number of signal voltage levels which can be specified and to the dynamic range of the system concerned. In the case of a system employing a 10 bit word, there are 1024 levels available for specifying the signal voltage, but if one uses a word length of 16 bits (only just over one and a half times as long), one can specify the signal level as being any one of 65 536 ($2^{16}$) levels.

The dynamic range is the relationship between the quietest sound which can be specified in the recording and the loudest sound which can be handled by the digital system. It is equal to the difference between the signal level corresponding to the digital '1' level and that corresponding to the greatest signal level which can be recorded, that is, to the number of bits shown in the second column of Table 2. For our more mathematically inclined readers:


Sony's DAD-1X digital audio disc player.

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Signal-to-noise ratio can be very high indeed. | The equipment is complex and therefore expensive. |
| No degradation of signals occurs on repeated copying. | Editing is impossible at present and will involve complex electronic equipment. |
| The recordings can be made very stable with passage of time and with repeated replaying. | No standards for digital recording have yet been agreed, so it is only a medium for the future. |
| The distortion can be far lower than is possible with the best analogue recording techniques. | |
| Small magnetic fields have no effect on the signal obtainable from digital tape recordings. | |
| No head bias current needed. | |
| Direct digital-to-digital copying will be prevented in the case of commercial recordings by special protection codes. (We leave the reader to decide whether this is an advantage or disadvantage!) | |

*Table 1.* **Advantages and disadvantages of digital recording as compared to conventional analogue techniques.**

Dynamic range ≅

$$10 \log_{10} (\text{no. of voltage levels})^2$$

The square in this expression arises because the voltage levels must be converted into power levels in order to express the value in decibels.

How many bits would you have in each word if you were designing a hi-fi system? Clearly your answer must depend on the amount of cash you have available and on the performance required from the equipment. The British Broadcasting Corporation has achieved excellent results in a digital system using only 10 bits per word (the BBC is well known for its very high quality sound signals). Sony has used 13 bit words in the Betamax recorder adaptor, but has now issued an improved adaptor using a 16 bit word length for use by the recording companies in the production of master tapes.

For domestic systems, 14 bit words have been suggested for providing the best quality one could require. For professional recording equipment it seems likely that a system using more bits will be chosen eventually. A 16 bit word length is a possible choice, since this could be made compatible with a domestic 14 bit word length if two bits of the 16 bit word remained unused in the domestic system. However, even more bits per word have been suggested by some people for use in the top class professional recorders — even up to about 20 bits per word to provide a dynamic range of about 120 dB.

Do audio enthusiasts really require a system which can have a dynamic range from below that of human hearing to above that of the threshold of pain where there is danger of bursting a person's ear drums? Only the user who pays for the equipment can answer such a question. The use of equipment with such wide dynamic ranges would eliminate the need for a recording studio to adjust the levels in the quiet and loud passages. No clipping would occur in loud passages, nor hiss in quiet ones!

| No. of bits/word | No. of voltage levels | Dynamic range (dB) |
|---|---|---|
| 8 | 256 | 48 |
| 10 | 1024 | 60 |
| 11 | 2048 | 66 |
| 12 | 4096 | 72 |
| 13 | 8192 | 78 |
| 14 | 16384 | 84 |
| 15 | 32768 | 90 |
| 16 | 65536 | 96 |
| 17 | 131072 | 102 |
| 18 | 262144 | 108 |
| 19 | 524288 | 114 |
| 20 | 1048576 | 120 |
| 21 | 2097152 | 126 |
| 22 | 4194304 | 132 |
| 23 | 8388608 | 138 |
| 24 | 16777216 | 144 |
| 25 | 33554432 | 150 |

*Table 2.* **The dynamic range of a system can be selected by an appropriate choice of word length.**

The only forecast we can make with certainty is that whatever standards are eventually selected for both professional and domestic digital recording, we shall not need to extend Table 2 — ever!

## The AES

The American Audio Engineering Society has recognised that standards for a digital recording system will have to be formulated before very much progress can be made. They have formed a standards committee with the difficult task of considering and evaluating the various proposals for digital audio systems and of recommending one particular standard for the industry. The general feeling seems to be that it is still not time to make decisions because we know so little about digital audio techniques, yet it seems that progress will be very slow until some standard is adopted!

At present there are at least fifteen major competitive systems and it seems certain that others will be forthcoming in the near future. Only one of these systems can be adopted as the future universal standard (unless the world is to have two or more non-compatible standards or possibly two or more similar compatible systems).

Already some manufacturers are making agreements to use each others' patent rights — such as the agreement between Sony and Philips. Sony has adopted the idea of marketing a single machine for recording both audio and video signals, whereas Philips are developing their sound-only system using a 114.5 mm diameter disc recorder system to provide a playing time of about 1 hour. Philips employ a diode laser pick-up, whereas RCA use the change in capacitance as the pick up device skims the surface of the record.

At present recording companies are making digital master tapes of the signals from their microphones. These master tapes can be copied without loss of fidelity, and then flown to any country where the recordings will be sold and used to make conventional analogue recordings for public sale. Although the recordings on sale are ordinary analogue ones, it is claimed ▶

*Continued on page 115*

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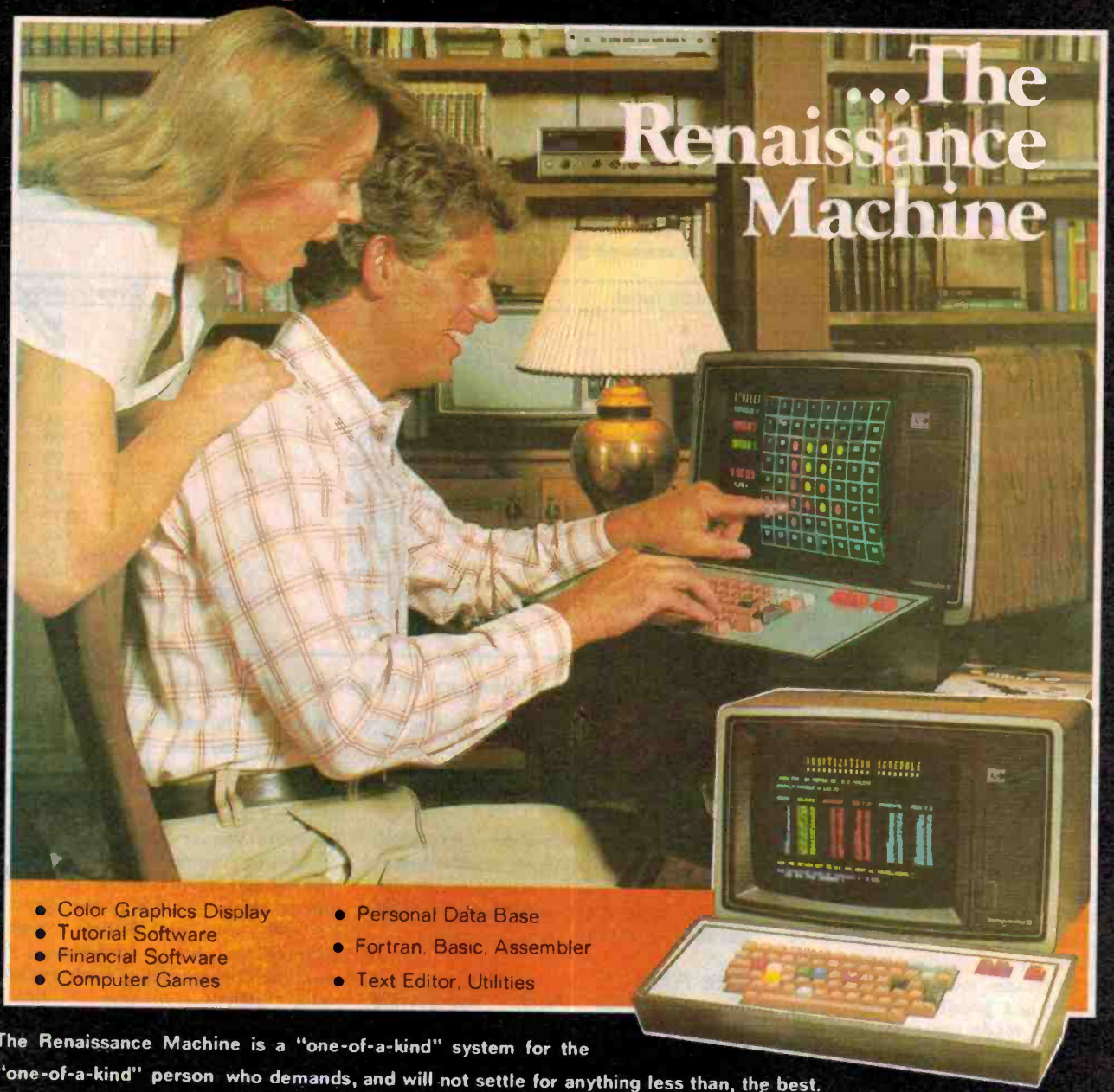


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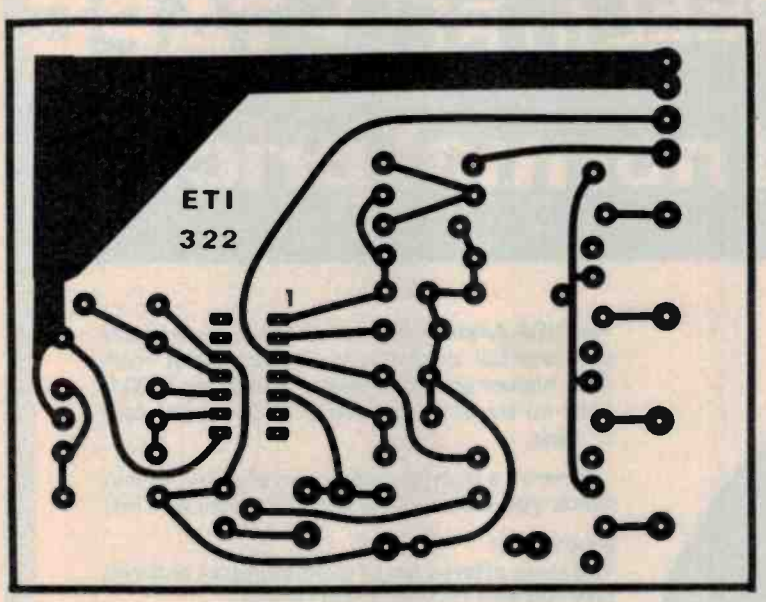
SONY AUDIO

AP3355




**Using ETI PCB Artwork**

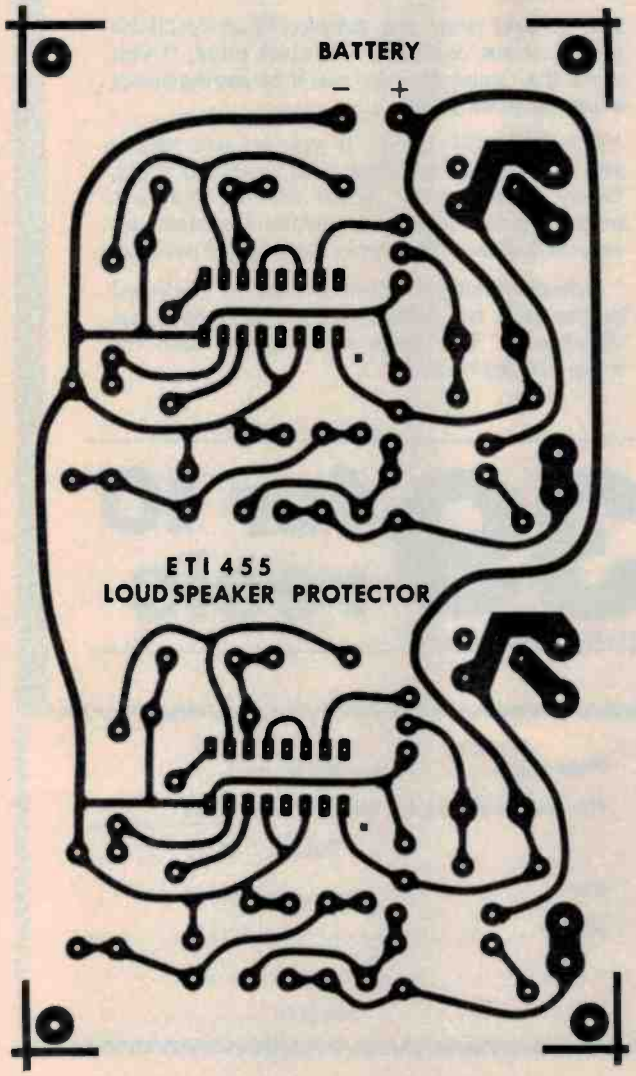
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007 which is UV sensitive and can be used under normal subdued light.

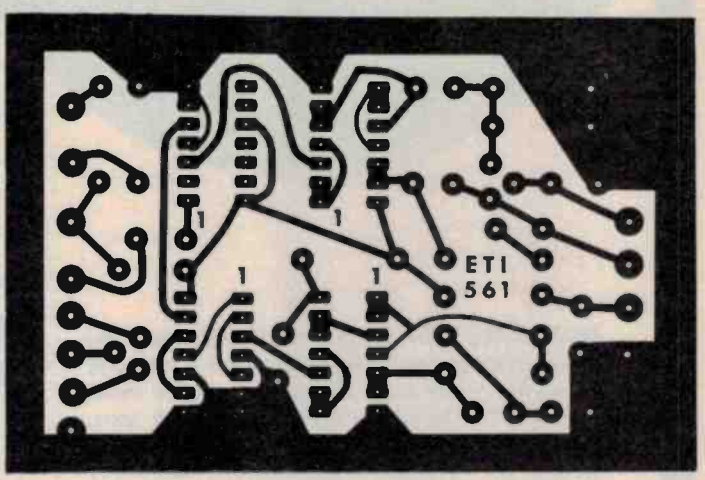
Cut a piece of film a little larger than the pc board and expose it to UV light through the magazine page. The non-emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner – it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

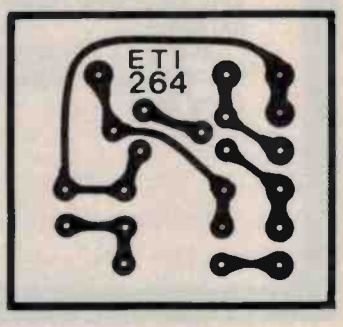
The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and pcb manufacture can be found in the September and December 1977 issues of ETI.

