Nov. 1980
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eti

ELECTRONICS TODAY INTERNATIONAL

PRIZES, PRIZES, PRIZES in great Maruni contest

COMPACT STEREO

Easy to build, low cost amp delivers 20 W/ch

Electronic thermometer

Soil moisture indicator

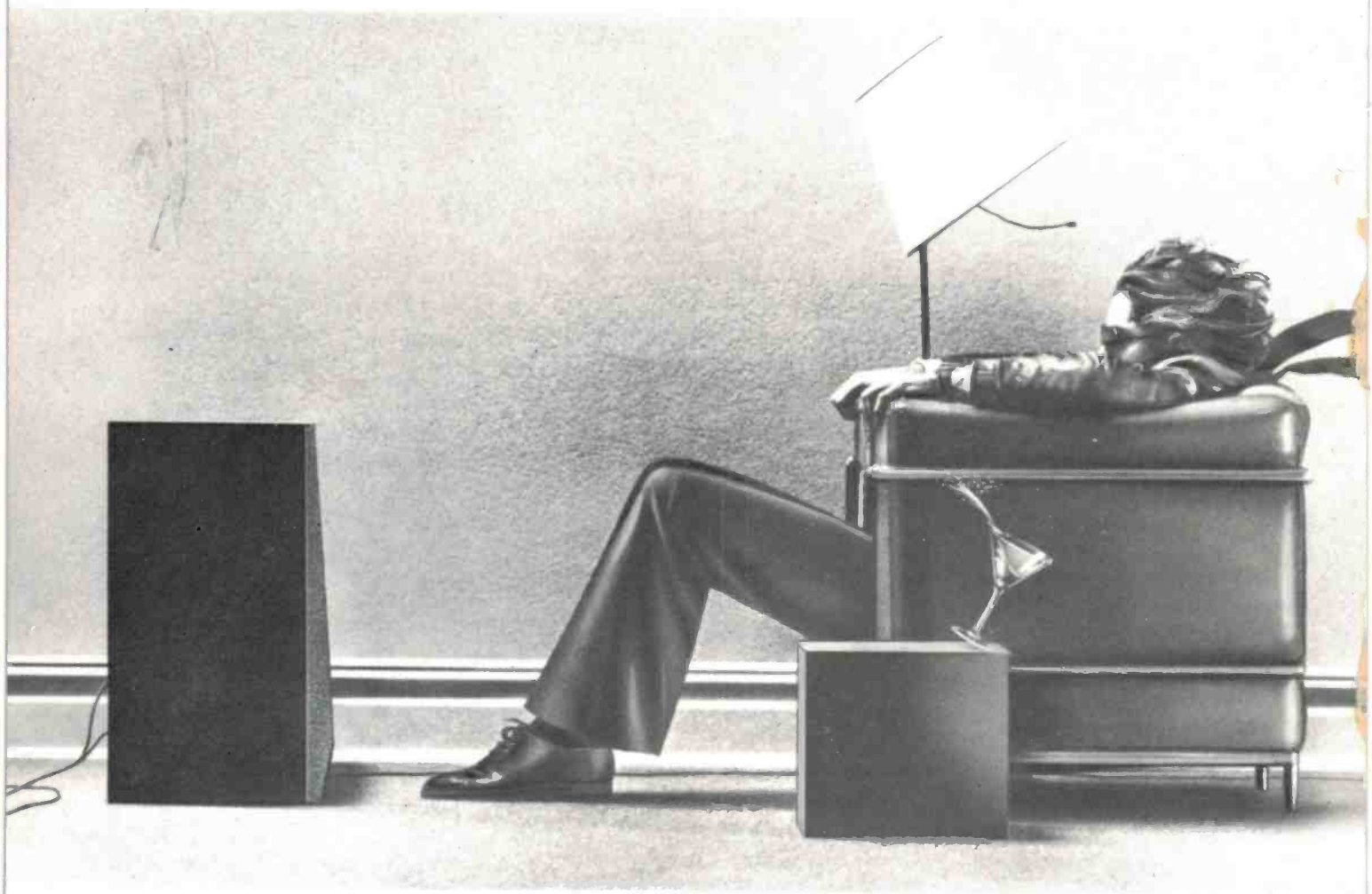
Pinball electronics

POWER MOSFETS – technology & techniques

Soundout 200 W stereo amp reviewed

Audiosound AM101 tuner

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



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

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

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

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

So even after a Maxell recording is 500 plays old, you'll swear it's not a play over five.

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write to Maxell Advisory Service,
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WT191/80

ELECTRONICS TODAY INTERNATIONAL

Registered for posting as a publication – Category B

QUICK INDEX

FEATURES:

SOUND SECTION:

PROJECTS & TECHNICAL

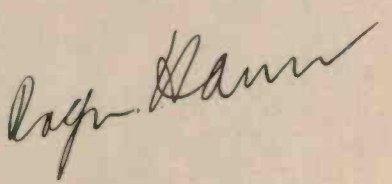
NO DOUBT many of you have seen the recent 'advertising' campaign on television and in the general press — "have a go, Australia" — aimed at stirring up a bit of national entrepreneurial drive. Whether the campaign will have the desired effect or not would be hard to measure, but we wholeheartedly endorse the general sentiments. We're an Australian-owned, edited, printed and published magazine, and proud of it. One of our many roles is to bring the activities of electronics manufacturers, distributors, importers and retailers to your attention. We'd like to add to that — 'Australian electronics manufacturers in particular'. Every week — no, every day! — we're deluged with press releases from a diverse range of electronics companies (and the word 'electronics' there is used in its loosest sense). Unfortunately, too few of these press releases are from Australian companies involved in electronics manufacturing.

We've been taken to task recently by a number of readers who have written saying that we give little publicity to Australian firms. One letter, prompted by our September editorial, from a local manufacturer of sound equipment is published on page 87 of this issue. It echoes the sentiments of many letters we have received on the subject.

There are several facets to the question, however. Firstly, we are unable to seek out items or stories on companies too often — there is just not enough time or manpower to do it. But we do make the effort and for us, it is well rewarded, judging from reader reaction.

Secondly, so many local electronics companies don't promote themselves. It doesn't necessarily require hiring a PR firm or consultant — a first class idea if you are big enough to afford it — but a little effort can go a long way. There are a number of small technical writing agencies around who can assit. It's no use sitting back complaining that the media won't give you a go — it's up to you to " . . . have a go".

The ball's in your court.



Roger Harrison
Editor

advertisers

eti ELECTRONICS TODAY INTERNATIONAL

COVER

This month's cover features our star project — the Series 3000 compact stereo hi-fi amplifier, and the LED soil moisture indicator. Composition and photo by Ivy Hansen.

features

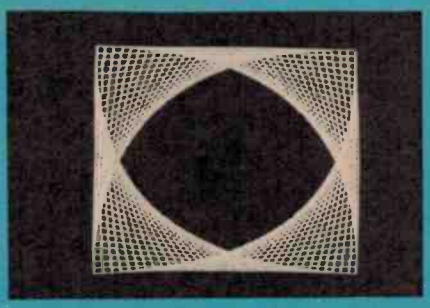
news

projects

sound

general

next month



MATROX VIDEO BOARDS REVIEWED
Craig Barratt looks at two stackable S-100 video graphics boards, the ALT 256 and ALT 512, from Matrox — see what smart things you can do with them.

HAVE YOU ALWAYS WANTED A REALLY GOOD HI-FI AMP ?
Well this one should fill the bill. Forget about SID, TIM, THD and noise, David Tilbrook has designed a superb integrated amplifier featuring MOSFET power output devices and specs unrivalled in any similar amplifier, be it kit or commercially made.

BUILD A pH METER
This project is straightforward and inexpensive. Using a locally made pH probe and featuring a 3½ digit LCD readout, it should have wide application. Keep your fish tank or swimming pool clean — balance the water's pH — use it in the school lab, etc, etc.

COMING SOON !

DISCRIMINATING METAL DETECTOR
Gold fever returned to Australia when the 27kg Hand of Falth nugget was found by a couple using a metal detector back in October. Get amongst it with our 'quad mode' detector. This design features three T/R modes of operation plus VLF, variable ground balance control, variable discriminate control, pre-wound search head plus incredible penetration and sensitivity.

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.

the most compelling story in Australia's aviation history

DICK SMITH'S SEARCH FOR THE KOOKABURRA

Research by Dick Smith Story by Pedr Davis

EDUCATE YOUR FAMILY AND FRIENDS WITH THIS INCREDIBLE BOOK!

This book presents the first account of the 'Kookaburra' and the men who flew the plane. It describes the harsh conditions endured by the first aviators in their daring quests to break records over long distances, or to carry passengers and mail across the continent.

This compelling account of great courage, daring and determination, gives a fascinating glimpse at the spirit of excitement which was evident in those pioneering days of Australia's aviation history.

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DSE825

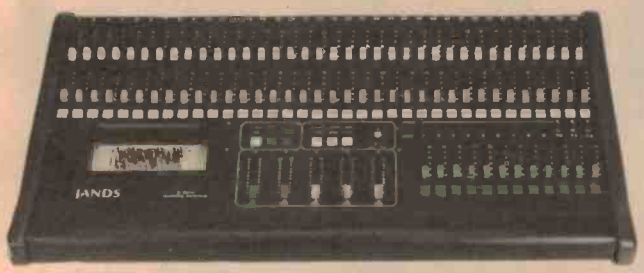
STAGE & EFFECTS LIGHTING

ALL YOUR REQUIREMENTS AUSTRALIA WIDE

DIMMERS

BARRATT LIGHTING IS PROUD TO ANNOUNCE ITS NEW RANGE OF DIMMER SYSTEMS — DESIGNED AND MANUFACTURED HERE IN AUSTRALIA.

JANDS JL24/8 AND JL36/12



These new generation lighting control desks have been designed by Jands as cost-efficient, state of the art units — with features not previously available in standard dimmer desks.

FEATURES (24 and 36 Channel Desks)

- 2 presets and masters.
- Scenemasters with pin-matrix.
- Variable rate chaser over 3 scenemasters.
- Flash-to-full buttons on each channel and on each master.
- Ad-kill function allows instant kill when any one flash button is pressed.
- Masters on chaser, scenemasters and overall.
- Optional desk lamps.
- Talk back link.
- Parts bin and padded armrest.

The Jands JL24/8 and JL36/12 offers a perfect package for most applications — BANDS, CABARET, THEATRE, SCHOOLS — anywhere accurate, fast and simple lighting control is needed.

CEITEX DIMMER RACK

After 4 years of research and development, Ceitex have released a 12 channel dimmer rack, compatible with Jands and Strand dimmer desks.
The Ceitex dimmer rack is a 12 x 2000 watt system, designed to run directly into 3 phase power at 30 amps per phase.
Standard size allows rack mounting with the system quite happy to tour — being of very robust construction.

FEATURES

- 12 x 2000 watt channels.
- Front trimming access to set top level.
- Drives inductive loads (Hotspots, Rainlights etc).
- Advanced RF filtering — less buzz, pop and plop than any comparable system.
- Modular construction — 3 x 4 way modules with easily removable triacs.
- Dimmer rack will interface with almost any desk currently available — self sensing interface.

JANDS DESKS AND CEITEX RACKS — THE PERFECT COMBINATION.

1981 STAGE LIGHTING COURSE

Barratt Lighting is promoting an intensive stage lighting course, to be held on Saturday 17th and Sunday 18th January, 1981. The course will cover a broad spectrum of the Stage and Effects Lighting Industry. The cost is $25.00, including refreshments, notes, and a night out on the Saturday night.
To enrol, or for further information, contact Barratt Lighting Pty. Ltd.

Call your nearest Barratt Lighting agent for hire or sale of Australia's best range of stage lighting equipment.

Not all agents carry complete stocks at any one time — phone ahead first. In any case, our ex-Sydney despatch to our agents is super-fast.

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WOLLONGONG: Trilogy Electronics 40 Princes Hwy, Fairy Meadow (042) 83-1219
NEWCASTLE: Your Move Lighting 37a Beaumont St, Hamilton (049) 69-3560
BRISBANE: Harvey Theatrical Lighting 21 Crosby Rd, Albion (07) 262-4622
BRISBANE: Rave Light & Sound 95 Bridge Rd, Fortitude Valley (07) 52-3310
GOLD COAST: Rave Audio Visual 2388 Gold Coast Hwy, Mermaid Beach (075) 38-3331
MELBOURNE: Clearlight Shows 17 Alex Ave, Moorabbin (03) 553-1446
MELBOURNE: Lighting Corporation 131 Brighton St, Richmond (03) 429-5122
ADELAIDE: Hiwatt Lighting 37 Angus St, Nth Adelaide 5006 (08) 212-2033
ADELAIDE: Optical Acoustics 22 Finnis St, Nth Adelaide 5006 (08) 267-2049
ACT: Topstage Productions 8/14 Kembla St, Fyshwick ACT 2609 (062) 80-4694
PERTH: Stagecraft 1142 Hay St, West Perth 6005 (09) 321-9363.
PERTH: Kosmic Sound 1074 Albany Hwy, Bentley (09) 361-8981
HOBART: Good Oil Sound 310 Liverpool St, Hobart (002) 23-5151
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NEWS digest

'Our' satellite gets go ahead

Australia is to have her own communications satellite, which will also be able to broadcast TV and radio programmes direct to homesteads in isolated areas.

The satellite, which will be launched towards the end of 1984, is currently expected to cost around $250 million.

Although it is well known that cost estimates for such large scale projects tend to increase exponentially with time, we understand the Government has no plans at present to organise a public lottery to raise the money!

Because of the setbacks encountered by both NASA's Space Shuttle and the European Space Agency's Ariane rocket, it has not yet been possible to decide where and by whom the satellite will be launched.

The satellite and its associated earth stations, for which tenders will be invited at the end of October, will be owned and managed by the Overseas Telecommunications Commission (Australia). OTC are always keen to remind us that they are an entirely separate statutory body and are quite independent of Telecom.

Automatic distortion analyser

Level setting, tuning and nulling are performed automatically by the latest THD analyser from Tektronix.

The AA501 analyser, with its companion SG505 oscillator, is designed to cut measurement costs by reducing the amount of time spent by skilled operators in setting up equipment. An option allows measurement of intermodulation distortion as well, on signals conforming to SMPTE, DIN or CGIF standards. For easy readout there's a 3½ digit LED display that indicates distortion in dB or percentage terms. Signal input to the AA501 is displayed in dB, dBm or volts and detector response is selectable for true rms or average.

A special feature of the analyser section is a 'reference memory' circuit to simplify measurements of gain/loss, frequency response and signal to noise ratios.

The oscillator is said to be accurate to within 0.0003% over the whole audio range and to have a frequency response that varies no more than 0.1 dB from 10 Hz to 20 kHz. A step attenuator gives calibrated outputs from +10 dBm to −60 dBm in 10 dB steps with variable attenuation in between.

More information is available from Tektronix Australia Pty. Ltd., 80 Waterloo Road, North Ryde, NSW 2113. Phone (02)888-7066.

Versatile digital panel meter

The Amalgamated Instrument Co. recently released a versatile LCD digital panel meter that can be supplied to suit a variety of measurements — from dc voltage to temperature, pressure etc.

The panel meter is locally designed and manufactured and can be obtained with a 12.5 mm or 19 mm high liquid crystal display.

The meters shown in the photograph here are configured to read temperature.

As optional extras the instrument can have recorder output, alarm relay contact closure or proportional control output. The meter can be powered from either 12 Vdc or 240 Vac. Price for the basic unit (12 Vdc supply) is $160.50, the 240 Vac model costs an extra $20.

Size is 96 mm wide by 48 mm high by 126 mm deep.

Details from AIC at P.O. Box 305, Narrabeen NSW 2101. (02)452-2648.

All solid battery

Storage batteries with a capacity seven times that of lead/acid types are being developed at The University of New South Wales.

Dr Les Harris of the Department of Physics is working to perfect an all solid cell with a lithium alloy anode and a cathode made of titanium disulphide. The latter is known as an intercalation compound because it has microscopic pores in which ions can be trapped.

The electrolyte will be lithium iodide in powder form. Complex physical and chemical interactions that take place when the compound is mixed with other electrolytic powders have enable Dr Harris to increase its basic conductivity by five hundred times.

Despite a predicted storage capacity of 200 watthours per kilogram, this kind of battery could never be used to power an electric vehicle because it would not be capable of the high discharge rates needed to accelerate from a standing start. Its most likely application is as a storage battery for solar generated electrical energy.

ERRATA

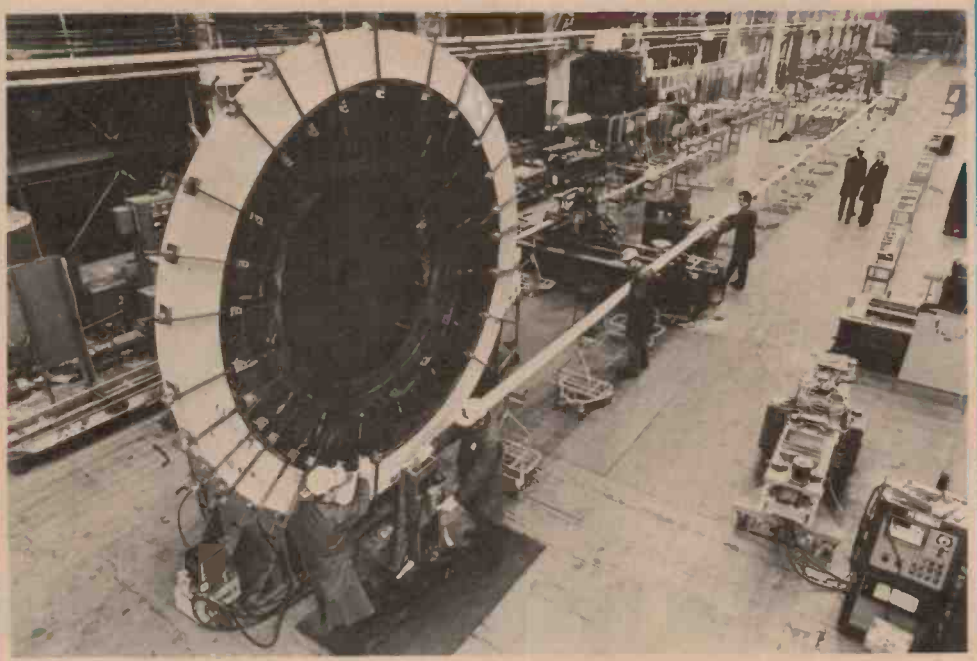
In the **ETI-475 AM Tuner**, details of RFC1 were left off the parts list. This is a Philips type VK200 and consists of a six-hole ferrite bead with 22 swg tinned copper wire passed through it five times. The bead is a type 4312-020-31550 and is commonly available. Also, in the antenna details the copy beneath the antenna matching coil should read: "For use with small loops 6-8 turns" and "For use with large loops 2 turns".

Did you miss it?

In last month's issue there was a loose insert which gave details of a new publication called the "Australian Microcomputer Handbook".

Produced by Computer Reference Guide, the book contains detailed summaries of the extensive range of microcomputers which are currently being sold in Australia. There are also eleven chapters on microcomputers and microcomputer systems, which cover everything from the Architecture of the CPU to Word Processing, from Basic Programming to User Markets. The book sells for $22 including post and handling.

If you missed the insert in your issue, you can obtain more details and an order form from Computer Reference Guide, Suite 204, 284 Victoria Avenue, Chatswood, NSW 2067. (02) 411-2567. Mention ETI.



SOME COIL !

Technicians at the US Westinghouse Electric Corporation wind another layer of copper onto a large magnetic field coil for use in the Tokamak Fusion Test Reactor (TFTR) at Princeton University. Westinghouse is making 22 coils for the fusion device. Each is wound with over 450 m of copper conductor weighing 11 200 kg, to a 3 m inside diameter and 4¼ m outside diameter.

Princeton University's Plasma Physics Laboratory will use the coils as part of a scientific proof-of-principle experiment on the use of Tokamak devices for fusion power under the US Department of Energy's fusion energy programme.

The water-cooled coils provide the magnetic field which serves as the primary containment for the plasma, which will reach temperatures near that of the sun — 100 million °C. The first coil will be shipped during 1980.

Another new face at ETI

Pictured here is William Fisher, our new sub-editor. Actually he's been working for us since the end of May, but was too shy to have his photograph taken before.

William, who came to Australia in November of last year, was born in the UK. In 1966 he was admitted to the London School of Economics to study philosophy but after a year there he decided that science was much more attractive and moved to the University of Nottingham. He graduated in 1971 with an honours degree in Physics and went to work as electron microscopy technician at the London School of Hygiene and Tropical Medicine.

Two years later he said goodbye to the world of leprosy and amoebic dysentry and became a technical writer for the Foxboro instrumentation company writing instruction manuals for industrial process control systems. In 1975 he began working for UK publishers Marshall Cavendish and stayed on their staff for two years, after which he became a freelance editor and scientific writer.

The Earth's magnetic field will flip

Recent satellite data suggests that the Earth's magnetic field will "flip over" soon (geologically speaking) — perhaps 1200 years hence.

Paleomagnetic evidence shows that the Earth's magnetic field flips over, the north and south magnetic poles exchanging position, at intervals ranging from 50 000 to one million years.

It seems from geophysical studies of the remanent magnetism in crustal rocks that the last reversal was about 700 000 years ago.

The coming flipover (or magnetic flip-flop) is suggested from data gathered by Magsat, a small satellite that burned up in the atmosphere back in June. Analysis of the satellite's data has confirmed previous observations that the strength of the Earth's magnetic field is slowly declining. According to Magsat, it's on the wane at about 1% per decade.

If it continues to decline at the same rate (a big if) the field should reverse about 1200 years from now. However, geophysicists say that other factors could precipitate an earlier or later change.

How a decline and reversal of our magnetic field would affect us is an open question. Certainly, it would influence the ionosphere and magnetosphere greatly but what effects it would have on climate etc are open to speculation.

Some theorists have linked previous field reversals to mass extinctions of fauna (dinosaurs etc), but there is little hard evidence.

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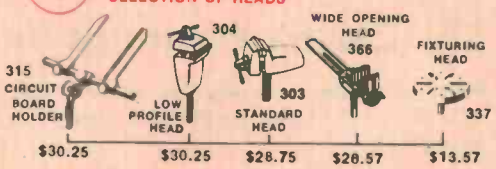
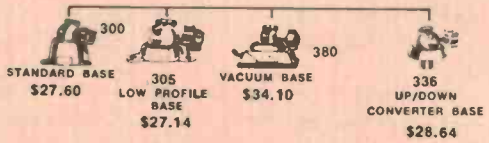
SCOPE PANAVISE SELF SELECTION CHART :

STEP 1 SELECTION OF HEADS



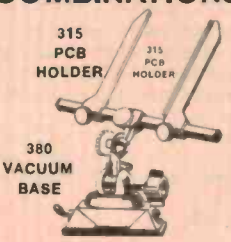
STEP 2 SELECTION OF BASES

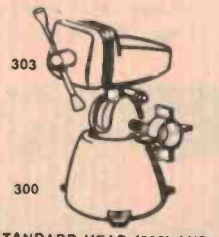


STEP 3 SELECTION OF BASE MOUNTS

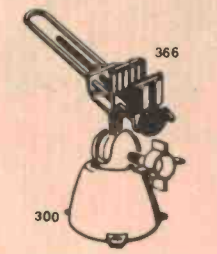
ALL ITEMS POST FREE

POPULAR COMBINATIONS





STANDARD HEAD (303) AND STANDARD BASE (300)



WIDE OPENING HEAD (366) AND STANDARD BASE

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- EASY FOCUS SYSTEM

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FOR ALL YOUR ELECTRONIC COMPONENTS

Dual polarisation for new earth station

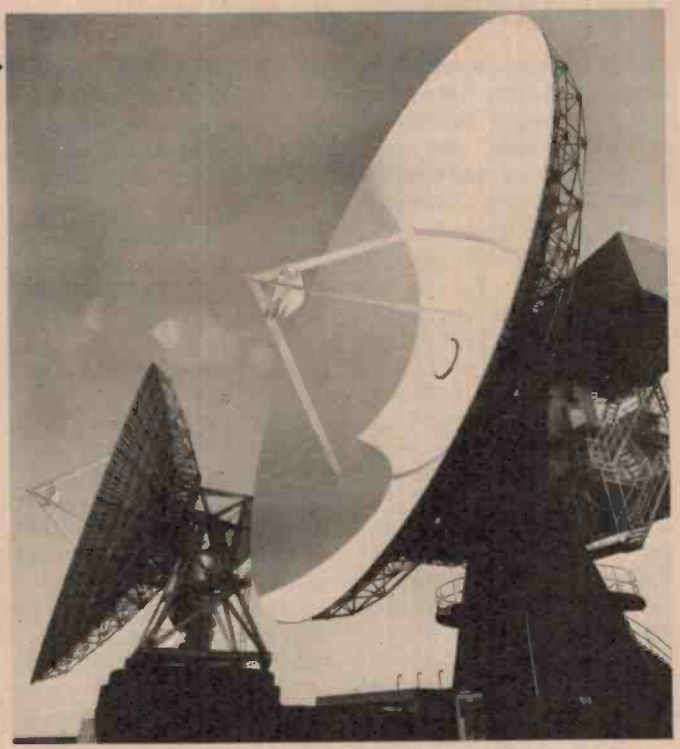
The second satellite earth station at Ceduna in South Australia will be able to handle twice as much information as its sister station.

This is because it is designed to interact with the next generation of Intelsat communications satellites, which will be able to transmit and receive two different signals simultaneously on the same frequency channel. This will be made possible by giving one signal a left-handed and the other signal a right-handed polarisation.

Another innovation is the use of non-refrigerated low-noise amplification of received signals. Instead of maintaining the whole amplifier in a cryogenic environment, thermal noise is reduced by cooling only the components of the front end by means of the Peltier effect. This is a thermoelectric phenomenon whereby a current flowing through the junction of two dissimilar metals will lower the junction's temperature. The cooling effect is only effective over a small volume but with miniaturised components this is not a problem.

Unlike the original earth station at Ceduna (which will stay fully operational), the new station does not have the electronics mounted directly behind the dish.

Instead, a beam waveguide fitted with some highly polished steel mirrors is used to convey signals between the equipment room and the antenna.



Fifty-six channel voice logger

Stancil-Hoffman's latest voice logging recorder can record up to 56 voice channels for more than 24 hours on a single reel of tape.

The CRM 5600 uses a tape 1100 metres long and 2.54 cm wide, running at the very low speed of 0.4 cm per second (one quarter the speed of an audio cassette deck). Bandwidth is 300 Hz to 3 kHz, which is adequate for recording speech intelligibly.

Voice logging recorders are used to give accurate documentation of vocal communications in such areas as air traffic control and military operations, where they may be essential for resolving disputes or tracing the cause of accidents.

The tape of the CRM 5600 may be run continuously or allowed to stop when all channels are silent, turning on again immediately and automatically as soon as any channel is opened again. One of the fifty-six tracks may be used to record a digital time signal so that an automatic search mode can search the whole day's tape in three minutes to locate a particular time.

More information from the distributors, Rank Electronics Pty. Ltd., P.O. Box 632, Chatswood, NSW 2067. Phone (02)406-5666.

OTC will track for ESA

The OTC's earth station complex at Carnarvon in West Australia will be used to track the European Space Agency's launch of two satellites next year.

The meteorological satellite Meteosat 2 and the Indian communications satellite Apple will be launched into geostationary orbits next February, using the Ariane rocket. The project is still on schedule, despite the spectacular failure of the last Ariane launch on May 23 this year when thermal instability in the combustion chambers caused the rocket to explode and destroy its payload.

By itself, Ariane does not have enough power to take satellites into geostationary orbits, so small 'apogee boost motors' are used to lift the payloads from elliptical transfer orbits. ESA is experiencing some technical problems in getting these motors ready in time for the launch and may have to swallow its pride and buy American equivalents instead.

Except for the launch station itself at Kourou in French Guyana, the Carnarvon earth station will be the only one in the world to provide tracking and monitoring facilities for both the satellites involved in the February launch. OTC are now contracted to monitor the European Space Agency's launches for the next five years.

Twelve into one does go !

Special combiners designed for the Australian Air Force enable common antenna working of twelve transmitters or receivers.

Each channel is continuously tunable over the range of 225 to 400 MH and the standard equipment allows frequency separations as little as 1%. With the use of an additional filter for each channel, this separation can be reduced to as little as 0.5%.

Power rating is 250 watts average per channel and each module can be removed for maintenance without disabling the others.

Technical writing service

David Glover, previously Marketing Services Manager for the Dick Smith Group, has established Glover & Associates: Technical Design Group — providing a complete design, writing and art service aimed specifically at manufacturers and importers of electronic products and their advertising agencies.

"Our service takes over where an advertising agency leaves off" says Glover. "We've got the right balance of technical knowledge and creative skill to make sure that brochures and point-of-sale material are both effective in communicating technical information and are visually arresting and easily absorbed."

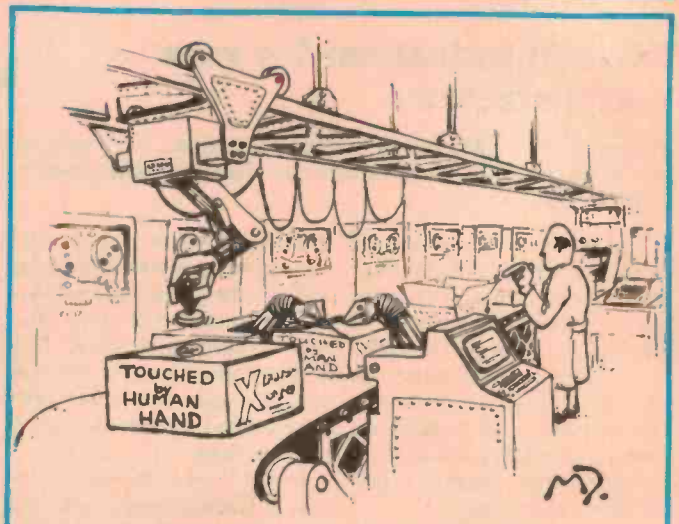
"Too often otherwise good ads and brochures are spoilt by copy that's obviously been written by someone with no technical knowledge and is either hard to understand or simply misleading."

With the increasingly wide range of technical products on the market it's become crucial for a product to be presented so that buyers can quickly understand and assess the product. Good promotional material is often enough to give one product an edge over its competition.

Another of the Group's specialities is instruction manuals.

"A good instruction or assembly manual can save a company a fortune in service calls and helps ensure repeat custom."

For more information on the services of the Group, contact David Glover on (02) 449-7454 or write to 17 Alma Street, Pymble 2073. (This is an unedited press release — Ed.).



Is this digital processing in automation ? . . . Ed.

Locally made instrument wins big contract

A quarter million dollar contract to supply Telecom Australia with direct reading cable fault locators has been won by Melbourne-based manufacturer Aegis Pty. Ltd.

The contract covers the supply of the CZ.8000 Direct Reading Cable Fault Locating instrument which is designed to locate shorts, crosses, earth faults etc in telephone cables.

It can indicate faults at distances up to 40 km with an accuracy of 0.5%, according to Aegis.

Distance to the fault is indicated directly in metres on a digital display.Compensation is provided in the instrument to account for variations in wire gauge and cable temperature. Reading accuracy is unaffected by fault resistances up to 1M5, say Aegis.

Aegis won the contract against strong competition, including Hewlett Packard and 3M. Aegis has been manufacturing cable locating and fault finding equipment for over ten years and currently has three instruments under contract to Telecom.

Electronic lightbulb to save power ?

The General Electric Company of the U.S.A. has developed an electronic light bulb which the company says will generate as much light as a normal 150 W conventional bulb, but consumes only one-third of the power.

Known as the Halarc bulb, the new lightbulb employs a radio frequency generator to ionise the gas within the bulb, generating an electric arc which provides the light.

As the RF starting circuit can give rise to interference the American FCC must give their approval to the bulb before General Electric can embark on a 10 000-unit test marketing of the Halarc bulb.

Otherwise, the FCC regulations would have required every bulb to be tested by the consumer or by General Electric once every three years to ensure it was not creating RF interference and this was felt to be impractical.

Brian Dance

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Pinball wizardry

Ever wondered how a pinball machine works? This article takes you for a guided tour of these complex machines.

Neil Dunn

Until quite recently, that seductive demon the pinball machine rattled and clattered its way through a five year life span totally unaided by modern electronic technology. Many of these vintage models are still in service today. With their innards exposed they resemble an old fashioned telephone exchange — there are banks of relays, solenoid operated rotary switches and motor driven counters. All of this electro-mechanical gadgetry is usually powered by a single 28 V source.

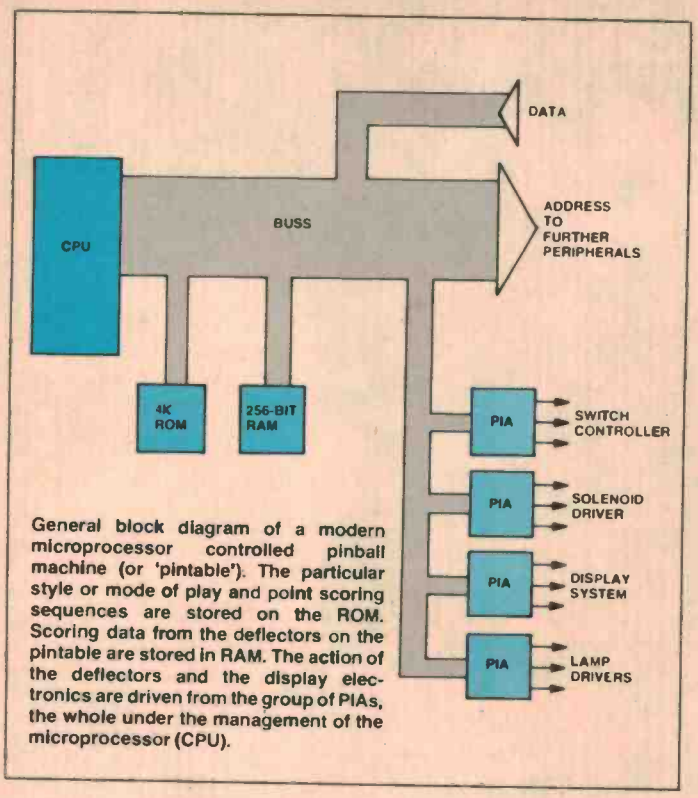
Alternating current is used for the solenoid array, which gives the high current relay contacts at least some chance of survival.

General illumination for the scenery and back glass is provided by 6.3 V 'dial lamps'. Bayonet cap mounted types are used for greater reliability. With anything up to 30 of these lamps used for general illumination and a similar number switched intermittently by relays, currents can easily reach 18 amps. It doesn't require much imagination to visualise the effect of a short on the tightly packed wiring loom if the lighting circuit is unprotected!

Playing the game

A brief review of the game will be helpful at this point. The player starts by projecting a 24 mm steel ball to the top of a sloping playfield area. The fun really begins as the ball commences its short but eventful journey to the dreaded outhole at the bottom of the playfield.

During its travel the ball will come into contact with various strategically placed obstacles. These fall into two ▶



General block diagram of a modern microprocessor controlled pinball machine (or 'pintable'). The particular style or mode of play and point scoring sequences are stored on the ROM. Scoring data from the deflectors on the pintable are stored in RAM. The action of the deflectors and the display electronics are driven from the group of PIAs, the whole under the management of the microprocessor (CPU).

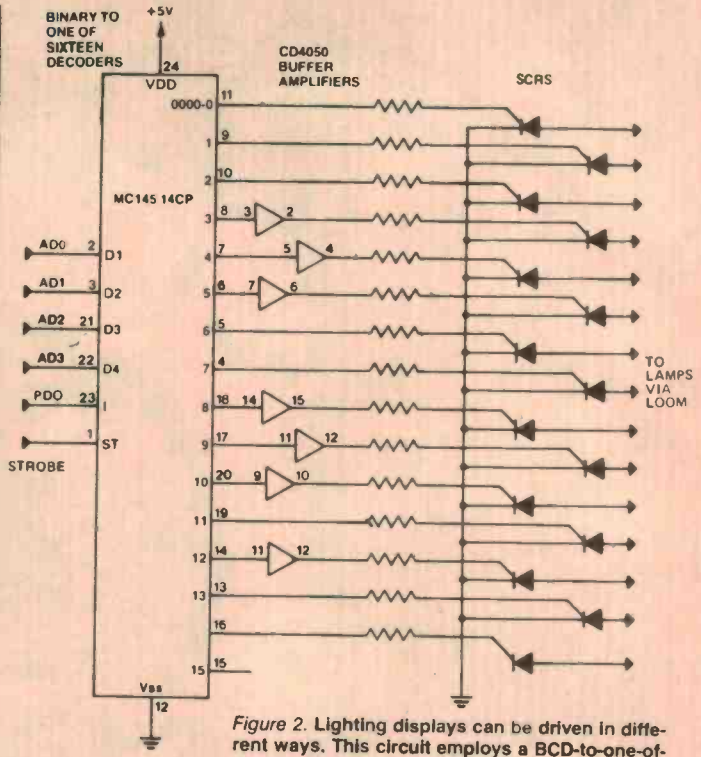


Figure 2. Lighting displays can be driven in different ways. This circuit employs a BCD-to-one-of-sixteen decoder driving an array of SCRs which control the lamps.

categories: passive deflectors, which are simply high quality rubber O-rings stretched around posts, and active deflectors which, generally speaking, sense the presence of the ball by means of leaf switches and use solenoid power to increase its speed on some new, and usually quite random, trajectory.

Every time the ball hits a deflector the player scores points — perhaps ten, perhaps ten thousand — which are accumulated in a mechanical counter. Simple logic circuits are usually incorporated so that particular sequences of deflector impacts accumulate bonus points. If the score reaches a predetermined total, the player wins a free game.

The player can try to hold the ball in play, and thereby gain points towards that elusive free game score, by controlling two or more 'flipper' arms which are capable of diverting the ball from its downward path.

To prevent anyone tilting the whole table to keep the ball in play, most pinball machines include one or more mercury or pendulum switches which make contact when the table is tilted more than a few degrees, actuating a relay which stops the game.

Flippers

These electro-mechanical devices have not been changed or adapted to electronic control in even the newest generation of microprocessor driven pintables. The power required for this function is quite considerable. Most

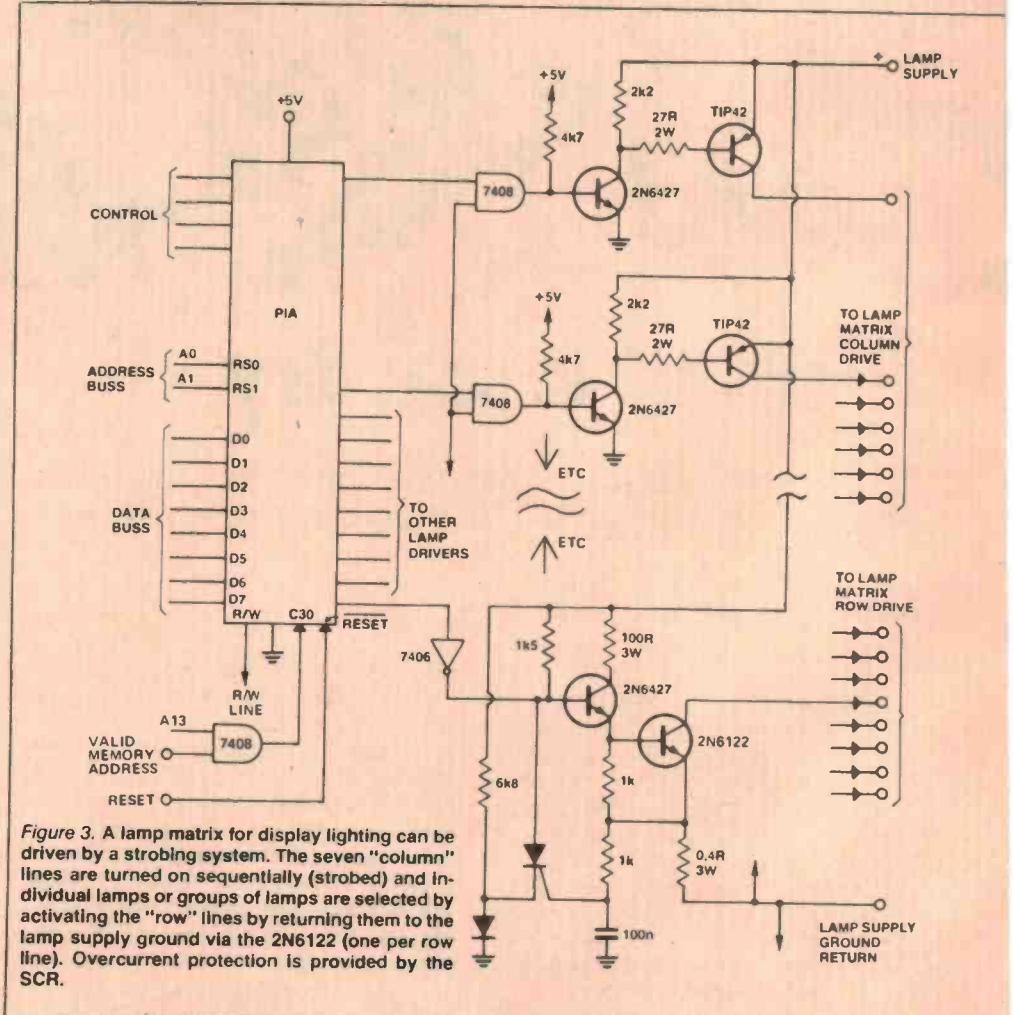


Figure 3. A lamp matrix for display lighting can be driven by a strobing system. The seven "column" lines are turned on sequentially (strobed) and individual lamps or groups of lamps are selected by activating the "row" lines by returning them to the lamp supply ground via the 2N6122 (one per row line). Overcurrent protection is provided by the SCR.

flipper solenoids, which are linked to the flipper bar by connecting rod and crank pin, operate from about 24 V and draw starting currents around 10 amps.