Please note that occasionally lack of space may prohibit the printing of blue type behind all pcb's. In this case the reader must resort to more conventional photographic techniques for pcb manufacture.



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**A two track professional digital audio recorder, Sony's PCM-1600.**

*Continued from page 109*

that the quality is considerably superior to the normal disc recording. This is now the best the industry can offer to satisfy consumer demand for ever better sound quality, but this first taste of what digital recording can do may greatly stimulate the demand for systems employing true digital discs and tapes.

## Bandwidth

As in most signal transmission systems, the all important factor relating cost and performance is the system bandwidth. What would be the typical bandwidth required in a digital system designed to provide very high quality audio reproduction? This depends on the sampling rate and on the number of words per bit, but can be estimated in the following way.

One must first decide the maximum frequency which one wishes to record or convey in the system. Let us suppose this is 20 kHz, since this is above the upper threshold of hearing of an adult. The sampling rate should be at the very least twice the uppermost frequency to be recorded, so a minimum sampling rate of 40 kHz is required. Let us further suppose that in our quest for high quality we choose a 16-bit word system. Each of the 40 000 samples per second must be coded according to the signal level as a 16 bit word, so the total bit rate is about 800 000 per second.

This bit rate implies that the system must have a frequency response to about 1 MHz for a monaural channel, whilst for stereo the bit rate and the required bandwidths are both doubled.

In practice a somewhat greater bandwidth is likely to be required to record a signal containing frequencies of up to 20 kHz. Although one *can* try to manage with a sampling rate of just twice the maximum frequency to be recorded, this may lead to practical difficulties. The 40 kHz sampling frequency must be removed on replay by means of a suitable filter and it is much easier to design such a filter – which must not produce any undesired signals in our high fidelity system – if the sampling frequency is raised somewhat.

In some proposed systems additional bits are made available for the detection and correction of errors, whilst coded digits may be used for various purposes. Present trends seem to be towards a sampling frequency of about 50 kHz for domestic digital audio systems and perhaps a higher frequency (possibly 100 kHz) for use in professional recording systems, but new developments may change our ideas on these matters. However, it seems certain that the bandwidth required from the system will be about 2 MHz or more for a stereo recording, and bandwidth plays a large part in determining the cost of the equipment.

## Errors and editing

The detection and elimination of bit errors can be vital in a digital recording system. Although one has only to detect whether each pulse of the bit is present or absent to be able to reconstruct the required signal, the presence of an important bit where there should be a blank can result in a relatively loud noise.

Error detection systems can operate by including a parity bit in each word so that the total number of bits in each word is either an odd or an even number. In other words the parity bit is made '1' or '0' so that the bit total is either odd or even according to the system employed. Many other error detection systems are possible and are being investigated.

One company, Decca, have even used a redundancy system in which every word is stored twice so that when an error detector shows an error is present, the correct word can be obtained.

One of the main problems with digital audio equipment is the extreme difficulty of editing any recorded material without transforming it into an analogue signal and back again into a digital one, thereby losing the advantages of the digital technique. One cannot just cut a length of digitally recorded tape with a pair of scissors and join the ends as if the tape were an analogue recording, since cutting the tape may cut through a digital word and interfere with the succeeding pulse positions.

Techniques of editing digital tapes are becoming available, but involve complex equipment which picks up and recognises the train of pulses so that the desired section may be omitted. In many cases it is normal to transfer only the required pulses to a new tape (and this can be done without any degradation in the signal quality).

Recording companies will be able to *include a special protection code* on each commercially manufactured digital record which will *prevent it being copied* with a digital-to-digital copying system. Such disks can be copied by converting their digital signals into an analogue form and recording the resulting signal, but the supreme quality of the digital recording will then be lost.

## Future prospects

The field of digital recording and reproduction offers one of the most exciting prospects ever for improving the quality of recordings and eventually may prove to be at least as important as the availability of long playing microgroove recordings nearly thirty years ago.

Apart from the Audio Engineering Society's work, a group of Japanese manufacturers have formed a Digital Audio Disc (DAD) Standards Committee which any manufacturer from any country can join. Over forty manufacturers are represented on this committee which considers the desirable specifications for digitally recorded discs, the recording systems, error correction techniques, etc.

Once the present quiescent stage has passed and suitable system standards have been agreed internationally, it seems that the digital recording scene is set for an explosive onslaught onto the market. One may hopefully expect domestic all-digital recording systems to be available by perhaps 1983 in reasonable quantity, but it could well be that we shall have to wait for another couple of years for the hi-fi revolution which, when it comes, will probably come very quickly. ●

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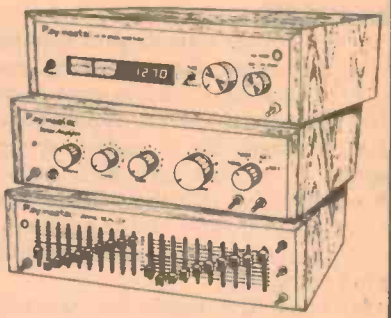

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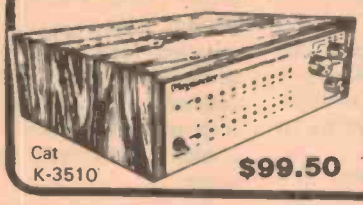

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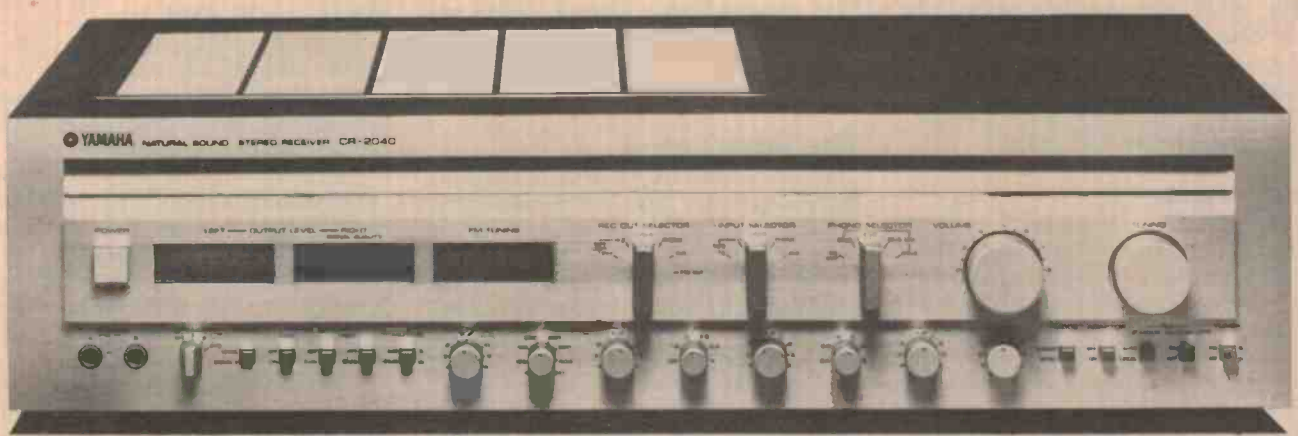


Y278/R

# Akai's PS-200C preamp and PS-200M power amp

Conventional design, solid construction and exemplary performance are features of these Akai partners.

MOST OF THE MANUFACTURERS of high fidelity equipment with a more than passing interest in the marketplace call for bigger and more powerful amplifiers. Even those manufacturers who have tended to specialise in the innocuous home high fidelity field have seen the growth in the professional and semi-professional field where the call has gone out for a bigger, better and more powerful equipment.

Akai Electric Company have obviously heard that call and the PS-200C and PS-200M preamplifier and power amplifier are designed to satisfy that demand. The external characteristics of the amplifier and preamplifier seem to be aimed at both segments of the marketplace, namely serious amateur and commercial/professional at the same time. We feel that without necessarily thinking about the ramifications, the design of these two units has drifted towards the amateur/commercial rather than the professional. The reasons for this deduction relate to the size in part, the weight in particular, and the general abuse-resistant characteristics which a professional amplifier should display.

The two units are unusual in that firstly the preamplifier is as heavy and as large as many medium sized power amplifiers, whilst the power amplifier is even heavier, and designed for the professional rather than the amateur.

## The preamp

The PS-200C preamplifier features most of the normal controls in a single line. Included in these is a subsonic filter with a cut-off frequency of 20 Hz, bass and treble controls, a three position tone control defeat switch with a loudness function position at the bottom, a stereo mode switch, a muting switch with two levels of muting (-30 dB and -15dB) and a dual-concentric balance/volume control with nominally calibrated attentuation steps. The facilities also include a tape monitor positioned with dubbing from tape 1 to 2, tape 1, source, tape 2 and dubbing from tape recorder 2 to 1. The last control is a selector switch for moving coil or moving magnet cartridges, tuner and two auxiliaries.

The rear of the preamplifier features coaxial inputs and outputs for all of the controls and a pair of parallel pin outlets for connecting externally switched and unswitched equipment. We thought this type of socket was unacceptable to the Australian electricity authorities and must therefore presume that these are sample units and are not intended for local sale.

The inside of the preamplifier is beautifully constructed, making use of one large printed circuit board, which is totally professional in its detail, although we felt somewhat larger and possibly heavier than most users could necessarily justify. Even the power transformer and power supply are carefully shielded in their own compartment to minimise stray leakage and possible hum problems.

The preamplifier is ruggedly constructed and in general terms, appears to have constructional features which are better than the normal Akai consumer production.

## The power amp

The power amplifier is, in many respects more impressive than the preamplifier. It features the minimum number of controls and inputs and outputs. The central recessed section of the escutcheon contains LED peak level indicators. The circuit responds to peak signal levels and levels corresponding to -42, -26, -15, -10, -5 and 0 dB and +3dB. There are two large meters on the front panel which read directly the average power into an 8 ohm load (where 0 dB level relates to 220 watt power output from each channel).

In the middle of the amplifier is a protection indicator light which illuminates when the speaker terminals are short-circuited or when the amplifier is over-loaded. This light will remain illuminated while the protection circuitry is in operation or if the power transistors in the output stage are damaged.

This circuit incorporates a time delay of about 2½ seconds to operate when the amplifier is switched on before power is provided to the output circuitry. In the bottom section of the front panel is a power switch, a subsonic filter, which operates below the cut-off frequency of 18 Hz. This is intended to remove the possibility of feeding direct current power into the speakers thereby destroying them.

On the right hand side of the panel are two input volume controls for left channel and right channel whilst on the rear of the amplifier there are two pairs of universal sockets for only two speaker systems. The inputs are of two different types, one pair for dc signals and one pair for normal type signals. These dc facilities indicate the possible laboratory role which the designers foresee for the PS-200M.

Like the preamplifier, the power amplifier also has one pair of switched and unswitched power output sockets (which are not normally found in imported equipment anymore).

The circuitry is well designed but conventional. The design is based extensively on long tail pairs and balanced dc circuitry. The protection circuit controls the supply voltages through a current detection circuit located immediately prior to the main power amplifier stage.

The inside of the power amplifier features a large power supply to suit the individual requirements of each of the amplifiers which are located on each side of the chassis. The wiring and interconnections are reminiscent of high


voltage power circuitry and it is clear that the designers do not intend to lose even the least little bit of capacity as a result of impedance losses within the wiring connecting power amplifiers to power supplies. The solid and heavy construction which the power amplifier features means that whilst the unit is well designed for commercial use it is not necessarily well suited to the professional musician if he intends to move this system from location to location.

## On test

We carried out our objective evaluation of the two units inter-connected as a system in the way that the average user would have them. The frequency response in the ac mode extends from 1.2 Hz to greater than 120 kHz, providing a truly flat overall frequency response within the range 20 Hz to 20 kHz. The sensitivity of each of the input sections is impressive. The moving coil sensitivity is 5.6 microvolts with the overload point occurring at 12 mV. The moving magnet inputs have sensitivities of 150 microvolts with the overload point of 460 mV.

The impedance for the moving magnet cartridge input is selectable at 35, 50 and 100 ohms, whilst the moving magnet input is fixed at an impedance of 50 k ohms. The output impedance is 25 milliohms which is quite acceptable. The distortion performance of the amplifier is good, being a maximum of 0.01% at rated power of 200 watts at 100 Hz and half that figure at higher frequencies whilst at the 1 watt level these figures rise very slightly at 100 Hz, drop at 1 kHz and remain the same at 6.3 kHz.

The transient intermodulation distortion of the amplifier is impressive whilst the hum and noise levels are also excellent. The dynamic headroom of the amplifier at the clipping point is 1 dB re 220 watts. The unit proved itself to be fully self-protecting with normal abuse in the form of short-circuits applied to the output and over-drive applied to the input.

The subjective testing of the unit was particularly pleasant and with either a moving magnet cartridge Shure V15 Mark 3 or with a Nakamichi moving coil cartridge type MC500 the performance was exemplary. When feeding into Quad electrostatic speakers the quality was quite outstanding. When feeding into higher powered speakers like the JBL-L110s we were able to produce rollicking rock output at 110 dB levels where the speakers became the limiting factor rather than the amplifier itself.

The subjective impression of the two units interconnected was of clear, transparent, neutral sound where the designers have stressed the classical design features to provide superlative performance.

Whilst most amplifiers are designed for two sets of speakers to be connected the PS-200M is not and this limited our ability to generate the maximum power drive that would enable the evaluation of the greatest possible loads. ▶

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The skill of the surgeon is twofold. It depends on his knowledge of his patient. And also, most importantly, on his ability to convert that knowledge into a series of swift clean movements with a scalpel.

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Empire produce some of the world's most advanced phono cartridges. The tip of the stylus is as sharp as and a great deal harder than the tip of a surgeon's scalpel. Wrongly positioned it will cut into the soft vinyl groove of a record instead of tracking safely along the surface. But at the same time it must pick up every subtle nuance of sound information contained in the groove.

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Empire make a complete line of phono cartridges. Each however has a unique advantage. Empire have developed a moving iron design of magnetic cartridge that allows the stylus to float free of its magnets and coils. This imposes far less weight on the record surface. And of course far less wear. Using a specially engineered hollow iron armature, Empire cartridges also are able to ensure greatly improved channel separation.

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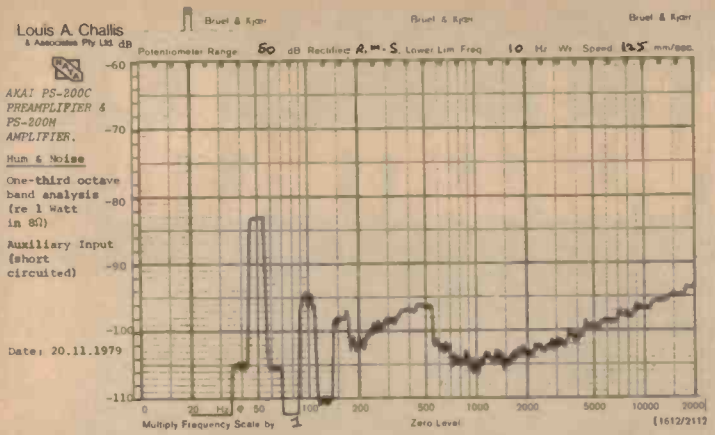
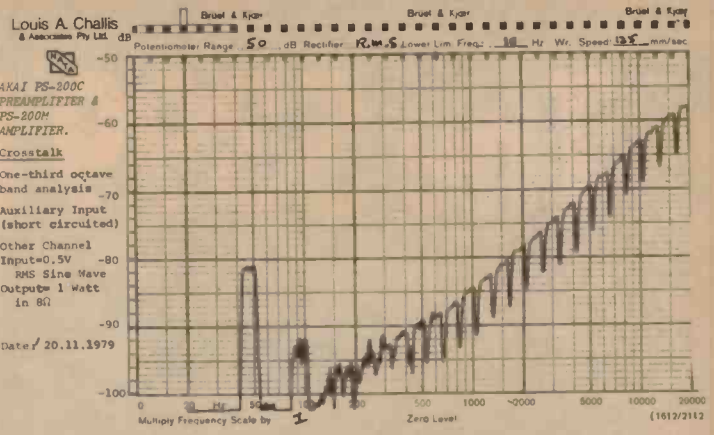
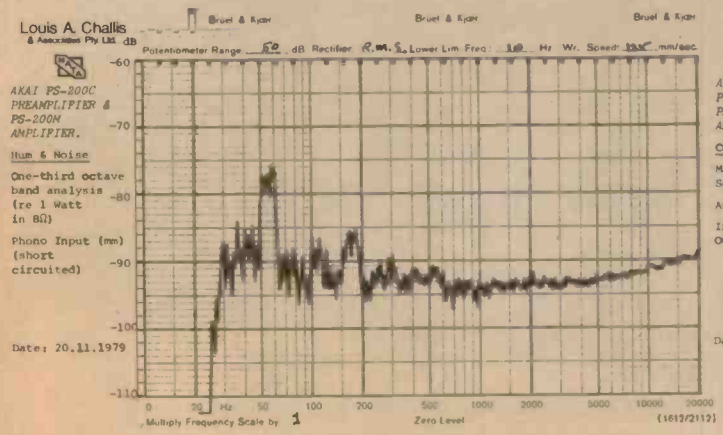
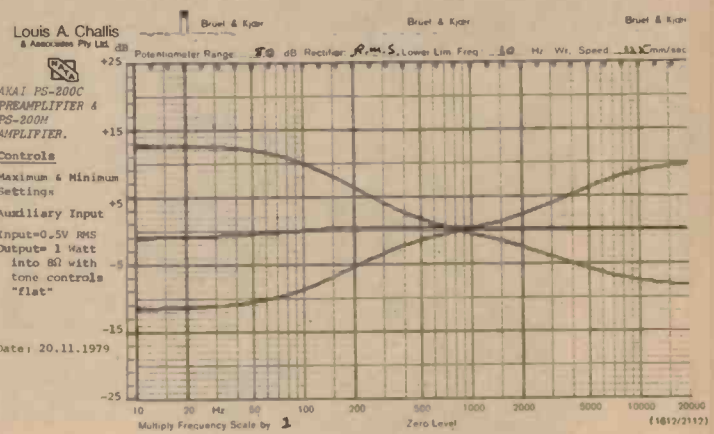



## Summary

The Akai PS-200C and PS-200M are a powerful combination designed, we feel, more for commercial rather than for amateur use. Their weight provides a restriction that tends to limit their use to fixed situations.

Whilst their objective or subjective performance is *exemplary*, with a price tag of over $2000 they are a trifle expensive in a marketplace where cost and cost benefit are continually assessed. ●

## THE AKAI PS-200C PREAMPLIFIER AND PS-200M POWER AMPLIFIER

*PS-200C:*
*Dimensions: 440mm wide x 90mm high x 475mm deep*
*Weight: 7.5 kg*
*Recommended Retail Price: $649*

*PS-200M:*
*Dimensions: 440mm wide x 198mm high x 459mm deep*
*Weight: 30 kg*

*Recommended Retail Price: $1,399*
*Manufactured by Akai Electric Company, Tokyo, Japan*



MEASURED PERFORMANCE OF AKAI PS-200C PREAMPLIFIER AND PS-200M POWER AMPLIFIER (S.N. 40485-15210, 40485-15336)

**FREQUENCY RESPONSE:** (-3dB re 1 Watt, 0.5V Input to Aux.)

| Tone Controls Centred | |
|---|---|
| Left: | 1.2Hz to >120kHz |
| Right: | 1.2Hz to >120kHz |
| **Tone Controls Defeated** | |
| Left: | 1.1Hz to >120kHz |
| Right: | 1.1Hz to >120kHz |

**SENSITIVITY:** (for 1 watt in 8Ω)

| | Left | Right |
|---|---|---|
| Aux: | 8.0mV | 7.9mV |
| Tuner: | 8.0mV | 7.9mV |
| Tape: | 8.0mV | 7.9mV |
| Phono (MC): | 5.6µV | 5.6µV |
| Overload: | 12mV | 12mV |
| Phono (MM): | 150µV | 150µV |
| Overload: | 460mV | 480mV |

**INPUT IMPEDANCE:**

| | Left | Right |
|---|---|---|
| Aux: | 36kΩ | 36kΩ |
| Tuner: | 36kΩ | 36kΩ |
| Tape: | 36kΩ | 36kΩ |
| Phono MM1 | 50kΩ | 50kΩ |
| MM2 | 100/50/35kΩ | 100/50/35kΩ |

**OUTPUT IMPEDANCE:** = 25 milliohms (@ 1kHz)

**HARMONIC DISTORTION:**

(At Rated power of 220 Watts into 8Ω = 41.9 Volts)

| | 100Hz | 1kHz | 6.3kHz | |
|---|---|---|---|---|
| 2nd | -82.1 | -93.2 | 87.3 | dB |
| 3rd | -83.6 | -87.3 | 91.8 | dB |
| 4th | -93.6 | -97.3 | 93.4 | dB |
| 5th | -95.4 | - | - | dB |

*THD 0.01% 0.005% 0.005 %*

(At 1 watt into 8Ω )

| | 100Hz | 1kHz | 6.3kHz | |
|---|---|---|---|---|
| 2nd | -77.6 | -95.4 | -85.7 | dB |
| 3rd | -81.7 | - | - | dB |
| 4th | -87.8 | - | - | dB |
| 5th | -92.8 | - | - | dB |

*THD 0.016% 0.002% 0.005 %*

**TRANSIENT INTERMODULATION DISTORTION:** Less than 0.1%
(3.15kHz square wave and 15kHz Sinc Wave mixed 4:1 to auxiliary input Output equivalent to 220 Watts.)

**NOISE & HUM LEVELS:**
(re 1 watt into 8Ω)
(with volume control set for 1 watt output with,
0.5V input (Aux.)
5mV input (Phono) (MM)
0.5mV input (Phono) (MC)

| | | |
|---|---|---|
| AUX | -81 dB(Lin) | -88 dB(A) |
| PHONO(MM) | -74 dB(Lin) | -81 dB(A) |
| PHONO(MC) | -66 dB(Lin) | -73 dB(A) |

**MAXIMUM OUTPUT POWER AT CLIPPING POINT:**
(IHF -A - 202) 150 V P-P
(20mS burst repeated at 500mS intervals) = 281 Watts
∴ Dynamic Headroom = 1.06 dB (re 220 Watts)

# The $399* Nakamichi

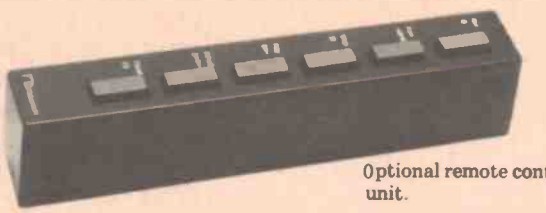
New Nakamichi 480 metal compatible 2 head cassette deck.

If you know Nakamichi products, you'll know $399* sounds too cheap for real Nakamichi quality. But if you know Nakamichi, the man, you won't be that surprised.

Nakamichi's genius for innovation has created a new Nakamichi range that makes brilliant reproduction at incredibly reasonable prices a reality.

Take the new 480. It is the personification of Professor Nakamichi's latest technology and his policy of producing components with an excellent performance/cost ratio.

Nakamichi 480 can play and record conventional and the new metal tapes and is available with an optional remote control unit. It has a frequency response of 20Hz-20KHz (-20dB Rec. level), wow and flutter less than 0.11%WTD peak, 0.06%WTD rms, signal to noise ratio (Dolby NR In, 70$\mu$s) — better than 62dB at



Optional remote control unit.

400 Hz, 3% THD WTD rms, cross-talk better than 60dB at 1KHz, 0dB, erasure better than 60dB below saturation level at 1KHz and total harmonic distortion less than 1.0% at 400Hz, 0dB (ZX, EXII tapes) and less than 1.2% at 400Hz, 0dB (SX tape).

And if you're not sure about all that technical jargon, it means, quite simply, that the Nakamichi 480 performs brilliantly. But don't take our word for it. Experience the difference Nakamichi technology makes to high fidelity sound reproduction by visiting your nearest Nakamichi dealer.

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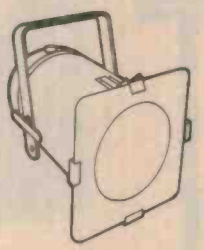
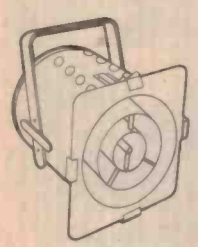


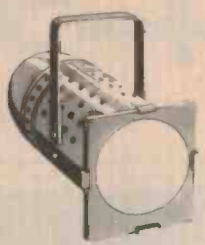
**PAR56**

300 watt, 240 volt sealed beam lamp. Available in either narrow or medium flood lamps with a remarkable 2,000 hours lamp life. APPLICATIONS: Stage lighting from overhead or sides; stage lighting from front of house using optional barn doors.



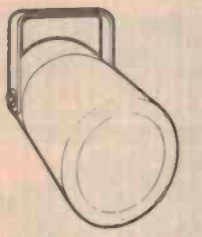
**ROCKBEAM**

1000 watt, 240 volt beamlight. Projects narrow, intense beam suitable for long throws of up to 30 metres. Standard T11 tungsten halogen lamp is used, giving 800 hours lamp life. APPLICATIONS: Long throw stage lighting; "Specials" lighting and pin spotting.



**PAR 64**

1000 watt sealed beam lamp, available in narrow spot or medium flood. The Par 64 is an American 120 volt lamp and the lanterns are operated in pairs, giving series operation to 240 volts. 2,000 hours lamp life. APPLICATIONS: Stage lighting from any position; optional barn doors offer beam shaping facilities.



**HOTSPOT**

The compact pencil beam light used by disco's and bands around Australia. Tiny Par 36 lamp gives punchy, intense shaft of light. Several versions are available for either single use or large installations. APPLICATIONS: Special effects lighting; mirror ball lighting for disco's, bands, etc.

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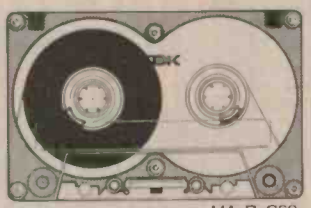
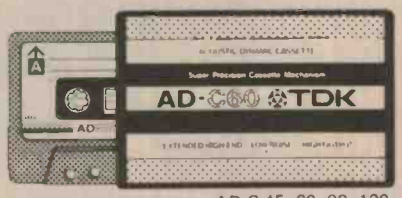


MA-R-C60

**SUPER AVILYN — SA** handles exceedingly high signal inputs without distortion due to increased MOL providing full dynamic range for both recording and playback.


SA-C 60, 90

**ACOUSTIC DYNAMIC — AD** has high MOL and is capable of recording playing pop rock and jazz music sources with plenty to spare but does not require special bias and equalisation settings.