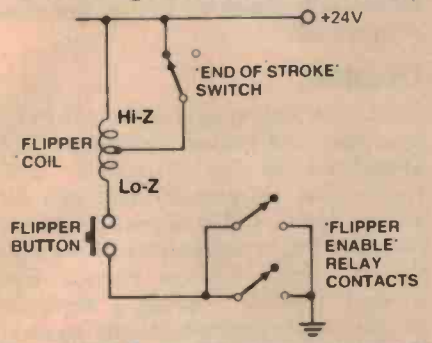


Figure 1. The flippers are driven by a solenoid having two coils — one high impedance (Hi-Z), one low impedance (Lo-Z).

Figure 1 shows a typical flipper circuit. The 'flipper enable' relays are closed when a coin is inserted in the slot. Note that in the rest state the 'end of stroke' switch is closed. This means that the higher impedance coil of the solenoid is effectively shorted out. Pressing the flipper button causes a high current to flow in the Lo-Z coil which generates an intense magnetic field, operating the flipper.

At the end of the flipper stroke a mechanical linkage opens the 'end of stroke' switch. This cuts off the low impedance coil and allows current to flow through the high impedance coil instead, which maintains a strong enough magnetic field to hold the flipper in position without drawing excessive power.

Lighting

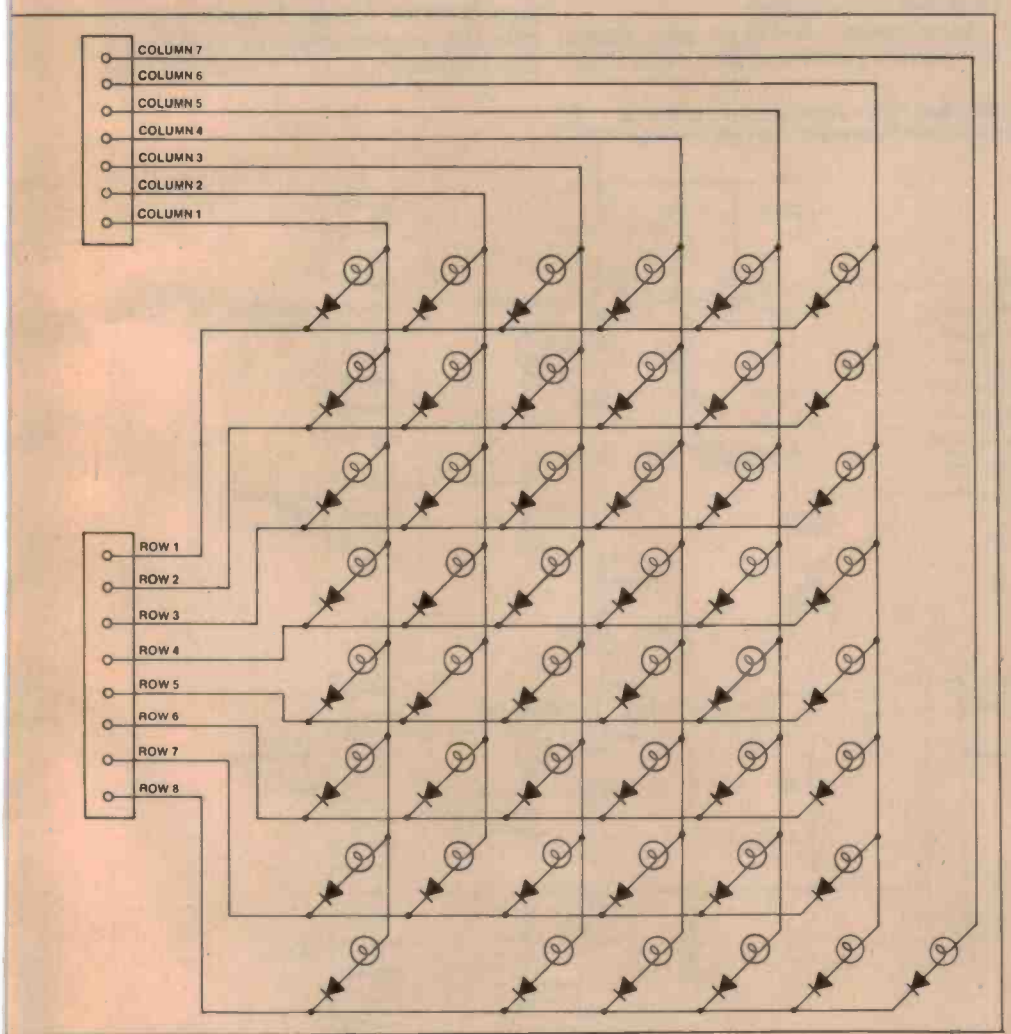
The more modern machines, with their strobing light shows and spectacular artwork are much more inviting than their predecessors. There may easily be as many as 60 lamps, which are controlled or driven in one of two ways.

The first alternative is to use individually driven transistors or SCRs. A typical circuit is shown in Figure 2. The SCRs or transistors (usually low power Darlingtons) are driven directly from TTL outputs or in some cases, CMOS running at 5 V.

The second method is to form a matrix of seven strobe lines and eight return lines. Figure 3 illustrates this. The eight strobe line drivers are turned on sequentially and only one is on at a time. A lamp anywhere in the matrix can be controlled simply by controlling the return line driver at the time the lamp's strobe line is active. All the return lines may sometimes be switched in at the same time so that each strobe driver must be able to conduct eight times the current of each of the return line drivers, but only for 1/8th of the time. This strobing technique reduces power supply current. Because each lamp's duty cycle is only 1 in 8, a high voltage supply is needed to put a strong enough pulse through the filament to provide a satisfactory RMS power output. Overcurrent protection is usually provided in the return line drivers as short circuits in lamp holders would otherwise be disastrous! This arrangement will allow the system to withstand a permanent short circuit on any lamp circuit without any other lamp being affected.

Data and strobe signals are usually provided directly by a microprocessor. As with all matrices of this type, isolating diodes are used on each lamp so that only one strobe line at a time will be active. Scanning speed is invariably high enough to eliminate flicker, so that all lamps may appear to be illuminated simultaneously.

In the system using individual SCRs the data source is usually a CMOS 4-to-16 line decoder/latch driving 15 lamps. Four of these are used, each one being accessed by the processor as a separate 4-bit output port. The disadvantage of this is that only four lamps can be on simultaneously.



Microprocessors

The most popular choice of CPU is the 6800 series. Around 3-4 Kbytes is typical for ROM space and about 256 bytes of RAM. At least part of this RAM is low power CMOS (usually 5101-L3) with battery backup from lithium or auto-recharging nickel cadmium cells. This special requirement is due to the accounting functions normally found in a pinball machine. Records are kept of the number of coins through each of the coin slots, the number of free games won and special scoring functions etc. All of this data must be maintained during the power off period.

One point of interest with battery supported RAM is that the processor must be held in a reset state during power down. It is otherwise possible that RAM data could be corrupted as supply voltages fall.

The chip enable input on the CMOS RAM is usually driven from the system reset line to ensure RAM validity. ▶

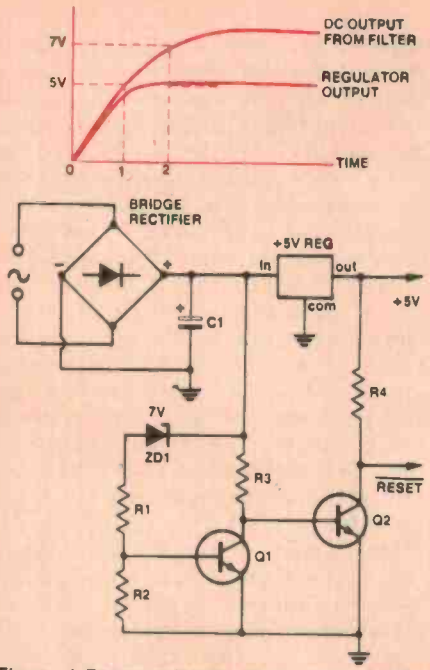


Figure 4. Power-up/power-down reset circuitry ensures RAM validity at all times.

The power-up/power-down reset circuit shown in Figure 4 is typical. It relies for its operation on the voltage differential between input and output terminals of the +5 V regulator. When power is turned on, the voltage across the filter capacitor C1 starts to rise, providing base current to Q2 via R3. Q2 will therefore conduct and its Vce will be low, thereby providing reset to the system as the regulated 5 V supply rises.

Note that Q1 is not conducting at this early stage because the zener voltage of ZD1 must first be overcome to provide base current to Q1. As the filter capacitor voltage rises still further and ZD1's voltage is eventually surpassed, Q1 conducts and diverts the base current away from Q2. Hence Q2 stops conducting and the reset is removed (time 2 on the graph). Since the processor and clocks etc. have been capable of running since time 1 (when the voltage across C1 reaches 5 V), an effective power up reset has been produced. If power is removed the reverse process takes place as the filter capacitor discharges below seven volts and Q1 is turned off.

The processor is not kept particularly busy, its major tasks being to scan and update the digit display and to scan the 50 or so switches that may exist. During a game the processor is of course performing calculations on scores and making logical decisions as each playfield switch is engaged.

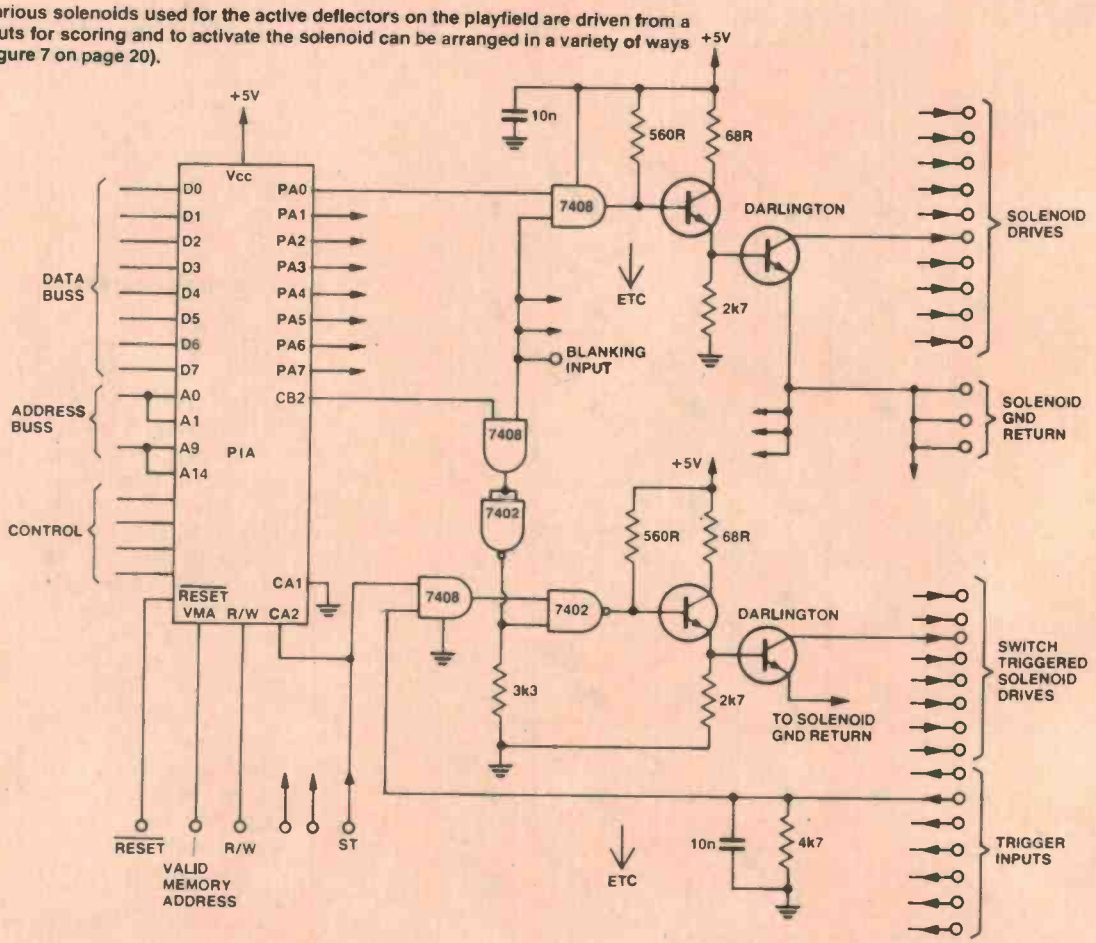
Input/output functions are almost exclusively performed with 6820 PIAs. Again a matrix technique is used to oversee as many as 60 independent switches. The PIA provides 1-in-8 strobe pulses on one output port and senses any closed switch on the other output port.

Displays

Data to be displayed is generated by the processor and routed via another PIA. Displays can be 7-segment LED, fluorescent, or planar neon gas discharge types. LEDs are least common because of their comparatively low light output. Neon displays operate from around 180-200 V using a regulated supply, while fluorescents run on about 60 V.

The cathodes of corresponding elements of each digit in the display are connected in common to make seven separate cathode data lines. A CMOS 4-bit-to-7-segment latched decoder feeds a constant current transistor driver in each of these lines with a 1 or a 0, depending on which segments have to be lit to display a particular character. To see how the system works, let's suppose that the processor wants to display the number 43210. First it sends signals to the decoder to make it generate the segment codes for each of the five characters 4, 3, 2, 1, and 0 in turn

Figure 6. The various solenoids used for the active deflectors on the playfield are driven from a PIA. Switch inputs for scoring and to activate the solenoid can be arranged in a variety of ways (see text and Figure 7 on page 20).



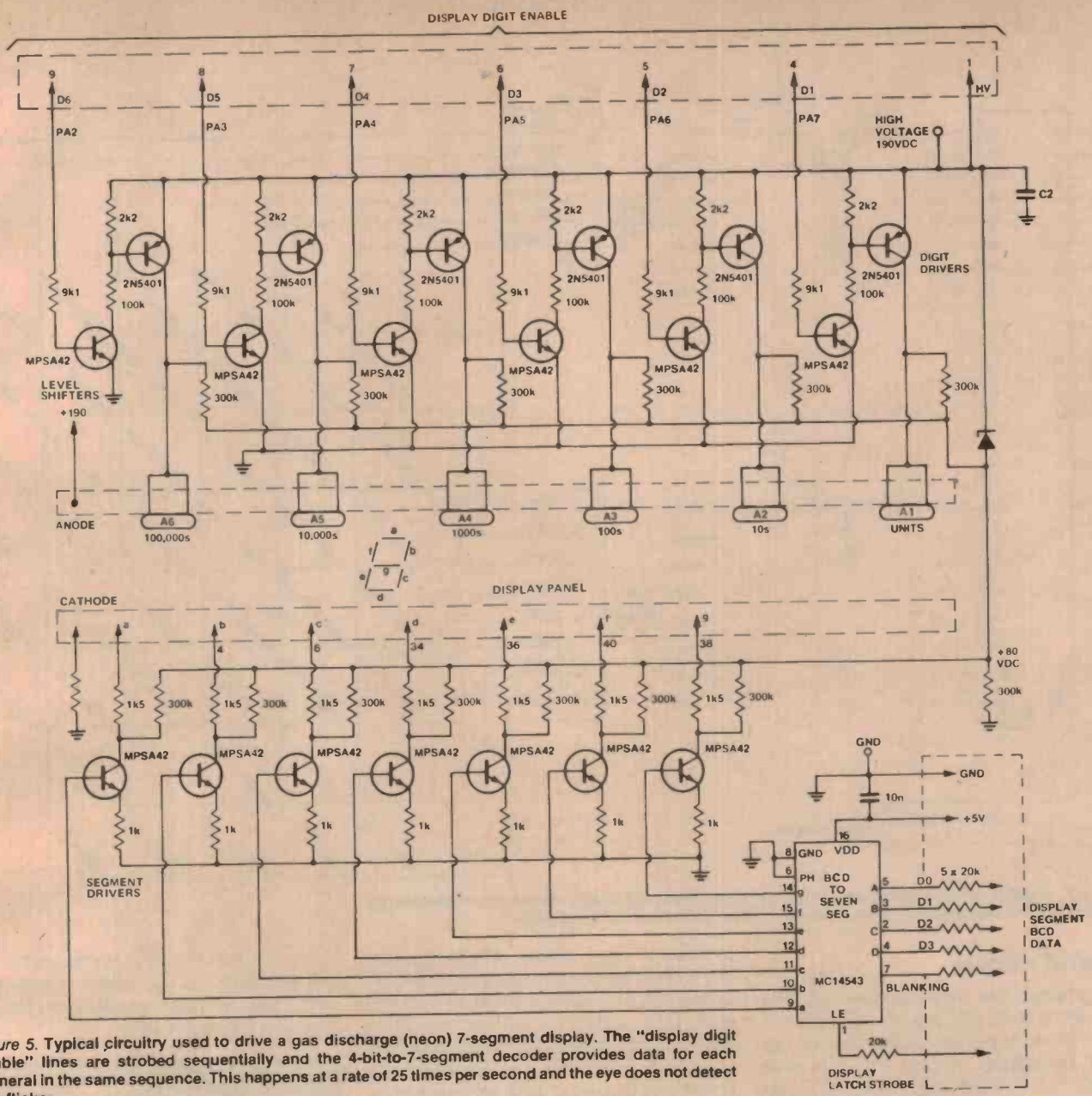


Figure 5. **Typical circuitry used to drive a gas discharge (neon) 7-segment display. The "display digit enable" lines are strobed sequentially and the 4-bit-to-7-segment decoder provides data for each numeral in the same sequence. This happens at a rate of 25 times per second and the eye does not detect any flicker.**

and repeat the sequence for as long as 43210 is meant to be displayed. If all six anode lines (one for each digit in the display) were activated, the result would be that the numbers 44444, 33333, 22222, 11111, and 00000 appeared on the display successively. But the anode for each digit is program controlled by another signal from the processor to make sure that it is only raised to operating voltage when the correct segment code is being presented to the cathodes. A multiplexer scans all six anodes in turn with the result that the correct character is displayed in each location. If the scan rate is faster than 25 times a second the human eye does not detect any flicker and the number 43210 appears to be steadily displayed.

Because of their high operating voltages, neon displays need high voltage driver transistors such as MPSA42s. Anode voltage is equal to the supply voltage in the 'on' state and about half this value in the 'off' state. Cathodes are driven towards ground when they are 'on' and held at half supply voltage when 'off'. This is done to stop possible arcing between cathodes and adjacent anodes.

Fluorescent displays work at a lower voltage and are most commonly driven by integrated devices, their filaments being supplied with ac from a separate transformer secondary winding.

Deflectors

Obviously, the active deflectors are the only ones that present any control problems. 'Bumpers' and 'kicking rubbers' run at around 24 volts and draw three to five amps. Back emf from their solenoids at turn off is quenched by 1 A diodes mounted at the coil terminations. The driver transistors are typically BD647 or TIP120 Darlingtons. The 2 V Vce sat. of a Darlington would not permit continuous operation of these devices without considerable heatsinking, but since all these active deflectors are only intended for momentary operation, heatsinks are not used.

There are two common methods of sensing/driving these devices. In the first, sense switches mounted on the device are detected directly by the processor, which calculates the new score and selects the appropriate solenoid driver, usually via a PIA and a 4-to-16 line decoder (74154).

The alternative method is to use two sets of switches on the device. One set actuates a transistor switch (BD647 and gating), which provides solenoid power. The other switch, which is usually mechanically coupled to the solenoid plunger, provides the score input to the processor. ▶

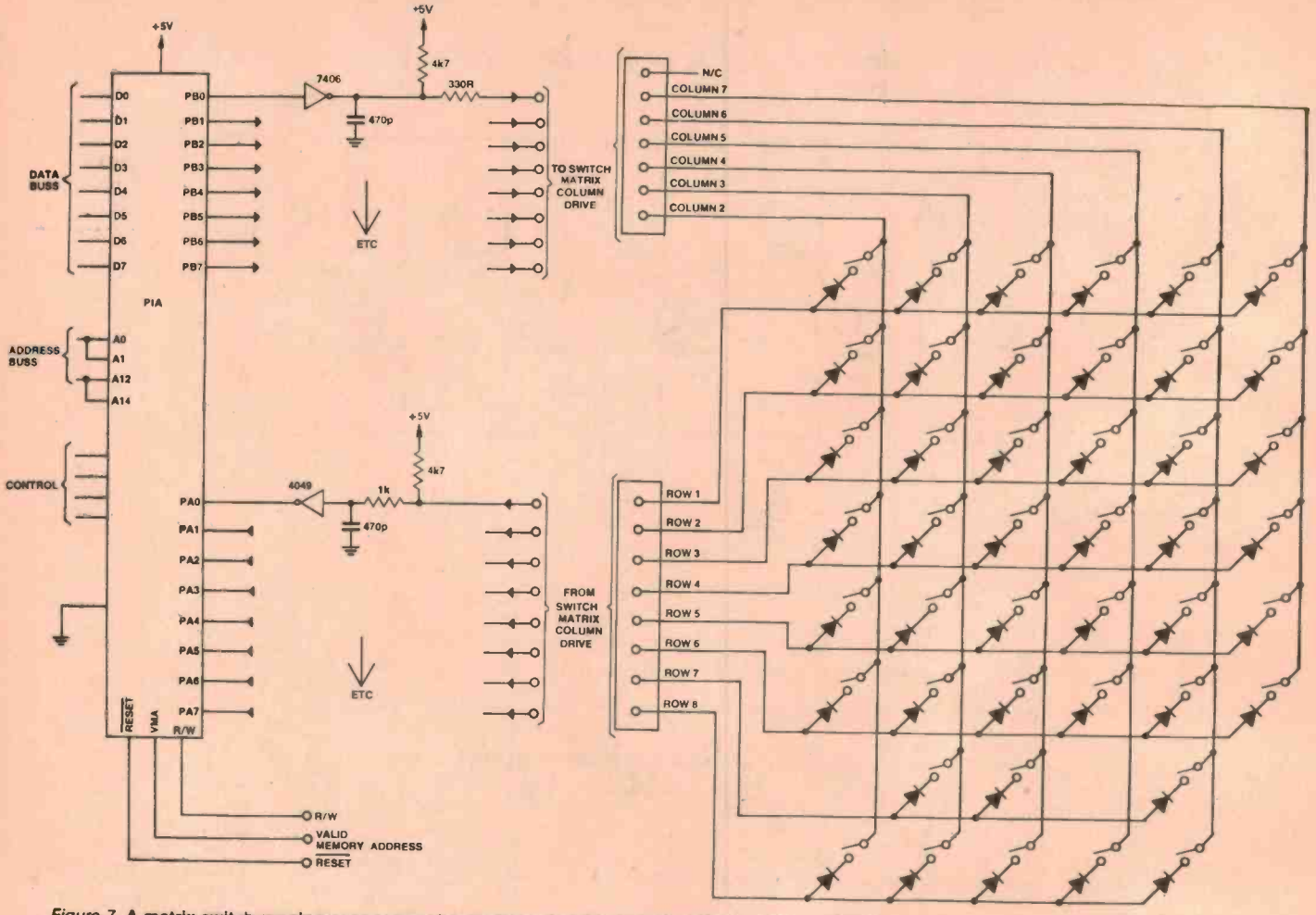


Figure 7. **A matrix switch sensing arrangement is sometimes used to activate deflector solenoids and provide scoring data to the microprocessor which then arranges the score display.**

Sound effects

In general, the introduction of microprocessor control has had little effect on the electro-mechanical devices in pinball machines. Except in one area. Early 'electronic' machines still used chimes as an audible announcement of scores. Typically three tones were used, one each for 10 point, 100 point and 1000 point scores. Inevitably electronics found its way into this domain.

The first step was to replace the mechanical chimes with three 555 timers driving something like an LM380 audio power stage. Further developments were the introduction of programmable counters and harmonic generation to add 'life' and flexibility to the system. Practically any frequency can be produced under program control with exponential fades and selectable harmonic content.

This is one area in which there is no standard practice. Each manufacturer has gone his own way in choosing between chips like the 76477 complex sound generator and a purely discrete system. In the more extravagant machines a complete microprocessor system is used exclusively to produce the weird and wonderful sounds. A 6802 processor, 512 bytes of ROM, a 6820 PIA and D/A converter allow enormous flexibility in sound generation and such a system is clearly the basis for the latest generation of 'talking' machines.

Prospects

What can we expect in the future? Most of the design work just described is around three to five years old. It is commonly known that at least one of the major US manufacturers will be releasing new hardware in their machines shortly. One smaller maker has opted for the Z80 system, even though this application involves control rather than data manipulation. Support circuitry for the Z80 is similar to that for the 6800.

There are obvious advantages in adopting the 'one processor/one job' approach, particularly for something like the F8 series with 'on board' RAM and ROM. It would be risky to predict what form the next generation of pinball machine electronics will take. Considering that 'leisure time' electronics is fast becoming a major part of the industry, we can expect to see some very sophisticated goodies inside the pintable before too long. ●

About the author

Neil Dunn began his electronics career as an apprentice mechanic in a small TV and radio repair shop. After completing his apprenticeship and passing the trade examinations he went to work in the electronics workshop of North Sydney Technical College and soon afterwards became a teacher of radio and television with the Department of Technical Education, a post he occupied for six years, teaching Radio Trades courses at all levels.

In 1973 he began working for Honeywell Information Systems as a technical instructor. There he became really involved in digital electronics for the first time, working on both hardware and software as a senior member of the technical support team. After four years or so he was itching to work on the actual design of microsystems, so when a vacancy arose at Electronic Control Systems of Chatswood, NSW he jumped in eagerly. The company was then manufacturing terminals based on the 8080 MPU and Neil was directly involved in designing a 32K RAM board, keyboard and interfaces for a typesetting terminal.

In May 1979 he began working for MFS & JE Heron, designing a complete microcomputer system and associated electronics for a pinball machine, a position he occupied until March of this year. He is now a freelance designer and writer.

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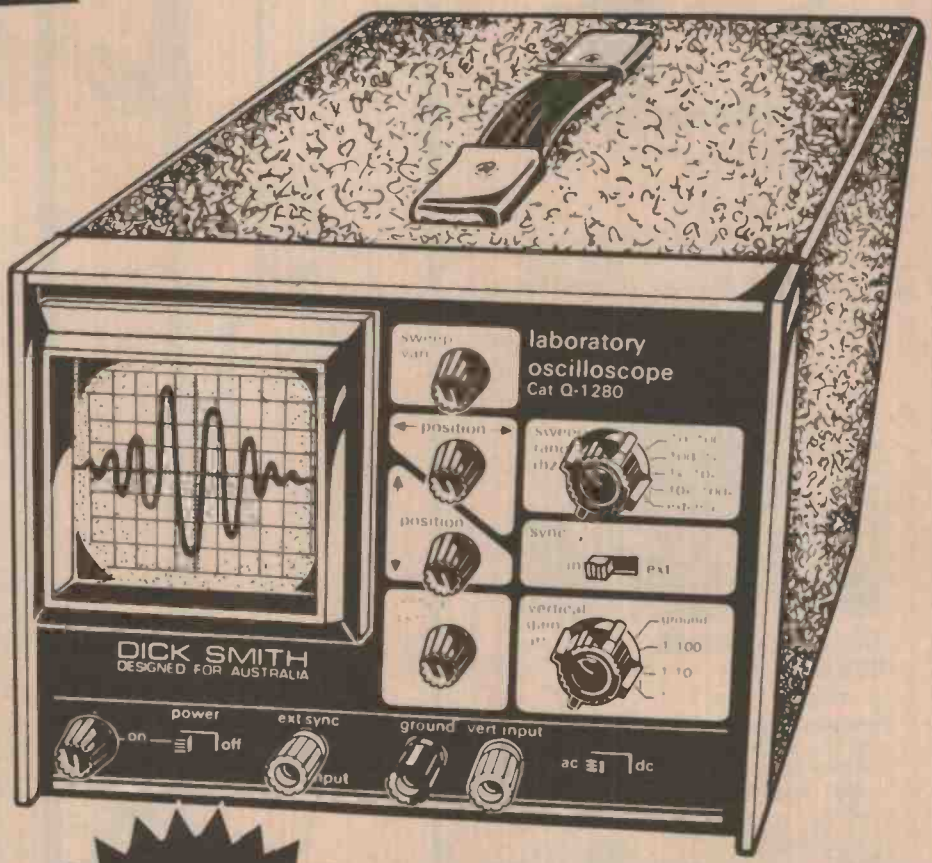

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Semiconductor research brings us the "superconducting transistor"

Researchers at the Argonne National Laboratory, in Illinois USA, have developed a special transistor that relies on the superconducting properties of semiconductors operated at very low temperatures.

Brian Dance

A VERY GREAT deal of research effort has been involved in the investigation of the behaviour of semiconductor junctions at very low temperatures. Now workers at the Argonne National Laboratory, Illinois, have developed an experimental superconducting transistor.

When it was discovered that an energy band gap exists in superconductors, it was natural to ask how this energy band gap compares with the well-known energy gap in semiconductor materials. In superconductors the energy band gap is considerably smaller than in ordinary semiconductor devices, but this is probably not the most important difference. In the ground state no charge carriers have an energy large enough to lift them above the band gap; in semiconductors the material is a perfect insulator in the ground state, whereas in superconductors it is a perfect electrical conductor and it is this difference which is so vital. The normal properties of semiconductors due to the band gap are masked in superconductors by the phenomenon of zero resistance in these materials.

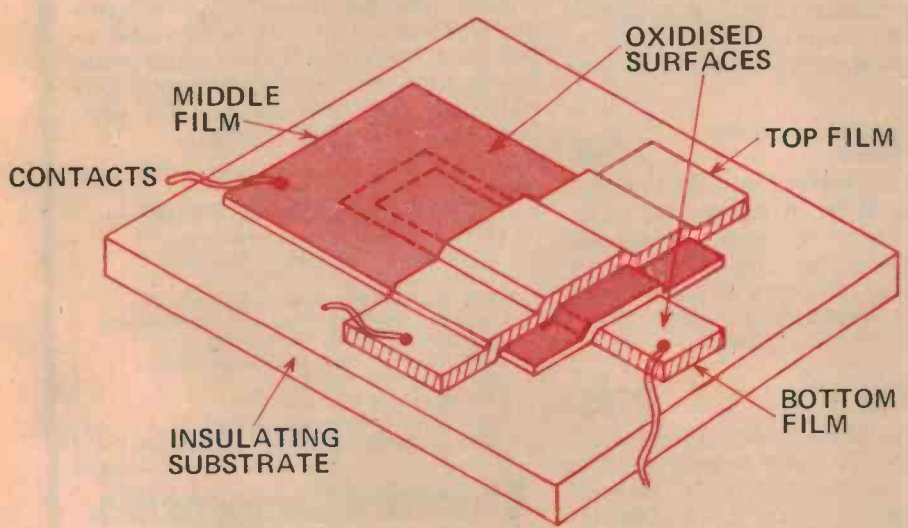


Figure 1. Basic construction of the 'superconducting transistor'. The top and bottom films are totally insulated where they overlap.

A transistor

The problems arising from the extremely highly conductive ground state in superconductors can be overcome by using very thin insulating barriers between the elements of a superconducting device. These techniques have resulted in the construction of a device which is a close analogue of the conventional semiconducting transistor.

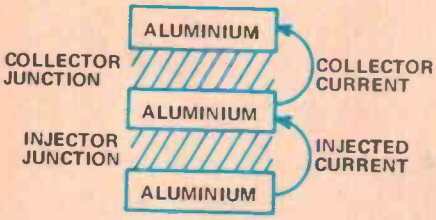
The new device is of great scientific interest from the theoretical point of view. Although the first device has a current gain of only four, workers at Argonne see no reason why similar devices with a current gain of about one hundred cannot be made using similar techniques. Although it is a little early to discuss applications for the superconducting transistor, it seems probable that it will be used as an ultra-low noise amplifier in cryogenically cooled electronic equipment. As the device will operate only at very low temperatures where superconductivity can exist, applications will be limited to research laboratories and to special industrial work where the problems associated with very low temperatures can be solved.

In the superconducting transistor, the barriers must be thick enough to prevent the Cooper electron pairs (which are the current carriers in the ground state) from penetrating the insulating layer, but single electrons in the excited state must be able to penetrate easily through the barrier. It has been found that a barrier about 3nm in thickness is suitable and that such a barrier reduces ▶

the tunnelling of Cooper pairs (the Josephson effect) to a negligible amount. A junction between two superconductors made in this way has certain similarities to a conventional semiconductor junction.

The superconducting transistor is a three terminal device constructed by stacking three thin films of aluminium on top of one another and oxidising the surfaces to form two insulating layers between the films. The structure is shown in Figure 1, the top and bottom films being totally insulated where they overlap.

The upper oxide junction between the two top superconducting layers serves to break up the Cooper pairs and injects single higher energy electrons into the middle film. The second junction amplifies this current of injected electrons by a cyclic tunnelling process. The bottom layer is similar to the collector of a conventional transistor, the middle layer is like the base and the upper layer is like the emitter.



Cutaway view of the junction showing the layered arrangement.

The multiplication of charge carriers depends on two crucial effects. One of these is the tunnelling of the injected electron into the lower (collector) layer and the other is the subsequent combination of this electron with a similar electron which has tunnelled through the barrier to form a Cooper pair; this creates a new excited electron in the middle (base) film. The process is then repeated until it is eventually terminated by energy dissipation after appreciable multiplication has taken place.

The collector power supply provides the energy required to regenerate excited charge carriers in the middle film and to keep the multiplication process occurring. The original signal creates the injected electrons.

The transfer function of a superconducting transistor is shown in Figure 2. This shows the injected current into the base region on the horizontal axis and the change in the collector current on the vertical axis. The four lines, in order of decreasing slope, are for temperatures of 0.625K, 0.650K, 0.695K and 0.703K, so although the lines are very linear, the collector current is very temperature dependent.

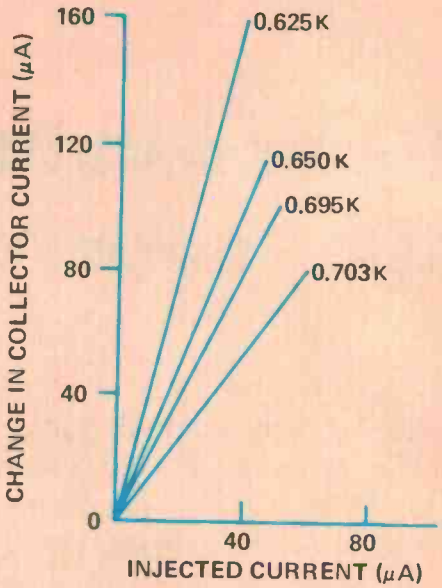


Figure 2. The transfer function of a superconducting transistor. Note the linearity of the function.

Readers requiring further information on this new device should refer to the paper by K.E. Gray 'The Superconducting Transistor', *Applied Physics Letters*, Volume 32, part 6, pages 392 to 395, 15th March 1978. ●

Series 3000 compact stereo amplifier

Phil Wait

"Small is beautiful" when you have a premium on space, but there's no need to sacrifice performance. This amp delivers 20 W/channel, has low distortion and costs less than $90!

THE TREND to living in 'compact' accommodation such as units, town houses and inner city terraces, has led to a demand for appropriately sized household goods and furniture — including hi-fi equipment. The major hi-fi manufacturers all leapt into this market last year, releasing various combinations of separate components and integrated arrangements generally tailored to a size to stack conveniently on a shelf or bench top and not take up precious space.

This project is aimed at those readers who want something to fill that requirement but want to 'roll their own' to save money or just to gain the satisfaction of having done it themselves.

Apart from that, this project is ideal for the beginner with a little construction experience who wants a 'meaty' project to tackle. This unit is quite simple to build as the majority of components are mounted on a single printed circuit board and the interwiring has been simplified with the use of 'ribbon' cable.

Despite the low price, compared to other such projects around, this unit is not a 'cheap' amplifier. The performance is demonstrably better than similar amplifiers that cost a great deal more and it can be teamed with some of

SPECIFICATIONS

Power output
25 W RMS; one channel driven
20 W RMS, both channels driven

Distortion (refer to graph)
1kHz: 0.03% @ full power
0.013% @ 12W RMS
10 kHz: 0.08% @ full power

Frequency response
Phono: within 1 dB, RIAA
Other inputs: within ±0.5 dB
from 10 Hz to 20 kHz; −3 dB @ 40 kHz

Hum
Phono: −60 dB w.r.t. 10 mV input
Other inputs: −70 dB w.r.t. 200 mV input

Noise
Phono: −80 dB w.r.t. 10 mV input
Other inputs: −86 dB w.r.t. 200 mV input

Tone controls (see text)
Bass: ±10 dB @ 50 Hz
Treble: ±10 dB @ 12 kHz

Slew rate
15 V/μs

Separation
Phono: 46 dB
Other inputs: 40 dB

Sensitivity
Phono: 2.5 mV for full output
Other inputs: 200 mV for full output

Tape output level
200 mV

our previously published hi-fi projects to obtain quite a respectable hi-fi set up.

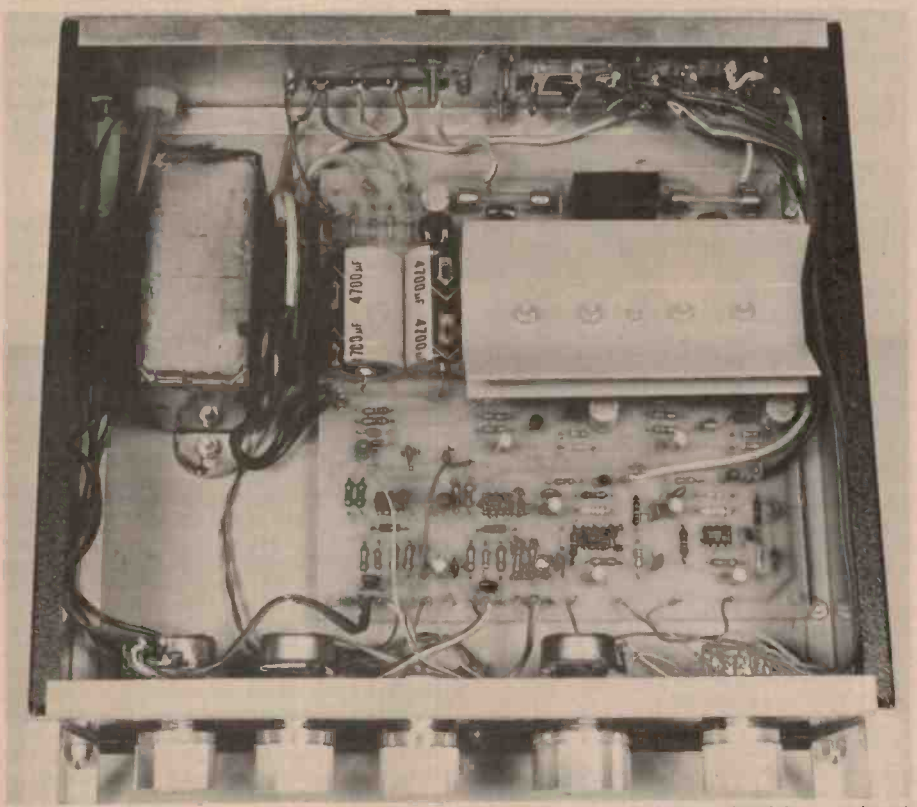
The design

Overall design is fairly conventional, except for the output stage, but we have paid attention to such details as transient intermodulation and slew limiting distortion as well as keeping total harmonic distortion within acceptably low limits.

The preamp stages employ common integrated circuits op-amps. The power amplifiers employ a differential input stage driving a complementary-symmetry class-B power stage. The output devices are TIP31C/TIP32C 'flatpack' transistors arranged such that a simple heatsink can be mounted on the pc board — which can be seen in the internal photograph. A conventional transformer/bridge rectifier power supply is used and speaker anti-thump circuitry is provided too.

The output stage of each channel is capable of delivering 25 watts (single channel) into an 8 ohm load. If you're building the amplifier as a Christmas present for your kids, in the interest of tranquillity, family relations and the sanity of the family cat(/dog/budgie/goanna) the power output might seem 15 - 20 watts too much. By the simple expedient of using a lower voltage transformer and changing a few resistors, the amp will deliver only five watts(*). This also reduces the heatsink requirement and the overall price (as the transformer's less expensive). The two different types of transformer are given in the parts list.

*Psst — kids. If the old fella has built you a five watt amp you can make it up to a 20 W/ch amp without much fuss. Read on.

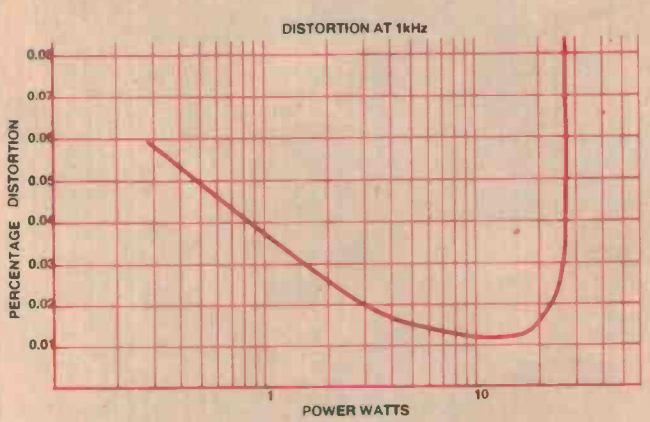


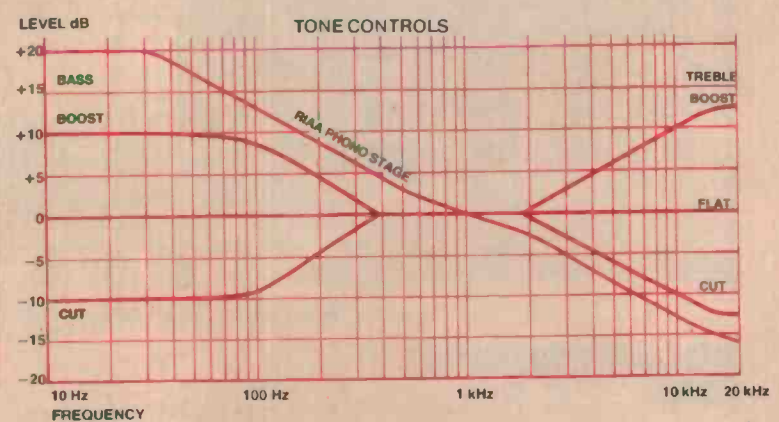
Internal view of the completed project shows the general layout and obvious simplicity — almost everything's on the pc board. We haven't anything much to say about the external appearance as it speaks for itself! Scotchcal transfers for the front and rear panels will be available from suppliers — see Shoparound on p.83.

When you turn an amplifier on or off, a loud thump may come from the speaker. This transient may have sufficient energy to destroy the speaker! It is caused by the supply line voltage rising (at switch-on) or falling (at switch-off) at different rates. This may cause the output to the speaker to swing wildly between the positive and negative supply rails under the worst-case conditions — spectacular, but costly if your speakers can't handle it. Consequently, we have provided an anti-thump circuit which only connects the speakers after a short delay whenever the amplifier is turned on. When the unit is turned off, the speakers are immediately disconnected, before the supply rails have a chance to fall appreciably.

Construction

We chose to assemble the amplifier in a Horwood instrument case measuring 255 mm by 255 mm by 78 mm overall. These are supplied with black, vinyl covered steel top and side panels and plain aluminium front and rear panels. Handles are attached either side of the ▶





HOW IT WORKS — ETI 476

This amplifier employs common IC op-amps in the phono and preamp stages driving a class-B power amplifier employing discrete circuitry. The power supply is conventional, employing a transformer and bridge rectifier with capacitor-input filters to derive positive and negative supply rails and incorporating a speaker anti-thump circuit.

The following description applies to one channel only as both channels are identical, except for component numbering. Components are numbers IC1, R1, C1 etc in one channel, IC101, R101, C101 etc in the other. Ganged controls are labelled SW1a, b or RV1a, b etc.

PHONO STAGE

The phono input, from a moving magnet turntable cartridge, is applied to the input of IC1, an LM301, via an R-C network (C1, R1) which provides a roll-off at subsonic frequencies. The feedback network for IC1 (R3, R4, R5, R6 and C4, C5) provides the correct RIAA compensation. Output from this stage goes to the Source switch, SW1, via C7/R7.

Resistor R7 maintains the negative side of C7 at 0 V to prevent speaker thump when operating the Source switch. The purpose of C6 is to reduce the gain of IC1 to unity at dc so that the dc offset at its output is maintained at a low value.

Capacitor C3 provides stability compensation for IC1. Resistor R2 and capacitor C2 provides RF interference immunity for the input of IC1.

Overall gain of the phono amp is about 300 and is designed to provide full power output with 2.5 mV RMS input at 1 kHz.

PREAMP-TONE CONTROL

The Source Switch selects the various inputs, applying them to the Volume Control, RV1, via the Tape Monitor Switch, SW2.

Output from the Volume Control passes to the input of the preamp-tone control stage via C8. Conventional tone control circuitry around the feedback of IC1 provides boost and cut at 12 kHz for Treble and 50 Hz for Bass. However, unlike conventional controls we have only provided a range of +/– 10 dB for reasons explained in the text.

General gain for this stage is around 10, and input sensitivity is 200 mV RMS for full power output. The slew rate for this stage has been set at 15 V/us so that it is slower than the power amplifier. This has been done by selecting the value of the compensation capacitor, C11 to limit the speed to that required. The R-C network formed by R15 and C12 provides additional slew rate limiting at the output of the tone control stage. This technique avoids transient intermodulation distortion developing in the power amplifier.

POWER AMPLIFIER

Keen-eyed readers will recognise similarities between this circuit and the ETI-452 Guitar Practice Amplifier (Jan 1980) and the ETI-453 General Purpose Amplifier Module (April 1980). There's no need to re-invent the wheel!

Ten transistors are employed (Q1 to Q10) in a discrete component design. Transistors Q1 and Q2 form a differential input stage. Q4 provides a constant current source for the input stage emitters, biased by R24 and LED1.

Output from the preamp-tone control stage is applied to the Balance control, and thence to the input of the power amplifier stage via C13 to the base of Q1. The collector of Q1 is directly coupled to the base of Q3, an emitter follower which is directly coupled to the base of the pre-driver, Q5. Diodes D1, D2 and D3 maintain about 1.8 V between the bases of Q7 and Q8. Each of these transistors will drop about 0.6 V across their base-emitter junctions. This leaves a total of 0.6 V to be dropped across the two 27 ohm resistors R27 and R28. Since these are of equal value, each drops 0.3 V and holds this across the base-emitter junctions of Q9 and Q10, the output transistors. As these two transistors require 0.6 V to be biased on, they will remain off until the applied signal raises the voltage on the bases above 0.6 V (with respect to 0 V). Only a little more than 10 mA through R27 and R28 will supply the extra 0.3 V to turn on the output transistors.

Transistor Q6 provides a constant current sink (or source, depending on your point of view) for the collector current of Q5, increasing the gain of the drive stage, Q5, and decreasing distortion. There is approximately a one volt drop across R26 (and incidentally, R19).

Emitter ballast resistors are included in the output stage, these being resistors R29, 30 and R31, 32. Their main purpose is to help prevent thermal runaway in this application and stabilise the gain of each output transistor. They play a secondary role as fuses in the event of a fault condition causing heavy conduction in the output devices. Hence, the text advises these resistors be mounted up off the pc board on their leads.

Negative feedback is supplied by the potential divider formed by resistors R23 and R20. The capacitor C3 represents a short circuit to the common rail (0 V) for ac signals in the audio range. Gain of the stage across the audio range is thus the ratio of R23 to R20, about 12 in this case. At very low frequencies the impedance of C3 increases, decreasing the gain of the power amplifier by increasing the amount of negative feedback. Capacitor C16 increases the speed of the ac feedback at high frequencies.

The base of Q1 is tied to 0 V and as the whole amplifier is dc-coupled, the quiescent output voltage will be held to a value less than about 50 mV.

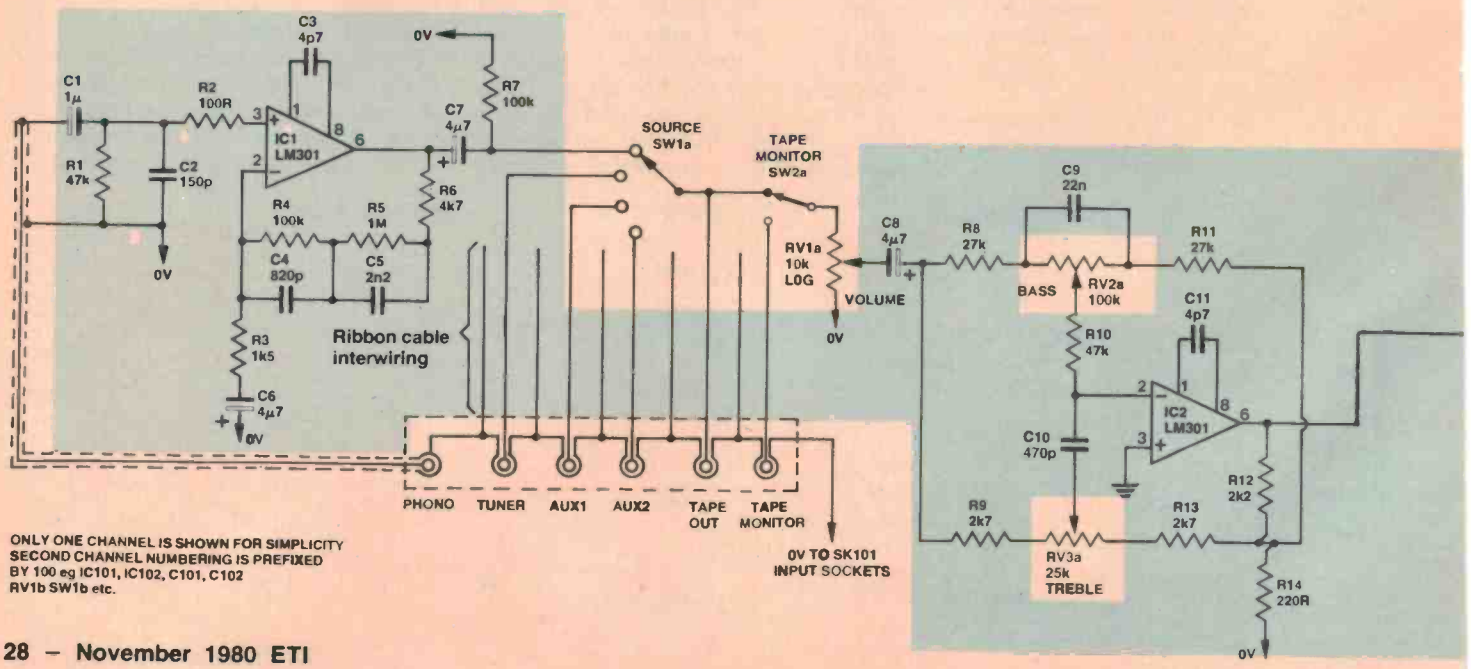
Output from the power stage is taken via a set of contacts on the anti-thump relay and a 2 A fuse, for speaker protection. The R-C network R33 and C17 provides output phase lage compensation.

The output stage devices — a TIP31C and complementary TIP32C — operate in pure class-B, the effects of crossover distortion being reduced by the feedback arrangements. These devices will deliver 25 W into an 8 ohm load. Only a modest heatsink is required as quiescent dissipation is low. The output devices are operated close to their SOAR limit under certain conditions, but no problems should arise. Lower power output can be arranged by reducing the supply rail voltage (see text).

POWER SUPPLY

The 240 Vac mains input is applied to the primary of the power transformer via the power switch, SW3, which isolates both active and neutral leads. A 'spike' suppression capacitor (C26) is connected on the mains input side of the power switch.

The secondary of the mains transformer consists of two windings connected in series, the 'centre tap' providing the 0 V return line. A bridge rectifier comprising diodes D4 to D7 provides positive and negative supply rails. The main supply rail voltages will depend on the transformer chosen for the desired power output as per the text.



ONLY ONE CHANNEL IS SHOWN FOR SIMPLICITY
SECOND CHANNEL NUMBERING IS PREFIXED
BY 100 eg IC101, IC102, C101, C102
RV1b SW1b etc.

Smoothing for each supply rail is provided by C20 and C21. Capacitors C22 and C23 reduce the supply rail impedances at high frequencies. The phono and preamp-tone control stages require +/– 12 Vdc supply rails and these are derived by conventional shunt zener regulators involving R36, R37, ZD1 and ZD2. Capacitors C24 and C25 provide bypassing for these supply rails. LED2 is a 'power on' indicator.

ANTI-THUMP

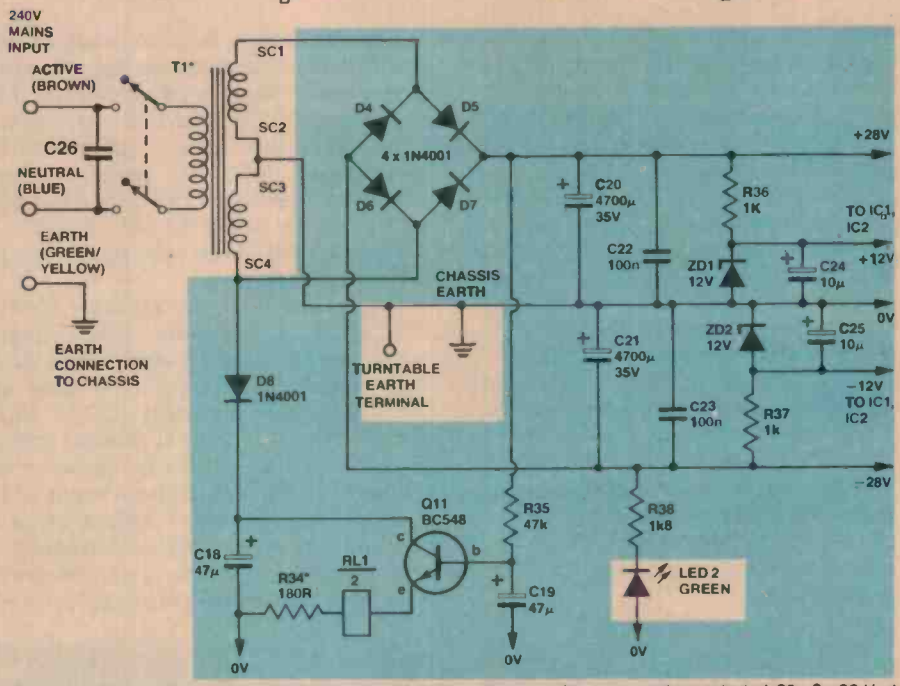
The anti-thump circuit involves D8, Q11, C18 and C19, R34 and R35 plus RL1. The object is to isolate the speakers from the power amplifier until the supply rails have stabilised following switch on and to isolate the speakers once again when the amplifier is turned off, before the supply rails have decayed.

The relay RL1 has two sets of contacts which are connected normally open. These contacts are in series with each channel's speaker output line, between the power output stage and the speaker protection fuse.

At switch on, D8 rectifies one side of the transformer secondary, rapidly charging C18, establishing collector supply for Q11 before the bridge rectifier smoothing capacitors have time to charge to a significant voltage. Until such time as C20 charges to 12 volts, Q11 has no base bias and is turned off. Thus, relay RL1 remains unoperated. As the voltage on C20 rises, capacitor C19 will charge via R35. When the voltage on C19 rises to about 12 V, Q11 will turn on and RL1 will operate, connecting the speakers. The R-C network formed by R35/C19 provides a time delay such that the voltage on C19 will only reach about 12 V after the voltage across C20 has risen to the full supply voltage. The delay is several seconds.

When the unit is switched off, C18 will rapidly discharge and the current through RL1 will drop below that required to hold it operated well before the supply smoothing capacitors (C20 and C21) discharge.

Resistor R34 limits the current through the relay to a safe maximum value when Q11 is on. Note that it is not required if the lower voltage transformer is used.

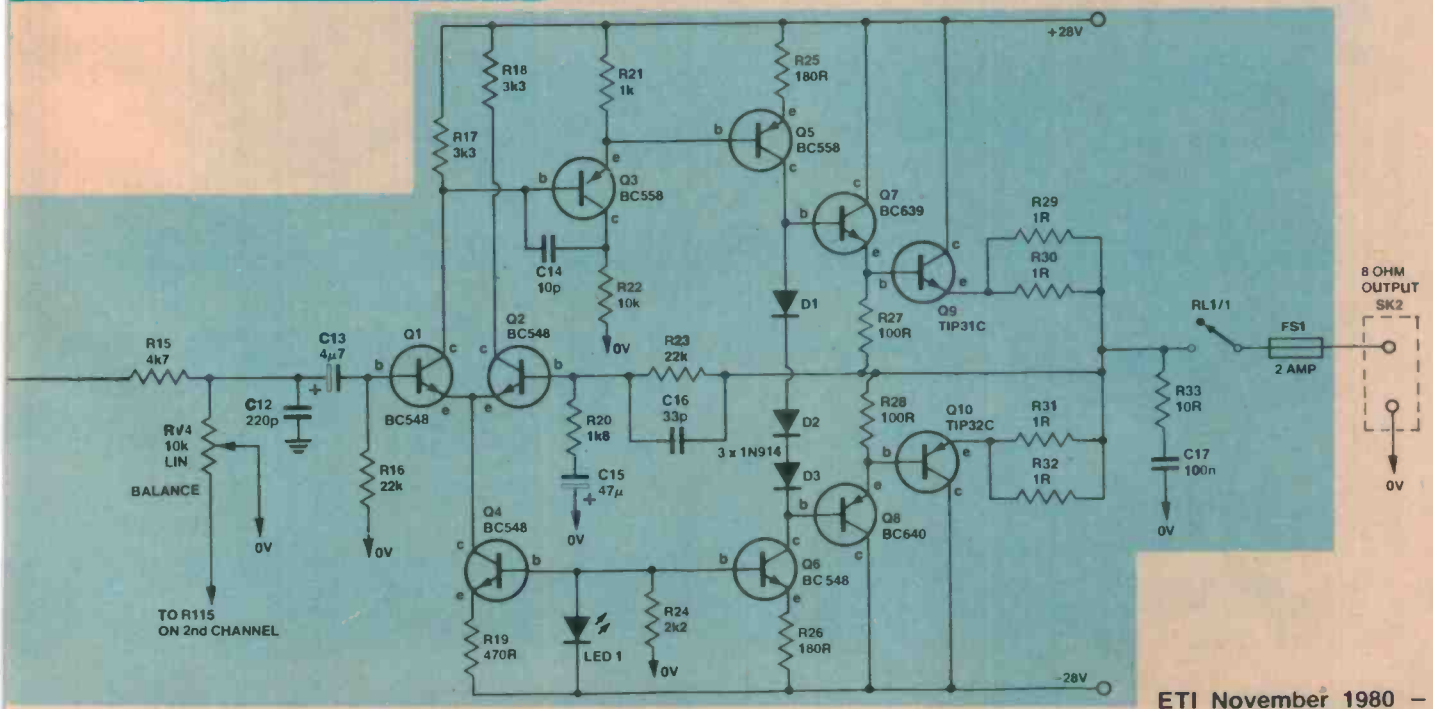


Power supply and speaker anti-thump circuit. A transformer with a secondary rated at 20 - 0 - 20 V at 1.5 A will provide 20 W per channel. For 5 W per channel operation, a 12 - o - 12 V at 0.8 A transformer is required. In the latter case, reduce the values of R36 and R37 to 390 ohms each and short out R34.

front panel and these can be obtained in plain aluminium or black anodised. We made up a black Scotchcal label with white lettering (i.e: 'reverse') for the front panel and used brushed satin aluminium knobs. The whole effect is quite attractive.

The layout of the controls on the front panel is kept quite simple. There are only two toggle switches — power and tape monitor. A stereo/mono switch was thought unnecessary as it would add to the cost and clutter up the simple front panel layout. They are rarely used these days in any case. The rear panel holds the input and output connectors, power cord and an earth terminal for other equipment such as a turntable, headamp or whatever.

We used an internally-mounted heatsink for the four output stage devices, made from a sheet of 16 gauge aluminium. This heatsink is the minimum recommended for 20W/channel opera-▶



tion. If you wish, the output transistors can be mounted on the rear panel, in the space above the speaker output terminals. Their leads may be connected to the pc board with hookup wire or ribbon cable in this case.

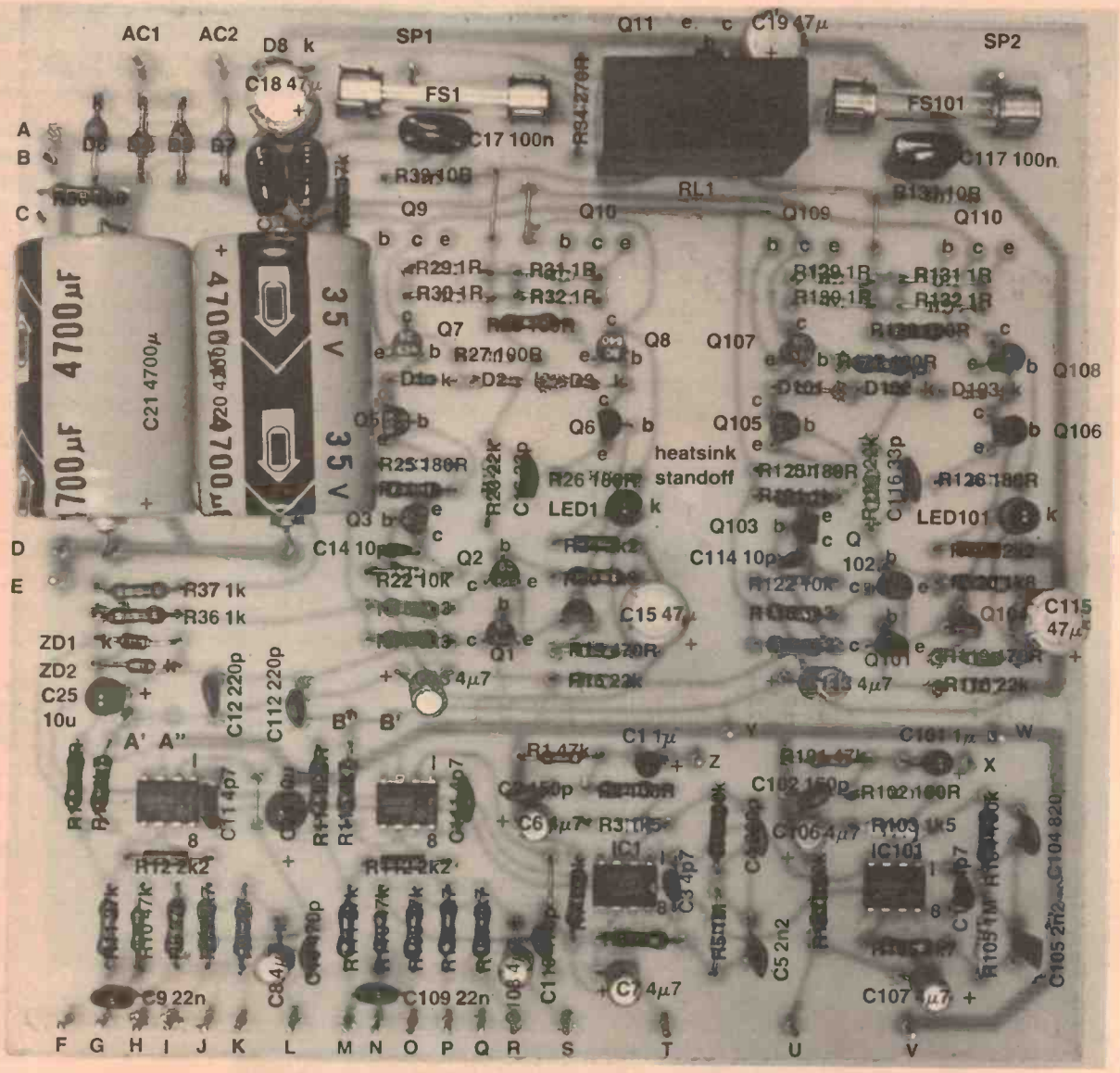
You will notice from the internal photographs that the phono input connection to the pc board is made with shielded cable, but the other inputs are made via a length of 20-wire ribbon or rainbow cable. This cable is wired in a signal-earth-signal-earth fashion so that each signal wire has an earth either side to provide some shielding. This we tried as an experiment and found it very successful. It simplifies the wiring enormously compared to using individual shielded cables. There was only a slight degradation in the cross-talk between channels and no increase in hum levels.

Construction is best commenced by loading the components on the pc board. The overlay photograph shows all the details. Insert the four link wires first. Note that a link should replace R34 if you intend using the lower voltage power transformer. This ensures that 12 V appears across the anti-thump relay coil at the lower voltage, ensuring correct operation.

Next mount all the resistors. Note that, if you're using the lower voltage power transformer, resistors R36 and R37 should be reduced to a value of 390 ohms each. Resistors R27 to R32 and R127 to R132 should be stood about 4 - 5 mm above the board to protect the pc board in the unfortunate event of a fault in the driver or output stages causing overheating of these resistors.

The capacitors can be mounted next. As usual, take care with the polarity of the electrolytic and tantalum capacitors. The lead length on the low value ceramic capacitors C3, C11, C14 and C103, C111, C114 should be kept as short as possible. Mount them so that the body of the component is right down on the pc board. The mains transient suppression capacitor is mounted off the pc board, but this is discussed later.

Now you can mount all the semiconductors, except the output transistors. Here too, take care with the orientation of the devices. The pinouts of the BD639s and BD640s do not have the base lead between the emitter and collector leads like most small signal transistors, so take care with these devices. Pay particular attention to the orientation of the diodes D1 to D3 and D101 to D103 as these set the voltages on the bases of the output transistors. If they are inserted the wrong way round



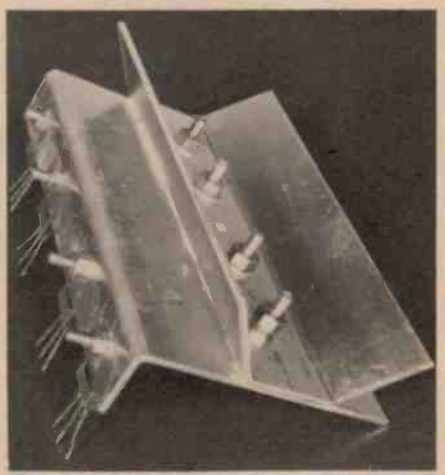
(or are open circuit for some reason) the output transistors won't last long, as we found out to our detriment! Apart from the disappointment, the smell is dreadful! If in doubt, use a multimeter to check the diode. Remember that the *positive* lead of an ohmmeter has the internal battery *negative* connected to it. Thus, this lead will be connected to the *cathode* of the diode when the ohmmeter indicates a low resistance (i.e: diode conducting).

Mount the relay, fuse clips and fuses next. Some fuse clips are hard to solder so to prevent overheating the pc board, first file the plating off the edge of the pins on each clip before you attempt to solder them in.

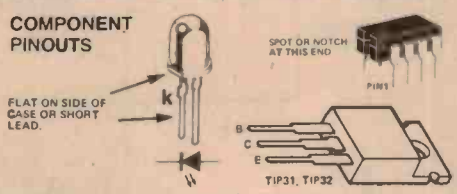
For all the external connections to the board we used pc board pins. They aren't essential, but they do make it considerably easier to wire the board to the other components. These pins are mounted at this stage.

If you haven't already noticed, there are two pads on the board, just above IC2 and IC102, that appear to have no purpose. Circuit-wise, these pads are located at the input to the power stage of each channel and are marked A' and B' on the overlay photograph. By breaking the track between the points marked A' and A", and B' and B", the preamp output and power amp input can be separated to provide connections for "preamp out — main in" sockets so that equipment such as a graphic equaliser may be used in conjunction with this unit. For those readers including this provision, the output impedance of any equipment used to drive the power stages of this unit should be between 4k and 10k.

The output stage transistors are mounted on the board last of all. If you mount them as we have done, drill and bend up the aluminium heatsink first. The accompanying drawing gives all the details. The 'fin' mounts on top of the L piece and the two are held tightly together with four nuts and bolts. Smear thermal compound between the two mating surfaces and insert the bolts with their heads on the side that will face the pc board. Make sure that the surface on which the transistors mount is both smooth and flat. Smooth the surface with emery paper if necessary. By the way, don't paint the heatsink. We painted ours to experiment with colour photographs inside the completed unit and found it adversely affected the thermal capacity of the heatsink. ▶



The transistors mounted on the heatsink assembly, ready to mount on the pc board.



PARTS LIST — ETI 476

Resistors all ½W, 5%

R1, 10, 35, 101	47k
R110	47k
R2, 27, 28, 102	100R
R127, 128	100R
R3, 103	1k5
R4, 7, 104, 107	100k
R5, 105	1M
R6, 15, 106, 115	4k7
R8, 11, 108, 111	27k
R9, 13, 109, 113	2k7
R12, 24	2k2
R112, 124	2k2
R14, 114	220R
R16, 23,	22k
R116, 123	22k
R17, 18	3k3
R117, 118	3k3
R19, 119	470R
R20, 120, 38	1k8
R21, 36, 37, 121	1k
R22, 122	10k
R25, 26, 125	180R
R126, 34	180R see text
R29 - 32	1R
R129 - 132	1R
R33, 133	10R

Capacitors

C1, 101	1u electro or tantalum
C2, 102	150p ceramic
C3, 103, 11, 111	4p7 ceramic
C4, 104	820p ceramic
C5, 105	2n2 greencap
C6, 7, 8, 13, 106	4u7, 16V electrolytic
C107, 108, 113	4u7, 16V electrolytic
C9, 109	22n greencap
C10, 110	470p ceramic
C12, 112	220p ceramic
C14, 114	10p ceramic
C15, 115	47u, 16V electrolytic
C16, 116	33p ceramic
C17, 22, 23, 117	100n greencap
C122, 123	100n greencap
C18, 19	47u, 35V electrolytic
C20	4700u, 35V electrolytic
C24, 25	10u, 16V tantalum
C26	10n to 100n, 240VAC Rated capacitor (value not critical)

Semiconductors

IC1, 101	LM301
IC2, 102	LM301
Q1, 2, 4, 6, 11	BC548, BC108
Q101, 102, 104, 106	BC548, BC108
Q3, 5, 103, 105	BC558, BC178
Q7, Q107	BC639
Q8, 108	BC640
Q9, 109	TIP31C
Q10, 110	TIP32C
D1 - D3, D8	1N914, 1N4148
D101 - 103	1N914, 1N4148
D4, 5, 6, 7	1N4001, A14A or sim.
ZD1, 2	12V, 400mW zener diode
LED1, 101	red LED, TIL220R or sim.
LED2	green LED TIL220G or sim.

Potentiometers

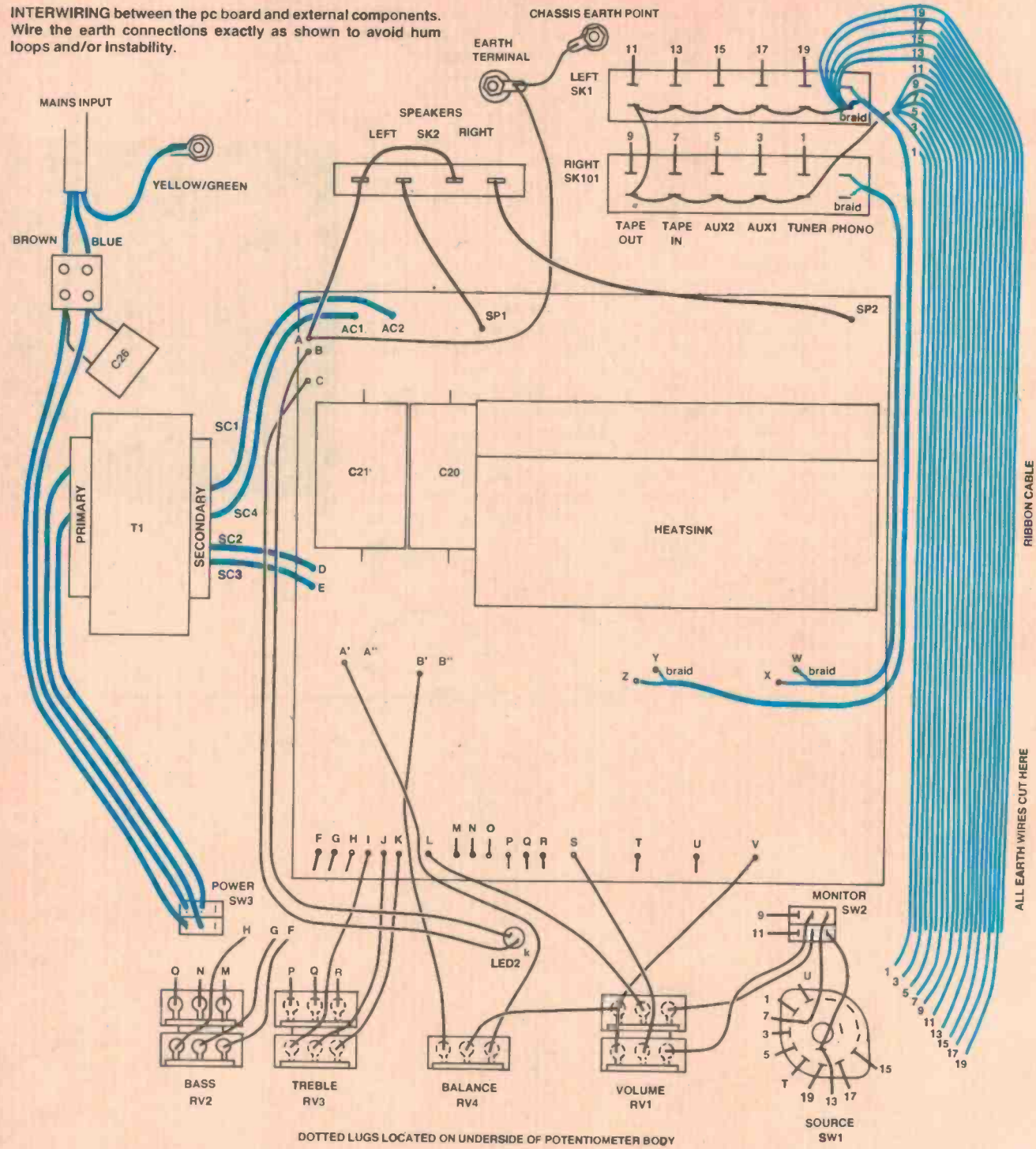
RV1	10k dual gang log.
RV2	100k dual gang lin.
RV3	25k dual gang lin.
RV4	10k single gang lin.

Miscellaneous

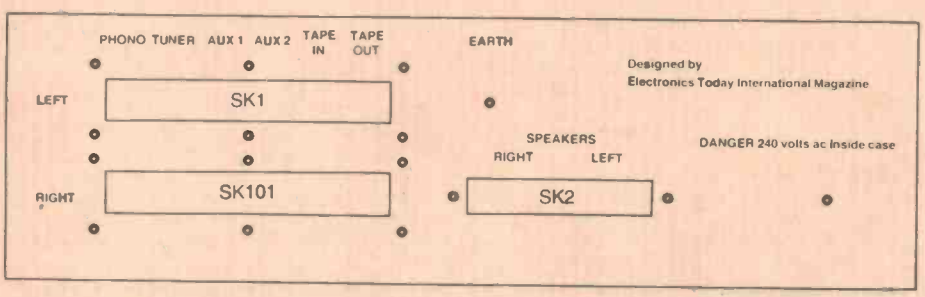
SW1	two pole, four position wafer switch
SW2	DPDT miniature toggle switch
SW3	DPST 240V rated miniature toggle switch
SK1, 101	six RCA sockets on insulated panel
SK2	set of spring contact speaker terminals on insulated panel
T1	For 25 Watts output 20 - 0 - 20V secondary at 1.5 amps Ferguson type PF3993 or similar For 5 Watts output 12 - 0 - 12V secondary at 800mA Ferguson type PL24/20VA or sim.
FS1, 101	2 Amp, 3AG fuses with pc board mounting clips
RL1	DPDT pc board mounting relay with 12 Volt coil, Takamisawa type VB 12 STAN or Pye 265/12/G2V

ETI 476 pc board, heatsink (see text), black screw terminal for turntable earth connection, Horwood case type 93/10/V (255 mm wide x 255 mm deep x 76 mm high), power cord and 3 pin plug, four 12 mm pc board standoffs, clamping grommet for power cord, nuts, bolts, length 20 wire ribbon cable, length shielded cable.

INTERWIRING between the pc board and external components. Wire the earth connections exactly as shown to avoid hum loops and/or instability.



DOTTED LUGS LOCATED ON UNDERSIDE OF POTENTIOMETER BODY



◀ REAR PANEL

SW1	POSITION FUNCTION	LEFT	RIGHT
1	PHONO	U	T
2	TUNER	1	19
3	AUX 1	3	17
4	AUX 2	5	15
—	TAPE OUT	9	11
—	TAPE IN	7	13

Source and monitor tape switches wiring legend.

Mount the output transistors as shown in the accompanying diagram. Note that a mica or plastic washer and insulating bush must be used with each one. Smear a small amount of thermal compound on both sides of the mica or plastic washer before you mount and screw the bolts down firmly to get good thermal contact between the transistor body and the heatsink.

Check that you have the transistors in the correct order and check also that there are no shorts between the collector pins and the heatsink.

Before the heatsink/transistors assembly can be mounted, bolt a 25 mm standoff pillar on the pc board as indicated on the overlay photograph. This is to secure the heatsink and relieve stress on the transistor leads.

Once you have the heatsink and output transistors all together, bring the assembly to the pc board and insert the leads of the transistors in the appropriate holes. A small pair of needle-nose pliers helps here. Push the transistor leads through the board such that they protrude about 2mm on the copper side of the board. Bolt the heatsink to the standoff and then solder the transistor leads.

That completes the pc board assembly.

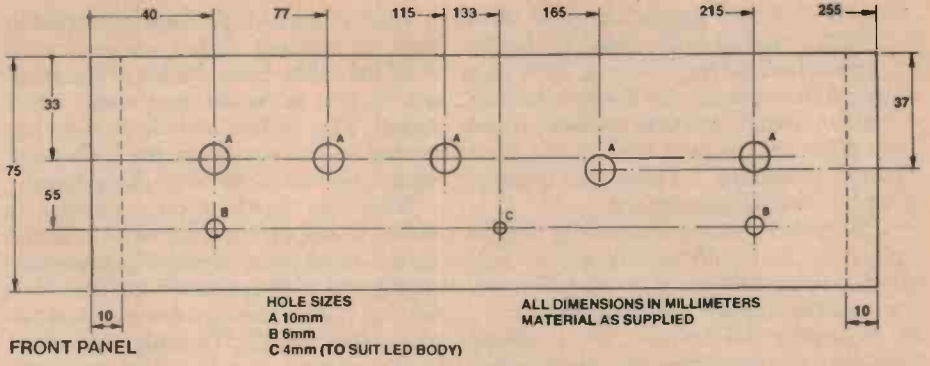
Next step is the metalwork. If you have purchased a pre-drilled case, just check that all fits and there are no burrs. If you've purchased an undrilled case, first thing to do is to disassemble it and scribe the hole positions on the front and rear panels as per the metalwork drawings. If you're going to use a Scotchcal front panel, this may be used as a template for drilling with the added assurance that all will fit when the holes are drilled. Don't take the backing off the Scotchcal at this stage as once it is stuck down to anything, you can't remove it without damaging the panel.

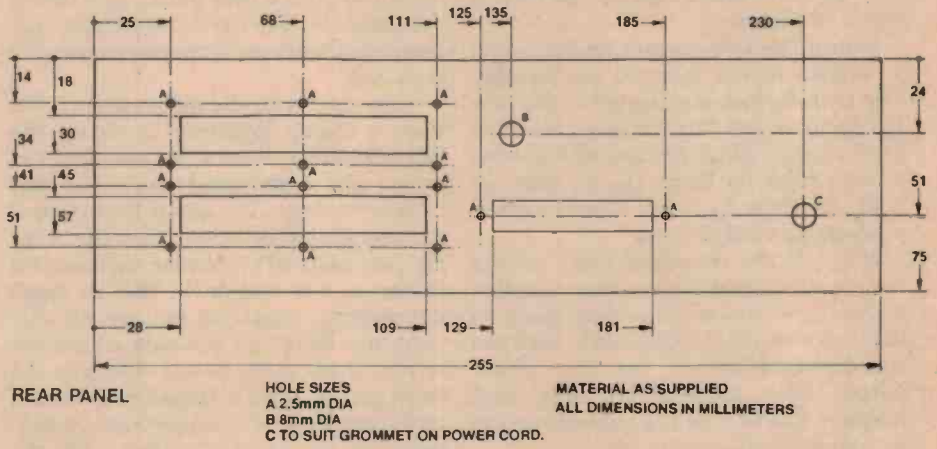
Carefully drill and de-burr all the holes. Slots are cut in the rear panel to accommodate the strips of RCA input/output connectors and the speaker connector strip. These can be cut using a 'nibbling' tool, which requires a single hole to be drilled, or by drilling a succession of holes and filing the edges of the slot straight.