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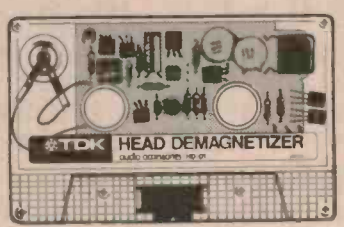


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TDK 7700

# Technics RS-M63 stereo cassette deck

Sporting most of the features that the market calls for, including metal tape facility, this machine provides first class performance and offers good value for money.

THE RS-M63 is a three-head stereo cassette deck with provision for the four primary cassette tapes – normal gamma-ferric oxide, chromium dioxide, ferrichrome and the new metal tape formulations.

In keeping with other manufacturers, Matsushita have decided to market a "state of the art" machine with most of the features that the market calls for but selling at a price which is to say the least attractive. In their initial aim of producing a basic machine, the market place will not be disappointed as this machine still has more frills than most and a striking appearance to boot.

## Features

The front panel, which is brushed satin aluminium moulding, contains an oil-damped cassette well mechanism through which the cassette can be seen when loaded. Below the wall there are a larger number of lever control switches for the mechanical mechanism than usual. As well as the normal controls, the unit contains the added function of a review capability on the "fast rewind" lever; a cueing facility on the "fast forward" mode and a timer stand-by switch. If the review and cueing levers are partially depressed it is possible to hear the signal on the tape as it is rapidly spooling backwards or forwards. This makes it relatively easy to find a selection on the tape and when the memory function is selected, to automatically go into the play mode.

The timer stand-by switch allows the unit to be connected to an external timer. The recorder automatically goes into record or play to record some special programme or material in the absence of the owner; or to play back a programme as a wake-up alarm should this be required.

The designers have incorporated a series of illuminated block "logic schematics" on the front panel to show the operation of the three-head system. These show whether the unit is on record; whether the output is looking at source or tape; and whether the erase head, record head or playback are activated for either recording, monitoring or playing of the system. Whilst this may appear to be a frill, it allows you to know at a glance the status of the equipment and whether you are actually listening to source or output. This was one feature of the machine which we particularly liked and which we feel is well worthwhile.

The other controls on the bottom row are Dolby in/out switch which is inexplicably described as a filter on the front panel, a three-position selector switch for chromium dioxide, ferrichrome or normal gammaferric oxide tapes; a separate metal in/out tape; a sensible output level control; a large "line input" level control with

concentric controls for left and right channel, and a dual concentric microphone control for the two tip-and-sleeve microphone sockets located on the right hand side of the deck.

The top right hand section of the panel contains an attractive and very effective dual-colour fluoroscan meter display. This covers the range −20 dB to +8 dB and changes colour from yellow to orange for signals above 0 VU. This is augmented by an intensity control knob on the right hand side of the deck which provides a small adjustment for the display's intensity. The unit also has a headphone socket and a rotary bias adjustment control. The handbook includes instructions on optimum bias settings for various brands of tape.

The rear of the cabinet is relatively sparse and features only a fuse, the two input and output coaxial sockets and a DIN socket for interconnection to an external amplifier. The cabinet is manufactured as a single plastic moulding covered by a metal lid, supplemented by a steel bottom panel to provide reasonable screening.

The inside of the cabinet features one large "mother board" printed circuit on the bottom; a small fluoroscan control board at the front; a small rectifier power supply board centrally located at the rear and the power transformer angled on the plastic frame to minimise inductive pick up. The drive mechanism with the three heads is also primarily fabricated from plastic mouldings and appears to be well constructed and well designed.

Technics are sufficiently sure of the quality of their construction for them to provide a 10 year limited warranty on the three heads. These feature a five micron wide record head gap width and a one micron wide replay gap width.

The block on which the record and replay heads are mounted is integrated into a single combination housing which Technics claim also reduces alignment problems such as azimuth loss. The erase head is a combination construction of Sendust/ferrite material which is designed to cope with very high erasure current and thermal dissipation which the new metal tapes require.

## On test

In the objective testing of the RS-M63 our first task was to determine the replay frequency characteristics. Fortuitously, this machine provided a replay frequency response which is particularly smooth and substantially better than most other machines that we have recently reviewed. On standard Maxell UDXL, the replay frequency response is 27 Hz to 17 kHz ±3 dB; on TDK SA the replay frequency response is 27 Hz to 16 kHz ±3 dB; and on TDK metal tape the replay frequency response is 27 Hz to 11 kHz ±3 dB. The inexplicable drop off in replay performance on the metal formulation tape appears to be the result of an equalisation mis-adjustment rather than an azimuth alignment problem. These performances are nonetheless good and almost equal to the best that we have seen.

The record to replay frequency responses provided a slightly different slant on the performance of this machine. At −20 VU the frequency response is 33 Hz to 12.5 kHz on Maxell UDXL; 33 Hz to 9 kHz on Sonychrome; and 33 Hz to 19 kHz on TDK metal tape. On repeating the record replay frequency response on the Maxell UDXL, at 0, −10 and −20 VU the frequency response inexlicably improved from 13 kHz to 15.5 kHz on the second sample of tape and this is the sort of performance that we would expect of this machine. The mechanical characteristics in terms of speed accuracy proved to be quite acceptable at 0.18% high, whilst the wow was as good as could be expected for the price.

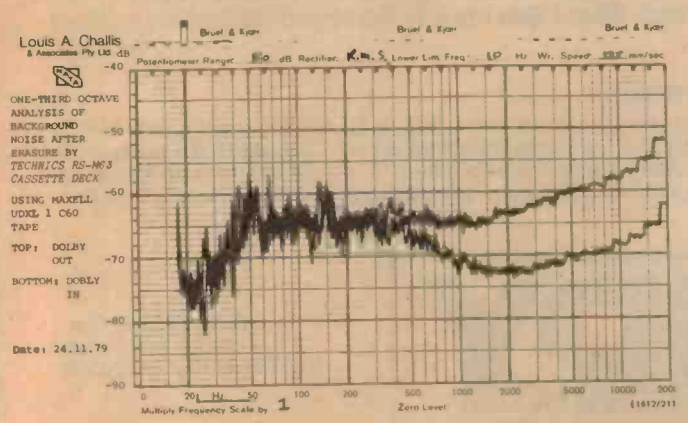
The harmonic distortion characteristics of the machine are much better than we would have expected, with a maximum distortion of 1.54% at 0 VU. At lower frequencies the distortion is lower and generally around 1% or less. At −6 VU the distortion drops down to only 0.7% at 6.3 kHz; 0.3% at 1 kHz; and a miniscule 0.25% at 100 Hz.

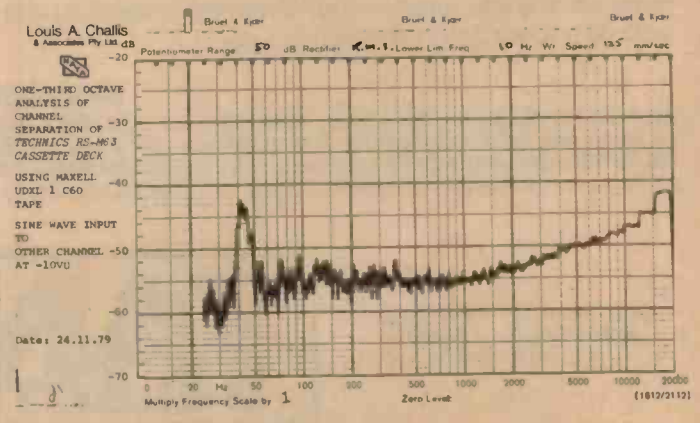
The maximum input level for 3% third harmonic distortion at 1 kHz is a very healthy +8 VU so that the dynamic range on UDXL is 66 dB(A) with Dolby in and substantially higher with chromium dioxide, chromium equivalents or metal tapes. These performance figures are most impressive and show that the new generation of cassette decks are almost an order of magnitude better than the previous generation.

The erase ratio for the machine is better than −90 dB with Maxell UDXL and better than −87 dB with TDK metal tape. This erasure performance is so much better than the previous generation of cassette decks that the problems of spurious signals being left over from previous recordings is now positively a thing of the past, as the erased signals are more than 20 dB less than the A-weighted noise threshold.

## Subjectively

In subjective use, the RS-M63 proved how flexible it could be. Whilst the three head LED display feature at the top of the deck may appear to be a frill, it is of unquestioned use when one is sitting back in a lounge room and you seek information that the machine is operating in the correct mode without approaching too closely. Whilst we doubt that other manufacturers will copy this feature, it is one which will be of use to the owner on odd occasions rather than on a continuous basis. We replayed a number of pre-recorded cassettes through the machine and were pleased at its fidelity, its lack of noise (particularly when the Dolby noise reduction system is used) and the reasonable dynamic range. In general ▶



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## SPECIFICATIONS

**AMPLIFIER: Frequency Response :** 30-20,000 Hz ± 1 dB **Signal-to-Noise Ratio:** 65 dB phono, 80 dB aux **Phono Input Overload:** 150 millivolts **AM TUNER: Sensitivity:** 250 microvolts per meter for 20 dB S + N/N **Image Rejection:** 35 dB **Signal-to-Noise Ratio** 40 dB **FM TUNER: Sensitivity (IHF):** 2 microvolts (5 dBf) **Capture Ratio:** 2 dB **Alternate Channel Rejection:** 50 dB **RF Interference Rejection:** Rated Excellent **Stereo Separation:** 40 dB at 1 kHz **THD:** 0.5% stereo, 0.3% mono **Signal-to-Noise Ratio:** 65 dB. **SIZE:** 14.9x48.8x36.8cm

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terms, this machine is comparable with almost any reel-to-reel machine that we have used and if anything, is much easier to use.

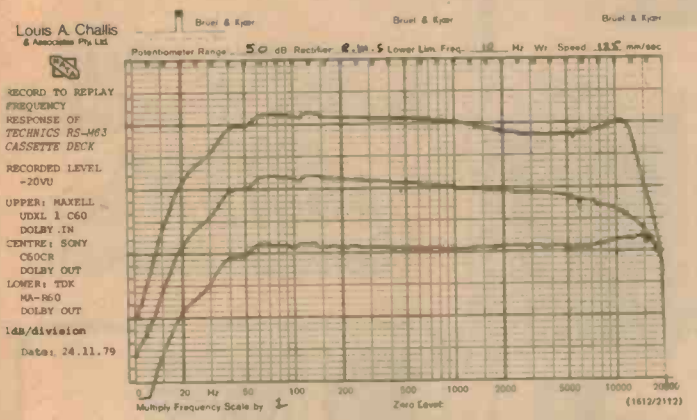
On record to replay, the machine features a flexibility which is outstanding and the fluoroscan display really does its job all the way up to the +8 VU setting at the extreme end of its indication range. With peaks under the +8 VU level the quality of reproduction on tapes recorded on the machine were more than acceptable. With peaks hitting +8 VU, noticeable colouration and distortion, particularly with Dolby in use, could be detected. Whilst the machine does not incorporate an inbuilt timer, suitable units are now available on the Australian market at a reasonable price and this feature, although not evaluated by us, may well prove to be a boon for those people who purchase this unit.

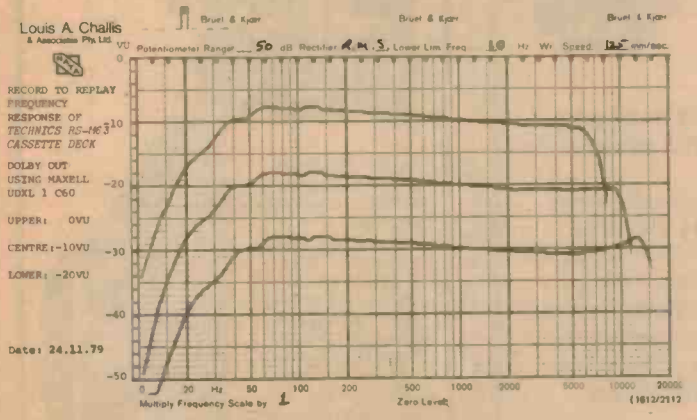
## Summary

Our overall impression of the RS-M63 Stereo Cassette Deck is that it is an excellent unit providing first class performance, good ergonomics, in what appears to be a sensible and reliable design. We rate this unit highly and believe that it offers very good value for money. ●

*Dimensions: 430mm wide x 142mm high x 270mm deep.*
*Weight: 6.3kg Price: $409 rrp.*
*Manufactured by Matsushita Electric, Tokyo.*








MEASURED PERFORMANCE OF

TECHNICS RS-M63 CASSETTE DECK,

SERIAL NO. CF900529

REPLAY FREQUENCY RESPONSE AT -20VU:

| | | | |
|---|---|---|---|
| Maxell UDXL | 27Hz | 17kHz | ±3dB |
| TDK SA-C60 | 27Hz | 16kHz | ±3dB |
| TDK MA-RC60 | 27Hz | 11kHz | ±3dB |

RECORD TO REPLAY FREQUENCY RESPONSE AT -20VU:

| Tape | Dolby | Lower -3dB Point | Max. Point and Frequency | Upper -3dB Point |
|---|---|---|---|---|
| Maxell UDXL I C60 | In | 33Hz | 100Hz +1.5dB<br>3kHz -2dB | 13kHz |
| Sony C60 CR | Out | 33Hz | 130Hz +2dB | 9kHz |
| TDK MA-RC60 | Out | 33Hz | 15kHz +1.5dB | 19kHz |

SPEED ACCURACY: 0.175%

WOW & FLUTTER: Wow: Average - 1.0% P-P

Flutter: Unweighted - 0.1% RMS
Weighted - 0.045% RMS

HARMONIC DISTORTION:

(Utilising Maxell UDXL 1)

| | | 100Hz | 1kHz | 6.3kHz | |
|---|---|---|---|---|---|
| OVU: | 2nd | -53 | -54.7 | -36.6 | dB |
| | 3rd | -60.7 | -39.3 | -58.3 | dB |
| | 4th | -68.1 | - | - | dB |
| | 5th | -59.5 | -56.2 | - | dB |
| | *THD* | *0.27%* | *1.1%* | *1.54%* | |
| -6VU: | 2nd | -53.9 | - | -44.1 | dB |
| | 3rd | -57.3 | -53.4 | -51.9 | dB |
| | 4th | -64.9 | -57.3 | - | dB |
| | 5th | - | - | - | dB |
| | *THD* | *0.25%* | *0.3%* | *0.67%* | |

MAXIMUM INPUT LEVEL:

(for 3% third harmonic distortion at 1kHz, utilising Maxell UDXL 1) +8VU

DYNAMIC RANGE:

(Utilising Maxell UDXL 1) Dolby Out 54dB(Lin) 57.5dB(A)
Dolby In 59dB(Lin) 66dB(A)

ERASURE RATIO:

(for 1kHz signal recorded at 3% third harmonic distortion)

Utilising Maxell UDXL I >90dB
Utilising TDK MA-RC60 >87dB

# The new generation of factory-built or kit-set Peerless loudspeakers

It's true most speakers *look* alike and that price alone never tells the whole story. But now the new generation Danish-built Peerless loudspeakers give you a recognizable difference in sound quality–a difference that has set Peerless a notch above the others for over 50 years.