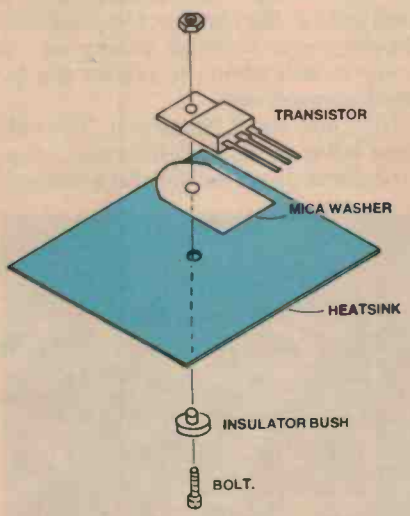
With the front panel drilling completed, the Scotchcal can be positioned and stuck down. Take care, making sure that it is properly aligned. With the Scotchcal in position, mount the front panel components, noting the potentiometers are slightly angled to ensure the centre of their range corresponds to the centre of the knob pointer. The bass control faces upside down to the other controls so that its terminals face away from the power switch. Note that the power and tape monitor toggle switches are sideways operating.

Mount the rear panel components next, making sure there are no shorts between the terminals and the chassis.

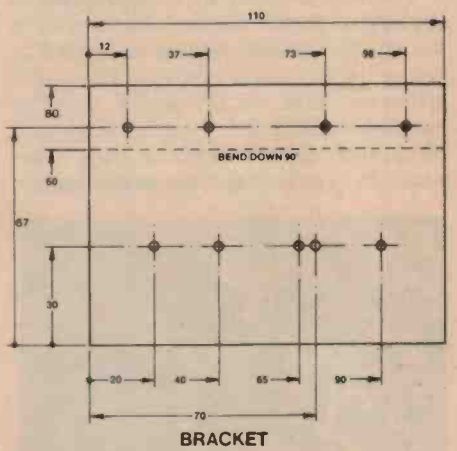
The bottom panel of the case needs to be drilled to suit the transformer mounting holes, mains terminal block ▶

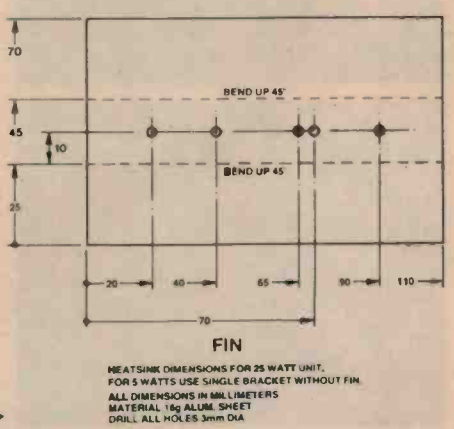






Assembling a flatpack transistor to a heatsink.





and the pc board standoff mounts. With this done, assemble the case leaving the top panel off for the moment. Note that the handles mount over the Scotchcal on the front panel, and that the bottom and top plates of the case overlap the front panel, protecting its edge and improving the overall appearance.

The bottom panel is normally held in place by four self-tapping screws but, owing to the weight of the transformer, we used four small nuts and bolts.

To protect the surface of whatever the equipment may stand on, we attached four 'stick-on' rubber feet to the bottom panel of the case.

Mount the transformer and pc board as shown in the internal photograph. The transformer is mounted in the rear left hand corner, furthest away from the phono stages which are sensitive to hum pickup from its field. The pc board is held in place by four 12 mm plastic push-in standoff mounts.

Now all the interconnecting wiring can be completed. The wiring diagram shows how this is done. Best place to start is with the ribbon cable between the function switch and the input/output RCA sockets. We also used ribbon cable to wire the potentiometers as it makes quite a neat job.

The high level inputs are connected to the source switch via the ribbon cable in which each second wire is connected to earth at the input sockets. The earth wires are then cut off neatly near the source switch. A bit of care in installing the ribbon cable will make a big difference in appearance if not performance.

The two phono inputs are connected to their respective input sockets with shielded cable. Both shields are connected to the pc board and their input socket. One of the shields is then extended to the earths on the high level inputs, but not to the other phono input.

Wire the earth wiring *exactly* as shown in the wiring diagram. The earth for the speakers is returned to the *power supply* end of the pc board and the earth for the inputs returns down one of the phono lead shields. The only connection to the chassis is made near the earth terminal on the rear panel, and this is returned to the earth connection adjacent to the power supply section on the pc board.

Take care with the mains wiring. We used a clamp grommet to secure the cable where it enters the case and the wires are terminated at a two-way terminal block. The earth lead (green/yellow) should be longer than the other two and secured to a solder lug mounted under a nut and bolt. The ac noise suppression capacitor mounts on this terminal block, on the side where the wiring leads to the power switch on the front panel. If your transformer comes with terminals, the suppression capacitor can be mounted there. All the 240 Vac wiring is passed along the left hand side of the chassis. Use spaghetti sleeving or heatshrink tubing on the power switch wiring to protect the exposed connections.

That just about finishes it. The only thing left to do is to carefully check your wiring and then give the unit a test run.

With no inputs and no speakers connected, turn the unit on. The LED on the front panel should light as should the two LEDs on the pc board. With a sensitive multimeter, check the voltage on the output terminals of each channel. You should read no more than 100 mV. Because the output stage operates in class-B there is no bias adjustment.

If all is well, turn the unit off, connect loudspeakers and a turntable or tape deck and you're ready to rock!

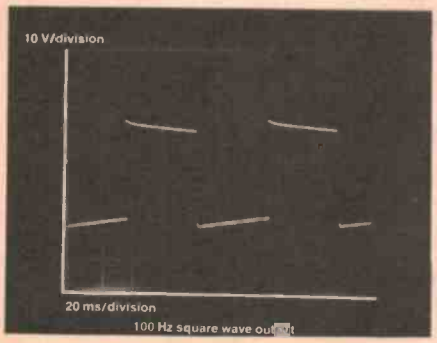
Trials

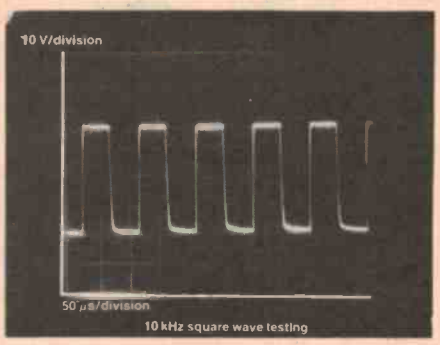
We gave the unit a thorough trial, running it into 'odd' loads etc, running it heavily into clipping and conducting extensive listening tests. The accompanying photographs taken from the oscilloscope in our lab show how the amplifier performs with square wave drive at different frequencies throughout the audio range plus one shot showing the amplifier's output when driven into clipping with a sine wave input. Performance of the unit is clearly very good.

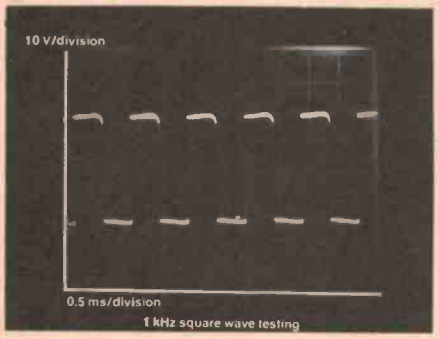
Just to convince ourselves, and you skeptics amongst the readers, we have also included a photograph taken from the screen of a Hewlett Packard model 3580A spectrum analyser we have on loan from Tech-Rentals for some development work (you'll be seeing more about it in the months to come — keep reading!). As you can see, this amplifier has quite a creditable performance.

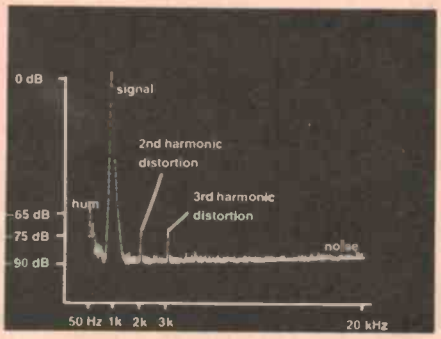
For listening tests we used a pair of our Series 4000/2 three-way loudspeakers in an average sort of domestic environment with a Sansui turntable and Shure M91 cartridge. Overall sound is very clean, with well defined bass and crisp top end and it was obvious that any sonic 'faults' were not contributed by the amplifier. The unit drove the Series 4000/2 speakers effortlessly to levels liable to raise neighbour complaints!

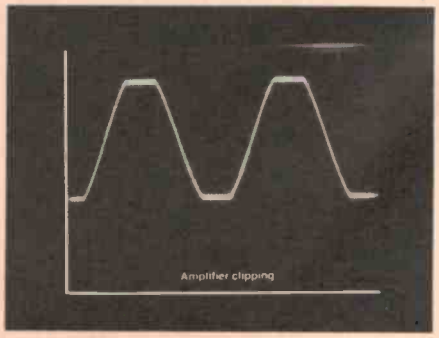
We think you'll be as pleased with the Series 3000 Compact Stereo Amplifier as we are. ●











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If a kit you want to build is not listed, the parts may be available anyway. Check the Dick Smith Catalogue, or call in to your nearest Dick Smith store.

ELECTRONIC MUSIC GENERATOR (See EA November)
Complete kit, including instructions ..... Cat K-3512 $12.50
PCB only ..... Cat H-8382 $1.90

TRAIN CONTROLLER (See EA November)
PCB ..... Cat H-8381 $1.90
All other components for this kit (including case) are normal stock lines

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PCB ..... Cat H-3631 $7.50
All other components for this project are normal stock lines.

MOISTURE INDICATOR (See ETI November)
PCB ..... Cat H-8632 $1.90
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Complete kit, including metalwork, etc. ... Cat K-3605 $75.00
Printed Circuit Board only ..... Cat H-8380 $4.00

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LM3914 IC ..... Cat Z-6295 $4.25
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EA's NEW MUSIC GENERATOR

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ONLY $12.50

Cat K-3512

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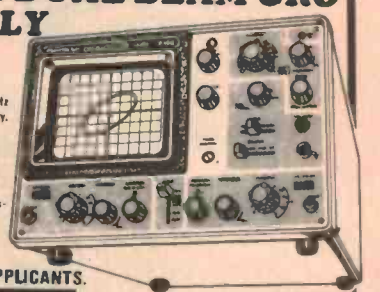

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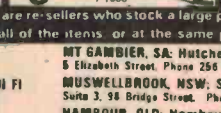

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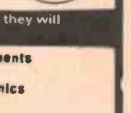

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Listed below are re-sellers who stock a large proportion of our range. However, we cannot guarantee that they will have any or all of the items, or at the same prices, as those advertised on these pages

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BENDIGO, Vic: Sumner Electronics
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BLACKHEATH, NSW: Goodwin Electronics
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BROKEN HILL, NSW: Crystal TV Rentals
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COFFS HARBOUR, NSW: Coffs Harbour Electronics
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DARWIN, NT: Kent Electronics
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The kit is complete to the last nut and bolt with the exception of the uranium. However, this should not be a problem, as the construction article gives full instructions on how to go about stealing your own.

No self respecting terrorist should be without this kit. Come to think of it, if all self-respecting terrorists built themselves a bomb, there would be no self-respecting terrorists left!

NOTE: Life expectancy of bomb constructors is invariably reduced dramatically: like to a few hours or less!

ONLY $19280472.00

NOTE: NO U_{235} SUPPLIED WITH THIS KIT — YOU MUST OBTAIN YOUR OWN!

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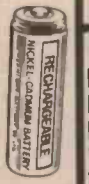

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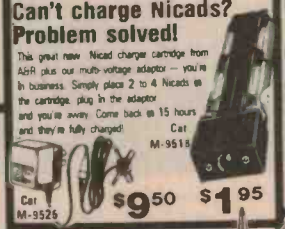

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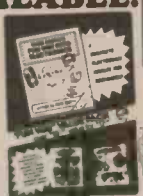

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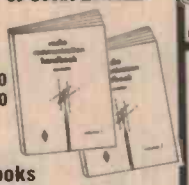

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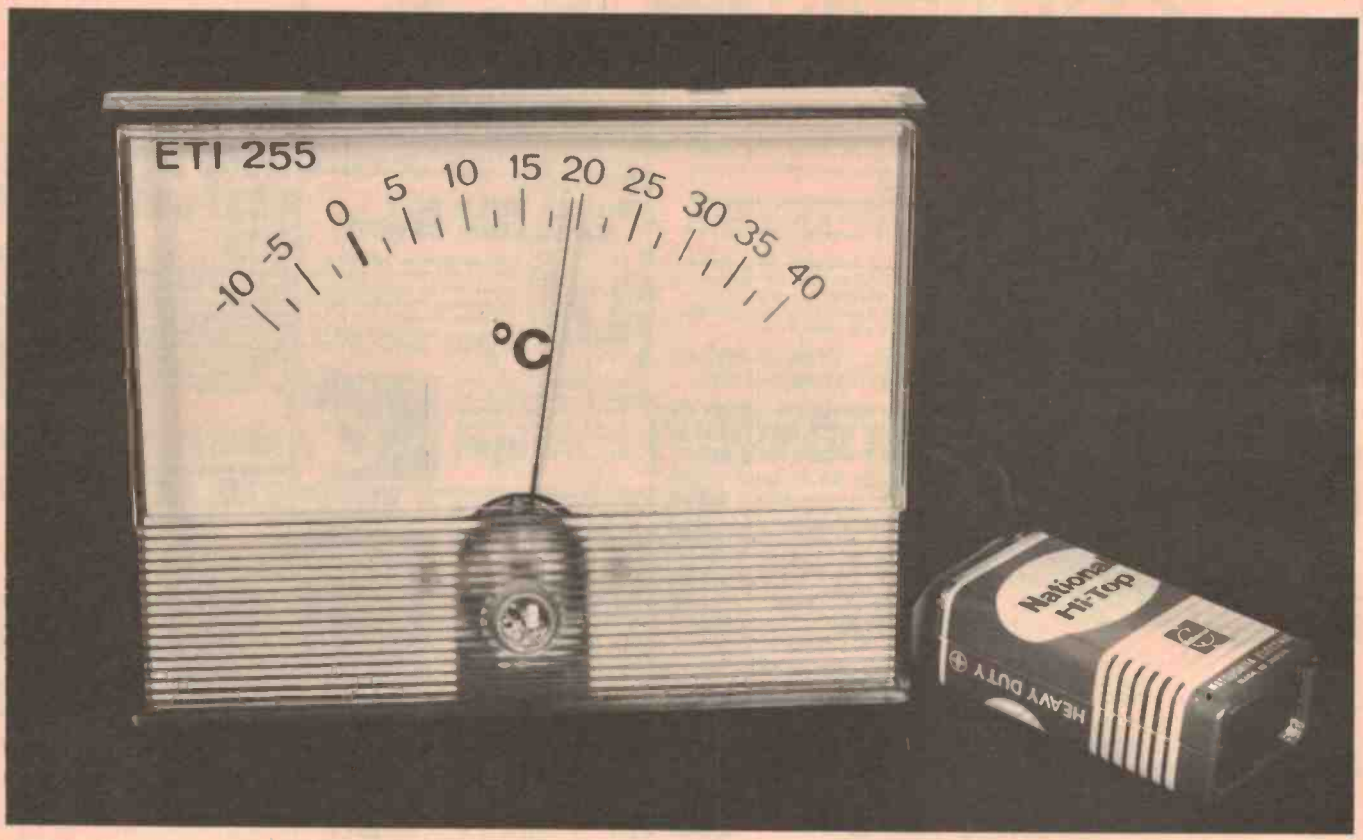


Electronic temperature meter is easy to read and easy to build

Jonathan Scott

This handy little thermometer can be used for local or remote indication of temperatures.

THIS TEMPERATURE meter project can stand alone or you can mount it in a desk top or even in the dash of your car if you don't mind cutting a hole for it. (If you've built all the ETI projects for motorists your dash must look like a piece of swiss cheese by now, so one more hole won't matter!)

Why an electronic thermometer, you may ask ? What's wrong with the ordinary mercury-in-glass type that's been with us for hundreds of years? It's hard to read, that's what. You have to go right up close to see the scale. And mercury thermometers are fragile, too.

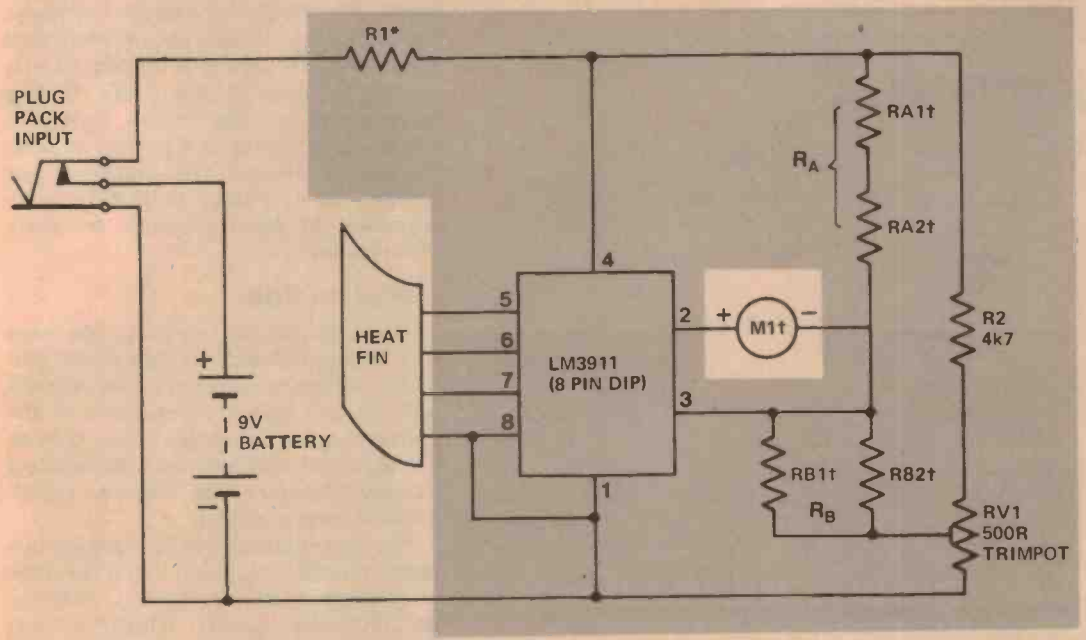
If you want to be able to read off temperature on a nice clear dial you need some kind of electric or electronic sensing element. There are several kinds of sensors you might use, including thermocouples, thermistors and diodes, all of which have their own advantages and drawbacks.

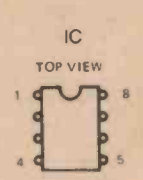
We chose to use a temperature sensing IC, the LM3911, recently introduced by National Semiconductor. There's a more detailed description of it on page 40, but basically it relies on the well-known fact that a transistor's base-emitter voltage varies with temperature — the warmer the transistor gets the greater the b-e voltage.

Because the LM3911 chip includes its own amplifer, it's very easy to use it to drive a meter. Apart from the IC and the meter, the only components in this project are five resistors and a trimpot. By choosing different values of resistors, you can build this temperature meter so that it indicates any temperature range you choose as long as it's between −25°C and +85°C.

We've specified resistor values to make the meter read from −10°C to +40°C, which should be fine for most locations, but in case you live somewhere like Birdsville we've also given values for a temperature range of −10°C to +90°C. But you don't have to stick to the ranges we suggest. Opposite you'll find formulae for calculating the necessary resistance values for any temperature range.

One more useful feature of this project ▶





*R1 = 470R (¼W or ½W) for 9 V operation; 1k8 for 12 V battery (11 - 15 V) operation.
†See table below for resistor values to suit different meter ratings.

HOW IT WORKS — ETI 255

Almost all the functions take place inside the LM3911 chip. Pins 5 - 8 are thermally connected to an internal temperature sensor circuit and transmit the external temperature from a small sheet of copper. The copper fin will generally be at air temperature.

An internal voltage reference, connected between pins 1 and 4, regulates the supply rail to 6.8 volts for the chip and external circuitry. The dropping resistor R1 sets the current to about 3.5 mA, maintaining about 1.2 mA to the IC and about 2.5 mA to the external circuit. It is desirable to keep the current into the IC as low as possible to prevent excessive temperature rise in the chip giving rise to inaccurate readings.

An internal op-amp sinks current from pin 2 in order to hold the voltage on pin 3 at a level which is linearly proportional to the temperature on the sensing pins. The meter, M1, monitors the current into pin 2 giving a reading which is directly proportional to temperature. The resistors R_A and R_B are calculated to give the required zero reading and full-scale temperatures. We have included a table with suitable values as well as formulae so you can roll your own.

The meter reading is linear with temperature and is calibrated to cover the desired range.

The trimpot RV1, compensates for variations between different ICs as well as compensating for temperature rise within the chip.

SUGGESTED VALUES

Range (°C)	Meter F.S.D.	R_{A1}	R_{A2}	R_{B1}	R_{B2}
0 to +100 (note: 85 max.)	100 μA	10k	6k8	27k	270k
0 to +50	50 μA	10k	6k8	27k	270k
−10 to +90	100 μA	8k2	8k2	27k	480k
−10 to +40	50 μA	8k2	8k2	27k	480k
−10 to +40	100 μA	8k2	zero	82k	15k

NOTE: maximum rated temperature is 85°C; minimum is −25°C.

Other temperature ranges can be covered, within the specified limitations of the LM3911, the required range resistor values being calculated from these formulae:

$$R1 = \frac{V_s - 6.9}{0.0035} \quad \ldots\ldots (1)$$

V_s = supply voltage

$$R_A = R_{A1} + R_{A2} \quad \ldots\ldots (2)$$

$$R_B = \frac{1}{1/R_{B1} + 1/R_{B2}} \quad \ldots\ldots (3)$$

Let $T_1 = T_0 + 5$ ..... (4)

using equation (4), calculate 'M'

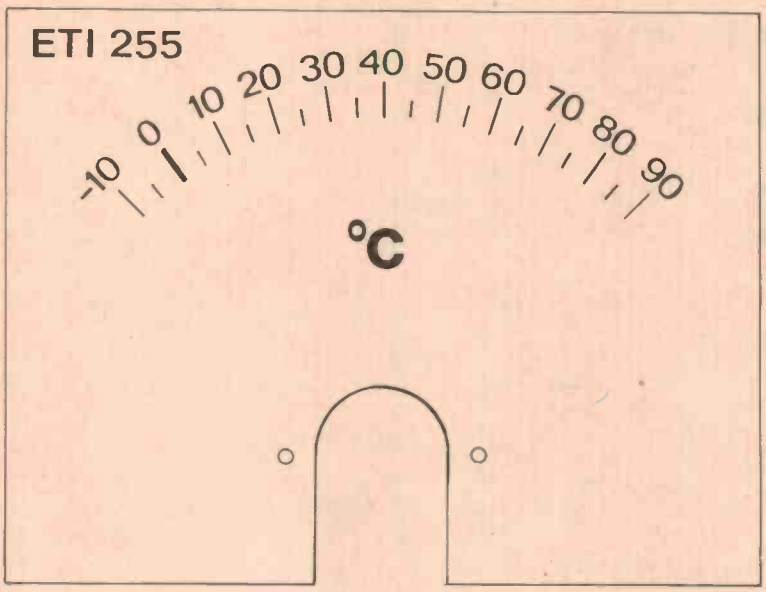
$$M = \frac{T_1}{685} \quad \ldots\ldots (5)$$

where T_0 = zero scale reading in °K
and T (°C) = T(°K) − 273 ..... (6)

$$\text{then } R_B = \frac{10^4}{M.s} \quad \ldots\ldots (7)$$

$$\text{and } R_A = \frac{10^4}{s(1-M)} \quad \ldots\ldots (8)$$

where s = meter sensitivity in μA/°C
(For example; if you choose a 100 μA meter and wish to cover a range of 50°C, then s = 2 μA/°C)



Full size artwork for meter scale covering −10°C to +90°C. Note that the limit for the LM3911 is +85°C.

THE LM3911 — HOW IT WORKS

The LM3911 is a highly accurate temperature measurement IC for use over a —25°C to +85°C temperature range. Fabricated on a single chip it includes a temperature sensor (pins 5 — 8), stable voltage reference (pins 1 and 4) and an operational amplifier.

The output voltage on pin 2 is directly proportional to temperature in degrees Kelvin having a sensitivity of 10mV/°K. By using the appropriate external resistors with the internal op-amp, any temperature range can be selected.

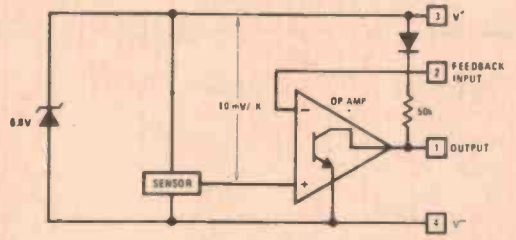
An active shunt regulator across the supply pins provides a stable 6.8 volt reference for the sensing circuitry, and allows the use of any supply voltage with the correct dropping resistor.

The input bias current is low and relatively constant with temperature to ensure high accuracy when a high source impedance is used. The output pin can be returned to a supply up to 35 volts to allow the circuit to drive lamps or relays.

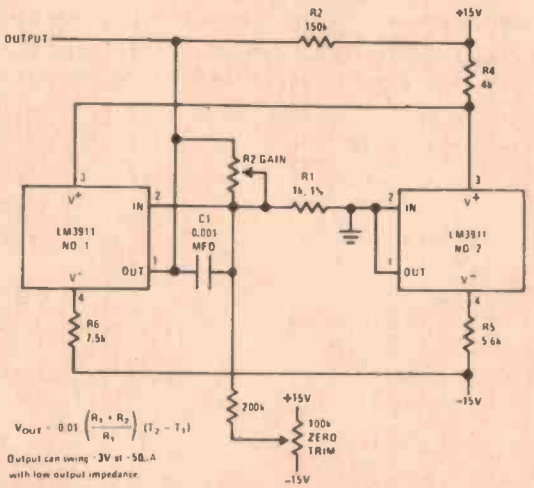
The temperature sensing element uses the difference in base-emitter voltages of two transistors operating at different current densities. Since this output depends only on transistor matching, very good stability and reliability can be obtained.

The op-amp can either be connected as an amplifier to give a linear temperature/voltage output or as a comparator to switch the output at a preset temperature. Therefore, the device can be used either as a measuring instrument or as a temperature controller.

The output can be calibrated for degrees Celsius, Fahrenheit or Kelvin.



Internal block diagram of the LM3911.



*The 0.01 in the above equation is in units of V/°K or V/°C and is a result of the basic 0.01 V/°K sensitivity of the transducer

Two LM3911s can be configured as a differential thermometer.

is that the meter doesn't need to be closely connected to the IC and the rest of the circuitry. You could, for example, have the electronics outside the house and the meter inside, so you could find out how cold it is outside without having to open the door and get chilled. Or less frivolously, suppose you're trying to grow exotic plants in a controlled temperature hothouse, you could use our project as a remote indicating thermometer to keep a check on their environment.

Construction

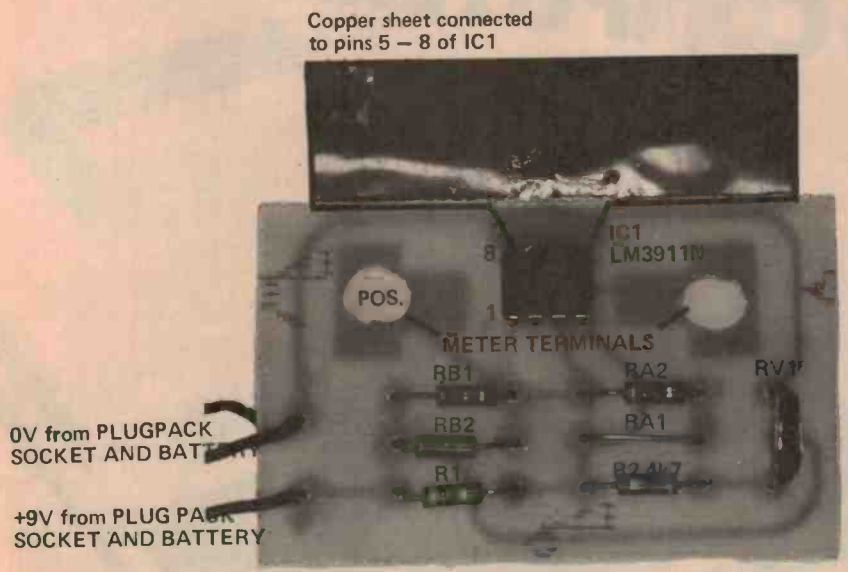
The entire circuit, including the heat fin, is assembled on a small pc board which is then mounted onto the rear of a moving coil meter. Connection to the meter is made by large copper pads on the pc board which can accommodate a variety of meters with different terminal sizes and spacings.

The thermometer can be mounted in a small plastic box, fitted into a car dash or perhaps built into a neat, desk-top unit for the 'shack'. Whichever you choose, be sure to leave a large enough hole in the box to allow free air flow across the heat fin so the meter reads the room air temperature and not that inside the box. If a remote reading unit is required the pc board can be mounted away from the meter.

The first job is to drill the holes into the pc board to suit the type of meter you have. Next fit all the components as shown in the overlay, taking care with the orientation of the IC and the polarity of the battery or power supply connections. The value of R1 is different depending on whether the unit is operated from a 9 V supply (battery or plugpack) or a 12 V supply (vehicle battery or plugpack). Values are beneath the circuit. The values of R_A and R_B are selected from the table for the required temperature range and meter used. Note that R_A consists of two resistors in series (R_{A1} and R_{A2}), while R_B consists of two resistors in parallel (R_{B1} and R_{B2}). Either 2% tolerance or selected 5% tolerance metal film resistors should be used for the sake of accuracy.

Power from a plugpack is applied through a shorting type socket so the unit can be battery operated when the plugpack lead is removed.

The 50 mm by 20 mm heat fin is cut from a small piece of 0.25 mm thick copper shim. Solder it to the pc board track connected to pins 5 - 8 of the IC (see overlay photo). A larger size fin may be used, but we found this one works nicely. In fact, the circuit will work well without any heat fin, but has a longer response time. Make sure the



Rear view of the instrument showing general assembly. You may prefer to use a rechargeable NiCad type, rather than the dry battery shown, for battery operation of the unit.

fin is not touching any other part of the circuit.

Finally, fit the meter after cleaning the meter pads on the pc board. The spring washer supplied with the meter should be assembled on the copper side of the board so it digs into the surface of the copper for good contact. If this is not done the meter connections may become a high resistance when the copper tarnishes after use.

PARTS LIST — ETI 255

IC1	LM3911N
R1	470R or 1k8
RA1	See table
RB1	"
RA2	"
RB2	"
R2	4k7

All resistors should be 2% or selected 5%, ¼W or ½W metal film types.

RV1	500R miniature vertical mounting trimpot
M1	50 or 100 microamp meter (to suit range). University TD 106 or similar.

ETI-255 pc board; case (if required); plug pack adaptor socket and 9V Plug Pack (Ferguson PPA-9/500 or similar); 9V battery (No. 216) and battery clip if required; small piece of 0.25 mm shim copper.

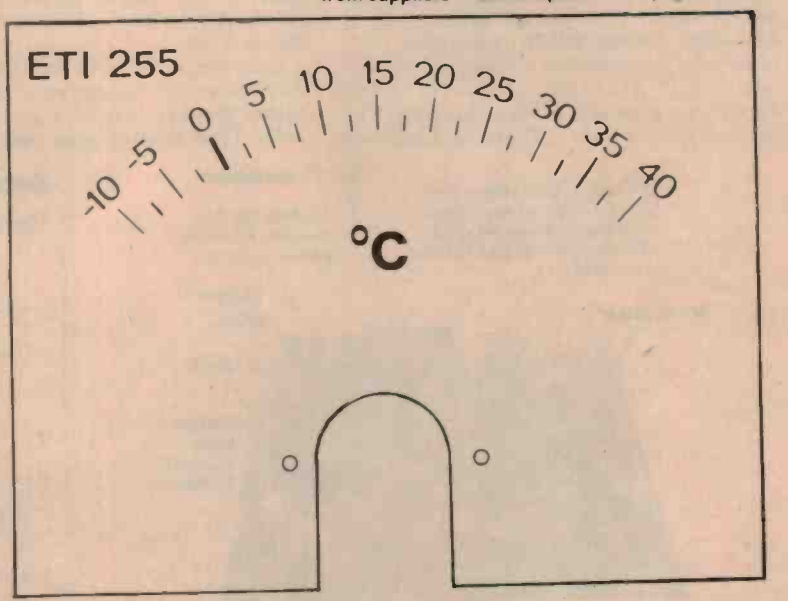
Apply power and adjust the zero set trimpot which should be capable of adjusting the reading about +/−10°C.

Calibration

Place the unit and a reference thermometer (choose a good one) in a cool place close together and after a few minutes note the difference in readings. Adjust the trim pot for the correct reading.

Two different meter face scales have been included for two temperature ranges, —10°C to 40°C and −10°C to 90°C. Values have also been calculated for 0°C to 50°C and 0°C to 100°C scales to allow standard scales on 50 μA and 100 μA meters to be used. ●

Full size artwork for meter scale covering −10°C to +40°C. Scotchcal meter scales will be available from suppliers — see Shoparound on page 83.



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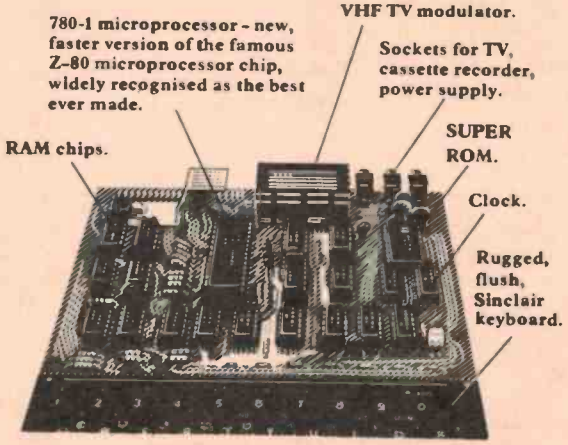

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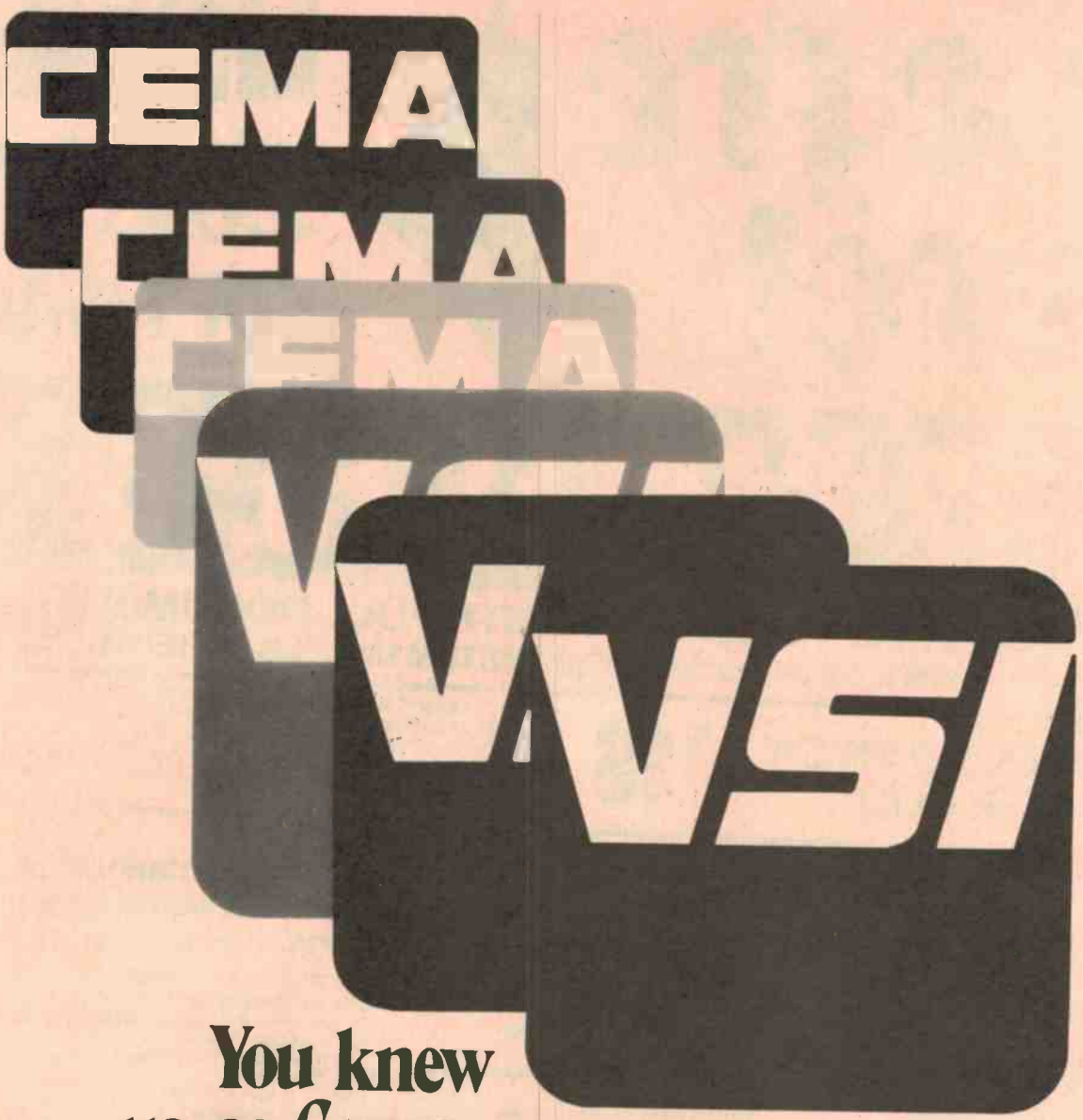

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Electronic Odometer

F.O. Eliason

THIS DEVICE, which is inexpensive and easy to build, will measure accurately how far a vehicle has travelled over the ground. It is of particular interest to persons who want to know accurately how far they have travelled down any of the thousands of unmarked bush tracks in Australia.

The device works by counting the revolutions of the back wheel of the vehicle using a phototransistor which looks at a white strip painted on the tyre. Signals from the phototransistor are processed in an integrated circuit to provide pulses at high enough level to operate a relay. Counting is achieved by making the relay operate in parallel with a function key on a cheap electronic pocket calculator.

Overall view of my odometer. The calculator and electronics are attached to a chipboard base. The phototransistor sensor is mounted on the wheel guard and connects via shielded cable.

The Circuit

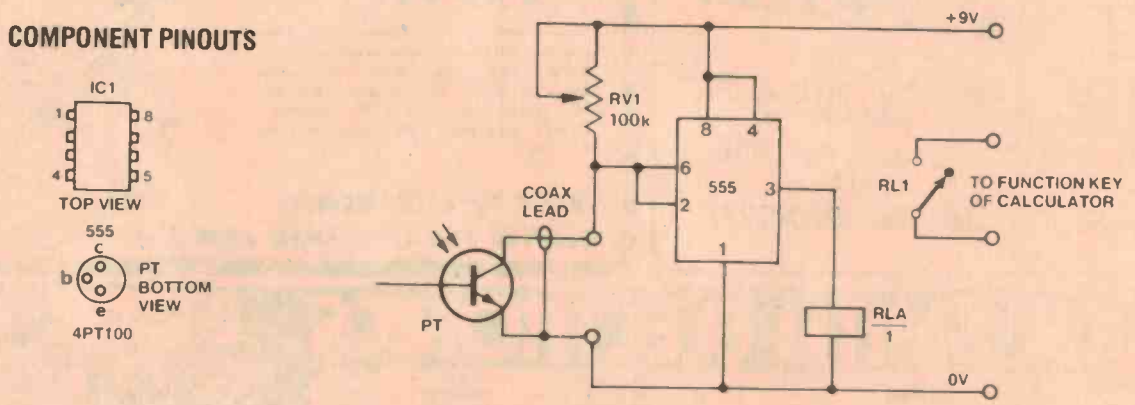
A 555 is connected to operate in the monostable mode as shown in the circuit. Its operation is controlled by a phototransistor type 4PT100 which has excellent sensitivity. The base connection of the phototransistor is not used.

Under "dark" conditions the collector-emitter resistance of the phototransistor is high and this holds the 555 in the 'off' state (pin 3 low). When the phototransistor is illuminated its resistance falls and the voltage at pin 2 falls. When this reaches about two thirds of the supply voltage, pin 3 is switched to the high state. Potentiometer RV1 provides control of the triggering point of the 555, permitting adjustment of the level of lighting which is to trigger the device.

The output from pin 3 operates a small reed relay. This can be any small relay with a coil resistance greater than 60 ohms. The type used was a Marble MEL 400, available from Dick Smith.

A Tandy pocket calculator type EC-201 was chosen to do the counting because successive unit additions or subtractions can be achieved by the operation (after setting up) of one function key, in this case the (=) key. Not all cheap calculators have this "totalling" facility. The contacts of the reed relay are parallelled across this function key.

Care has to be exercised when opening the calculator to ensure that the four moulded locking tags are not broken off. When opened, peel the sheet of switch retaining plastic back from the area of the = switch and solder two 100 mm long tails to the printed circuit runs leading to each side of this



The circuitry is simplicity itself. The potentiometer (RV1) provides control of the triggering point of the 555. The function key you use on the calculator will depend on the make — the Tandy EC-201 (like most) will totalise using the = key, others employ the + key.

switch. Spend some time preparing the surface and ensure that a good soldered joint is made.

The switch board inside the calculator sits on four plastic spigots and a way has to be found to get the board back onto these spigots while closing the case, otherwise there might be problems with the relative positioning of the keys on the case and the switches on the printed circuit board. When you have closed the calculator I suggest that you secure the wires to the case with epoxy glue to take the strain off the soldered connections.

The sensor assembly is shown in the photograph. It is made of 23 mm square-section lightweight steel tube with a flange welded to it to match the turned-in flange of the mudguard. It is secured to the mudguard by two self-tapping screws.

One end of the tube is sawn off at an angle to give an end parallel to the tyre. The other end is drilled and a small steel tube welded over the hole to form a gland. The purpose of the gland is to take the strain of the cable off the electrical connections of the device inserted into the tube and to make it watertight. When mounted, the sensor is no more than 20 mm from the tyre.

The phototransistor, which incidentally can be obtained from Tandy, and terminals were fixed to a strip of paxolin and slipped into the sensor tube and sealed in place with silicone rubber. To eliminate the effect of glare, a small plastic tube, painted with matt black, was slipped over the phototransistor and held in place with silicone rubber. The coax lead was fed through the gland and soldered to the terminals. The gland was then sealed with epoxy glue and the sensor tube was sealed with silicone rubber.

A point which must be taken into consideration is movement of the wheel vertically with respect to the mudguard (when the vehicle is laden or when it lunges). The ideal mounting point for the sensor is at 3 o'clock. Thought should also be given to covering the end of the sensor tube with clear plastic to keep it free from dust and water.

The few components used in association with the calculator were mounted together with the calculator on a wooden board as shown in the photograph. In the arrangement shown, the calculator and relay circuit each have their own nine volt batteries.

Setting up

Test the circuit in stages during construction. Set RV1 to mid position to start with and adjust it subsequently to take account of the light level. The unit is so simple that there is really nothing else to do. This unit has been used at speeds up to 50 kph but it might do a lot more and be of some interest to rally drivers. Cyclists might even be interested. I built my system to help me find my way to remote gold mining sites located in the depths of State forests.

The advantage of using a calculator to do the counting is that, apart from being ready-made, it will allow a constant to be keyed in so that it will display the exact distance travelled in yards, metres, miles etc., instead of just wheel revolutions. ●

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Soil moisture indicator

Phil Wait
Simon Campbell

Don't drown your plants or dry them out! Take some of the guesswork out of watering with this handy little instrument.

EXPERT GARDENERS can tell by touch when their plants have too little or too much water, but the rest of us could use a little help sometimes. This instrument makes use of the fact that the resistance of soil decreases as the soil gets wetter. A constant current is fed through the soil between the two electrodes of a probe and the voltage drop between them is measured. A line of five light emitting diodes is used to give a simple and robust indicator of the moisture content which can easily be recalibrated to suit different soil types.

For this kind of measurement to work, it is important that both of the electrodes are made of the same metal. Dissimilar metals will set up a small electrochemical cell, generating a voltage which can upset the reading.

Soil and circuitry

If you take an ohmmeter and insert the probes into the soil quite close together the resistance reading you will obtain can vary from as little as 3 k to several megohms. The reading will depend on a number of factors: the distance between the probes, soil density, acidity/alkalinity of the soil, surface area of the probes and the moisture content of the soil. Dissimilar metals in the probe affect the reading as previously explained. If the physical dimensions of the probes are fixed in some way then the greatest variation in soil resistance will be due to the moisture content of the soil. Quite large variations in soil density will have less effect, surprisingly enough.

At first thought, it seems a common moving coil meter could be used in a simple ohmmeter-type circuit. However, with pointer-type displays, non-technical people using the device tend to worry about quite minor variations in the position of the pointer

With the probe in 'soggy' soil, only the top LED will light. In 'wet' soil, the top two LEDs will light — and so on until, with the probe in 'parched' soil, all LEDs will light!

— even if the scale is only calibrated in gross sections. (This gives rise to comments such as: "The needle is two millimetres further up the scale than when I took a reading this morning"). Secondly, the device should be inexpensive and rugged. Whilst we're not accusing gardeners of being clumsy, one must recognise that accidents do happen and few low cost moving coil meters would survive a one metre drop onto a hard floor!

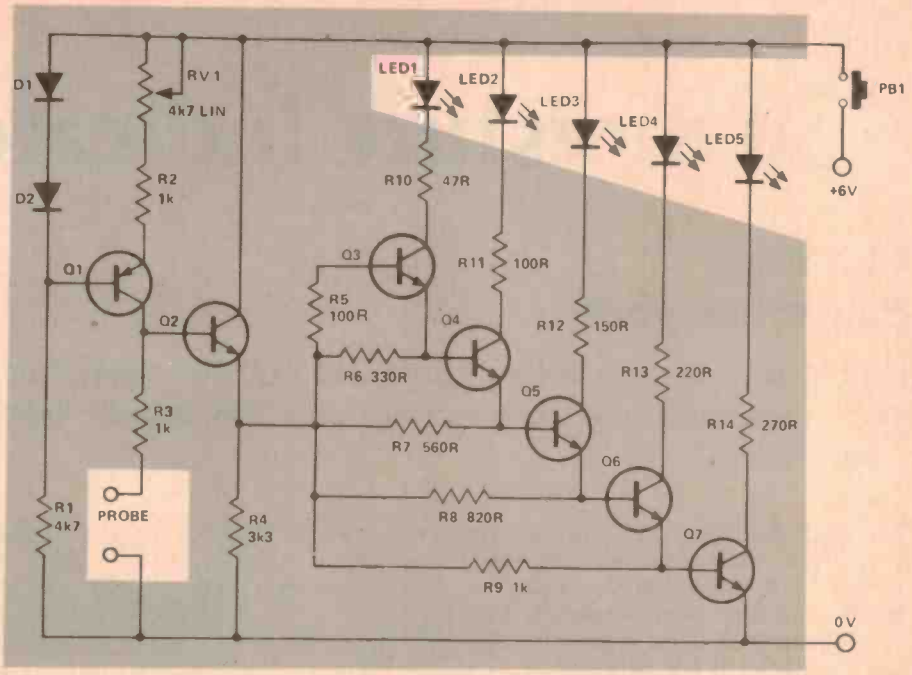
We opted for the 'all solid state' approach and chose to use an LED display arranged as a sort of bargraph. The resulting project is quite a rugged instrument that gives repeatable results, is easy to build and inexpensive. The unit is powered by four AA cells.

The probe problem was neatly solved ▶

using a standard 6.5 mm jack plug. The circuit passes a constant current through the soil via the probe and the resulting voltage drop across the probe connections drives the LED display circuitry. This consists of a series of transistors that turn on in turn as the voltage across the probe connections rises with increasing soil resistance. If the soil is quite dry, all LEDs will light, if the soil is 'soggy' only one (LED5) will light. At this juncture, we should point out that the front panel lettering showing "soggy-wet-moist-dry-parched!" is a little tongue-in-cheek but it does give a general guide as to what the display indicates.

Construction

Our unit was housed in a plastic zippy box measuring 150 mm long by 90 mm wide by 50 mm high. This is a convenient size and the completed unit is easily held in one hand while the probe is inserted into the soil with the other hand.



HOW IT WORKS — ETI 247

The electrical resistance of soil varies primarily with the moisture content. The greater the moisture content, the lower the resistance. If a constant current is passed through two electrodes inserted in the soil, the voltage drop occurring across the electrodes will vary with the soil resistance, increasing with increasing resistance. This fact can be used to indicate moisture content of the soil in conjunction with a suitable display.

The circuit employs a constant current generator to pass current through the probe contacts via the soil. The voltage across the probe contacts is then buffered by an emitter follower which drives the display circuitry. This consists of five transistors, the collectors of each driving a LED, each transistor being connected to turn on successively as the voltage across the probe contacts increases with increasing soil resistance. A block diagram is shown in Figure 1 here.

Transistor Q1 and associated components provide the constant current source for the probe contacts. Figure 2 shows the collector characteristics of a typical silicon transistor. They show that, if you hold the base current constant, the collector current will remain substantially constant for a widely varying range of collector voltage. Figure 3 shows the general circuit of a constant current generator. The voltage between the base and the emitter return (common, the +ve supply line here) is fixed by the zener diode. Thus, the voltage across the emitter resistor (Ve) is fixed at a value equal to the zener voltage (V_Z) minus the base-emitter voltage drop of the transistor (0.6 V for silicon transistors). With a fixed voltage across R_e, the current through it will be constant. Thus, the emitter current, and therefore the collector current, of the transistor will be constant. The resistor supplying current to the zener is generally chosen so that zener current is five to ten times greater than the base current of the transistor.

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

In the project circuit diagram, two forward-biased silicon diodes are used to 'clamp' the base voltage of Q1 to about 1.2 volts below the positive supply rail. Thus, the voltage across RV1/R2 will be about 0.6 V. The collector current can be adjusted by RV1 between a maximum of 600 μA and about 100 μA minimum.

The collector of Q1 drives the probe contacts via R3. The collector voltage of Q1, which varies with the variation in soil resistance across the probe contacts, drives the base of Q2, which is connected as an emitter follower. The emitter load of Q2 (R4) will thus have a voltage across it directly proportional to the collector voltage of Q1, less the 0.6 V base-emitter voltage drop of Q2.

The voltage across R4 then provides drive to the bases of the display transistors Q3 to Q7.

When the voltage across R4 reaches about 0.6 V, Q7 will turn on and LED5 will light. Now, the emitter of Q6 is connected to the base of Q7 and 'rides' up on the base-emitter voltage of Q7. The voltage across R4 will have to reach 0.6 V above the base-emitter voltage of Q7, or 1.2 V, before Q6 will turn on, lighting LED4. Similarly, the emitters of Q5, Q4 and Q3 each ride up on the base voltage of the previous transistor and the LEDs will light in turn as the voltage across R4 exceeds successive 0.6 V increments. Thus, LED3 will light when the voltage across R4 reaches 1.8 V, LED2 will light when it reaches 2.4 V and LED1 will light when it reaches 3.0 V. The voltage across R4 will be maximum when there is a high resistance across the probe contacts and thus all LEDs will light when the soil in contact with the probe is dry. When the soil is quite wet, the voltage across the probe contacts will be low and the current set by RV1 should be just sufficient to permit LED1 to light.

Resistors R5 to R9 inclusive limit the base current of the display transistors while resistors R10 to R14 limit the current passed through the LEDs. Resistor R9 is a higher value than R5 so that excessive base current does not occur in Q7 as the voltage across R4 increases. Resistors R6 to R8 are successively higher in value than R5 for the same reason.

The collector currents of transistors Q3 to Q7 will vary with the variation in base current as the voltage across R4 rises and falls. Thus, resistors R10 to R14 have values chosen to limit the maximum current through the LEDs to about 10 - 15 mA.

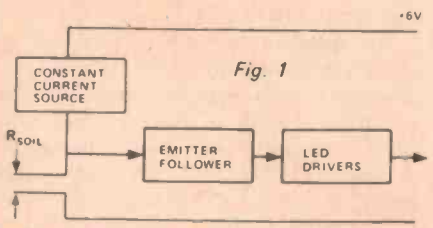


Fig. 1

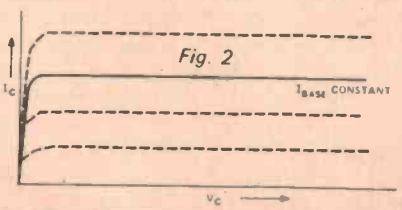


Fig. 2

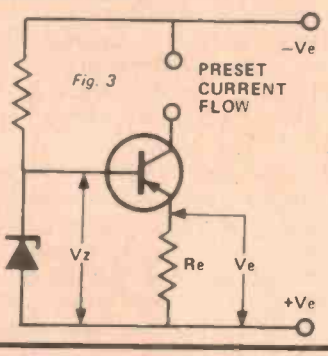


Fig. 3

PARTS LIST — ETI 247

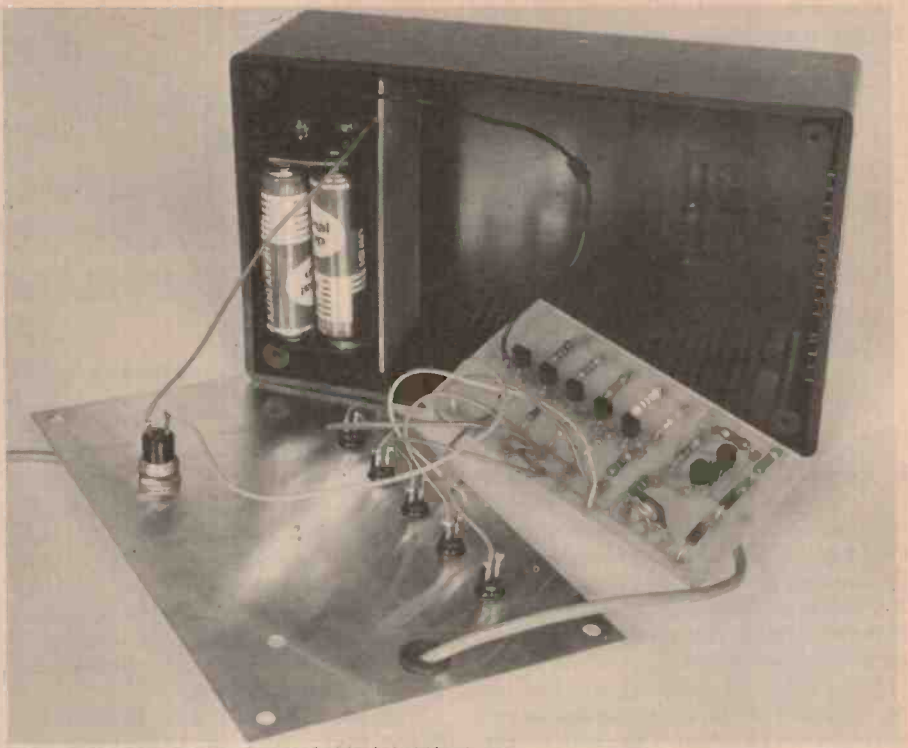
Resistors all ½W, 5%
- R1 ..... 4k7
- R2,R3,R9 ..... 1k
- R4 ..... 3k3
- R5,R11 ..... 100R
- R6 ..... 330R
- R7 ..... 560R
- R8 ..... 820R
- R10 ..... 47R
- R12 ..... 150R
- R13 ..... 220R
- R14 ..... 270R

Potentiometer
- RV1 ..... 4k7 min. vert. mounting trimpot.

Semiconductors
- D1,D2 ..... 1N4148 or sim.
- Q1 ..... BC557, BC 177 or sim.
- Q2-Q7 ..... BC547, BC107 or sim.
- LED1-LED5 ..... any LED, TIL220R or sim.

Miscellaneous
- PB1 ..... momentary push button switch

ETI-247 pc board; four AA batteries with holder; mono phono plug for probe; Pentel pen type R56 for probe handle (or similar); plastic zippy box to suit.



Internal view. Note how the battery holder is held in place.

The five LEDs and the pushbutton switch are mounted on the aluminium front panel and the probe lead is passed through the panel via a grommeted hole. Another hole in the panel provides access to the SET trimpot so that the unit can be readily calibrated.

All the other components are mounted on a pc board which fits neatly across the box, held in place by the grooves on the walls which are readily seen in the internal photograph. Although this project could be constructed on matrix board or tag strips, we recommend you use the pc board as it helps prevent wiring errors.

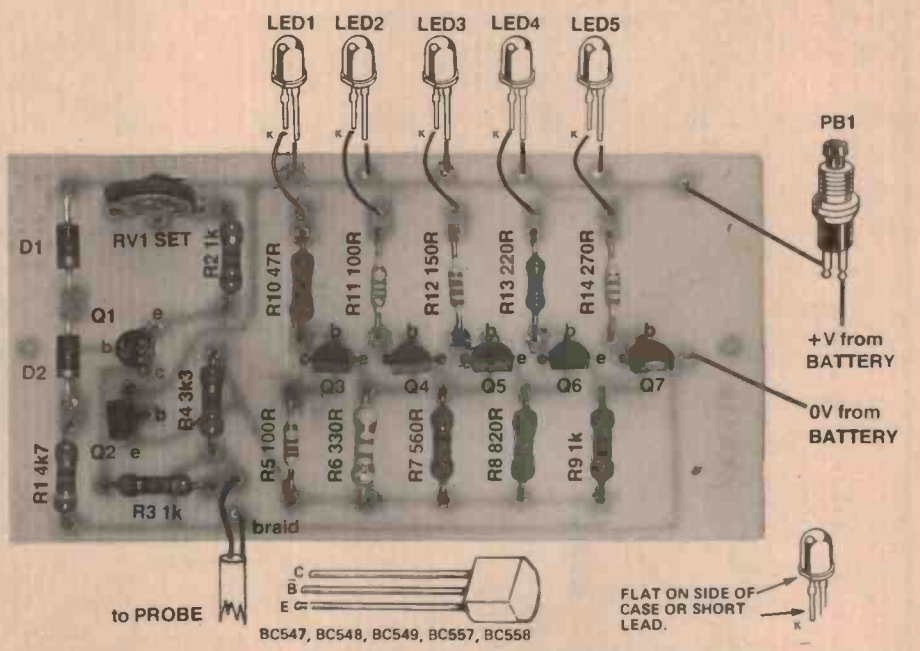
The probe is constructed using a standard 6.5 mm phono jack plug which ensures a constant distance between the electrodes, a uniform contact area to the soil and electrodes of similar material. A ballpoint pen barrel serves as a handle. A piece of pc board with two strips of copper to act as electrodes could equally well be used, but it would be necessary to have the electrodes plated to prevent corrosion which would adversely affect the operation of the project.

It is best to commence construction by drilling the holes in the aluminium panel. We have reproduced the front panel artwork here and you can use that as a guide. There are eight holes altogether. The hole which provides access to the SET trimpot is 4 mm in diameter while all the rest are 6 mm in diameter.

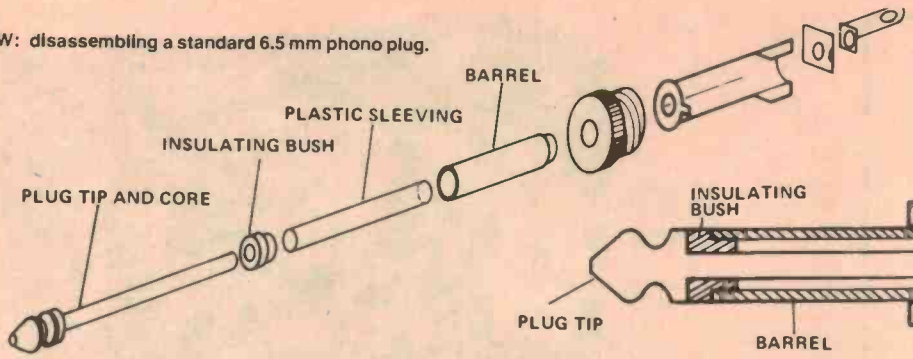
We dressed up our project using a Scotchcal front panel. This gives the unit a permanent finish and a 'professional' appearance. If you are using a Scotchcal front panel then this should be attached to the aluminium panel before any components are mounted on it. Scotchcal panels for this project should be available from a number of suppliers — see Shoparound on page 83.

The next thing to do is trim the pc board to size so that it fits into the box without jamming. You might strike it lucky and find it fits without trimming, but if not, file one end of the board until it slides neatly into place. Using the pc board as a template, mark and cut a scrap of pc board or aluminium sheet to size to act as a retainer for the battery holder. ▶

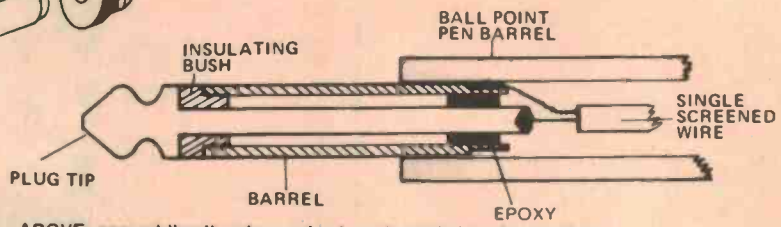
Component overlay for the pc board and external wiring.



BELOW: disassembling a standard 6.5 mm phono plug.



CONSTRUCTING THE PROBE



ABOVE: assembling the phono plug barrel and tip into the pen barrel.

Mount the components on the pc board next, using the component overlay here as a guide. Take care with the orientation of the transistors and the two diodes. Most common small signal transistors will work in this circuit, but if you use a type different to that specified then check the pin connections to ensure correct orientation on the board.

The LEDs and pushbutton switch can be mounted on the front panel now and wired to the pc board. Take care to wire the LEDs correctly. A grommet should be mounted in the hole through which the lead to the probe passes. The probe lead is passed through this hole and wired directly to the pc board. Next wire the leads to the battery holder, making sure you have the polarity correct, insert four AA cells and mount the battery holder in place. Note that the retaining piece securing the battery holder in the zippy box should not be the full depth of the box to allow the battery leads to pass between its top edge and the front panel.

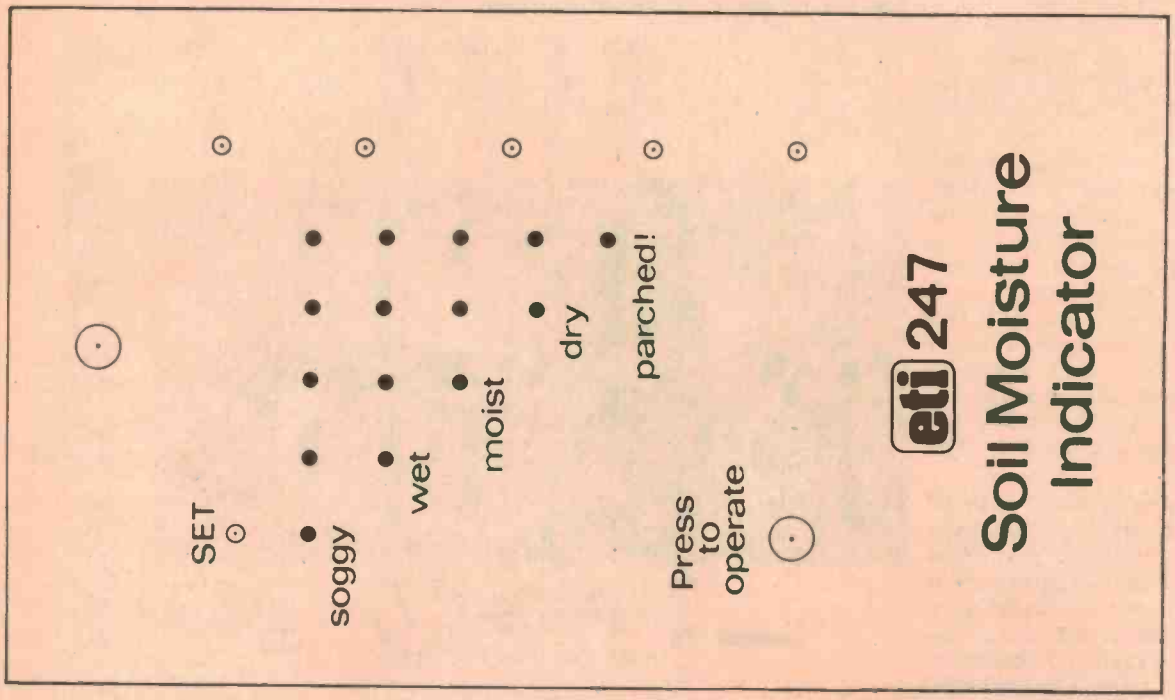
The probe can be constructed next. The exploded diagram here shows how it's done. We cut the ends from an exhausted type R56 Pentel ball pen and used the empty barrel as the barrel of our probe. The 6.5 mm phono jack plug is a neat fit inside the barrel.

Pass the shielded wire through the barrel and solder the end to the jack plug connections as shown in the diagram. Be careful to avoid short circuits between the braid and inner conductor of the cable. Don't use too much heat or the insulation on the inner conductor of the cable will melt back up inside the braid and you may get intermittent short circuits.

At this stage you can do a dry run (pardon the pun . . . Ed.). Press the pushbutton and most or all of the LEDs should light. If not, try adjusting the SET trimpot. If you still have no joy, check your wiring and the orientation of components on the pc board.

Setting up

The unit needs to be set to give the correct indication. Set up a few pots with earth 'as you like it', ensuring one is thoroughly dry and one is thoroughly wet. Insert the probe in the wet soil and adjust the SET trimpot so that only the top LED (LED 5) lights. Then insert the probe in the dry soil and see that all the LEDs light. Try the probe in soil of varying wetness and you'll get a good idea of how to interpret the display. After all, correct interpretation of the indication is just as important as the operation of the unit. Once set, the unit should not require any further adjustment. ●



Full size reproduction of the front panel artwork. Scotchcal panels will be available from suppliers — see Shoparound on page 83.

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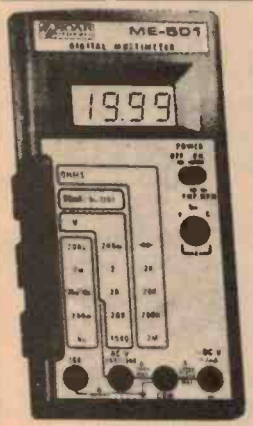

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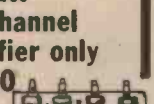

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4. With rack mounting case and 'C' core transformer $219.00
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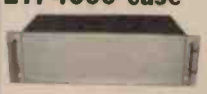
6. With rack mounting case and toroidal transformer $241.00

No change is needed to amplifier circuitry to add the 'C' core or Toroidal Transformers. They are both rated at 28–0–28 volts/2 Amps on secondary and could be used in many applications where A.C. hum, or in the case of the toroidal, where size is also a problem. (Save up to $70 on locally produced toroidal transformers.)

Rack mounting ETI 4000 case



Beautifully designed (supplied in flat pack), satin anodised 1.6mm aluminium front and back panels, with surfaces suitable for screen printing etc. Top and bottom panels of hard wearing black "marviplate" with 1.0mm steel base. Side panels 3.0mm satin anodised aluminium with chrome handles.

Four aluminium extrusions are used to hold the top, bottom, front and back panels in position.

Size: 134mm(h) x 419mm(w) x 280mm (d) $55.00

Slimline Amplifier Case

Same as used in description on ETI4000 Rack mounting case with overall dimensions: 89mm(h) x 413mm(w) x 289mm(d). – They come with wooden sides or for Rack mounting.

Wooden sided version $42.00
Rack mounting version $49.90
– beautifully constructed.

Wooden-sided case

Exactly the same size and same materials as used in ETI4000 rack mounting case, except side panels are made of teak wood (13mm) for a really superb looking case.

ONLY $45.00

60W Low Distortion Amplifier Module Kit (ETI470)

Complete 60 watt amplifier module kit (as used in ETI4000 amplifier). Absolutely everything including heat sinks and all hardware. Features very low distortion and very simple mechanical construction. Can be used to replace existing amplifier modules and bring your present system up to scratch.

..... ea. $28.90

ETI 471 High Performance Stereo Pre Amp Control Kit

Designed to complement 60 watt ETI470 modules, but is such an exceptional design it can be used to update existing systems or incorporate in new designs, as it has features unheard of in other pre-amp designs, e.g., all connections through RCA sockets and controls going direct to PCB. Everything designed for high performance. Power requirements: +15, –15 Volts DC at less .5 Amp

..... $47.90

ETI 472 Power Supply Kit

As used in 4000 Amplifier. From 240 V A.C. input gives out + and – 40 volt rails to supply power to amplifier modules. Also gives out + and – 15 volt rails for pre-amp supply. Kit comes complete with transformer.

- with Standard Transformer .. $47.90
- with "C" Core Transformer .. $57.90
- with Toroidal Transformer .. $79.00

Separate Components for 4000 Amplifier

All components are available separately for the ETI4000 Amplifier.

- ETI470 PCB $3.50
- ETI471 PCB $9.50
- ETI472 PCB $4.50
- BDV64B $3.56
- BDV65B $3.56
- Washers and bushes for BDV64B/65B (Set of 4) $1.45
- Front Panel (drilled) $15.00

Transformers

TOROIDAL TRANSFORMER

Beautifully engineered toroidal transformer 240V primary to two 28 volt secondary windings at 2 amps.

This will give a DC rail voltage of 40 volts plus and minus after your power supply – the exact voltage used on innumerable pieces of audio equipment.

Excellent when used in slimline amplifier cases as is the trend now.

Not to mention the excellent low hum figures encountered with these types of windings – that's why all $1000–$5000 amps are using them.

Grab one before they all go at only $59.90 ea ... comparable ones are over $130 ea.
(size: 40(h) x 100(diam)mm approx.)

"C" TRANSFORMER $26.50

300 WATTS!

Playmaster 300W Amplifier Module Kit

(EA June '80)

The full technical know-how of the 'Electronics Australia' staff has been put into designing this superb project.

The 300 Watt Amplifier Module Kit includes heatsink, thermal cut-out, nuts, bolts, silicon grease, mices, solder ... all you need is a soldering iron, screwdriver, a pair of cutters, drill ... and Stanley knife ... and it's a good idea to have a trusty multimeter ... (we have them from $9.50)

..... MODULE KIT ... $75.00

Power Supply to suit 300W Playmaster

... INCLUDES TRANSFORMER & all necessary components to make up power supply kit complete.

..... $52.95

Power Transformers

to suit Playmaster 300 Watt Amplifier

..... $32.50

Sprite Fan (4") 240V a.c.

Recommended by EA for this project.

..... ONLY $29.50

Chassis & Hardware Pack

300WATT P/M (EA July 80) (Less Case & Fan).

If you have made the amp module, the speaker protector and wish to put them all into a case with the power supply, then you'll need this pack to finish everything off. It includes LED, binding posts, switch, extra resistors and capacitors, wire, front label, nuts, bolts and spacers.

..... ONLY $9.95

Case The ideal case for this amp is the rack-mounting ETI4000 Case for $55.00 or wooden sided ETI4000 Case for $48.00 (shown elsewhere in this ad.)

MATT BLACK SPRAY .. 125gm can $2.50

P/M 300W Loudspeaker Protector Kit

(EA July 80)

For an amplifier of such enormous power output this "loudspeaker protector" is mandatory. If you don't want your loudspeakers destroyed and it only costs $12.95
(includes PC board and all components)

Sick of making audio kits?

Well – here's your answer ... buy a beautifully made slimline tuner already constructed or superb direct drive turntable ... both manufactured by one of the most respected hi fi makers in the industry – HITACHI.

HT-40S Direct Drive Turntable

Engineering at its best.

Specs: 2 speed, S/N Ratio 75dB, adjustable speed change with inbuilt strobe. – speed deviation .003%

Frequency response (with Dual MT-35 Cartridge – INCLUDED ... 10–25,000Hz.

..... ONLY $189.00

FT-3400 AM/FM Stereo Tuner

FM SECTION 88–108MHz, sensitivity–1.0μV (75Ω). Frequency response 30 to 15,000Hz, stereo separation 45dB, 300Ω or 75Ω antenna.

AM SECTION 530–1605 kHz, 15μV sensitivity, signal to noise ratio 53dB.

..... ONLY $179.00

ETI 455 Speaker Protector

Because of the modern trend to use dc coupling in the output stages of modern amps the speaker becomes very prone to accepting a high dc voltage.

The answer of course is to build a "speaker protector" and one of the best is our ETI455 Kit (March 80 ETI) for only $26.00

– Supplied in short form (less case) to enable you to put it into your existing amp.

Brighten up your stereo speakers

Add a pair of Philips AD0162/T8 Tweeters (with crossover capacitors included).

..... ONLY $30.30 PAIR

– You'll be amazed at the high frequencies you never knew were there.

Audio Crossover Chokes

Top quality, air-cored, high powered, low DC resistance crossover chokes.

Following many requests from our customers we now have these chokes so that you can design your own cross-overs.

0.8 millihenries $7.00
1.0 millihenries $7.00
2.5 millihenries $7.50

ETI 438 LED Level Meter

Features eight LEDs which tell you exactly what power you are emitting and whether you are clipping (exceeding power ratings of amp). A very simple kit to construct and requires 20–32 V d.c. or 15-20V a.c. to drive.

Please state Amplifier Power Output when ordering, for matching Resistor.

..... ONLY $11.95

What else do we carry?

All electronic hardware (boxes, veroboard, PC board, etc.), tools, wire, cable, semiconductors, valves, Hi Fi, Kits, PA Equipment, Microphones, Speakers, Car Radios, Car Tape Players, Car Audio Accessories, intercoms, books, transformers, Resistors, Capacitors, heatsinks, coils, TV aerials and accessories, CB accessories and meters.

Power Amplifier FETS USED IN HIGH POWERED STEREO AMPS

– 2SK134 and 2SJ49 (new on the market).

..... $17.90 per complementary pair
..... or $8.95 ea.

Famous TE-15 Grid Dip Meter

... It's been around for a long time but still very popular.

* Operates as a grid dip, oscillator, absorption wave-meter and oscillating detector.

SPEC's: – Frequency range: 440kHz – 280MHz in 6 coils.

..... STILL ONLY $89.00

125 mm (5") Horn Speakers

ON SPECIAL – ONLY $7.95 ea.

SAVE $1.55

3 foot Helical CB aerials

– TOP QUALITY (less base & lead)

..... ONLY $14.50 ea.

A LARGE VARIETY OF DICK SMITH PRODUCTS AT DICK SMITH PRICES AND ON A SUNDAY TOO!

Transistor Assisted Ignition

(from design in EA Dec. '78)

Complete kit, right down to last nut and bolt ... exactly as made by EA. ... even using genuine diecast box.

"Electronic ignition is in but CDI systems are out" ... quote from EA. Has dwell extension and results in a hotter spark at high engine speeds and is directly compatible with electronic tachometers.

STILL ONLY $32.50 – (compare our price with others).

Complete Coral 300mm (12") 4 speaker, 3 way kit (including woodwork)

..... ONLY $218.00 !!!

Philips 12" (300mm) 3 way 80W kit .. $320pr
Playmaster 12"(300mm) 3 way Kit .. $298pr
Mail Order: $1.00 packing "freight on"

Coral 250 mm (10") 3 way 3 speaker kit

(50 watts, 8 ohm). Consists of two 10" (250mm) woofers, two 5" (125mm) midrange and two 2½" (62.5mm) tweeters, with two 3-way crossover networks and all screws, terminals and internal wiring.

..... ONLY $95.00 pair

Box size requirements: 56cms(h) x 33cms (w) x 27cms(d)

Coral 200mm (8") 3 way 3 speaker kit ONLY $68 pair

(35 watts, 8ohm). Consists of two 8" (200mm) woofers, two 4" (100mm) midrange and two 2½" (62.5mm) tweeters with two 3-way crossover networks and all screws, terminals and internal wiring.

ETI 4000/2 Speaker Kit

Includes all speakers as used in ETI4000/1 system with the exception of the 178mm(7") lower midrange speakers. The crossover network is also different as it is a three way system (in kit form).

Mail Order: $1.00 packing.
"freight on" carrier ..... $360 pair

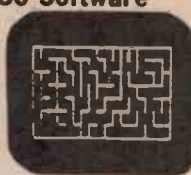
Famous System 80 Computer

..... ONLY $750

With every System 80 sold we are offering FREE SOFTWARE UP TO $20, and our variety of System 80/TRS80 software is one of the best in Sydney – come in or write for free software listing.

N.B. VIDEO MONITOR Extra .. $149.50

TRS 80/System 80 Software



MATCH CARDS & BANKSHOT – Two programmes on one cassette.

MATCH CARDS is a concentration type game where you match numbers, letters or graphic shapes. For one or two players. Automatic scoring rates your recall ability.

BANKSHOT is a billiard-like game for those who think they know all angles. Hit the ball into the pocket, but you must hit a wall first.

(Cassette) $11.95

POKER PETE – Play 5 card draw poker. Watch Peter shuffle and deal cards. He will challenge you with bluffs, raises, calls and folds. And Pete has a gun. 3 levels.

(Cassette) $12.95

FASTGAMMON(TM) As described in Sorcerer Software, but made for TRS80 or System 80.

Cassette $21.95
Diskette $26.95

RUMMY MASTER – Play Rummy against the computer. Exceptional graphics display your hand, the discards and cards that have been melded you.

(Cassette) $12.95

LOWBALL POKER – How low can you go. It's you against Micro Molly and the lowest hand wins. Don't take her for granted – Molly plays an excellent game.

(Cassette) $12.95

ETI 4000/1 Speaker Kit

Includes 2 only AD12250/W8 300mm(12") woofers 2 only AD70601/W8 178mm(7") lower midrange, 2 only AD02180/S08 50mm (2") midrange, 2 only AD01610T8 25mm(1") dome tweeters, 2 only 4-way crossover networks (designed by ETI and in kit form) plus full instructions on assembly. (box kit separate).

Mail Order: $1.00 packing.
"freight on" carrier ..... $459 pair

Complete 4000/1 Speaker System

(including speakers, crossovers and boxes – everything you need to complete this fantastic pair of speakers).

Mail Order: $1.00 packing.
"freight on" carrier ... ONLY $698 pair

ETI 4000/1 Speaker Boxes

... Includes two professionally assembled speaker boxes exactly as described by ETI for this project ... all that is required for you to do is screw speakers and crossovers (in kit form) in and mount innerbond inside. Walnut finish. Dimensions: 100cm(h) x 30cm(w) x 35cm(d).

Mail Order: $1.00 packing.
"freight on" carrier ..... $300 pair

Complete 4000/2 Speaker System

(including speakers, crossovers and boxes – everything you need to complete this fantastic pair of speakers).

..... ONLY $560 pair

Radio direction finding with the Realistic DX-160

David Jeanes VK2BSJ

WHEN THE Realistic DX-160 came on the market some years ago, the receiver included the Low Frequency band of 150 to 400 kHz. In this band are found marine and aeronautical radio beacons, which transmit omnidirectional signals suitable for direction finding (D/F).

To enable the DX-160 to provide D/F information, a simple modification to the Band A aerial coil is necessary, plus the construction of a loop antenna.

The loop antenna

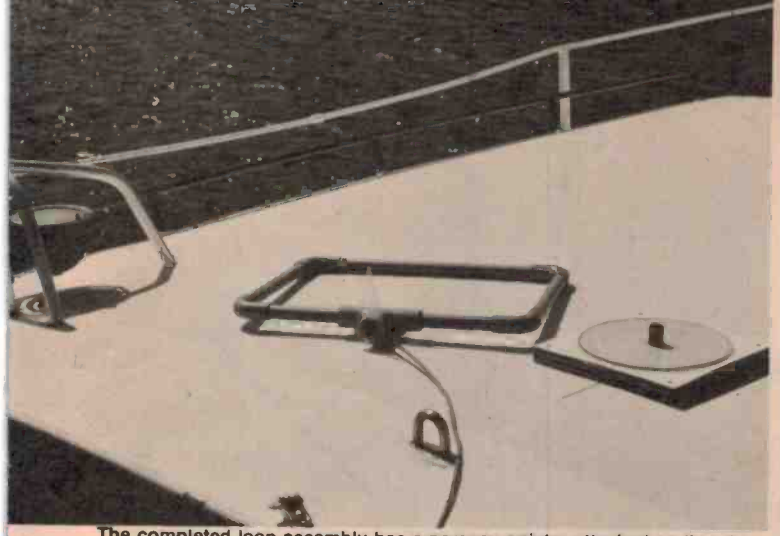
By experiment, it was found that four turns of wire wound around the edge of a piece of light plywood, 300 mm square, appeared to match well into the antenna coil of the receiver's Band A. The directional qualities of this loop were excellent. Distinct nulls in signal strength were obtained from several aero beacons in the Sydney-Newcastle area. Signal pickup was more than adequate. Williamtown aero beacon, some 120 km away, was received at good strength. Having resolved the question of the number of turns for the loop, it remained to construct a practical, rugged loop antenna.

Rigid PVC electrical conduit was chosen for the loop housing, as it is inexpensive, easy to work and glue, and several types of elbows and sockets are available.

A one metre length of 6 mm bore PVC conduit, plus four 90° elbows and one T-piece with inspection panel were purchased. A small tin of PVC conduit solvent provided adequate glue for all joints.