The range of new generation Peerless loudspeakers includes the fully assembled *PAS series* plus the money-saving *PLK kit-sets*. Both series contain drive units with the following characteristics.

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☐ Large ceramic ferrite magnets for high power handling. ☐ Specially coated cones reduce colouration to a minimum. ☐ Cones are supported by a single-roll foam or rubber surround to maintain excellent linear motion. ☐ Bass response is clean and tight at all listening levels.

### Peerless Midrange Units

☐ Sealed back units prevent interaction with the woofer. Distortion and colouration are reduced to a minimum. ☐ The rear side of the cone is coated with a special damping material to eliminate colouration. ☐ Specially impregnated polyurethane cone rim provides high degree of linearity.

### Peerless Tweeters

☐ Dome tweeters designed for the highest accuracy of reproduction with low distortion flat response and wide dispersion. ☐ The sealed back isolates the tweeter from interference. ☐ Specially developed dome fabric ensures no degradation of performance even after prolonged heavy loading. ☐ Assembly mounted on a precision diecast plate where rigidity ensures permanent alignment.

### Peerless Dividing Networks

☐ Peerless crossovers use air-cored chokes for maximum power handling, and special electrolytic capacitors to ensure long term reliability. ☐ All components are mounted on fibreglass printed circuit boards for maximum durability, while coded clip connectors eliminate the need for soldering.

### Power handling

The power handling capacity is high and conservatively rated at 100W RMS, however, due to the high efficiency of Peerless speakers, the recommended amplifier power is between 25-100W RMS.

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# Koss Pro/4AAA stereo head-phones

"In terms of comfort, lack of distortion and general performance . . . "these headphones . . . rate very highly".

OVER THE LAST SIX YEARS we have used a set of Koss Pro 4/AA headphones for general monitoring in our laboratory. Whilst we have been generally impressed with their performance in terms of ruggedness and reliability their frequency response has left much to be desired.

The Koss Pro/4AAA model stereo headphones are an improved version of the older Pro/4AA series. These have been redesigned to achieve a wider frequency response and markedly improved wearing comfort. They have the ability to accept higher voltages and simultaneously deliver higher output without suffering from gross distortion.

The appearance of the Pro/4AAA is typical of many new American consumer items with a little bit more chrome in the headbands and in the earphone yokes, a generally higher quality of finish in the plastic mouldings, and most noticeably a complete change in design philosophy for the ear cushions.

The Pro/4AA also featured soft, comfortable ear pieces but the ergonomic design of those earpieces left much to be desired. Whilst many users may have found the 4AA earpiece comfortable, I for one did not, and always felt that the designers miscalculated or used very soft human ears in formulating their design parameters.

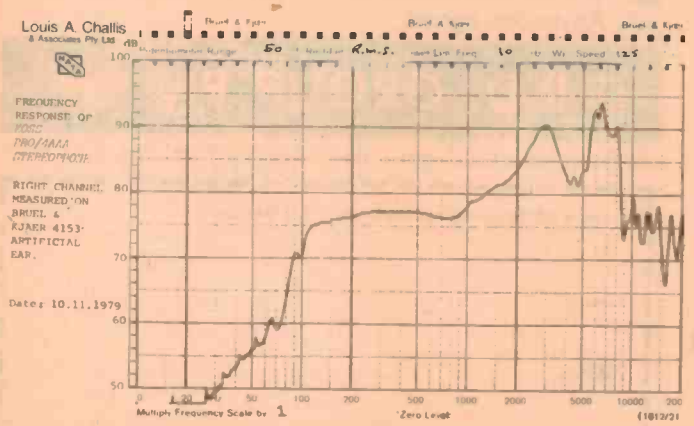
## Oh, the fit . . .

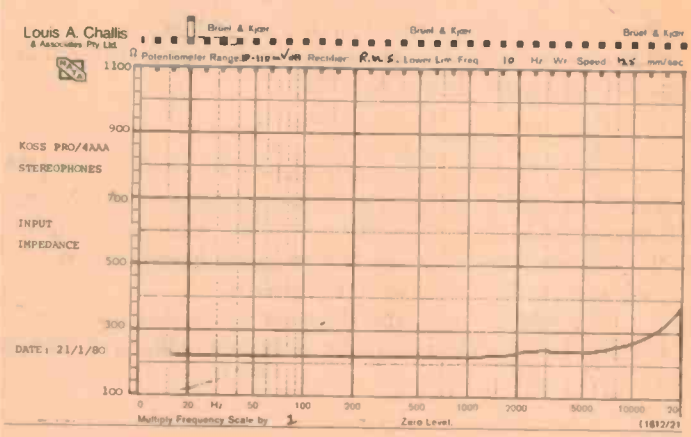
The new, contoured Pneumalite ear cushions in the Pro/4AAA series were designed specifically to fit the contours of a wide range of human ears and as a consequence these headphones are far more comfortable to wear than the 4AA model. As if to prove the point, in an A-B test between the 4AA and the 4AAA, we found that it is readily possible to wear the 4AAA for many hours without noticeable discomfort, whilst the 4AA soon make their presence known. If the cushions are an advance, then the over-head band on the 4AAA is an even more significant advance. The 4AA featured a closed cellular foam insert in the plastic headband. These were intended to be comfortable, but were nonetheless only partially effective. The 4AAA by contrast utilises a separate thin padded plastic yoke below the main headband section which provides excellent contouring to the scalp, stable seating for the headband without problems of slip, and is a major factor in these headphones achieving a high level of user comfort. The earpieces swivel through + or - 30 degrees, and are gimballed at their centre for a further + or - nominal 30 degrees to achieve a universality of fit which makes them one of the most comfortable sets of stereo headphones on the market.

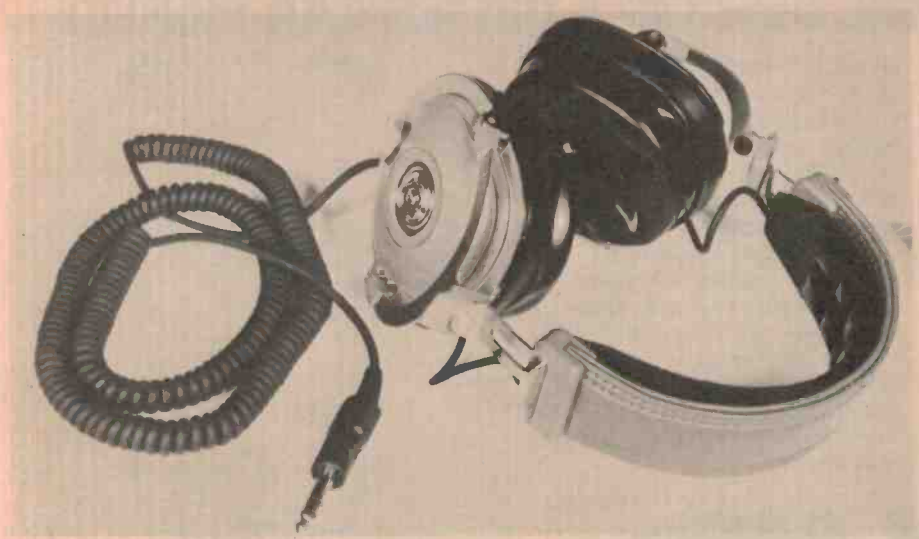
## On test

Koss have not just rested on the comfort and appearance but have spent considerable effort in improving the technical performance of these headphones. The most significant improvements are derived through the use of a larger diaphragm with a nominal 15 $cm^2$ radiating area, with a 25 mm diameter voice coil. In order to keep their options open for commercial as well as amateur usage they have incorporated a fitting on the left ear for fitting standard "close mouth" boom microphones of the type used by studio controllers, traffic controllers and for other similar activities.

We measured the frequency response on our Bruel and Kjaer artificial ear





type 4153. The frequency response is not quite as broad as stated by the manufacturers, who describe it in terms of a "10 Hz to 22 kHz frequency response". At frequencies below 90 Hz the response drops off very rapidly and the main diaphragm resonance occurs at approximately 75 Hz. Between 100 Hz and 20 kHz the overall response is reasonably good, although both the left and right ear exhibit rising responses at approximately 3 kHz and again at approximately 6 kHz. The left ear exhibits a very sharp response at 7.5 kHz whilst the right ear exhibits a somewhat broader resonance extending between 5.5 and 8.5 kHz. These characteristic responses are audible and provide a substantial increase in the "overall presence" of the headphones. The response surprisingly, does extend beyond 20 kHz, although it is a trifle peaky. The low frequency performance of the headphones would vary slightly on most human heads compared with our artificial ear and that would, in part, be a function of the quality of fit of the Pneumalite ear cushions over the individual's head. Notwithstanding, however, the frequency response exhibited by these headphones is a dramatic improvement over the Koss 4AA. Although the frequency response may not look as flat as you may desire, they are nonetheless excellent when compared with the majority of other dynamic headphones in the marketplace.

We were impressed by this aspect of the performance, but were even more impressed by the low distortion characteristics of these headphones. At normal listening levels distortion is remarkably low, at 90 dB typically less than 0.14%. At the 120 decibel level which is extremely loud, the distortion was still less than 0.7% at 1 kHz and even lower at the other test frequencies.

This performance places the Koss Pro/4AAA s in the commercial monitoring headphone class and would make them equally suitable as stereo headphones for training the deaf or even for high level test headphones for possible use with audiometers. These characteristics are also suitable for use in speech communication systems in noisy environments, where an effective signal to noise ratio and low distortion are essential to override extraneous intrusive noise. In order to evaluate this capability within the headphones we measured their sound isolation characteristics. At 100 Hz this was only a decibel, at 1 kHz the noise isolation had risen to a useful 17 decibels, whilst at 6.3 kHz the figure was 32 decibels. Whilst these headphones may not have been specifically designed with this function in mind, it is worth noting that the noise exclusion performance is both practical and effective.

Our Ref: E28

MEASURED PERFORMANCE OF
KOSS MODEL PRO/4AAA STEREOPHONE, SERIAL NO. NIL

Louis A Challis and Associates Pty Ltd

FREQUENCY RESPONSE:
(Typical) 90Hz to 20kHz +1.7dB, -3dB

SENSITIVITY:
(for 90dB SPL @ 1kHz) 440mV

INPUT IMPEDANCE:

| | |
|---|---|
| 100Hz | 220Ω |
| 1kHz | 230Ω |
| 6.3kHz | 260Ω |

TOTAL HARMONIC DISTORTION:

| | 90dB | 120dB |
|---|---|---|
| 100Hz | 0.06% | 0.36% |
| 1kHz | 0.14% | 0.69% |
| 6.3kHz | 0.027% | 0.24% |

REDUCTION OF EXTERNAL NOISE:

| | |
|---|---|
| 100Hz | 1dB |
| 1kHz | 17dB |
| 6.3kHz | 32dB |

Date: 10.11.1979

## How they sound

We subjected the Pro/4AAA headphones to a wide range of programme content and even compared their performance in terms of an A-B test against our reference electrostatic headphones, and against the previous model, 4AA.

The subjective impression is one of particularly clean sound with these units exhibiting a trifle more presence than most electrostatic headphones. They provide the type of sound that most purchasers would describe as pleasant and attractive. The top end response comes close to equalling the best performance of Koss's top of the line electrostatic headphones but, it should be noted, at only a fraction of the cost. The distortion characteristics are, by and large, *impeccable* and these headphones can reproduce high level rock music which suffers only slightly from the limited low frequency performance.

## Summary

The Koss Pro/4AAA stereo headphones are a worthy successor to the 4AA model and incorporate many worthwhile design features and improvements that make them one of the better dynamic headphones available on the market. In terms of comfort, lack of distribution and general performance they rate very highly. If the low frequency performance in the 20-90 Hz region were as good as the performance they exhibit from 90 Hz to 20 kHz, they could readily become the best stereo dynamic headphones on the market. ●

### KOSS PRO/4AAA STEREO HEADPHONES

*Nominal Impedance: 220 ohms*
*Weight: 440 grams* *Price: $143*
*Coiled lead with moulded tip ring and sleeve plug.*
*Left ear headphone fitted with boom mount to accept close mounting microphone.*

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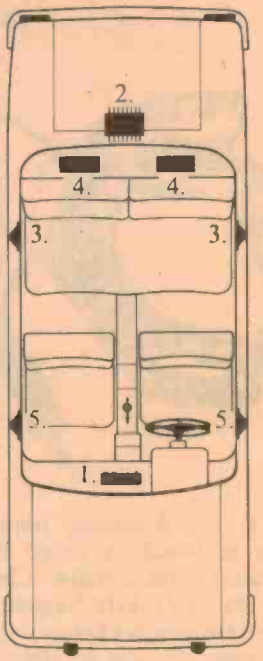


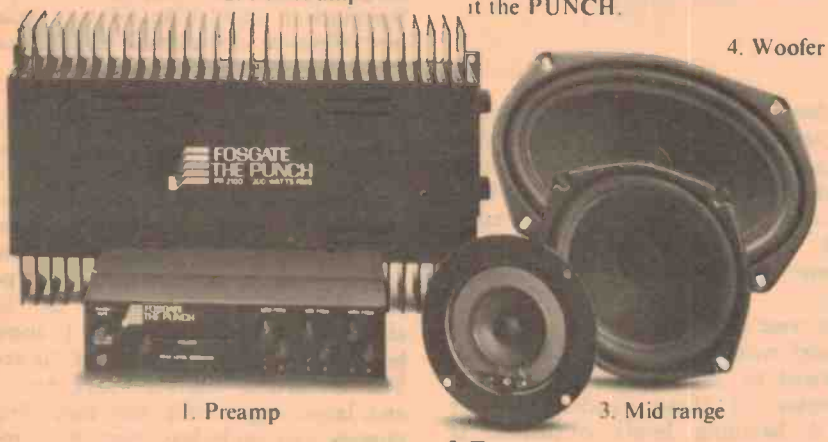


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# The gullible listener

## John Gardiner

The pratfalls of subjective reviewing, reviewed.