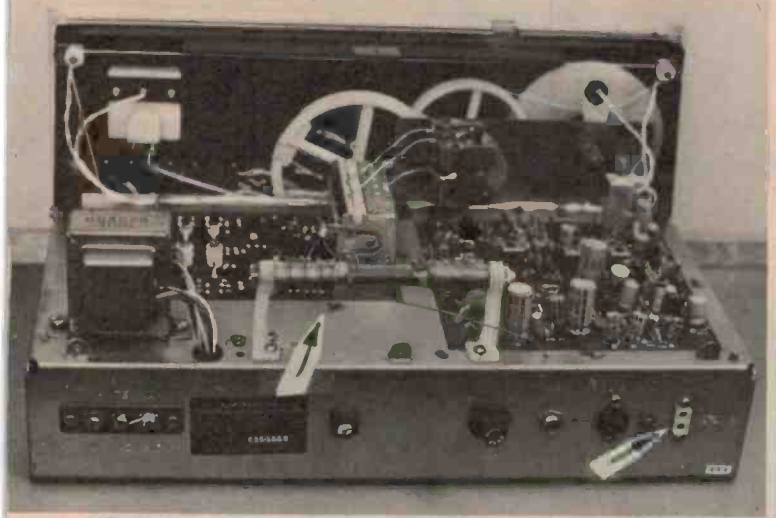
My final loop dimensions were 350 mm wide by 220 mm height overall. Cut the PVC conduit with a hacksaw, to provide the side and top sections. Two lower sections are needed to allow the T-piece to be centred at the bottom of the frame.

David Jeanes' boat, the "Nikki". The DX-160 and D/F loop are installed on board.

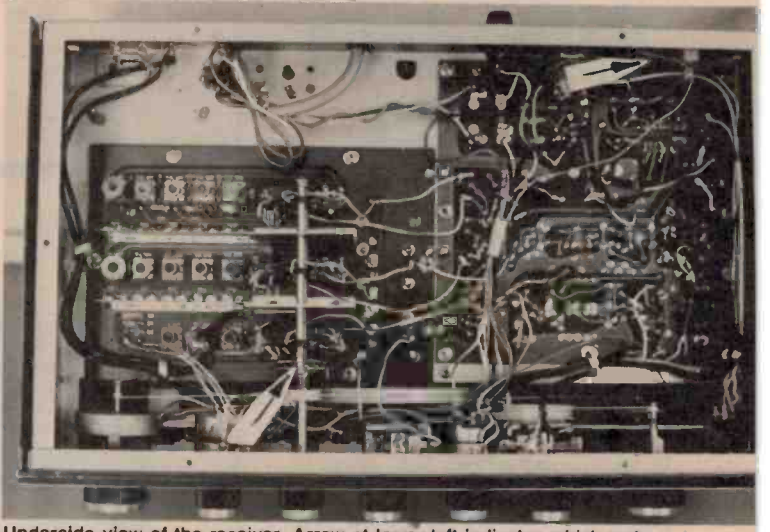


The completed loop assembly has a perspex pointer attached so that the direction may be read off a compass rose on the loop mount.

The completed loop assembly mounted as described. The compass rose on the base is carefully aligned fore and aft.



The upper arrow shows the four-section Band A loopstick coil. The arrow at lower right shows the STANDBY socket — now used for the loop input.



Underside view of the receiver. Arrow at lower left indicates which wafer section on the bandswitch is re-wired; at right, the STANDBY socket.

Assemble the conduit sections and elbows to check for symmetry. For the loop conductor, I used a length of four-conductor telephone cable. String the cable through the various elements of the loop frame, leaving a few centimetres spare to emerge through the inspection panel of the T-piece.

Using the PVC solvent as directed on the can, cement the sections to the elbows and T-piece, laying the frame on a flat surface to maintain a true shape. When the solvent has cured, trim off the ends of the phone cable, exposing 20-30 mm of the multi-core conductors. The wire colours are black, green, white and red. Solder the green of one cable to the black of the other cable end. Continue with white to green, and red to white. When these three joints are soldered and tape insulated, the black and red ends remaining become the connections of a four turn loop.

Twin conductor shielded audio cable is satisfactory for the feeder between loop and receiver. This cable is soldered to the loop black and red wires. No earth for the shield is required at the loop end.

To provide bearing information, a perspex pointer is glued to the bottom section of the loop frame T-piece, orientated 90° to the plane of the loop. A base plate for the loop to rotate on was made from a 360° compass rose — cut from an old marine chart. The rose was covered with perspex then glued to a square piece of waterproof plywood. The base plate can be mounted along the fore and aft axis of the vehicle (boat, car etc.) with the 000 degree of the rose pointing exactly forward.

If a small section of the 6 mm conduit is glued into the exact centre of the base plate, the loop frame can sit on this axle and be rotated by hand to find a null in the signal strength. When not in use the loop can be slipped off the base and stowed away safely.

Receiver modification

When the receiver covers are removed, it will be evident that a loopstick antenna system is used for Band A to provide some directional quality. That loopstick coil wound in four segments is T1 and is connected between earth and tag 'A' of the bandswitch wafer.

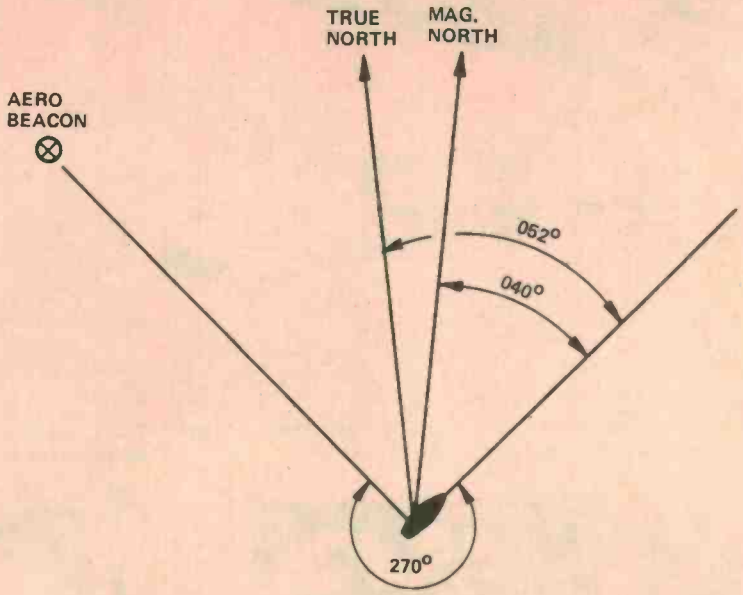
With the receiver upside down, dial facing you, the correct wafer section is that nearest the front and the lug in question is at one o'clock.

The STANDBY socket on the rear panel provides an ideal entry for the loop feed line, and a plug is provided. Follow the Standby wiring to the pc board and permanently solder a link across the terminations.

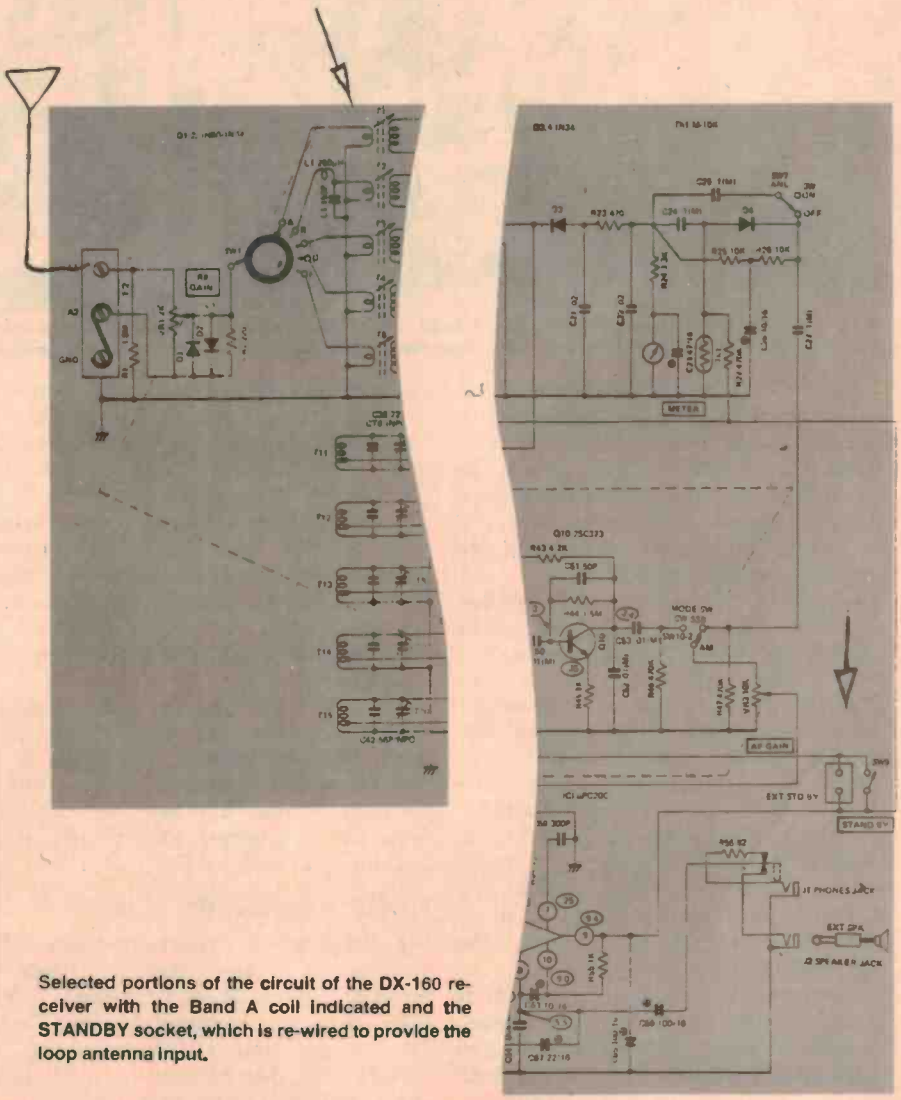
Remove the wire on lug A of the bandswitch and wire it to one of the Standby socket terminals. Locate the earth end of T1 primary and wire it to the other terminal of the Standby socket. T1 primary is now isolated from earth and will provide a balanced load for the loop.

All other bands are unaffected by the modification and operate from the regular antenna terminals. The loop feedline braid may be earthed adjacent to the Standby socket.

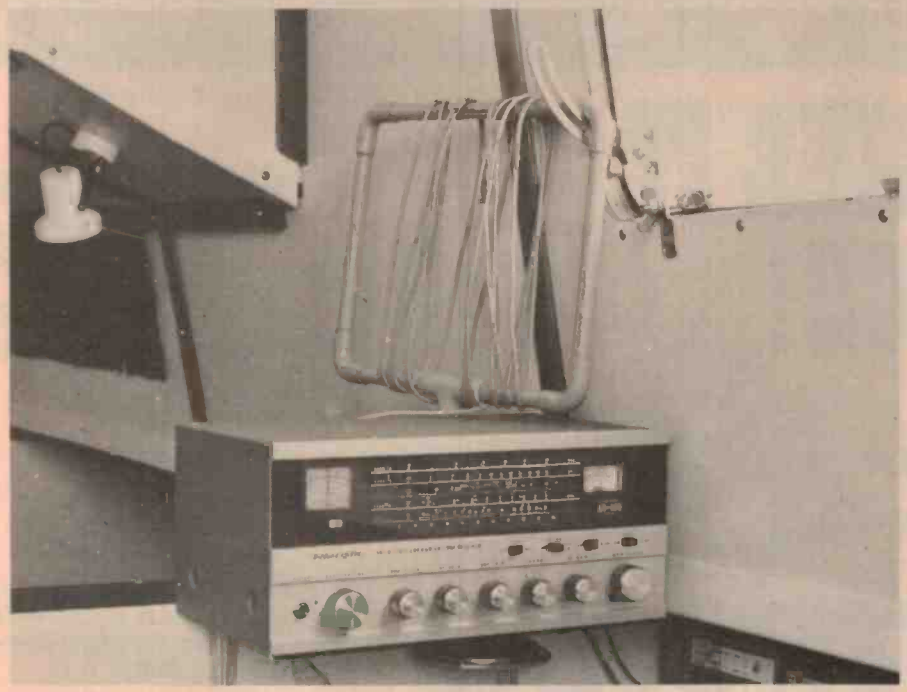
It is assumed that for D/F operation, the receiver is being operated on 12 Vdc. Mains operation may reduce the effectiveness of loop signals. The Standby switch on the front panel is now redundant and may be wired to switch on the dial lights during 12 V operation. ▶



How to find the true bearing of the vessel using the radio direction finder.



Selected portions of the circuit of the DX-160 receiver with the Band A coil indicated and the STANDBY socket, which is re-wired to provide the loop antenna input.



The DX-160 general coverage and D/F receiver is mounted in a convenient place in the cabin of the Nikki. When not in use, the D/F loop antenna is stowed above the receiver.

D/F operation

As the receiver rear cover is masonite, on-air testing will indicate whether it is necessary to shield the interior from outside signals. If so, aluminium foil may be wrapped around the rear cover, ensuring the foil is earthed.

Aeronautical radio beacons are virtually the only transmissions evident on Band A. A very few marine beacons are spotted around the Australian coast. A list of aero beacons, their frequency, callsign and position in latitude and longitude may be obtained from the Airways Operations Branch, Department of Transport.

With the regular antenna disconnected and the loop mounted on its baseplate, switch to these functions:- band switch to band A

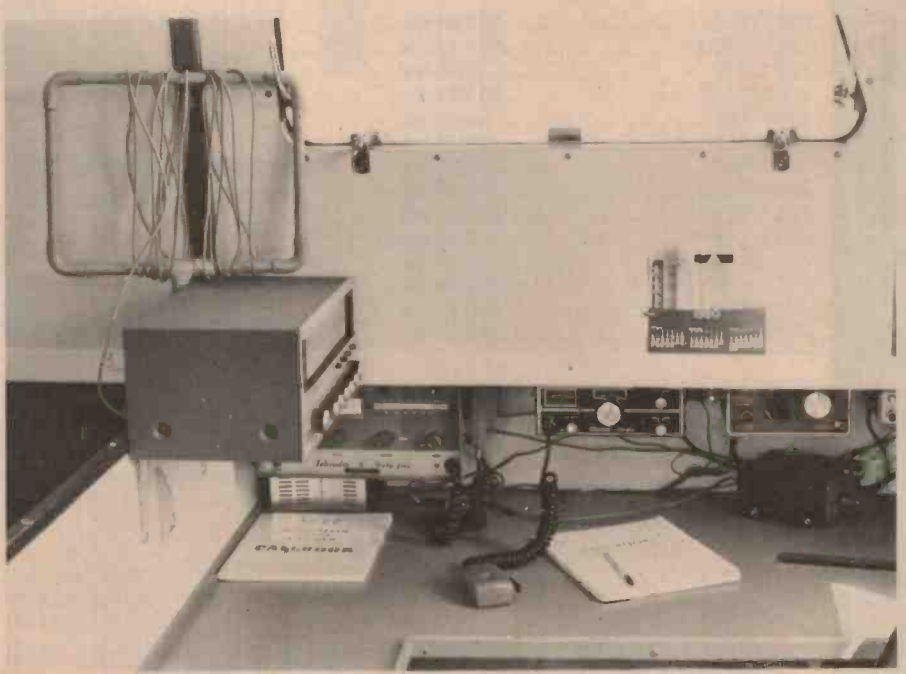
- ANL off
- Mode to CW-SSB
- AVC to FAST
- RF gain advanced about ¾ way
- BFO to 12 o'clock
- Audio gain as desired

Tune in an aero beacon and note the morse identification. Adjust the tuning for a beat note of comfortable pitch. Adjust antenna trim for minimum S-meter reading. Rotate the loop for a signal null and note the bearing indicated by the pointer against the compass rose. Swing the loop 180° and note the bearing of the second null. In almost all situations the general direction of the transmitting station is known, so that the correct null and bearing is easily ascertained.

To plot the bearing on a chart or map, the heading of the vehicle must be known. On my vessel, the magnetic compass is adjacent to the loop. The loop is swung for a null and simultaneously the compass heading is noted. In the example shown, assume the compass course, corrected for deviation, is 040° magnetic and the relative loop bearing of the aero beacon is 270°. A magnetic course of 040° off the NSW coast where magnetic variation is 12° east, would mean that the vessel was in fact heading 052° True. Add the true heading, 052° to the relative radio bearing of 270° and we obtain the true direction of the aero beacon of 322°. To plot the bearing *from* the aero beacon to the ship, subtract 180° from 322°, giving 142°. Draw a line *from* the aero beacon in the direction of 142° and the ship will be somewhere along this bearing line.

A second bearing, taken shortly after the time of the first bearing, from a second aero beacon, would provide a bearing line which would cut across the first. The intersection of these two lines gives the ship's position. The accuracy of the position depends primarily on the correctness of the vehicle's heading at the time of the bearings. Other errors peculiar to direction finding by radio are outside the scope of this article. Briefly listed, they are:- quadrantal error caused by metallic objects in the vicinity of the loop; coastal refraction applicable to ships at sea and 'night effect' where distant signals on the same frequency or skywave signals from the selected beacon cause the loop null to fluctuate away from the true direction.

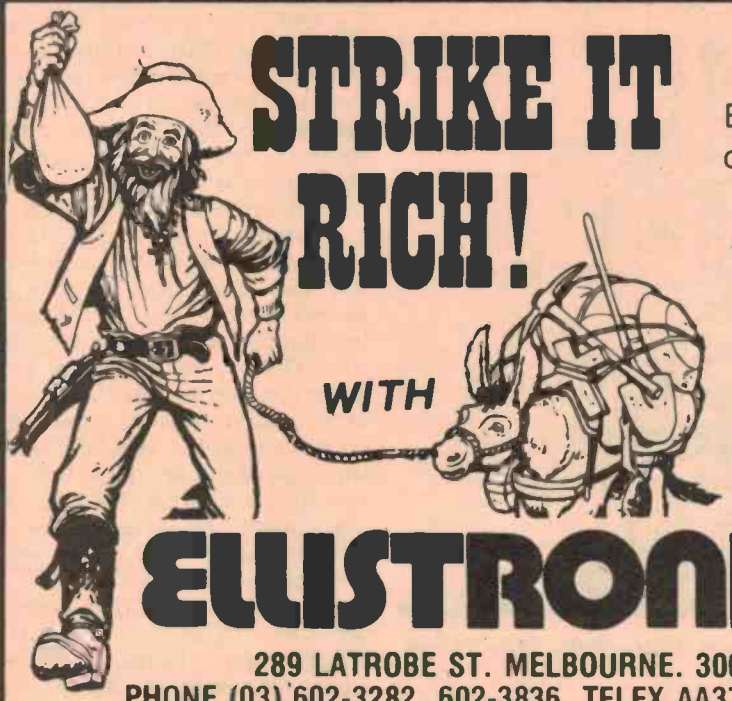
Broadcast stations are not satisfactory for direction finding purposes because the band is crowded with signals, identification of the station is difficult and its exact position is often unknown. Ground wave propagation is reduced at the higher broadcast frequencies and skywave propagation enhanced at night. ●



The 'electronics' aboard the Nikki includes a Teleradio 65 marine transceiver, a Swan 40m monoband rig, 146 MHz FM rig, a depth sounder and assorted other items.

NATIONAL — FAIRCHILD — PHILIPS — INTEL — RCA — RAYTHEON — SYNTECH — TEXAS — MOTOROLA — W

UTILUX — SYNTECH — ADCOLA — WELLER — BISHOP GRAPHICS — ADAPTIVE — ALPHA — LITRONICS — FLUKE — AIM — SIGNETICS —



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Z80 C.P.U.	$10.81 ea.
Z80A C.P.U.	$11.14 ea.
Z80 C.T.C.	$9.49 ea.
Z80A C.T.C.	$11.44 ea.
Z80 P.I.O.	$6.65 ea.
Z80A P.I.O.	$8.57 ea.
Z80 SIO/O	$38.67 ea.
Z80A SIO/O	$49.90 ea.
Z80 SIO/1	$38.67 ea.
Z80A SIO/1	$49.90 ea.
Z80 SIO/2	$38.67 ea.
Z80A SIO/2	$49.90 ea.
Z80 SIO/9	$38.67 ea.
Z80A SIO/9	$49.90 ea.
2732	$66.00 ea.
MB 8414 (2114 CMOS 250ns)	$21.00 ea.
65 x 08 1k x 1 CMOS	$9.00 ea.

FLOPPY DISC CONTROLLERS

FD 1771	$37.00 ea.
FD 1791	$62.00 ea.
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8 BIT MPU'S

6802	$11.80 ea.
6808	$10.50 ea.
6809	$46.77 ea.
6821	$5.10 ea.
6840	$7.84 ea.
6845	$38.94 ea.
6847	$28.00 ea.
6850	$4.40 ea.
6852	$5.50 ea.

RISTON 3000 COATED FIBREGLASS BOARD

SINGLE SIDED	
6" x 3"	$1.60 ea.
6" x 6"	$2.30 ea.
9" x 6"	$3.35 ea.
12" x 12"	$7.95 ea.
DOUBLE SIDED	
6" x 3"	$2.30 ea.
6" x 6"	$3.30 ea.
9" x 6"	$4.10 ea.
12" x 12"	$9.45 ea.

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DIRECT IMPORT PANEL METERS AT LOW, LOW PRICES

MU-65 1MA — 120 ohms
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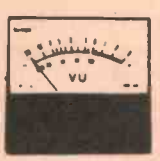
Dimensions: Overall — 100mm(W) x 82mm(H)
Scale — 100mm(W) x 50mm(H)
Mounting: Hole required — 63mm
Bolts centres — 80mm(W) x 64mm(H)
Nuts and washers provided

$10.18 ea. plus $1.52 tax

MU-45
O-1MA-120 ohms
O-50UA-1400 ohms
O-5ADC-3 Shunt
0-30VDC-100 ohms
$6.91 ea.
plus $1.04 tax



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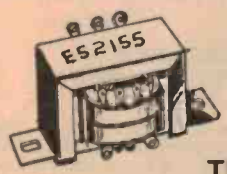

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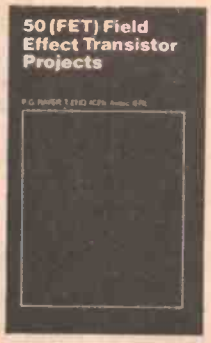

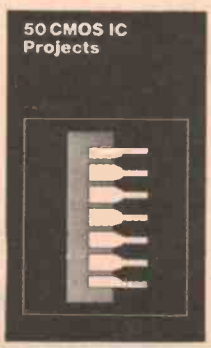

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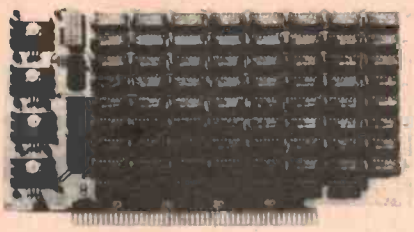

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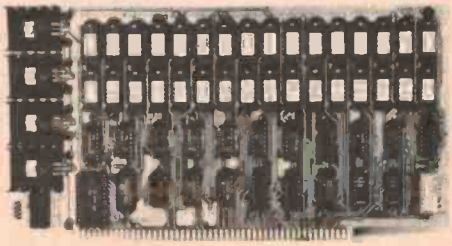

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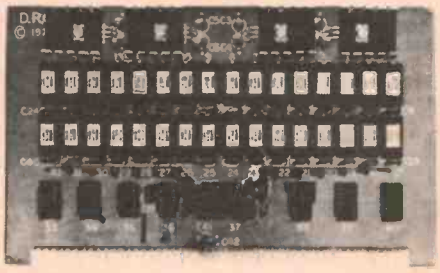

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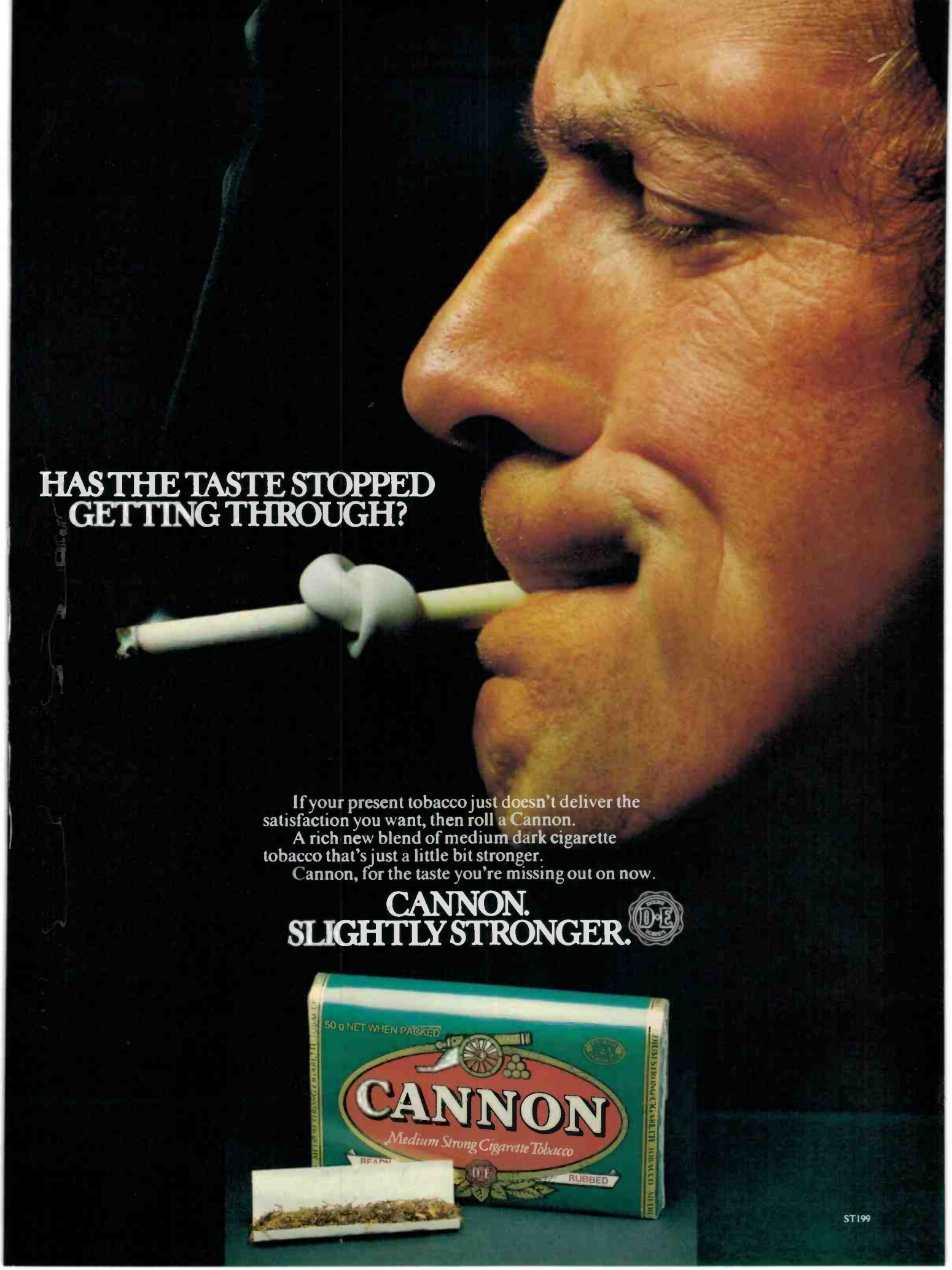
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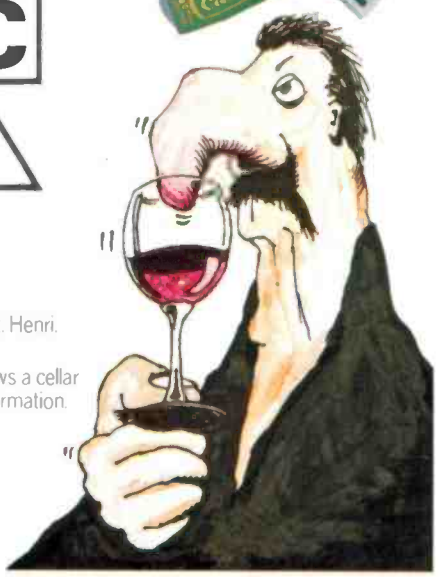

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Lab Notes

Transistor arrays

— using the 3046/3056/3086 IC

Peter Single

Transistor arrays are a very useful electronic building block often overlooked by both hobbyists and professionals. This article describes a variety of circuits that can all be built using the 3046/3056/3086 — a common IC.

A transistor array consists of several transistors on the same piece of silicon. They are generally mounted in a 14- or 16-pin dual-in-line or T05 package. Because all the transistors are manufactured together, they are very well matched and because they are all on the same piece of silicon their thermal tracking is excellent.

Arrays may contain NPN transistors, 'super beta' NPNs, PNP transistors, zener diodes, transmission gates, SCRs and PUTs. The PNPs found in arrays are usually of inferior quality, having low β, low current handling capacity and poor frequency response. They are really only suitable for bias networks and similar low frequency applications.

The substrate connection

All transistor arrays have a connection labelled 'substrate'. Often it is connected to the emitter at an NPN transistor, or it may simply be brought out to a pin on the IC. A cross section of two transistors in an array is shown in Figure 1. The substrate consists of P-type silicon which isolates the two transistors shown as long as the collector-to-substrate junctions remain reverse biased. This is achieved by connecting the substrate to the most negative part of the circuit.

Beware of tricks which use the collector-to-substrate diode. They are dangerous! Figure 2 shows why. The substrate forms a PNP transistor with the base of the NPN transistor, which generates a latch. This latch can be active unless the PNP transistor is held off by taking the substrate connection to the most negative part of the circuit. Remember, when designing with arrays, BEWARE THE SUBSTRATE CONNECTION !

Another point to watch is that if the power supply is connected the wrong way round the collector-to-substrate diode may be forward biased, which can often destroy the array.

An internal schematic and pin connection diagram for the 3086 is shown on page xx. A similar diagram is shown in the RCA Data Book, but with one significant error! *The substrate connection is pin 13 not pin 12.*

Current mirrors

A very useful circuit configuration that is easily implemented with arrays is the current mirror. Figure 3 shows the basic circuit.

The collector current of a non-saturated transistor depends on the base-emitter voltage. If two identical transistors have identical base-emitter voltages their collector currents will be the same. In Figure 3, Q1 is diode connected and presents a low impedance to the input current. Transistor Q2, whose collector current mirrors that of Q1, is ▶

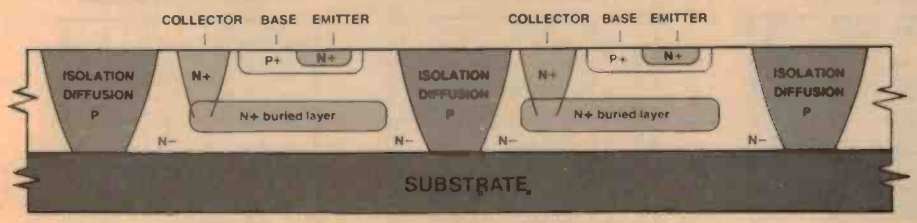


Figure 1. Cross-section of two transistors in a transistor array IC.

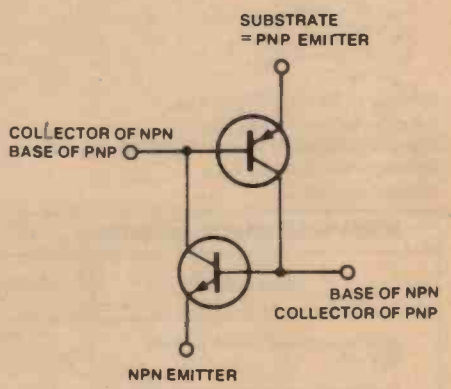


Figure 2. Beware the collector-to-substrate diode!

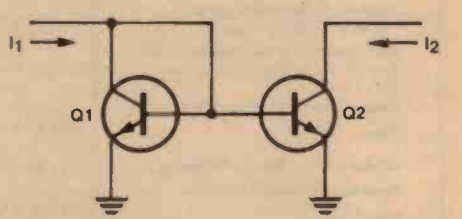


Figure 3. Basic circuit of a current mirror. Connected like this, Q1 and Q2 on the array will have identical collector currents.

Lab Notes

SELECTED DATA ON THE 3045/3046/3086 TRANSISTOR ARRAYS

General Description

The 3045, 3046 and 3086 each consist of five general purpose silicon NPN transistors on a common monolithic substrate. Two of the transistors are internally connected to form a differentially-connected pair. The transistors are well suited to a wide variety of applications in low power system in the dc through VHF range. They may be used as discrete transistors in conventional circuits however, in addition, they provide the very significant inherent integrated circuit advantages of close electrical and thermal matching. The 3045 is supplied in a 14-lead cavity dual-in-line package rated for operation over the full military temperature range. The 3046 and 3086 are electrically identical to the 3045 but are supplied in a 14-lead moulded dual-in-line package for applications requiring only a limited temperature range.

features

- Two matched pairs of transistors
  V_{BE} matched ±5 mV
  Input offset current 2μA max at I_C = 1 mA
- Five general purpose monolithic transistors
- Operation from DC to 120 MHz
- Wide operating current range
- Low noise figure 3.2 dB typ at 1 kHz
- Full military temperature range (3045) −55°C to +125°C

applications

- General use in all types of signal processing systems operating anywhere in the frequency range from DC to VHF
- Custom designed differential amplifiers
- Temperature compensated amplifiers

absolute maximum ratings (T_A = 25°C)

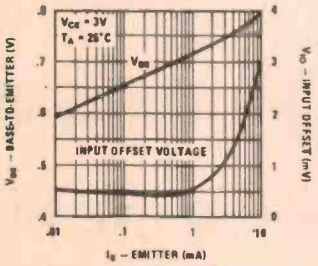
	3045		3046/3086		
	Each Transistor	Total Package	Each Transistor	Total Package	Units
Power Dissipation:					
T_A = 25°C	300	750	300	750	mW
T_A = 25°C to 55°C			300	750	mW
T_A > 55°C			Derate at 6.67		mW/°C
T_A = 25°C to 75°C	300	750			mW
T_A > 75°C	Derate at 8				mW/°C
Collector to Emitter Voltage, V_{CEO}	15		15		V
Collector to Base Voltage, V_{CBO}	20		20		V
Collector to Substrate Voltage, V_{CIO} (Note 1)	20		20		V
Emitter to Base Voltage, V_{EBO}	5		5		V
Collector Current, I_C	50		50		mA

electrical characteristics (T_A = 25°C unless otherwise specified)

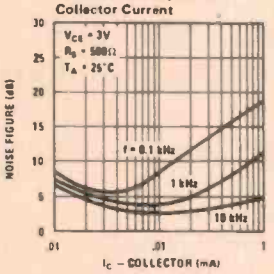
PARAMETER	CONDITIONS	LIMITS 3045, 3046 MIN	LIMITS 3045, 3046 TYP	LIMITS 3045, 3046 MAX	LIMITS 3086 MIN	LIMITS 3086 TYP	LIMITS 3086 MAX	UNITS
Static Forward Current Transfer Ratio (Static Beta) (h_{FE})	V_{CE} = 3V, I_C = 10 mA	40	100		40	100		
	V_{CE} = 3V, I_C = 1 mA	40	100		40	100		
	V_{CE} = 3V, I_C = 10 μA		54			54		
Input Offset Current for Matched Pair Q_1 and Q_2 $\lvert I_{IO1} - I_{IO2} \rvert$	V_{CE} = 3V, I_C = 1 mA		.3	2				μA
Base to Emitter Voltage (V_{BE})	V_{CE} = 3V, I_E = 1 mA		.715			.715		V
	V_{CE} = 3V, I_E = 10 mA		.800			.800		V
Magnitude of Input Offset Voltage for Differential Pair $\lvert V_{BE1} - V_{BE2} \rvert$	V_{CE} = 3V, I_C = 1 mA		.45	5				mV
Magnitude of Input Offset Voltage for Isolated Transistors $\lvert V_{BE3} - V_{BE4} \rvert$, $\lvert V_{BE4} - V_{BE5} \rvert$, $\lvert V_{BE5} - V_{BE3} \rvert$	V_{CE} = 3V, I_C = 1 mA		.45	5				mV
Temperature Coefficient of Base to Emitter Voltage $\left(\frac{\Delta V_{BE}}{\Delta T}\right)$	V_{CE} = 3V, I_C = 1 mA		−1.9			−1.9		mV/°C
Collector to Emitter Saturation Voltage ($V_{CE(SAT)}$)	I_B = 1 mA, I_C = 10 mA		.23			.23		V
Temperature Coefficient of Input Offset Voltage $\left(\frac{\Delta V_{IO}}{\Delta T}\right)$	V_{CE} = 3V, I_C = 1 mA		1.1					μV/°C

Note 1: The collector of each transistor of the 3045, 3046, and 3086 is isolated from the substrate by an integral diode. The substrate (terminal 13) must be connected to the most negative point in the external circuit to maintain isolation between transistors and to provide for normal transistor action.

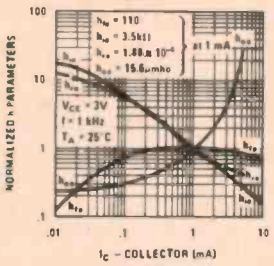
Typical Static Base To Emitter Voltage Characteristic and Input Offset Voltage for Differential Pair and Paired Isolated Transistors vs Emitter Current



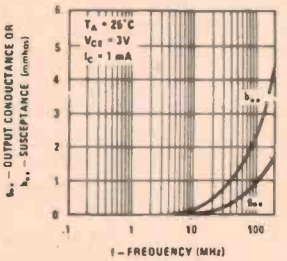
Typical Noise Figure vs Collector Current



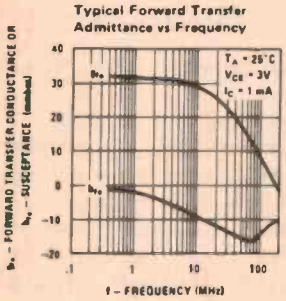
Typical Normalized Forward Current Transfer Ratio, Short Circuit Input Impedance, Open Circuit Output Impedance, and Open Circuit Reverse Voltage Transfer Ratio vs Collector Current



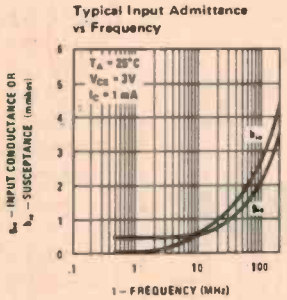
Typical Output Admittance vs Frequency



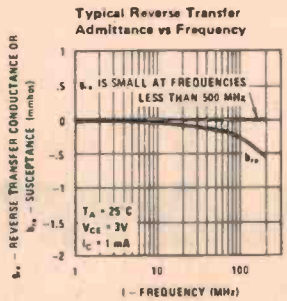
Typical Forward Transfer Admittance vs Frequency



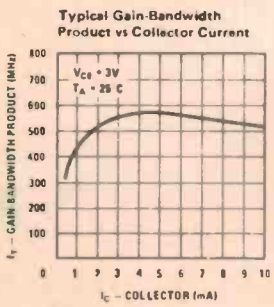
Typical Input Admittance vs Frequency



Typical Reverse Transfer Admittance vs Frequency



Typical Gain-Bandwidth Product vs Collector Current



connected as a dc-coupled common emitter amplifier and has a very high output impedance.

Current mirrors constructed from discrete components are not nearly as accurate because two discrete transistors chosen at random will rarely be identical. Also it requires extra construction to ensure that the transistors are held at the same temperature, because transistor characteristics are very temperature-dependent.

But two transistors on an array, having been manufactured side by side and being incorporated in the same piece of silicon, are very well matched. Errors in mirrors constructed using arrays are generally less than ten per cent.

A current mirror provides a regulated high impedance current sink. Its output will generally go to 200 mV from earth before the mirror transistor saturates, making it very useful for linear ramps, biasing networks and a host of other applications.

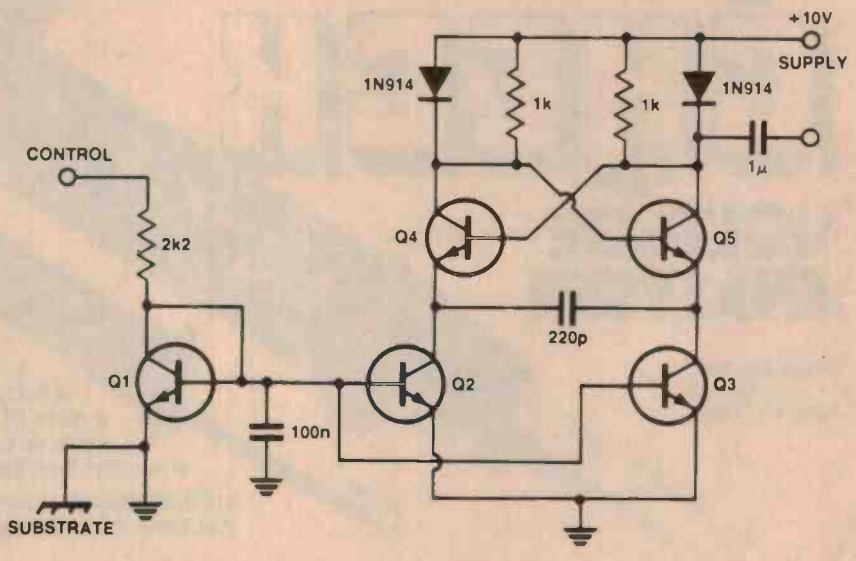


Figure 4. Circuit of a voltage controlled oscillator. Transistors Q2 and Q3 in the array form a current mirror with Q1. The voltage at the 'control' input sets the collector currents of Q2 and Q3 which controls the oscillator frequency. Circuit oscillates around 10 MHz with 5 V on the control input.