EVERY CHRISTMAS the Royal Institution presents a series of scientific lectures for young people. In England, these are televised every evening during the first week of the New Year and they make for compulsive viewing. Last year we had Professor Carl Sagan talking about planets, and the discussion about space exploration and our knowledge of the solar system was fascinating. However there was much of incidental interest in these lectures for anyone involved in scientific investigation and objective assessment through observation.

Examples were given of the many pitfalls awaiting the observer who deduces a theory from too few facts and then uses the new theory to 'prove' something else! Now this sounds like familiar territory to anyone who has been following the audio scene for the last few years. Perhaps we can learn something from Professor Sagan.

One of his examples concerned Percival Lowell, a respected astronomer in his time, who made a study of Mars, and from his observations he drew a map. Now we *know* that there are no canals on Mars because the Viking probe photographed the surface in great detail. Yet for years, based on Lowell's observations, it was popularly believed that Mars had canals because his telescope observations had 'proved' it. In fact, it was the brain of the willing believer which saw the canals, and where visual information was missing, it was the brain which filled out the detail. A series of blobs became a straight line and a straight line became a canal. But a canal is a man-made waterway. *Ergo* there must be, or have been life on Mars! All this is now discredited but it was once a very plausible theory.

## Observation and emotion

If the eye is so easily deceived, what of the ear? The key message from Professor Sagan was that we should mistrust all observations where judgement can be obscured by emotion. That, I think, is a very powerful message for reviewers of all persuasions, and it is particularly relevant to the testing of equipment and the reviewing of records. All of us must have been guilty at some time or other of liking or disliking something for the wrong reasons. That is why I like to see emotional (i.e. subjective) tests supported where possible by unambiguous objective test data. If there is no apparent correlation between the two, then it would seem probable that one or the other is incorrect. Either the wrong tests have been applied or the listening panel has been misled by some unrecognised factor.

Audio is, after all, not a Black Art, but an artistic science and what can be observed can be explained. That is not the same as saying we are able to explain it: sometimes we cannot — immediately. This is why there are areas of disagreement between reviewers; some will devise a theory to fit the known facts, others will wait for research to uncover further facts. There is no reason to doubt the sincerity of reviewers as observers but if a number of us diverge widely in our findings, we cannot all be right. We can, however, all be wrong, which is a sobering thought and should make us choose our words with care!

There are many theories about at the moment on which I have reservations: I don't dispute that certain phenomena are *possible* but I do require proof that they exist, and even more that they are *significant*. I believe there is a great danger today of chasing the ghosts which haunt the fringes of high fidelity instead of concentrating on more material and fundamental issues.

## Tests and theories

An example is the controversy which has raged recently about the characteristic sound of some equipment, and the theories which the debate has produced (Ref. 1). If there is fundamental disagreement between two groups of observers (whether they be reviewers, engineers, musicians, manufacturers or hi-fi enthusiasts) when assessing the relative merits of certain pieces of equipment, this would indicate that it is probably not the equipment which should be criticised but the method of testing it.

It also seems to me that if there is a conflict between objectively derived data and that derived by subjective observation, we should not too hastily dismiss the objective data. Most reviewers have far more experience in measurement techniques than they have of interpreting the results of subjective evaluation. This is not in any way to decry listening tests; they are an essential part of reviewing. But it is important that the results should be statistically and intelligently analysed, so that we don't have to resort to extravagant phrasing to disguise a paucity of information.

Some of the BBC's Research Department reports are well worth studying in this connection as they often give details about their tests and their analysis of the results.

## A-B testing

One of the first decisions a listening panel has to make is whether to do an A-B type of test or whether to consider each piece of equipment separately and so make an absolute judgement without reference to other equipment. If an A-B test is chosen the next question is whether the two items to be compared should be fed from synchronous music sources, so that when a changeover occurs there is no break in the signal. Or whether there should be a small time lag so that when switching from A to B it is possible to hear a repeat of the last few bars heard on A. In my experience most panels choose the synchronous approach, yet in many ways it is more logical to have a time lag.

The next point about an A-B test is that it is only possible to compare two sources at a time. Therefore, if several ▶

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JOHN GARDINER is an independent technical writer and audio equipment tester/reviewer from Woking in Surrey, UK. He spent a number of years in the BBC Technical Operations Department in both Radio and TV studios and is currently with the Decca Recording Company running a technical liaison department. He is the author of two books on Tape recording and won the 1977 BASF Audio Writer of the Year award. Incidentally, the Concise Oxford defines 'pratfalls' as: fall on buttocks; humiliating failure.

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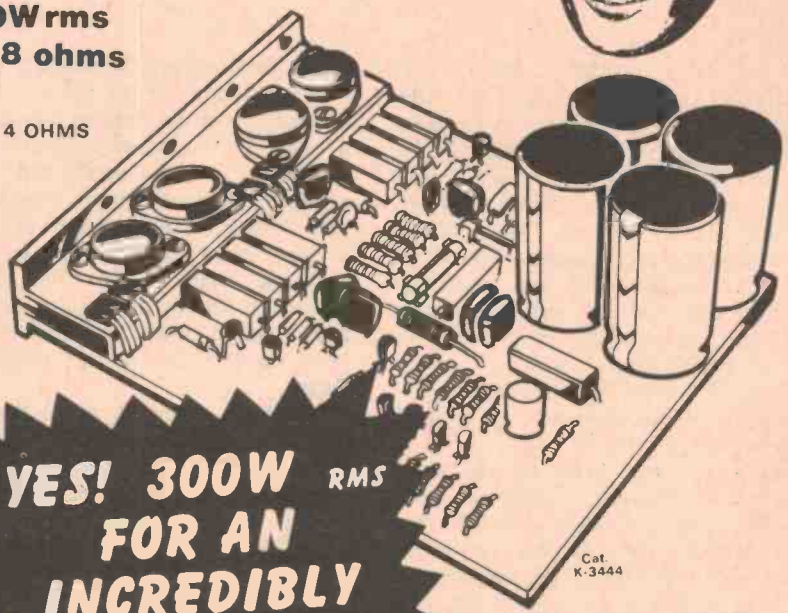


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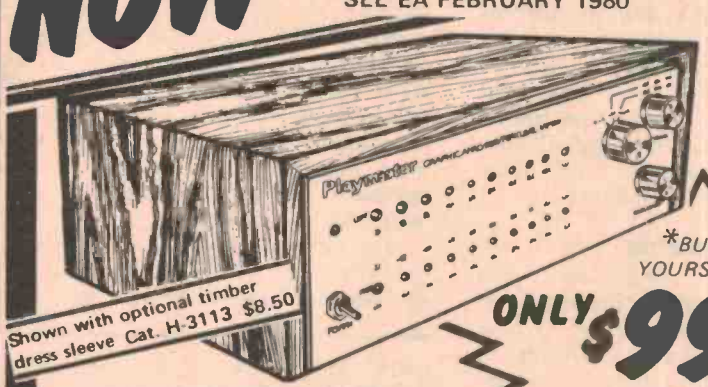


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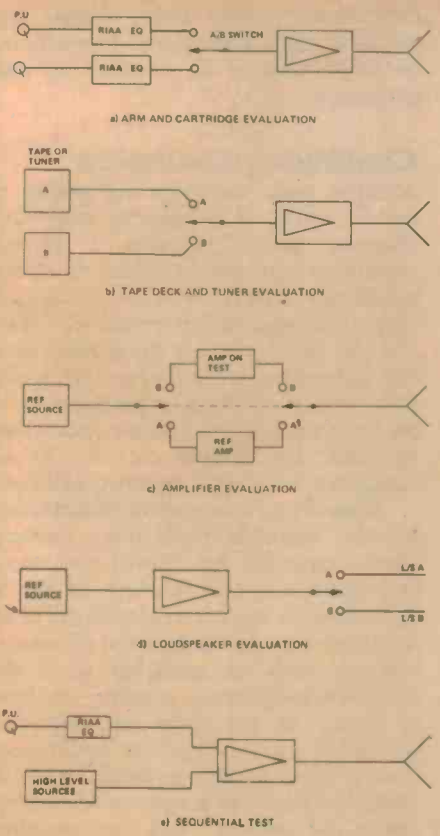


*Figure 1.* Alternative listening tests.

units are to be tested there is the choice either of selecting one unit and using this as a reference, or selecting a well known proprietory unit against which all the others can be compared. The latter approach would seem to have more to commend it because the reader will probably have some knowledge of the proprietory unit and thus he will have some yardstick against which to relate the panel's judgement to his own experience. The difficulty is, of course, that the reader's judgement is coloured by his own room acoustics and therefore the yardstick will only help some listeners.

What is important about this type of test is that verbal comments are kept to a minimum and that the panel do not compare notes during the marking. One effective method is a deviation scale with a central O representing the reference source and a scale extending either side from, say, -5 to +5. A series of judgements can then be recorded quickly with a minimum of effort. Time should be allowed between tests for the marking to take place as it is difficult to write and to listen critically at the same time. The duration of the listening session is of great importance as it is fairly widely accepted that 30 minutes of concentrated listening is the maximum that should be expected from an observer before his findings become unreliable. This assumes that we are looking for subtle differences in quality rather than major defects that are readily detectable by more crude methods.

There are also certain psychological problems associated with this type of listening test. For instance there is a tendency to prefer the second of two sources in an A-B test and so it is necessary for the reference channel to be changed, and for the panel's marking to be cross checked against the changes. It follows that the observers should not know at any time which equipment they are listening to as this can easily influence their judgement.

## Ambiguity

In a series of experiments I was recently involved with, to evaluate new methods of recording master tapes, it was found that tests had to be carefully programmed if ambiguous results were to be avoided. One problem is that the brain automatically regards any test of this sort as a challenge. This means that although on one level it is trying to make an impartial judgement, there is another part of the brain looking for clues in the test material. A slight amount of tape hiss here, a drop out there, perhaps a particular pattern of clicks on one channel; any of these things may be latched on to and subconsciously used as a clue to determine which is the reference source. The brain is very good at this sort of thing and it is very hard to guard against it.

Another factor is the relative response and relative loudness of the systems being compared. A significant number of listeners will prefer the louder source regardless of other factors and a discrepancy of as little as 1 dB can give misleading results. Similarly, a variation in amplitude/frequency response in the mid-frequency band of 1 dB will lead to erroneous observations. Thus if a ½ dB rise in one source corresponds with a ½ dB dip in the other, we must look very carefully at the test results.

It has also been established that a large number of individual observations should be tabulated and statistically analysed. The analysis can then be given a 'confidence level' which indicates the chances of the result being accidental (Ref. 2). Ideally, the same test should be given to more than one panel. Most panellists regard it as a defeat if they can hear no difference between two sources and it is advisable to do some dummy runs to make them aware of this. It is surprising how many people if given a non-operational 'A-B switch' will prefer B to A, although no change of source has taken place.

In the space available it is not possible to discuss A-B testing in great detail but I think the above points are sufficient to show that an A-B test must be painstakingly set-up, and that it is very easy for erroneous data to be collected. This is not to say that such a test is no good, merely to put in a word of caution. I believe that a reviewer has a responsibility, where possible, to give some objective support for his findings. Frequently this proves impossible, particularly with transducers.

It follows, I think, that if a simple A-B test is difficult to set-up, the problems of setting up similar tests to evaluate, say, six systems are immense and should not be minimised. In fact the question that should be asked is, whether the detection of subtle and elusive differences between one piece of equipment and another are significant to the reader. There is perhaps a danger of a reviewer writing for himself or his colleagues, rather than for the readers who pay his fees!

## Sequential testing

The alternative to the A-B type of test is even more frightening in the margin for error it offers. For want of a better expression we will call this the sequential test, and throughout this discussion we are, of course, concerned with marginal differences in performance. We assume that anyone with more than a passing interest in high fidelity will be able to identify major shortcomings, regardless of the test method used.