Voltage controlled oscillator

A circuit for a voltage controlled oscillator is shown in Figure 4. It consists of a controlled bias system with Q2 and Q3 forming a current mirror with Q1. To understand the oscillator, imagine that Q5 is turned hard on. Transistor Q2 will slowly pull Q4's emitter low until Q4 starts to turn on. As it does so it will pull Q5's base low, turning Q5 off which turns Q4 harder on. This regenerative action continues until Q4 is fully on and Q5 off. Q3 then slowly starts to turn Q5 on and the process continues.

The rate of oscillation depends on the charging time of the capacitor between the collectors of Q2 and Q3. If the current through Q2 and Q3 decreases, the charging time increases and the oscillator frequency decreases. Because Q2 and Q3 mirror Q1, varying the current through Q1 will vary the oscillator frequency.

The circuit will oscillate at about 10 MHz with 5 V on the control pin. It can be made to run at 30 MHz by placing germanium diodes between collector and base of Q4 and Q5 and increasing the control voltage. The diodes should be inserted with their cathodes to the transistor bases to stop the transistors from saturating and storing charge in their bases. Such charge storage slows transistors down.

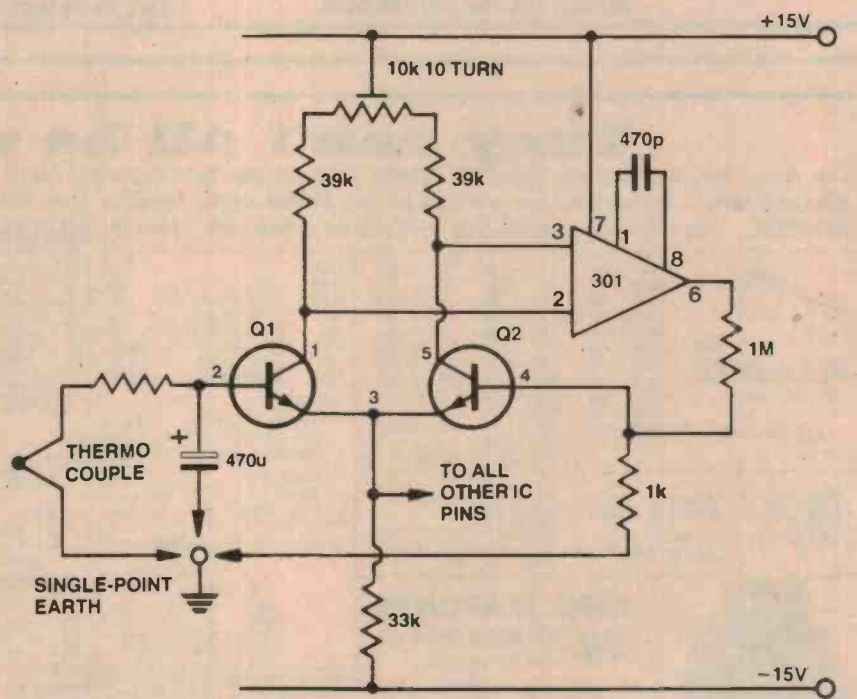


Figure 5. A useful thermocouple amplifier. Input offset nulling is independant of temperature in this circuit, unlike many circuits.

Thermocouple amplifier

Figure 5 shows a circuit for an amplifier with a gain of 1000, suitable for use with thermocouples.

The biggest problem when using op-amps as thermocouple amplifiers is the temperature drift of the input offset voltage. Most methods of nulling the input offset are ineffective if the temperature varies. This circuit solves the problem by eliminating the input offset voltage ▶

Lab Notes

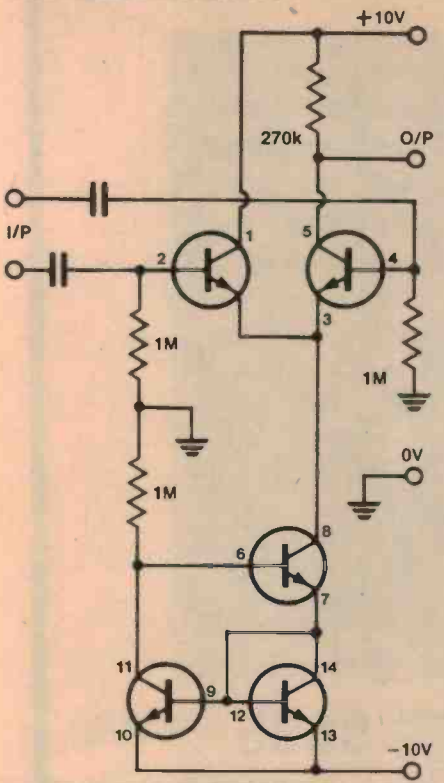


Figure 6. This differential amplifier has a very high common mode rejection ratio (cmrr). Constant current source for the differential pair is a variation on the current mirror. Circuit is suitable for bio-electronic applications such as in a cardiac monitor or EMG.

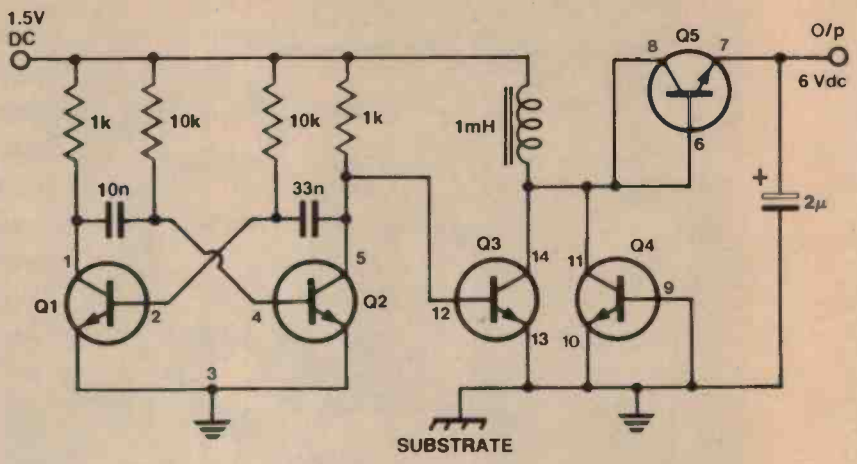


Figure 7. This ringing choke inverter is just the thing for powering CMOS circuits from a single 1.5 V cell in portable applications. Operation is explained in the text.

entirely. With a piece of wire replacing the thermocouple adjust the pot until the output of the amplifier is at 0 V. Since the bases of both Q1 and Q2 are at earth there is no input offset voltage.

This amplifier has very high open loop gain and will happily amplify any hum or other noise at its input. It will also oscillate through any capacitive coupling between output and input or between the supplies and the input. To avoid this, supplies should be well by-passed and earthing should be 'star' configured.

The substrate is not connected to the negative supply, because under extreme conditions the 20 V maximum collector-to-substrate voltage could be exceeded. However, no part of the array will ever go more negative than the substrate, so the circuit is quite safe.

The other transistors on the array should not be used as they may generate temperature gradients between Q1 and Q2.

Differential amplifier

The circuit shown in Figure 6 has a very high common mode rejection ratio and is suitable for circuits such as cardiac monitors where the desired signal may be buried in a lot of common mode noise. It's a differential amplifier biased by a variation of a current mirror that has very high output impedance to improve the common mode rejection.

Ringing choke inverter

This is a simple circuit, illustrated in figure 7, which generates about 6 V at 50 mA from a 1.5 V battery. It could be used to power CMOS from a single pen-light battery when a compact, portable circuit is required.

Transistors Q1 and Q2 form an astable multivibrator. When Q2 turns off, Q3 turns on and current flows through the inductor from the supply. The point 'A' on the waveform diagram (Figure 8) is the point where Q3 saturates. When Q2 turns on, cutting off Q3, the inductor tries to maintain the flow of current. Q5 is connected as a diode and current will flow through it until the voltage on Q4's emitter zeners the reverse biased junction. This is point 'B' on Figure 8.

When the inductor no longer has the energy to pump current into Q4 or Q5 it starts to oscillate (or ring) with its own parallel parasitic capacitance. This is point 'C' on Figure 8. The amplitude of ▶

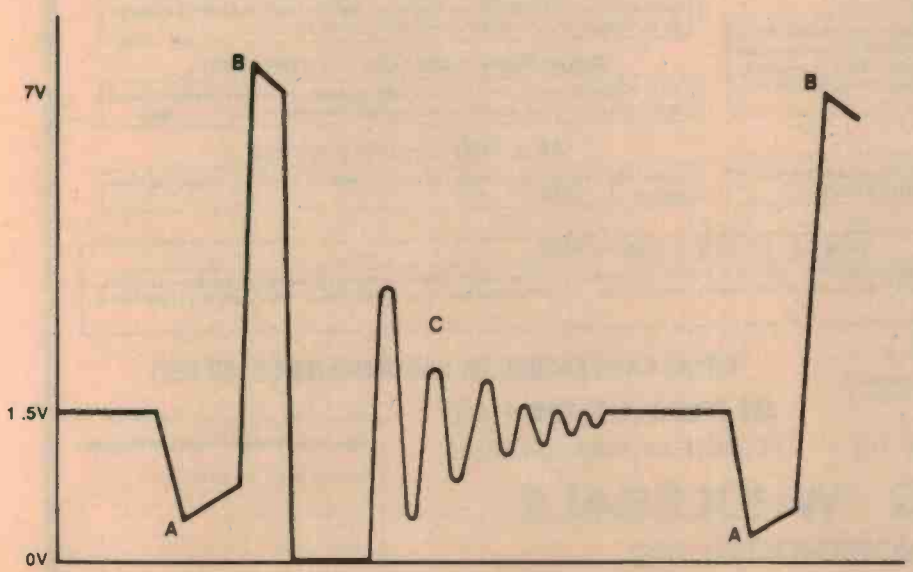


Figure 8. Typical waveform at the collector of Q3 in the ringing choke inverter.

Lab Notes

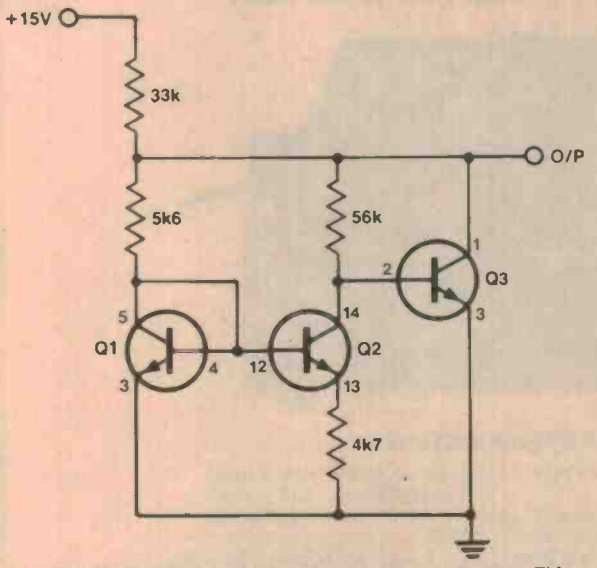


Figure 9. Typical circuit of a 'band gap' voltage reference. This has excellent long term voltage and temperature stability. Output is 1.4 V, within 7 mV from 20°C to 100°C.

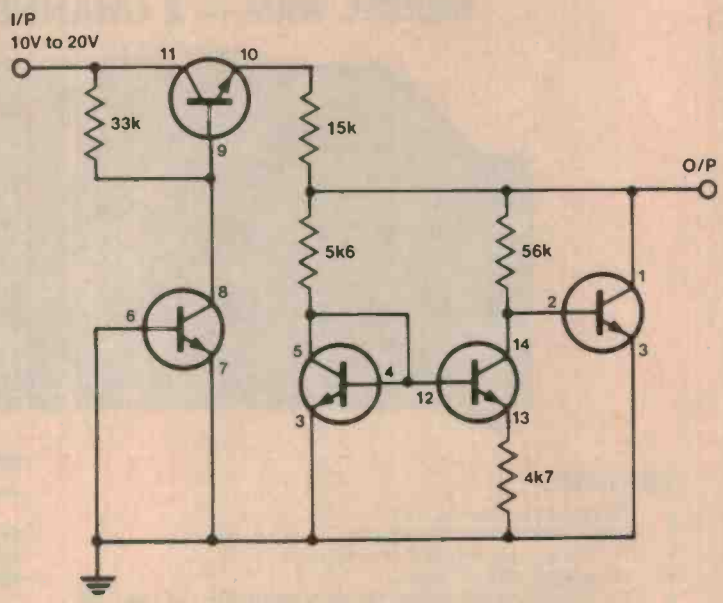


Figure 10. Improved performance can be obtained from a band gap voltage reference by adding a pre-regulator. This employs one transistor in the array as a zener and the remaining transistor as a series regulator.

the oscillation gradually decreases until Q3 is next turned on, restarting the whole process. The frequency of oscillation is a few kiloHertz.

Band gap reference

The band gap reference shown in Figure 9 is a voltage reference circuit with excellent temperature and long term stability. Its output is around 1.4 V and it may be used as a stable reference in 5 V systems.

The voltage generated on the emitter of Q2, being the difference between Q1's and Q2's base-emitter voltages, has a positive temperature coefficient. Since the current through Q2's emitter also flows through the 56k resistor, the voltage across this resistor also has a positive temperature coefficient. The base-emitter voltage of Q3 has a negative temperature coefficient. The values of resistors in the circuit have been chosen so that these temperature coefficients just cancel. My prototype varied by just 7 mV over the range from 20°C to 100°C.

To build a working band gap reference, high quality resistors must be used. Metal film types with 2% tolerance are best.

One problem encountered with this circuit is that its output varies slightly with the bias current through the 68k resistor. This can be overcome by providing the circuit with a pre-regulator, as shown in Figure 10. The pre-regulator uses the two remaining transistors on the array, one of which is connected as a zener diode.

If a high drive capability, or voltages greater than 1.4 V are required, then an op-amp or a non-inverting amplifier may be used as a follower. Figure 11 shows the connections. A 3140 op-amp makes an excellent follower as it may be operated from a single supply. ●

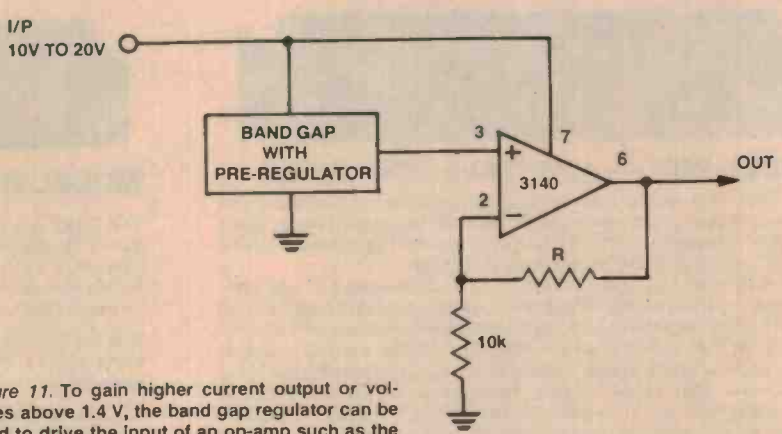
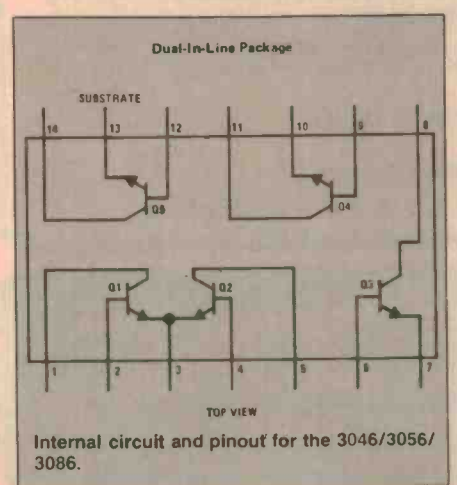


Figure 11. To gain higher current output or voltages above 1.4 V, the band gap regulator can be used to drive the input of an op-amp such as the 3140. The equation shows how to obtain different outputs.



Internal circuit and pinout for the 3046/3056/3086.

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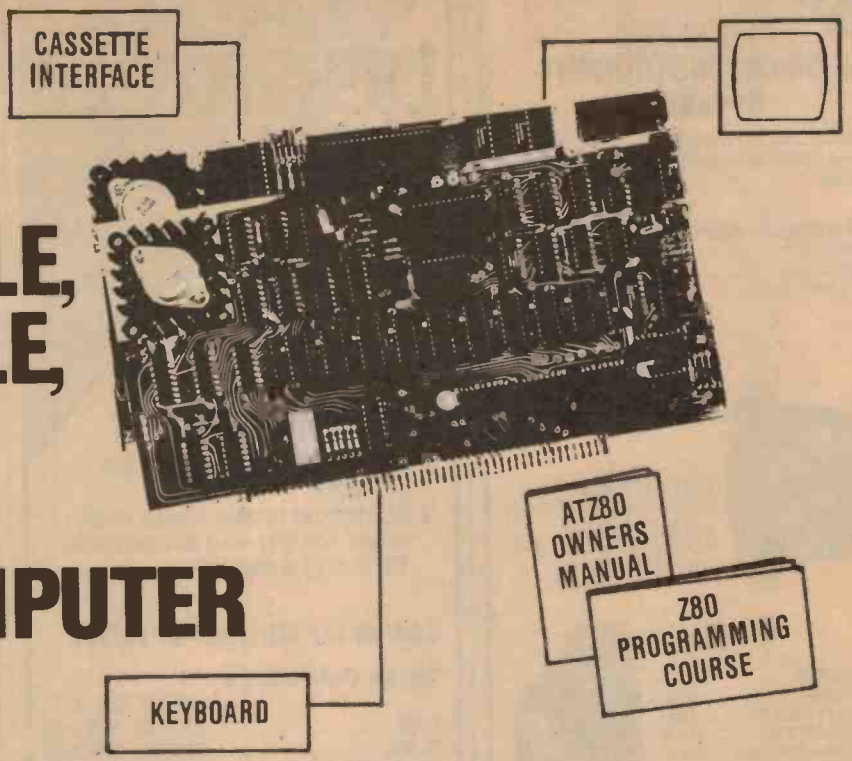

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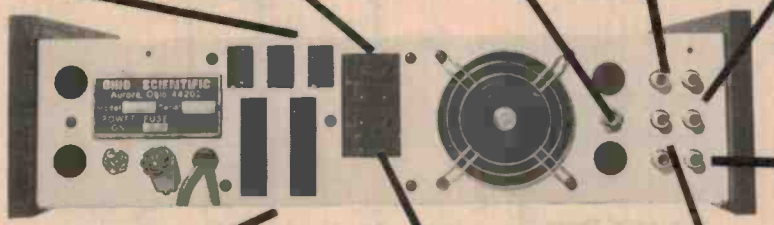

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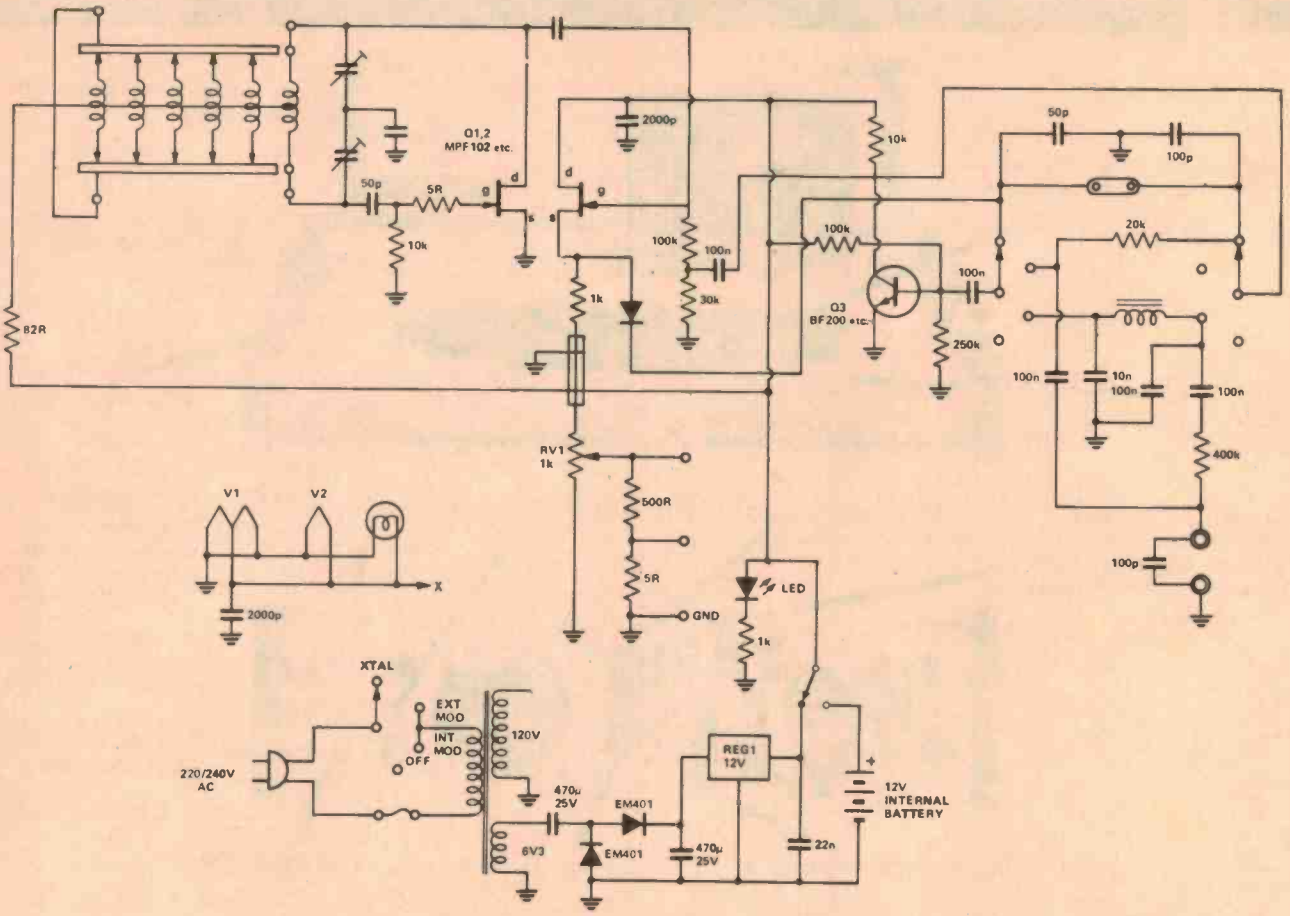
LOCKWOOD TCG46/6 A

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.



Solid state conversion of the TD20D RF Generator

One of the most common pieces of test equipment sold in this country is the TD20D RF signal generator. The instrument can be made battery operated for portable use and an improvement in stability gained by replacing the two valves with solid state components. This technique was very popular about 10 years ago to improve the performance of the older valve communications receivers.

The circuit shows the modifications. The 12BY7 has been replaced with a pair of MPF102s (or similar FETs) and the 6AQ5 with a BF200 or similar bipolar transistor.

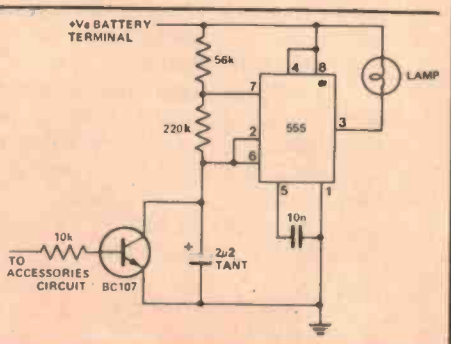
The high voltage power supply has been dispensed with and the power is taken from the 6.3 V heater winding through a rectifier and regulator, or an internal battery. The panel lamp has been replaced with a LED.

This note comes from **Richard Hannam of Townsville, Qld.**

Dummy car alarm

A flashing light on your car dashboard could be an effective deterrent to thieves, leading them to believe that an alarm system lurks behind it.

This circuit, from **Gregory Smith of Meadowbank NSW,** uses a 555 timer (what would we do without them?) to flash a small lamp. When the key is in the ignition and the accessories circuit is completed, the BC107 conducts and the 555 is inactivated. As soon as the accessories circuit is opened (by removing the ignition key), the transistor is cut off and the 555 activated. So the dummy alarm is set every time you leave the car.



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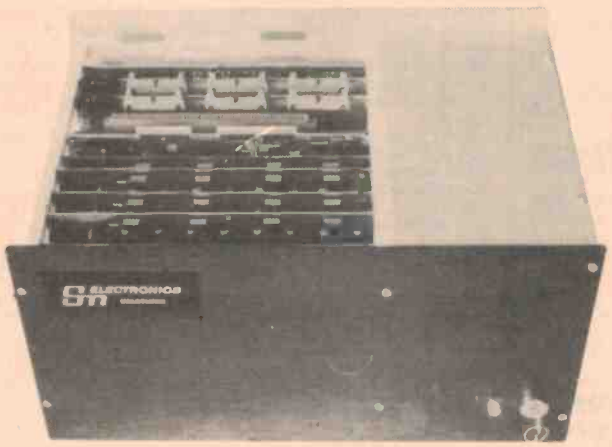

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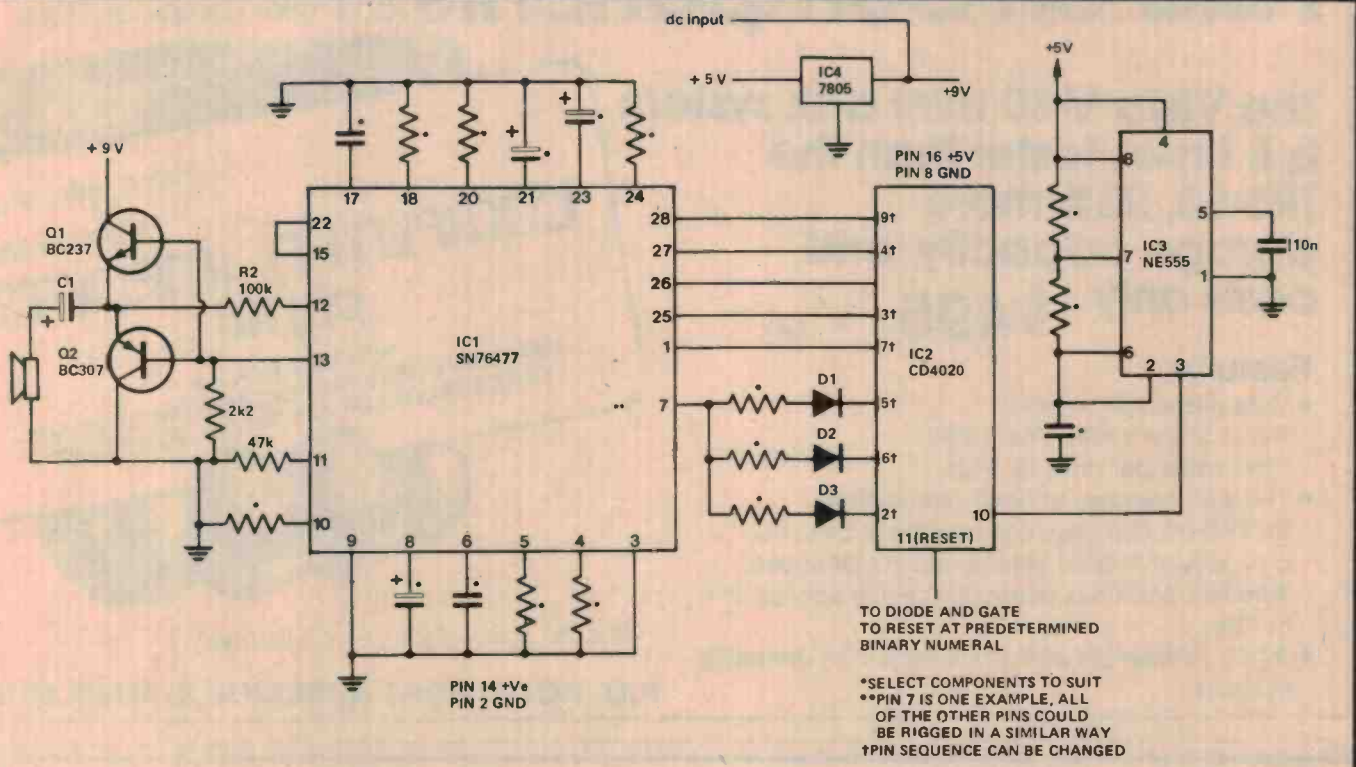
SME SYSTEMS

Ideas for Experimenters



Computer music — without the computer !

Those seemingly random musical sound effects one hears on movie tracks when a computer on screen is "thinking" are familiar to just about everyone. More recently, the sounds of 'machine music' have been heard. This circuit can be arranged to produce a whole range of similar sounds, play tunes, random notes and sounds, etc, with that familiar machine music sound.

Centred on a Texas Instruments SN76477, a 'sound synthesiser' chip, plus two other ICs, selecting the values of a group of resistors and capacitors will determine the 'sounds' you want, while selecting the speed of a 555 clock and the way the SN76477 is interfaced to a divider chip will determine the sequence of sounds to be played.

The 555, IC3, is connected as an astable multivibrator. The two timing resistors (between pins 8-7-6) and the timing capacitor determine the repetition rate. Consult the data on the 555 to select values for these components so that IC3 runs at the speed you wish (anything from say, 10 Hz to 1 kHz). The output of the 555 drives a 4020 divider and its outputs drive the SN76477 'function select' inputs. The resistors and capacitors around the SN76477 marked with an asterisk are chosen from the data sheet and applications circuits to produce the desired sounds. Output from the SN76477 drives a simple audio power output stage (Q1 and Q2) and an eight or fifteen ohm speaker. C1 is a 1000 uF electrolytic.

So that the sound sequence repeats, the 4020 is reset using a diode AND gate. Note that the sequence of output pin connections of the 4020 can be changed around.

Pins 1, 9, 22, 25, 26, 27 and 28 on the SN76477 all require TTL level pulses (generally active high) to select the appropriate function. The table here shows what is selected when each pin is high and low (0 or 1).

G.P. Hicks (L/App) from the RAAF Base, Laverton, Victoria, who sent in the idea, says that a 4017 could be used instead of the 4020. He also notes that if the VCO resistor on the SN76477 is altered experimentally, and using a similar circuit arrangement to drive pin 7 as shown here, it may be possible to play tunes.

Pin 9 (system enable)			Pin 22 (VCO/SLF select)
0 (system enabled)			0 (VCO selected)
1 (system disabled)			1 (SLF selected)
Pin 1	Pin 28		O/P (envelope logic)
0	0		VCO
0	1		Mixer only
1	0		One shot (mono)
1	1		VCO/mono
Pin 27	Pin 25	Pin 26	Output (mixer)
0	0	0	VCO
0	0	1	SLF
0	1	0	Noise
1	0	0	SLF/noise
1	0	1	SLF/VCO/noise
1	1	0	SLF/VCO
1	1	1	inhibit

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. If you are looking for a particular component or project — 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 page immediately before the DREGS page (inside the back cover).

This month's projects are a mixed bag (we try to appeal to as many of the diversified readers' interests as we can each month) but little difficulty should be experienced in obtaining parts for all the projects. The only exception involves the **Takamisawa relay** specified in the Series 3000 Compact Stereo Amp.

New Relays

The Takamisawa range of relays are a low cost, high performance line distributed here by Associated Controls Pty Ltd of 55 Fairford Rd, Padstow NSW, and 214-224 Wellington Rd, Mulgrave Vic. Of particular interest is the VB series which are almost identical to the relay type we have been using in projects over the past few years, but retail for a considerably lower price! The VB relays have either DPDT contacts rated at 5 A or SPST contacts rated at 10 A. Within the range, a whole variety of contact materials and coil voltages are available — from 3 V to 60 V.

We intend specifying these relays in projects in the future and our pc boards will be designed to accept both the older style relays and the Takamisawa VB series.

In Sydney, Radio Despatch Service, David Reid Electronics and George Brown are stocking these relays (less than $3 over the counter at one-off prices from one supplier!). In Melbourne, the only supplier we could find was Stewart Electronics, 44 Stafford St, Huntingdale.

The 3045/3046/3086

Those readers pursuing applications of this wonderful little transistor array IC, as featured in this month's Lab Notes, should have little difficulty in purchasing the IC in one form or another. According to the data sheet in Lab Notes, it's not going to matter too much which number IC you choose out of the three, depending on the application. National Semiconductor (LM series) and RCA (CA series) make them.

Around Sydney, you'll be able to get the 3045/3046/3086 at Radio Despatch Service, David Reid Electronics and AWA Microelectronics (554 Parramatta Rd, Ashfield 2131).

Victorian enthusiasts are better served (lucky blighters!) as the IC can be obtained from All Electronic Components, Ellistronics, Magraths, Radio Parts, Rod Irving Electronics and Tasman Electronics.

Projects

This month's feature project, the **Series 3000 Compact Stereo Amplifier, ETI-476,** should prove quite popular. Kits and components should be readily available, even as you read this, as we notified suppliers more than six weeks in advance of publication.

Just prior to going to press, those suppliers who indicated they would be stocking kits for this project were: All Electronic Components, Rod Irving Electronics and Tasman Electronics — all of whom are in Melbourne.

However, as we've used commonly available components throughout (except for the Takamisawa relay, but we've already told you about that), pc boards, cases, Scotchcal panels and all components will be available from the following suppliers: In Sydney — Radio Despatch Service, Electronic Agencies, David Reid Electronics; in Melbourne — Ellistronics, Magraths, Radio Parts (components, but no pc boards) in addition to those stocking kits just mentioned.

All components, printed circuit boards and Scotchcal panels will be generally available for the **Electronic Thermometer, ETI-255,** and the **Soil Moisture Indicator, ETI-247** See October issue Shoparound, page 65, for details on the availability of Scotchcal front panels, meter scales and labels. The **ETI-475 AM Tuner,** featured in the September issue, is being stocked as a complete kit by All Electronic Components, we are advised. Printed circuit boards and all other components except the case are stocked by Radio Despatch Service. Following an unfortunate initial delay, pot cores for this project are now obtainable.

Complete kits for October's feature project, the **ETI-568 Flash Trigger,** are stocked by All Electronic Components, Rod Irving Electronics and Tasman Electronics in Melbourne and Electronic Agencies in Sydney. All components, Scotchcal front panel and all, are available from Radio Despatch Service in Sydney.

Archeologists, treasure hunters and metal detector enthusiasts will be happy to know that All Electronic Components in Melbourne will be stocking pc boards, components and — most importantly — pot core coil kits for the **ETI-566 Metal Detector,** as revisited in Lab Notes in the October issue.

AC output plugpacks

Most plugpack power supply units available have in-built rectifiers and filters and provide a dc voltage output. However, there are some applications where an ac output plugpack is required. The ETI-475 AM Tuner is an example.

There are several brands of 12 Vac output plugpacks on the market and you can obtain them with a 200 mA or 500 mA current rating. So far as we have been able to find out to date, the following suppliers stock one or another: In Melbourne — All Electronic Components, Rod Irving Electronics, Tasman Electronics; in Sydney — Radio Despatch Service. Dick Smith stores everywhere stock one rated at 12 V/500 mA output.

The PPB9/500 plugpack specified for the ETI-475 AM Tuner is also generally available through the same sources.

Fastest zippy box in the west

Readers near and far, especially in West Australia, will be interested to learn that Altronic Distributors Pty Ltd of 151 York St, Subiaco 6008 W.A., has recently released a new style zippy box, as used with so many of our projects.

At first glance it looks like most other zippy boxes around — black plastic case, aluminium panel held on with four screws — but on closer inspection, it's cunningly different. They're Australian made and the inside walls are grooved to permit a pc board to be slid in vertically (in the conventional manner) but a tapered embossing with a 'stop' incorporated permits an appropriately sized pc board to be "snapped in".

The Altronic zippy boxes come in four sizes: H0101(UB1) measures 150 x 90 x 50 mm, H0102(UB5) is only 83 x 54 x 28 mm. Pricing and complete information is available from Jack O'Donnell, Altronic Distributors Pty Ltd, at the above address, or phone (09)381-7233.

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This is Australia's fastest selling microcomputer: the superb System 80 available only through Dick Smith Electronics (& authorised re-sellers).

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Now all that has changed: we're proud to announce the release of the System 80 S-100 Expansion Interface. The System 80, through its S-100 expansion interface, can now be used with hardware and software devices from over 200 different manufacturers. Just in case you didn't know, 'S-100' is the industry standard, which means you aren't tied to any one supplier for add-ons. A single supply source means that prices can be – and usually are – sky-high because there is no competition!

So now we expect the System 80 to really boom – not just to hobbyists, who've had it all their own way until now – but to businesses, to students, to housewives, to industry . . . There are virtually no limits to the System 80 system. All it takes is imagination.

And don't forget: software requirements for the System 80 are virtually the same as for the TRS-80: so most of the thousands of programs written for it will also run on your System 80 system!

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16K RAM, LEVEL II MODEL (Cat X-4005) $750.00

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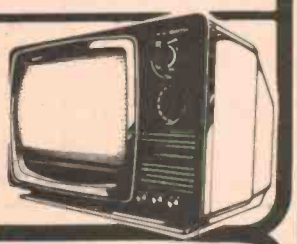
The System 80 will run with any TV set: but in case you need a monitor, check this one out! P.S. This monitor will also work with most other micro-computers. Compare our prices and SAVE!

USE WITH ANY COMPUTER!

$149.50

Cat X-1196



NOW: FULL S-100 EXPANSION

Yes! It's here! Add the S-100 Expansion Interface to your System 80 for incredible versatility.

It gives you:

- **All interface logic for the S-100 expansion bus.**
- **A floppy disk controller capable of controlling up to four single-density drives (such as our Pertec drives at right) for up to 400K bytes of storage capacity.**
- **A full Centronics-type parallel printer port.**
- **An RS-232C serial communications port, capable of communicating with modems and acoustic couplers. May also be used to drive a teleprinter or other serial printer instead of a parallel printer.**
- **Two vacant S-100 card sockets, to plug in further expansion items.**

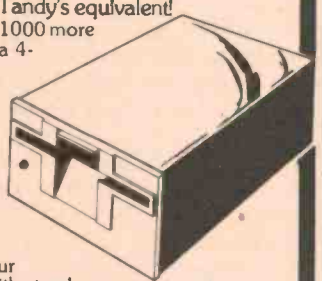
ONLY $499.00 ***INCLUDING RS-232C PORT!***

Cat X-4010

HUGE SAVING ON TANDY'S PRICE!

BARGAIN PRICED MINI DISK DRIVE

$200 less than Tandy's equivalent! You'd pay over $1000 more from Tandy for a 4-drive system! This incredible drive is world-famous Pertec brand; offers higher capacity than Tandy drive and will work with System 80 or TRS-80. Ask for more info. at your nearest Dick Smith store!



X-3230

$379

16K (or 32K) CARD

Just plugs into the expansion box . . .

Expand your System 80 Memory – up to 48K via the expansion interface. The plug-in card comes with 16K RAM, with room for another 16K. So with one card and our 16K expansion kit, you can have a full 48K! Much lower cost than TRS-80 expansion (currently $220/16K!) Cat X-4016.

$199 INCLUDING 16K RAM

DISK PRICES TUMBLE!

Unbelievable prices for either hard or soft sectored mini diskettes. Suit virtually all disk drives available. Buy from Dick and save a fortune!

Hard Sector (X-3505)
Soft Sector (X-3510)

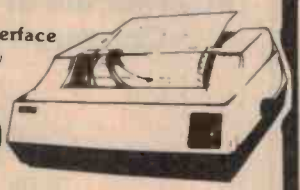
Trade enquiries welcome

WERE $5.95 EA! NOW:
1 – 10: $4.95
10 – 100: $3.95
100 UP: $3.50

ITOH 8300 BUDGET PRINTER

For budget printing, you can't go past this one! Uses standard tractor-feed paper, gives high quality print from its 7x5 dot matrix. Up to 240mm paper, prints 125 chars/sec. For either System 80 or TRS-80. Cat X-3255.

Uses Printer Interface and cable below



$970

FAN-FORM COMPUTER PAPER TO SUIT ABOVE PRINTER. 2000 SHEETS

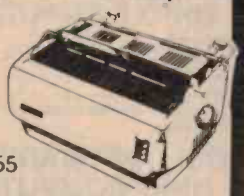
Cat X-1189 ..... **$35.00**

LETTER QUALITY DAISY WHEEL PRINTER

For top quality print, try this: it's over $300 cheaper than Tandy's daisy-wheel, and is capable of proportional printing! Limited stocks when they arrive.