Now there are two basic faults which are common to very many comparative reviews and it is difficult to eliminate them. Firstly, there is the time it takes to remove one system and set up another so that it can be assessed under identical conditions. This means that a multiple listening test must be prolonged, with breaks in concentration whilst the equipment is re-aligned. Protracted and frequently interrupted listening sessions do not usually make for accurate observation. Secondly, it frequently happens that when one unit is substituted for another, an unwanted variable is introduced. One example is a multiple loudspeaker test: if the units have different sensitivities, the gain of the reference drive amplifier will have to be changed in order to produce the same sound pressure level, and this may have an unsuspected influence on the panel's judgement. Conversely, with amplifier tests it is feasible that some amplifiers will interface better with the chosen loudspeaker than others and again give misleading results. ▶

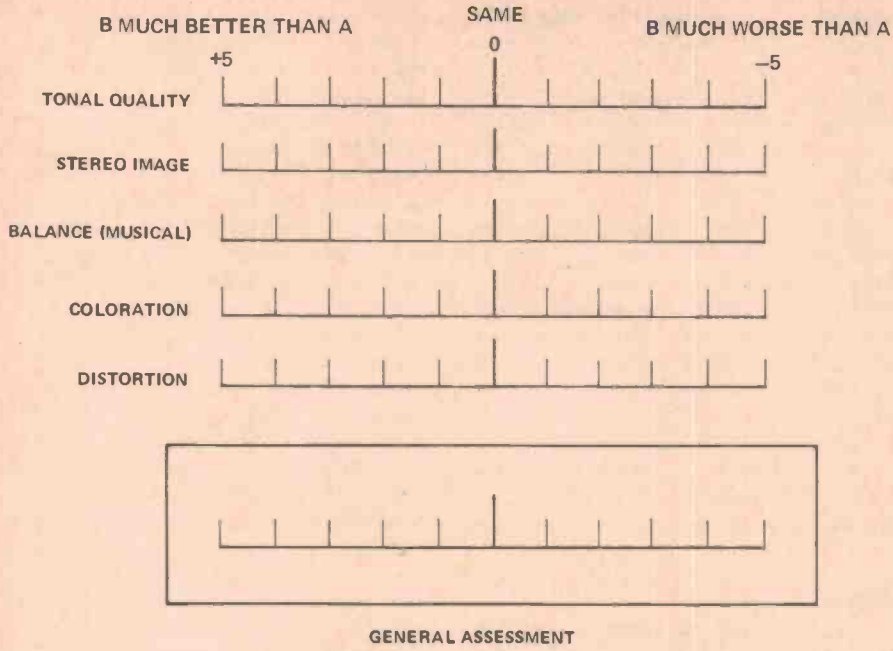


*Figure 2.* **Sample of listening panel questionnaire suitable for statistical analysis.**

In any form of scientific experiment it is standard practice to have a 'control' sample against which to assess the effect of a test. The idea is to keep the control in the same environment as the samples and then to examine the effect of varying just one condition on each of the samples. At the end of the experiment if a sample differs from the control it may reasonably be assumed that the change was caused by the variable factor. If more than one variable is introduced the experiment is of doubtful value. The implication of this is obvious: any listening tests in which more than one condition is varied at any time, is suspect.

There is another snag to sequential testing and it is that the ear no longer has a reference. It has to make an absolute judgement of sound quality, and the ear, like the eye, can be misled. Everyone is familiar with optical illusions and there is no denying that they exist. It would be surprising if the ear were not fallible in a similar way; and if it is to be deprived of a reference against which to test its judgement, it is likely to suffer from cumulative delusions. It is self-evident, I think, that the more combinations of equipment which are used in a listening test, the greater are the chances of an erroneous conclusion.

## The phase debate

There has been correspondence in the technical press recently on matters directly related to listening tests (Ref. 3). It is perhaps worth summarising some of these arguments, as they highlight the difficulties facing the listener who is trying to make a valid judgement. For instance, there is the matter of phase. We are not concerned with inter-channel phase differences which are readily audible, but with absolute phase. What happens if we reverse the connections to both loudspeakers in a given system? A number of distinguished scholars have applied themselves to this one — and arrived at opposite conclusions! However there are some grounds for believing that changing the overall phase of a system may subtly affect the quality of reproduction.

The argument goes something like this: musical instruments often produce asymmetric waveforms and at the time of recording, a positive going wave produces a forward movement of the loudspeaker cone. Any correctly set-up reproducing system will be arranged so that in-phase signals cause identical movements from both loudspeakers. Hitherto, no one has seriously bothered to ensure that the polarity of the reproducing loudspeaker is the same as for the original recording. Therefore, what was originally a forward movement of the loudspeaker cone could become a backward one and vice versa. Hence the compressions and rarefactions of the sound wave produced will be in the opposite sense to that of the live sound.

The ear itself is an asymmetric detector and the suggestion is that it could be sensitive to such an absolute phase reversal. In case there is anything in this theory the inevitable conclusion must be that all listening tests should be carried out under both normal and reversed phase conditions. The amount of work entailed is, needless to say, enormous.

## Continuing discussion

Another topic concerns the quality of certain types of connecting wire. One reviewer whose opinion I respect maintains that certain cables do have a significant effect, but that a top class system is required to reveal it. I have not yet experimented along these lines and so have an open mind on the matter. However, if there is something in it, we have yet another variable with which to tease the fallible ear. Is all our equipment identically wired, gentlemen?

Then there is the matter of distortion on the available programme sources. Peter Baxandall has shown that some amplifiers are near perfect so far as conventional tests are concerned (Ref. 4). How then do we perform a listening test on such an amplifier when the available programme sources can have *in excess* of ten times the harmonic distortion of the amplifier under test? It well could be that an amplifier which auditions badly is simply more perfect than the others and is revealing deficiencies elsewhere in the system.

In this article we have deliberately assumed the mantle of the Devil's Advocate and looked at the black side of subjective testing. Obviously tests which are conscientiously performed frequently give sensible and acceptable results. But conflicts do arise and when there is dispute common sense frequently goes on holiday. Some manufacturers are now refusing to submit any equipment for review by any magazine.

In this way everyone suffers.

What is required is some standardisation of listening tests so that there is better correlation between various reports whilst leaving room for individual preferences. We must train our ears and we must beware of feeding them with ambiguous data and expecting them still to give accurate assessments. We should also understand that the ear, like the eye, is fallible and that because someone else claims to hear something: "It Ain't *Necessarily* So." ●

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1. 'Positive Feedback' and correspondence, Hi-Fi News. Nov. '77 to Feb '78 Letters: Wireless World. Jan and Feb. '78
2. 'Facts from Figures' by M.J. Moroney (Pelican). Pages 246 to 270.
3. Letter: Wireless World, J. Moir. Jan '78.
4. 'Audible Amplifier Distortion'. Peter Baxandall. Wireless World. Nov '77.

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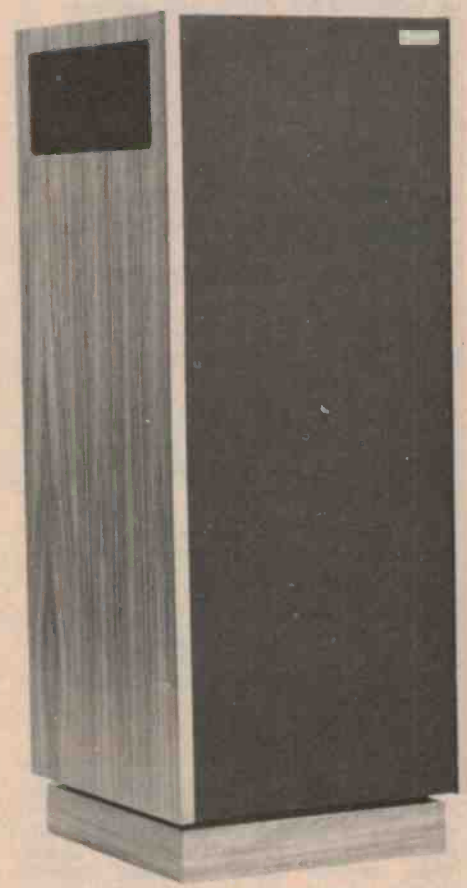

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# KITS for projects

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 only listed the projects published in the last few years, with their dates of publication, so this page can also be used as an index, even though kits are not available for some of them (as far as we know). Any companies who wish to be included in this list should phone Jan Collins on 334282.

### 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 to six months.

Magnifying glasses may be bought at many general hobby shops, Newsagents and some stationary suppliers. Squint a little – it helps !

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### Key to Companies

A Applied Technology Pty Ltd, 1A Paterson Avenue, Waltara, NSW 2077.

B Bill Edge Electronic Agencies, 115 Parramatta Road, Concord (PO Box 1005, Burwood North 2134).

C J. R. Components, PO Box 128, Eastwood, NSW 2122

D Dick Smith Electronics P/L, Cnr Waterloo & Lane Cove Roads, North Ryde, 2113.

E All Electronic Components, 118 Lonsdale Street, Melbourne, Vic 3000.

F Tasman Electronics, 12 Victoria Street, Coburg, Vic 3058

J Jaycar Pty Ltd, PO Box K39, Haymarket, NSW 2000.

K S M Electronics, 10 Stafford Court, Doncaster East, Vic 3109.

L Ellistronics, 289 Latrobe Street, Melbourne, Vic 3000.

M Mode Electronics, PO Box 365, Mascot, NSW 2020.

N Nebula Electronics Pty Ltd, 15 Boundary Street, Rushcutters Bay, NSW 2011

O Orbit Electronics, PO Box 7176, Auckland, New Zealand.

P Pre-Pak Electronics, 718 Parramatta Road, Croydon, NSW 2132.

R Rod Irving, PO Box 135, Northcote, Vic 3070

T Townsville Electronic Centre, 281E Charters Towers Road, Rising Sun Arcade, Townsville, Qld 4812.

V Silicon Valley, 23 Chandos Street, St Leonards, NSW 2065.

W Willis Electronics, 993 Hay Street, Perth WA 6000.

Y Trilogy, 40 Princes Highway, Fairy Meadow, NSW 2519

### Project Electronics

041 Continuity Tester . . . . . T,D,B
042 Soil Moisture Indicator . . . . . T,D,B
043 Heads or Tails Circuit (Oct 76) . . T,D,E,A,B,L
044 Two Tone Door Bell (Oct 76) . . T,D,E,O,A,B,L
045 500 Second Timer . . . . . T,D,O,A,B
047 Morse Practice Set . . . . . T,D,O,A,B
048 Buzz Board . . . . . T,D,A,B
061 Simple Amplifier (Oct 76) . . . . . T,D,O,A,B
062 Simple AM Tuner (Mar 77) . . . . . D,E,B
063 Electronic Bongos . . . . . D,A,B
064 Simple Intercom (Nov 76) . . . . . T,O,A,B
065 Electronic Siren . . . . . D,O,A
066 Temperature Alarm (Dec 76) . . . . T,D,E,A,B
067 Singing Moisture Meter . . . . . D,B
068 LED Dice Circuit (Oct 76) . . . . . T,D,E,A,B
070 Electronic Tie Breaker (Jan 77)
071 Tape Noise Limiter (Jan 78) . . . . . E,L
072 Two-Octave Organ (Jun 78) . . . . . D,B
081 Tachometer (Mar 77) . . . . . T,E,O
082/528 Intruder Alarm . . . . . T,E,A
083 Train Controller
084 Car Alarm . . . . . D,A,B
085 Over-rev Alarm
086 FM Antenna
087 Over-LED
088 Hi-Fi Speaker

### Test Equipment

132 Experimenter's Power Supply (Feb 77) . . . . E
133 Phase Meter (Apr 77) . . . . . E
134 True RMS Voltmeter (Aug 77) . . . . . E
135 Digital Panel Meter (Oct 77) . . . . . E
136 Linear Scale Capacitance Meter (Mar 78) . . . E
137 Audio Oscillator (May 78) . . . . . E
138 Audio Wattmeter (Nov 78)
139 SWR/Power Meter (May 78)
140 1 GHz Frequency Meter-timer (Mar 78) . . . C
141 Logic Trigger (Jan 79)
142 High Current Power Supply (Feb 79) . . . . . E
143 Curve Tracer (Jan 79)
144 Expanded-scale RMS Voltmeter (Jun 79)
148 Logic Test Probe (Jul 79)

### Simple Projects

243 Bip Beacon (Apr 77)
244 Alarm Alarm (Feb 77)
245 White Line Follower (Nov 77)
246 Rain Alarm (Apr 78) . . . . . L
248 Simple 12V to 22V Converter (Jul 78)
249 Combination Lock (Apr 79) . . . . . E
253 'Hot Potato' Game (May 79)
254 Egg Timer (Jun 79)

### Motorists' Projects

316 Transistor Assisted Ignition (May 77) . . D,O,E
317 Rev Monitor Counter (Jul 77) . . . . . E
319 Variwiper MK II (Sep 78) . . . . . E
320 Battery Condition Indicator (Apr 79) . . . D,E

### Audio Projects

448 Disco Mixer(Nov 76
449 Balanced Microphone Amp (Nov 76) . . . J,E,L
450 Bucker Brigade Audio Delay Line (Dec 77)
451 Hum Filter (July 79) . . . . . D
470 60 W Amp Module (May 79) . . . A,B,E,P,R,S
471 Stereo Preamp (June 79) . . . . . A,B,E,P,R,S
473 Series 4000 Moving-coil Cartridge Preamplifier . . . . . J
480 50-100 Watt Amp Modules (Dec 76) . . . . . J,E,D,O,R,A,,B,L
481 12 V 100 Watt Audio Amp (May 77) . . . . . E
481 High Power PA/ Guitar Amp (Jun 77) . . . . O
482 Stereo Amp (Jan 77) . . . . . O,E
482 Stereo Amp Part 2 (Feb 77) . . . . . O,E
483 Sound Level Meter (Feb 78) . . . . . F
484 Simple Compressor Expander (Jul 77) . . . . E
485 Graphic Equalizer (Jun 77) . . . . . J,E
486 Gowl-round Stabilizer (Nov 77) . . . . . J
487 Audio Spectrum Analyser (Feb 78) . . . . . E
489 Audio Spectrum Analyser 2 (Apr 78) . . . . J,E
490 Audio Compressor (Dec 79)
491 Graphic Equaliser (Mar 79)
495 Transmission Line Speakers (Aug 77)

### Miscellaneous

546 GSR Monitor (Mar 77) . . . . . E
547 Telephone Bell Extender (Jun 77) . . . . . E
548 Photographic Strobe (May 77) . . . . . E
549 Induction Balance Metal Detector (May 77) . . E
550 Digital Dial (Aug 78 . . . . . E
551 Light Chaser (Sep 78) . . . . . E
552 LED Pendant (Sep 78)
553 Tape/Slide Synchroniser (Oct 78 . . . . . E
556 Wind Speed/Direction Indicator (Dec 79)
557 Reaction Tester (Feb 79) . . . . . E
558 Mast-head Strobe (Feb 79)
559 Cable Tester (Mar 79)
577 General Purpose Power Supply . . . . . J
581 Dual Power Supply (Jan 77) . . . . . E
582 House Alarm (Jul 77) . . . . . T,O,E,A
House Alarm – Installation Instructions (Aug 77)
583 Marine Gas Alarm (Aug 77) . . . . . E,E
585 Ultrasonic Switch (Sep 77) . . . . . R,O,E,T,L
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) . . . . . N
591 Up/Down Presettable Counter (Jul 78) . . . . E
592 Light Show Controller (Aug 78) . . . . . E
593 Colour Sequencer (Dec 79)
594 Development Timer (Apr 79)
595 Aquarium Light Controller (May 79)

### Electronic Music

602 Mini Organ (Aug 76) . . . . . O,E,D,B
603 Sequencer (Aug 77)
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 78) . . . . . O,E,A
631 Keyboard Encodér (Apr 77) . . . . . O,E,A
632 Video Display Unit (Jan-Mar 77) . . . . . O,A
633 TV Sync Generator (Jan 77) . . . . . E,A
634 8080 Educational/ Prototyping Interface (Jul, Aug 78)
635 Microcomputer Power Supply (Sep 77)
637 Cuts Cassette Interface (Jan 78) . . . . V,O,E,A
638 Eprom Programmer (Jul 78) . . . . . E,A
639 Computerised Musical Doorbell (Mar 78) . . .A
640 S100 VDU (Apr, Jun 78) . . . . . V,O,A
641 S100 Printer (Sep 78)
642 16k S100 RAM Card (Feb 79) . . . . . K
650 STAC Timer (Nov 78)
651 Binary/hex Trainer (Jun 79)

### Radio Projects

712 CB Power Supply (Jun 77) . . . . . O,E
713 Add-on FM Tuner (Sep 77)
714 VHR-Log-Perlodic Antenna (Feb, Mar 78)
715 VHF Power Amplifiers (Nov 77)
716 VHF Power Amplifiers (Jan, Feb 78)
717 Crosshatch Generator (May 78 . . . . . E
718 SW Radio (Oct 78) . . . . . E
719 RF Field Strength Indicator (Nov 78)
720 2 m VMOS Power Amp (Jan 79)
721 Aircraft Band Converter (Mar 79) . . . . . D,E
722 Antenna for ETI-721 (May 79
724 Microwave Oven Leak Detector (Jul 79) . . . D

### 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)
810 Stunt Cycle TV Game (Jun 78) . . . . . O,D,B
811 TV Tank Game (Oct 78) . . . . . O,E,D,B
812 Wheel of Fortune (Dec 79)
813 Race Track Game (Jan 79)

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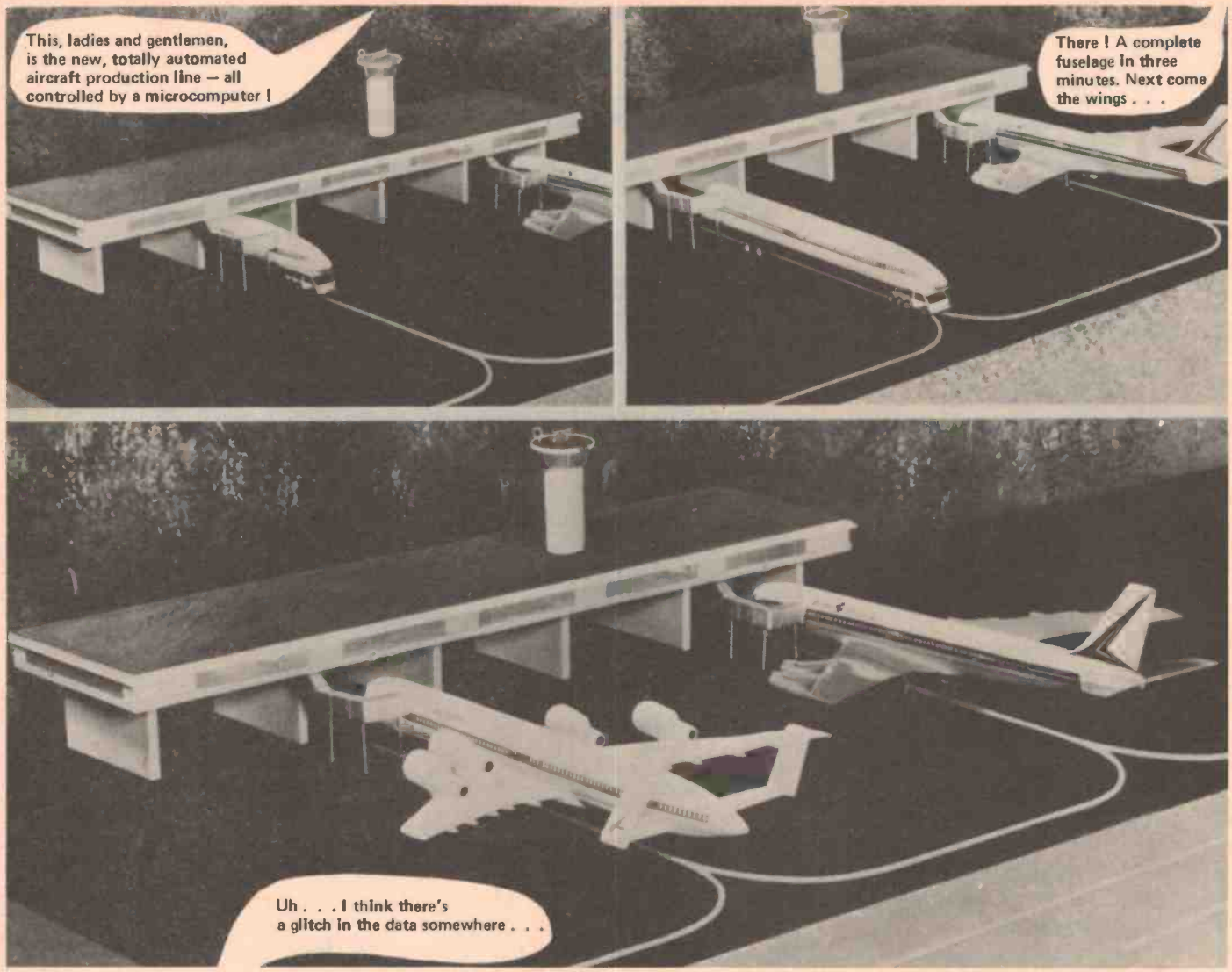


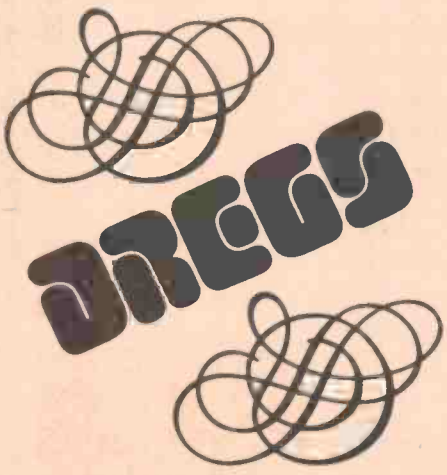


IT SOUNDS LIKE the daydream doodlings of a demented project designer, but an electromagnetic propulsion system capable of accelerating projectiles by as much as 500 or 1000 times that of gravity (9.8 m/sec/sec) is under construction in the US.

It works like this: A re-usable 'bucket' is suspended by on-board magnets in a U-shaped guideway. The payload sits inside the bucket. Coils built into the guideway can be pulsed to repel the bucket; if the pulses are properly synchronised, the bucket can be accelerated down the guideway to very high speeds.

We are told that, given an efficient guideway and the right pulse-generating equipment, a bucket could be launched from such a mass driver . . . once every second! Theoretically (and where have we heard that before . . . Ed.), there are no limits to the length of the guideway or the momentum of projectiles launched from it.

From a report issued by the Massachussets Institute of Technology, we read that "Mass Driver Two" is now under construction at Princeton and MIT using off-the-shelf components.

They don't say what happened to Mass Driver One . . . perhaps it was hurriedly dismantled following a rash of UFO reports in the wake of some over-exuberant student experiments?

## Synergistic sinecure

Dick Smith's Christmas television advertising campaign last year made much of the beer-powered radio featured in his "Fun Way Into Electronics" book. The beer-powered radio idea is not new however, having been submerged for around 10 years.

We were surprised to learn that they were exported from New Zealand to Australia back in 1969!

The enterprising 'inventor' was Kiwi Jim Coyle of Kitparts Pty Ltd, who then had an electronics company in Wanganui on the west coast of New Zealand's North Island. Plunging some meter probes in his after-work beer one evening showed plenty of volts so he spent the next week developing a suitable broadcast receiver that would run off a glass of beer. He marketed the receivers, as Christmas presents, on both sides of the Tasman.

Now that's Synergistic Beer Drinking at its finest!

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# Waveform Fidelity: The big difference is how little difference there is.

The ultimate function of a tuner is to provide an audio signal to an amplifier – ideally one that will be an exact duplicate of the original broadcast.

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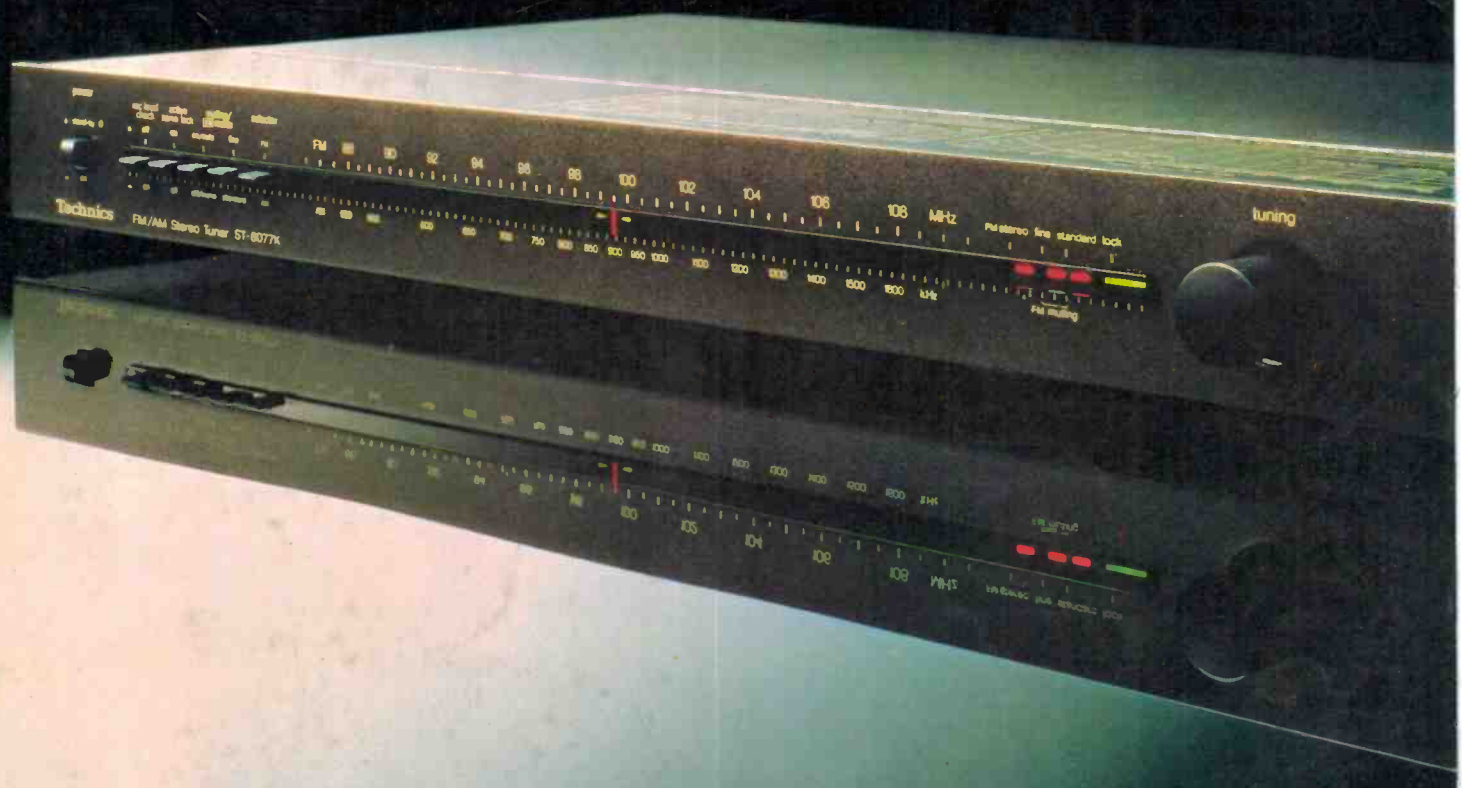
Technics ST-8077K AM/FM stereo tuner incorporates a number of innovations to meet these two key criteria.

To achieve waveform fidelity under a variety of conditions – the real test of a tuner – Technics have pursued waveform fidelity in part by paying special attention to the handling of the 19 kHz pilot signal. Likewise, in the IF stage a surface acoustic wave filter works with ceramic filters to maintain very low distortion and stable stereo separation.

At the same time operational ease and elegance haven't been neglected. The ST-8077K features muting controls, LED tuning and a slim attractive design.

The ST-8077K AM/FM stereo tuner has been designed and built to performance standards that will be fully realised with the matching SU-8077K integrated DC amplifier.

See and hear for yourself at your Technics dealer.

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