Takes standard stationery!

DUE IN STOCK SHORTLY



Cat X-3265

$1995.00

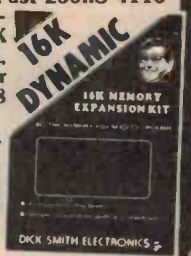
PROGRAM CASSETTES

Popular C-10 computer cassettes (just the right size for programs!) with computer-quality tape. Suitable for all 'compact cassette' type units (which everyone uses!) Cat X-3500

$1.95

SAVE A FORTUNE ON MEMORY IC'S

Were almost $100 more twelve months ago! Fast 250nS 4116 RAMs, for upgrading your 4K or 8K to 16K, 16K to 32K or 32K to 48K. 8 IC's in pack. With full instr. Cat X-1186



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Also available individually: Cat Z-9310 .... $7.90 ea.

DON'T NEED FULL S-100 EXPANSION?

Use this parallel printer interface if you don't need full S-100 expansion. Save a bundle! Uses similar connecting cable to S-100 interface

$49.50

PRINTER CABLE Cat X-4013

Fitted with edge connector at one end, 57N-36 plug at other: suits virtually all Centronics-type printers. Use with either S-100 interface or parallel printer interface.

$39.50 Cat X-4014

SOUND OFF

Add sound to your System 80 programs! Includes amp, programs and full instructions. You can add sound to existing programs too! Also suits TRS-80.

$19.50

Cat X-3648

MICROSOFT™ EDITOR/ASSEMBLER PLUS!

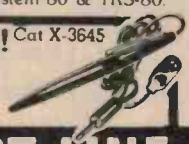
Editing, assembling & debugging power you've never had before! Equivalent of Tandy's Editor/assembler and T-bug products **but in one package and at less than half the price!** And it's far more powerful! Suits System 80 & TRS-80.

LIGHT PEN BARGAIN!

Cat X-3645

The best value around. Gives your System 80 or TRS-80 an eye. Easy to use, has simple programs

$9.95



$39.95

Cat X-3680

COMPUTER HOT LINE . . .

Want to know more about our computers? Or are you having troubles? We've set up a special computer hot line just to help you out. Call between 9AM & 5PM on Sydney (area code 02) **888 2002**

SOFTWARE
for System 80 or TRS-80

GAMES AND EDUCATIONAL SOFTWARE CURRENTLY AVAILABLE

TIME TREK **$17.95**
You're boldly going where no man has gone before ... Mind you, those pesky Klingons attack you from time to time, so you'll need fast reflexes as well as sharp wits. Nine levels of difficulty. Cat X-3650

STIMULATING SIMULATIONS **$17.95**
No less than 10 different games: all fascinating and original. Art Auction, Forest Fire, Monster Chase, Nautical Navigation, Lost Treasure, Business Management, Gone Fishing, Rare Birds, Space Flight and Diamond Thief. Cat X-3652

ELECTRIC PAINTBRUSH **$17.95**
This is a special machine language 'graphics interpreter' program, which lets you program dazzling graphics displays using simple high-level commands. Easy—and fun! Cat X-3654

BRIDGE CHALLENGER **$17.50**
Keen on Bridge? This game never gets tired of playing with you. Ideal for practising and improving your level of play – whether you're an expert or just a beginner. Needs a 16K machine. Cat X-3656

MICROCHESS **$22.50**
Think you're a wizz at chess? This program will put you to the test! But think out your moves carefully; the computer is out to beat you! One of the top selling chess programs in the USA. Cat X-3658

BLOCKADE **$17.95**
You'll need fast reflexes and good co-ordination for this one. It's written in machine language so it can give really high speed graphics. Try to force your opponent into a collision with a moving wall; without running into a wall yourself! Cat X-3659

PUNTER'S DREAM **$12.50**
Place your bets, please the race is about to start! Study the form of the various horses before placing your bets. Then the race is on! The program looks after the 'betting accounts' of up to nine punters, and can even cream off a percentage for the 'house'! You get a realistic simulation of racetrack probabilities. Use it for fun or to improve your strategies! Needs a 16K machine. Cat X-3660

BANDITO **$14.95**
Like playing the one-arm bandits down at the club? Here's one you can play seated at your friendly System 80! Tell the machine how much you want to spend, and it will feed it through. Watch the handle go down, the reels spin, and your money go! Then experience that familiar thrill when you hit a jackpot. Needs a 16K machine. Cat X-3661

MATHS/SPELLING **$9.95**
Here's a great way to coach spelling and maths: imagine how much more interesting the lessons are if the computer is giving the problems! Help stamp out illiteracy and poor spelling – this great program can help you do it! Cat X-3662

AIRMAIL PILOT **$12.95**
You're back in the early days of aviation. You must get the mail through in the shortest possible time. Your cloth-covered bi-plane must take you through unpredictable winds and electrical storms – can you make it! Cat X-3663

INTERLUDE **$22.50**
This is the adults-only game for your computer. After the kids have gone to sleep, let the computer give you ideas for the rest of the night! It comes with a 'comprehensive' instruction manual! (Note: this program is NOT available to any person under 18 years of age). Do not purchase this program if you are easily offended. Needs a 16K machine. Cat X-3675

SIMUTEK 1 ..... **$17.95**
Not just one, but FIVE superb space fantasy games. Includes Graphic-Trek 2000 (try to dock the Enterprise with the space station without being shot down!), Invasion Worg (protect the Earth), Star Wars (get in to the Death Star, plant a Bomb and get out again!) Space Target (a battle game) and Saucers (an action graphics game). Complete with instruction book. Needs 16K. Cat X-3658

POKER PETE **$15.95**
Like a game of poker? He's a pretty shrewd player – hard to beat, although it can be done. Has really intriguing graphics, needs 16K machine. Cat X-3664

DEATH TRAP **$9.95**
How's your co-ordination? Escape from the minefield without getting caught; ready to try again. Only it gets tougher! This one has sound effects, too. Requires a 16K machine. Cat X-3688.

SPEED READING COURSE **$19.95**
A set of programs on two cassettes designed to help readers of all ages improve their reading skills. Written by a primary school teacher. Requires a 16K machine. Cat X-3692.

SCURVE INVADERS (Learning fun I) **$9.95**
A unique program combining basic maths drill with the ever-popular 'Space Invaders' game. Sound effects plus three levels of difficulty. Learning has never been so much fun. Needs 16K. Cat X-3694.

HANGMAN/CONCENTRATION (Learning fun II) ... **$9.95**
Great fun to play, but also increase familiarity with words. Two programs, can be played with two players or two teams. Requires 16K. Cat X-3696.

ALPHABET COUNTDOWN/RHYME TIME (Learning fun III) **$9.95**
Another two games which give players of any age practice in selecting and manipulating words. Gives percentage correct. Requires 16K. Cat X-3698.

DICK SMITH ELECTRONICS

SEE OUR OTHER ADVERTS IN THIS MAGAZINE FOR OUR STORE ADDRESSES AND RESELLERS

LETTERS

Dear Sir,

As dedicated manufacturers of high fidelity amplifiers we were pained by your September editorial. We wholeheartedly agree with you that tariffs ought not to be used to protect insignificant industries, hi-fi not excepted, but why must you assume that our hi-fi industry is bound to stay 'miniscule'? Does this sort of attitude advance Australia?

If you employed the reverse attitude and gave a little publicity to the forty-plus companies in Australia currently manufacturing audio amplifiers and the substantially greater number producing loudspeakers and ancillary equipment, perhaps these companies could become large enough either to merit the tariff protection they are now receiving or not to need such assistance at all. This is not to say that Australian companies could ever compete with cheap budget equipment, but they could easily perform well at the middle and high end of the market.

We venture to suggest that, like us, other manufacturers are experiencing acceptance from overseas markets and heavy going within Australia.

A little 'intelligent investigation' might reveal an industry waiting to burst into life, given a little media coverage and awareness. How about publishing a series of articles on Australian domestic hi-fi equipment? It might provide interesting reading for many enthusiasts and be an example of positive thinking by the media which would eventually filter down to all Australians.

Peter A. Stein
ME Sound Pty Ltd
Dyers Crossing, NSW

Taking last things first, we are always delighted to publish articles on Australian made domestic hi-fi equipment. You, and the readers of like mind, should be delighted with the review of the Audiosound AM101 tuner on page 138 of this very issue.

Where are the "forty-plus" companies that comprise 'our' domestic hi-fi industry? Why do you all hide your collective lights under a bushel . . . or a wool bale, or whatever? Don't be bashful. If you're proud to be Australian, tell everybody. Let us know what you're doing — regularly. To put the ball back in your court, why have you never submitted any of your equipment to us for review? Why don't we have a file of press releases or news items from you? We don't get any, that's why. If we don't get anything, we can't print anything. If we don't print anything, nobody gets to hear about you. If nobody gets to hear about you, nobody knows who you are . . . etc. If you succeed at exporting, clearly you've put some effort into it. Have you put the same effort into local promotion? If you've had little result from local promotion, do you know why?

We don't say the local 'domestic hi-fi' industry (miniscule or not) doesn't deserve tariff protection — but you're going to have to promote yourselves if you want recognition.

Roger Harrison
Editor, ETI

Dear Sir,

Your illustration of the Sinclair DFM in the August issue of ETI was to me like the proverbial red rag to a bull.

Sinclair used to market quite good expensive hi-fi units world-wide until it switched into the more profitable field of computers and suchlike. When it abandoned the hi-fi business, what did it do about the many thousands of Sinclair amplifiers and FM units already in the hands of consumers? Quite simply, it washed its hands of all responsibility!

When my Sinclair amp broke down I wrote to Sinclair requesting semiconductor specifications as the required transistors could not be physically identified. I received a duplicated letter in reply, which said in effect, "Sorry, we are no longer in the market and therefore cannot assist".

I wrote to an English magazine, complaining bitterly, and they must have forwarded my letter to Sinclair because eight months later I received a reply from Mr Clive Sinclair's office. Sinclair Radionics did not exist any more and Mr. S was busy launching his new computer!

It's not unreasonable to suppose that if Sinclair doesn't make a success of DFMs and computers it will give that away too with the same 'devil take the hindmost' attitude.

If a company goes bust, then that's just bad luck — these things happen. But to merely shift emphasis to an allied field and wipe the slate clean in respect of service responsibilities is downright diabolical!

I would be gratified if this matter could be aired in your magazine. There are still man ardent hi-jfi buffs who swear by the products of the 'mother country' from manufacturers like KEF, SME, Rogers and Quad for example. But it's no wonder that as a nation we now buy most of our products from Japan. The Japanese give service!

Ian Stuart
North Balwyn, Vic.

We can understand your anger at being 'caught' with a now-useless piece of equipment and sympathise wholeheartedly. The editor was caught himself, in a similar fashion, some years ago. The history of some of the Sinclair enterprises has certainly been "chequered", to put it mildly.

However, there is no reason for you to transfer your anger or anxieties about the situation to Sinclair instruments, calculators and computers. These are marketed in Australia by Consolidated Marketing, under the banner of Sinclair Equipment (Australasia) Pty Ltd, of 308 High St, Kew, Vic 3101; phone (03) 861-6224. The company provides after-sales service on all the Sinclair products distributed here by them. They are, in fact, Sinclair service agents for the Australasian-Pacific region, according to Mr Julian Barson whom I rang before composing this reply.

It is easy to understand your reluctance, and that of other consumers, about buying products from a company or companies where there has been a history of collapse and no follow-on service. It may not be peculiar to British products, but the availability of local service, and particularly long after the product has been superseded, does wonders for the image and goodwill of a company. As you say, this is where the Japanese companies excel, and consumers give them the custom. The message is clear — he who gives the service gets the repeat custom.

Roger Harrison,
Editor, ETI

Dear Sir,

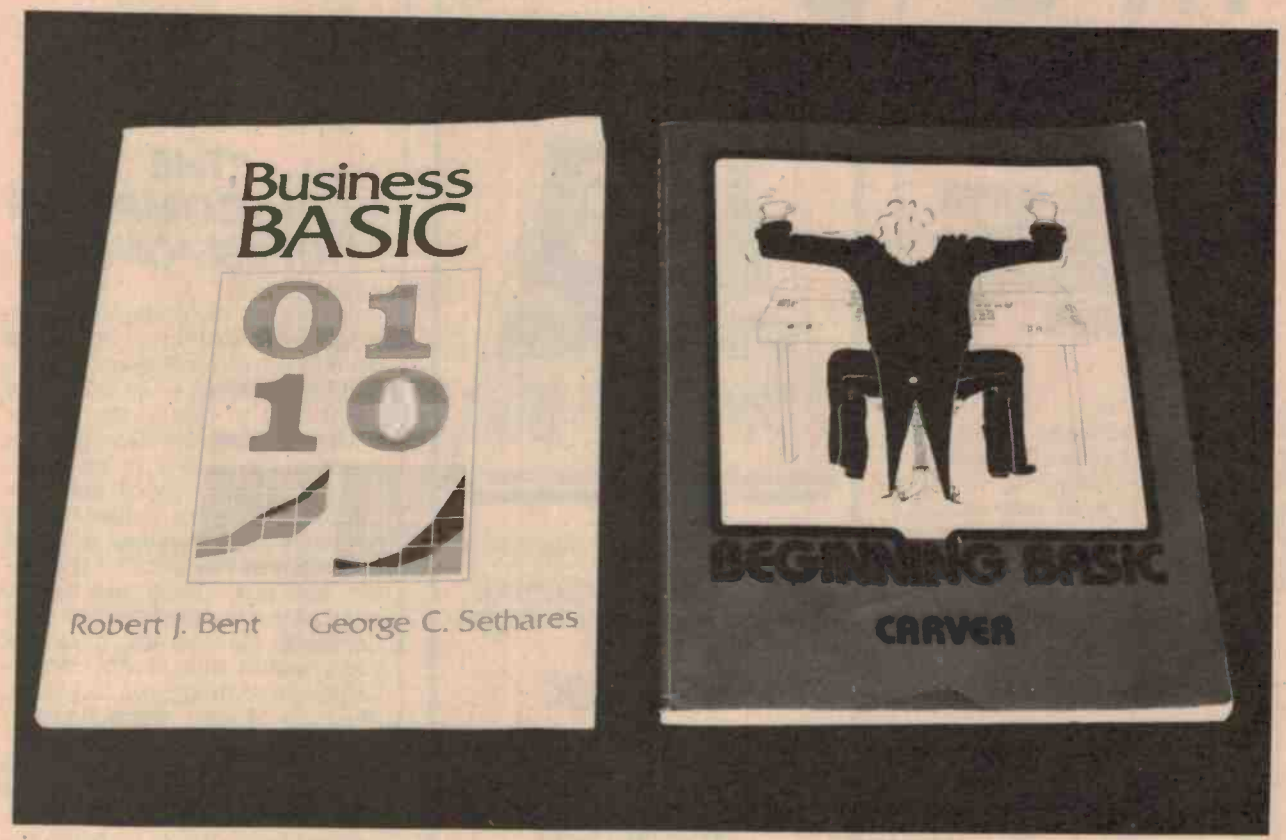
The Electromyogram biofeedback project that David Tilbrook designed (Sept/Oct 1979) has proved to be most useful to me and is in daily use.

I find it is particularly helpful in teaching relaxation techniques to patients and in encouraging active movement in poorly functioning muscle groups.

Margaret Goldfinch
Prince Henry Hospital, Sydney

READER OFFER

computer books



Beginning BASIC — **Carver**

Beginning BASIC is not *just* another programming text. It is "... written for the true beginner in the world of programming. The important concepts are explained simply, yet with enough detail to enable the reader to understand why a particular programming technique is used. Short, simple and, for the most part, *non*mathematical examples illustrate each programming idea or BASIC statement. In addition, flow charts have been used extensively throughout the book to illustrate the logic of various programming methods. These flowcharts, in conjunction with sample programs and narrative, provide the student with multiple means of assimilating the ideas of programming."

The above is a precis of the author's introduction to the book and neatly sums up what it's all about. Nine chapters, 200 pages; 280 x 215 mm.

PRICE: **$10.95**
post & handling $1.50

Business BASIC — **Bent & Sethares**

"This is great for the first-time business user with no previous computer or programming experience. There's a brief look at hardware and software, leading on to exercises in problem solving and the first program. Small business users who have ingested the contents of this book will be able to converse on much more equal terms with slick salesmen and white-coated experts."

The above is a review of this book by ETI staffer Elaine Ray, published in the September 1980 issue, page 89. Fifteen chapters, 223 pages; 280 x 215 mm.

PRICE: **$11.95**
post & handling $1.50

NOTE: This offer is made by Wadsworth Publishing Co. (A'Asia) and ETI is acting as a clearing house only. Cheques or money orders should be made payable to **COMPUTER BOOKS OFFER** and sent, together with this coupon (or photostat) to "Computer Books Offer", ETI magazine, 15 Boundary St, Rushcutters Bay NSW 2011. We will process your order and pass it on to Wadsworth who will send you the goods. Please allow up to four weeks for delivery.

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Business BASIC (Bent & Sethares) ..... ($11.95) .....
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The Compucolor II microcomputer

After putting this machine through its paces we're not surprised it's America's fourth best selling small computer.

A fully integrated system based on the 8080A microprocessor, the Compucolor is a sophisticated and very usable machine that represents good value for money.

Its most attractive feature is obviously its colour graphics capability. Eight 'primary' colours can be selected by keys at the left of the keyboard, namely red, green, blue, magenta, cyan, yellow, white and black, and by using various combinations of these basic colours the makers say that as many as 56 different 'secondary' colours can be generated. Sixteen PLOT functions make it easy to generate an astonishing variety of patterns without getting involved in complex programming. For example to draw a straight line it is only necessary to specify the end points. There are 16 384 separately addressable plotting blocks arranged in a 128 x 128 array.

The 33 cm screen can also display 32 lines of 64 characters. The 64 standard ASCII characters are formed in a 5 x 7 dot matrix within a 6 x 8 dot pattern and there are also 64 special characters, including chess symbols and playing card suits, which use the whole 6 x 8 dot matrix.

The keyboard is standard ASCII, four level coded with 132 codes. Seventy two crossbar commercial keyswitches are provided, including CPU reset and automatic (single chip driven) disk loading.

The built-in minifloppy disk drive uses double-sided, segmented 40-track disks with a density of approximately 19 tracks per cm, giving a total storage capacity of 51.2K per side. Transfer rate is 76.8 kilobytes per second and access time is 200 milliseconds.

The Model 5 Compucolor II has 32K of user RAM, against the 8K and 16K provided on the Models 3 and 4, but these two can both be expanded up to 32K by means of extra RAM modules.

The CPU clock period is set at two microseconds and there are a total of 512 input/output ports, of which only 25 are implemented in the standard unit, leaving 487 spare ports, which obviously give the Compucolor considerable scope for applications involving lots of peripherals.

The disk operating system includes a comprehensive range of file control commands. For example, pressing the AUTO key instructs the system to search for a 'MENU' program on the disk, load it and run it to display a list of disk contents. The 'DIRECTORY' command lists all the files on one side of a disk, detailing their names, addresses and lengths.

At the back of the unit is an RS-232 interface for connecting a printer or modem. The baud rate at this interface can be independently software controlled on a range of seven rates between 110 baud and 9600 baud.

BASIC, Fortran and Assembler languages are all contained in ROM. There are 25 statement types, five command types, 18 mathematical functions and nine string functions. The disk file commands include copy, device, directory (mentioned above), initialise, load, print, read, re-name, save, run and write.

A wide range of video games software is available and new items are being introduced all the time. Real time colour games obviously make the Compucolor very attractive to children, which is one reason why it's probably the best small computer for use in schools. Any intelligent child, even a six-year-old, should be able to make the transition from games to programming without any difficulty.

The Compucolor's ability to display statistical information in the form of bar graphs, histograms or two-dimensional curves make it a very useful educational aid in the sciences and especially in the social sciences. Since it's very easy to 'boot up' the machine, to load it and to reset it, it's clear that there's a great future for it in the classroom. Here at last is something that turns children's obsession with the TV screen to educational advantage.

The Compucolor II is distributed by Anderson Digital Equipment Pty Ltd, P.O. Box 322, Mt Waverley Vic 3149; (03) 543-2077. Our review machine came from The Logic Shop who are at 212 High St, Prahran Vic 3138 and 91 Regent St, Chippendale NSW 2008. Phone (03) 51-1950 or (02) 699-4910.

Elaine Ray

Microcomputer Handbook

Recently published by Computer Reference Guide of Chatswood, NSW, the "Australian Microcomputer Handbook" has 11 chapters on microcomputers and micro systems plus detailed summaries on the range of micros and desktop computers sold in Australia.

The first section covers everything from Architecture of the CPU to Word Processing, BASIC programming to User markets. The second section covers all the machines from A1 Electronics to Zenith and Zilog. The book sells for $22, including post and handling.

Last month's issue carried a loose insert on this book. If you missed it, a copy can be obtained from Computer Reference Guide, Suite 204, 284 Victoria Ave, Chatswood NSW 2067. (02) 411-2567. Mention ETI.

Portable micro has unique features

The Findex microcomputer is a completely integrated, portable system that weighs only 14 kg, and features bubble memory and gas plasma display.

Not much larger than a portable electric typewriter, it contains a CPU, keyboard, floppy disk drive or bubble memory, gas plasma display and plain paper printer. You can obtain an acoustic coupler as an option and a built-in rechargeable battery that gives enough power for one hour's use.

The system is built around the Z-80 microprocessor, with a clock rate of 2.8 MHz, but it can also be supplied with the 4 MHz Z-80A. Standard dynamic RAM provision is 48 kilobytes, expandable to 2 megabytes, and there is 1K of static RAM. The ROM capacity is 8 kilobytes, expandable to 32K.

The model 100TD has a single minifloppy disk drive that holds 200k bytes with an access time of 40 to 75 milliseconds. There is also an option for a built-in dual disk drive.

Instead of the disk storage, the model 128TD has 128K of magnetic bubble memory, which can be expanded to two megabytes on the same controller (but only half a million can be accommodated inside the case). Access time to the bubble memory is claimed to be only eight milliseconds!

The gas plasma display panel has six rows of 40 or 80 characters each, formed on a 5 x 7 dot matrix. If necessary it can be interfaced to a full CRT screen. The printer is a dot matrix impact type that can print up to 135 columns per line at 25 lines per minute on multi-copy plain paper.

Findex uses CP/M as its operating system. In addition to the disk operating system it includes a monitor, text editor, assembler and debugger. When interfaced to an external hard disk drive it can address up to 128 megabytes with 8M per file.

We had an all-too-brief 'play' with the machine shortly before press deadline and were most impressed with the boot-up speed of the Findex. The display is well formatted and very clear — it's visible under almost any lighting conditions, ideal for field applications. The printer is a real convenience. Construction is very rugged, obviously designed to take a 'beating' in expected applications 'out in the field'.

Retail price of the Findex is around $14 000, depending on which options are chosen. For more information contact the distributors, Mensa Computers Pty. Ltd, Suite 3, 454 St Kilda Road, Melbourne, Vic 3004. (03) 26-5683.

We think the Findex micro is such an interesting machine that we've arranged to borrow one and try it out thoroughly for ourselves. Watch for our review in a forthcoming issue of ETI.

New Vector systems

The Vector 3 integrated video console is the basis for two new small business microcomputer systems from Vector Graphics.

Their System 2800 offers two megabytes of mass storage on 200 mm disks, with formatting that is IBM compatible. The dual disk drive has an access time of 91 milliseconds and a transfer rate of 500K bits per second.

Built into the Vector 3 console are a Z80 MPU, 64K of dynamic RAM (of which 56K is usable) and a video board that can handle displays of 24 lines of 80 characters, using an 8 x 10 matrix font.

Standard software on System 2800 is CP/M, Microsoft BASIC-80, RAID debugger and SCOPE editor. Software packages available as options include general ledger, accounts payable and receivable, inventory control and word management.

The Vector Intelligent Partner (VIP) is a low cost system aimed at businesses that have not previously used a computer. It uses the same Vector 3 video console as the System 2800 but has less scope for mass storage — just a single 130 mm disk drive. Nevertheless it can still run the same standard software and if a second minidisk drive is added the VIP can cope with all the optional accounting and word processing packages.

Suggested retail price for the System 2800 is $8500 and for the VIP $4300 (plus tax in both cases).

More information about Vector products is available from the NSW distributors, Dicker Data Projects Ltd, 31 Cawarra Road, Caringbah, NSW 2229. (02) 525-4707.

ANNOUNCING A DAISY WHEEL TYPEWRITER FOR YOUR TRS-80 OR SYSTEM 80!!! ★ ONLY $1995 ★

MICRO-80 has converted the new OLIVETTI ET-121 DAISY WHEEL typewriter to work with the TRS-80 and SYSTEM 80 or any other microcomputer with a Centronics parallel port. The ET-121 typewriter is renowned for its high quality, fast speed (20 c.p.s.), quietness and reliability. MICRO-80 is renowned for its knowledge of the TRS-80/SYSTEM 80 and its sensible pricing policy. Together, we have produced a dual-purpose machine:- an attractive, modern, correcting typewriter which doubles as a correspondence quality Daisy-Wheel printer when used with your micro-computer.

How good is it? :- This part of our advertisement was typeset using an ET-121 driven by a TRS-80.

77 TRACK DISK DRIVES
DOUBLE YOUR CAPACITY

DD-7S **$775**
Micropolis Floppy Disk, 77 Track, 100% larger capacity than most mini-floppy drives, complete with cable, power supply, chassis, and includes NEWDOS '80.

DD-7 ... ... **$649**
Same as above but no cable or Newdos '80.

DC-4 ... ... **$45**
4 drive connector cable.

★ ★ SPECIAL ★ ★
MPI DISK DRIVES ONLY $339!!

40 track bare drive for TRS-80. Only requires readily available 5 volt 0.7 amp and 12 volt 1 amp power supply to be up and running. Can be mounted in simple cabinet or used bare.

DISKETTES FOR TRS-80

BASF single side/single density ... $4.50 ea
BASF double side/double density ... $5.90 ea
VERBATIM 77 track ... ... $6.99 ea
Minimum Order 10

EXATRON STRINGY FLOPPY
$352.50 incl p&p

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

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Price shown is for a built-up and tested unit. SYSPAND 80 is also available in kit form, call or write for details and price.

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MT-32 . . . $149.00

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

MT-32A without RAM $149.50
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These are prime, branded, 200 ns (yes, 200 ns!) chips. You will pay much more elsewhere for slow, 350 ns. chips. Ours are guaranteed for 12 months. A pair of DIP shunts is also required to upgrade the CPU memory – these cost an additional $4.00. All kits come complete with full, step-by-step instructions, no soldering is required. You don't have to be an electronic type to instal them.

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TRS-80 and SYSTEM 80 OWNERS **TRS-80 and SYSTEM 80 OWNERS**

SUPPLIERS FOR NDKS S-4000

MATHEMATICS

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

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

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

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

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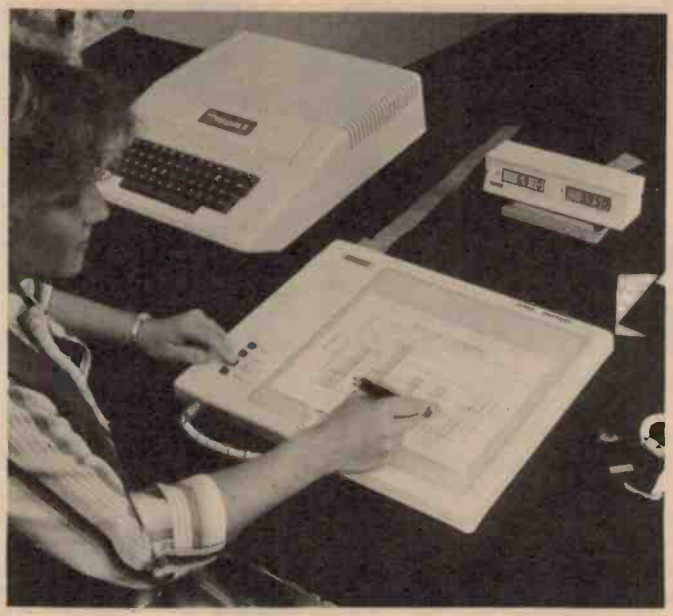
$$e_{rms}^2 = 4KTR(f_2 - f_1)$$

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

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

$$A^{-}+B^2=C^2$$

Printout



Apple II digitiser updated

The new DT-11A version of the HI PAD digitiser includes a slot interface card for the Apple II, a floppy disk software package, stylus and menu overlay.

Functions supported by the software include Draw, Line, Area, Background, Pen Colour, Separate, Catalogue, Save, Load and Shape. A plastic overlay that serves as a menu allows the user to select from these functions to generate a variety of manipulable colour graphics displays.

Features of the DT-11A include slot independence, BASIC and Pascal compatibility, assembler driver code, user controls and an optional cursor. For use with the Apple II it requires a 48K system and the Applesoft firmware card, but no magnetic blanking is needed and the digitiser is not oversensitive to static.

All up price for the digitiser with interface, software overlay and stylus is $995 plus tax. More information from Anderson Digital Equipment Pty Ltd, P.O. Box 322, Mount Waverley, Vic 3149. (03) 543-2077.

New User groups

We've recently been told about three new computer users groups in different states.

The first is the Victorian O.S.I/6502 users group. Interested people are asked to contact Ian Eyles at 10 Forbes St, Essendon, Vic. 3040 or phone (03) 375-3478 after hours.

Then there's the 'Queensland Sorcerer Users' or QSU, whose secretary is Ian Branch at 41 Chuter St, Stafford Heights, Qld 4053; (07) 350-2889. QSU say they have no plans to publish a newsletter at this stage but they will be issuing "Hints and Kinks" sheets on an occasional basis.

In South Australia there's now a Commodore Computer Users Association, whose address is P.O. Box 60, Clarence Gardens, SA 5039. The group meets at 7.30 pm on the first Tuesday of each month, usually at the Adelaide University Union Building. More information from Earle Rowan on (08) 297-7253.

Avoid the 15% surcharge

A practice has come to light recently where certain US microcomputer suppliers add a 'surcharge' to products bought from outside the country.

Catalogues carry a note requesting the payment of a 15% surcharge on items exported.

It turns out that it is not necessary to pay the surcharge and potential customers are advised to 'buck'. Offer to pay postage or freight and everybody gets a fair deal. If they won't come to the party, shop somewhere else.

First to try the surcharge stunt were Jade, followed more recently by QT Computer Systems.

Many thanks to a reader from JT Microcomputers for the information.

Japanese business micro

A Japanese-made desktop microcomputer aimed at business users has just been released in this country.

The PALM RL-800 is based on the Z80A microprocessor. It has 64K of internal RAM and mass storage is provided by an integral dual floppy disk drive system which has a total capacity of 736 kilobytes on double-sided double-density disks.

The built-in 300 mm monochrome video screen can display up to 24 lines of 80 characters, using a 7 x 9 dot matrix font. Cursor control, edit and auto-repeat are among the functions incorporated in the 89 key detachable keyboard unit.

The RL-800 can be used with a wide variety of printers, because in addition to two parallel Centronics standard I/O interfaces it also has two serial synchronous or asynchronous I/O interfaces with variable modulation rates which comply with the RS232C/CCITT-V24 specifications.

Application software includes programs for accounts receivable and payable, general ledger, invoicing, inventory control, payroll, order entry and word processing.

For more details contact the national distributors, GFS Electronic Imports, 15 McKeon Road, Mitcham, Vic 3132. (03) 873-3939.

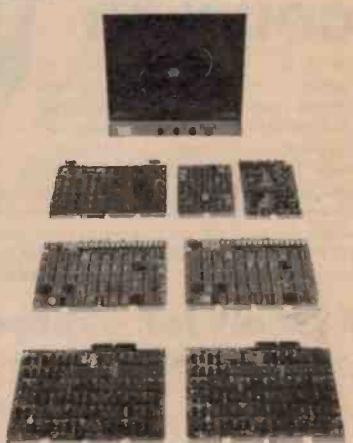
Matrox video boards

A new range of colour graphics controllers from Matrox are built on cards compatible with LSI-11 and PDP-11.

The boards display a 256 x 256 raster with four bits per pixel, which allows sixteen colours or scales of grey. Boards may be combined to provide more bits per pixel with no extra hardware. For example two boards operated together will provide 256 colours.

Sync may be derived internally or from an external master, allowing the boards to be integrated into existing facilities.

Next month's ETI will probably contain a review of one of these boards.



For more information about Matrox products, contact the distributors, Measuring and Control Equipment Pty Ltd, P.O. Box 78, Epping NSW 2121. (02) 86-4060.

BUILD NOW FOR CHRISTMAS!

Get ready for the Christmas festivities and save $$$! You'll be surprised at how easy a Dick Smith Kit is to build; and your Christmas bill won't cost you a fortune!!!

NEW EA CHASER

What a way to add life to your next Christmas party with this incredible Light Chaser. Features include reverse/forword chasing, variable flash rate control plus an invert/normal switch. This switch can make two lights appear to move instead of one at a time. The versatility is increased with 'auto reverse' & 'auto invert' functions. When either control is switched on, the unit will automatically inverse or reverse the display at any set rate. All this makes it a worthwile project that will save $$$ and give hours of entertainment.

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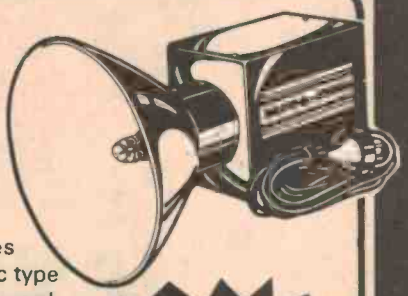
ETI STROBE



Get your Christmas party swinging with this superb Disco Strobe. This popular kit contains up-to-date circuitry and comes complete with photographic type reflector, perspex safety guard and instructions. Vary the flash rate to the beat of your music.

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K-3140

Turn your music into a light show. This unit will accept an audio input from almost any amplifier and uses the information to control 3 channels of colour. The ideal unit for your Christmas or New Year's party, disco, bands etc etc. Also makes an ideal present.

$69.50

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Cat. S-3850/52/54/56

SWIVEL BASE Globe Holder attaches to wall or ceiling.

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Cat. P-5620

HOLD IT!

Line socket for bayonet mount lamps makes it ideal for running wander light leads for loft & outside. Ideal for holding standard colour globes for parties, Xmas decorations outside etc.

95¢

P-5510

OTHER EXCITING DICK SMITH KITS...

ACOUSTIC COUPLER

We've lost count of the number of customers who have asked for this project: well here it is! This acoustic coupler acts like a modem without any physical connection to the phone lines. It uses your standard telephone handset, placed over a small microphone & speaker in the coupler case, & transfers the information from your computer by sound. Hence the name, acoustic coupler.
Now you can have your computer talk to another across the street, across the town – even across the country (or further!) It is a must for all serious computer users, and we hope to release the kit soon.

A must for everyone with a computer

$75.00

Cat. K-3605

LEDS & LADDERS GAME

One of our most popular kits of the past was the intriguing 'LEDS & LADDERS' game described in EA in 1975. Now EA have come up with a new version of the game which is not only easier to build, it is also easier to play! Can you climb out of the well without being plummeted down again?

AND NOW FOR THE BEST NEWS: This kit is actually $1.00 cheaper than it was in 1976 – despite 4 years of inflation! Makes an ideal gift.

Was $16.75 in 1976

NOW ONLY

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Cat. K-3390

DICK SMITH ELECTRONICS

SEE OUR OTHER ADVERTS IN THIS MAGAZINE FOR OUR STORE ADDRESSES AND RESELLERS

Print-out

For 2650 fans

This column has been written by Brian Young of the 2650 Enthusiasts Group. It's the first of an occasional series that he'll be contributing for the edification and entertainment of 2650 users.

This is a DUMP and LOAD program for the 2650 microcomputer that will allow storage on tape at approx 3000 baud (six seconds per 1k). A very simple interface is required to operate this program. It uses the first five bytes of memory (immediately after the program) as its own scratchpad. It was written by Max Crisp for his RCA-1802 and modified by Max and myself for the 2650.

The LOAD program is from 0F00-0F59, and the DUMP is 0F5A-0FDE.

Use as follows:-

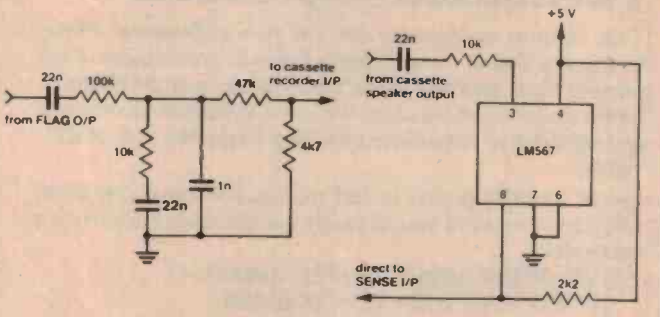
LOAD . . . Type GF00(CR).
Now switch the sense input to the output of the squaring op-amp. When the LOAD is successful, a 'P' will be printed. If you don't get a 'P', rewind the tape and try again. You must press 'RESET' to exit from the LOAD program . . .

DUMP . . . Type GF5A(SP)(AAAA)(SP)(XX)(CR).
Where AAAA is the Start Address of your DUMP and XX is the number (in hex) of 256-Byte blocks you wish to DUMP. Be sure you have your tape running on RECORD before you press 'CR'.

These programs are extremely reliable and well worth using. There are two listings given so you can put it above your programs depending on how much memory you have. I will be pleased to relocate it anywhere in memory if necessary.

If you would like more information about this program, please write to me at the 2650 Enthusiasts Group, 115 Grey St, Traralgon, Vic 3844.

Brian Young




```
0F00  20 CC 0F E1  75 08 05 00  06 FF 20 86  00 18 02 FA
0F10  00 B4 80 18  7C 07 21 FB  7E B4 80 18  6E 5A 67 3B
0F20  35 58 13 3B  22 CC 0F E0  3B 1D C2 3B  1A CE EF E0
0F30  81 C1 DA 77  1B 54 21 50  84 50 3F 02  B4 3F 00 8A
0F40  1B 44 B5 01  14 1B 02 04  01 B4 80 18  7C 07 21 FB
0F50  7E 80 B4 80  18 6C 64 01  1B 78 3B 87  CD 0F E0 CE
0F60  1F E3 3F 02  DB CE 0F E2  75 08 20 C1  0E 0F E3 CC
0F70  0F E1 3B 3E  F9 7C 04 01  3B 38 0F 0F  E2 18 27 A7
0F80  01 CF 0F E2  3B 31 0C 0F  E0 3B 27 02  3B 24 14 0E
0F90  EF E0 C3 81  C1 03 3B 1F  DA 75 0F 0F  E0 87 01 CF
0FA0  0F E0 3B 12  1B 50 01 64  01 3B 0C DB  7E D8 7C 1F
0FB0  00 00 07 07  1B 03 C0 07  04 80 64 01  FB 7E B5 01
0FC0  18 04 07 18  1B 03 07 31  14 CF 0F E4  76 40 FB 7E
0FD0  74 40 0F 0F  E4 A7 16 FB  7E 80 07 0D  58 5E 17 FF
0FE0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF

1F00  20 CC 1F E1  75 08 05 00  06 FF 20 86  00 18 02 FA
1F10  00 B4 80 18  7C 07 21 FB  7E B4 80 18  6E 5A 67 3B
1F20  35 58 13 3B  22 CC 1F E0  3B 1D C2 3B  1A CE FF E0
1F30  81 C1 DA 77  1B 54 21 50  84 50 3F 02  B4 3F 00 8A
1F40  1B 44 B5 01  14 1B 02 04  01 B4 80 18  7C 07 21 FB
1F50  7E 80 B4 80  18 6C 64 01  1B 78 3B 87  CD 1F E0 CE
1F60  1F E3 3F 02  DB CE 1F E2  75 08 20 C1  0E 1F E3 CC
1F70  1F E1 3B 3E  F9 7C 04 01  3B 38 0F 1F  E2 18 27 A7
1F80  01 CF 1F E2  3B 31 0C 1F  E0 3B 27 02  3B 24 14 0E
1F90  FF E0 C3 81  C1 03 3B 1F  DA 75 0F 1F  E0 87 01 CF
1FA0  1F E0 3B 12  1B 50 01 64  01 3B 0C DB  7E D8 7C 1F
1FB0  00 00 07 07  1B 03 C0 07  04 80 64 01  FB 7E B5 01
1FC0  18 04 07 18  1B 03 07 31  14 CF 1F E4  76 40 FB 7E
1FD0  74 40 0F 1F  E4 A7 16 FB  7E 80 07 0D  58 5E 17 FF
1FE0  FF FF FF FF  FF FF FF FF  FF FF FF FF  FF FF FF FF
```

Printout

For Sorcerer Apprentices

This column is intended for the non-professional Home Computer Owner — specifically Exidy Sorcerer users. It will present hints and tips and a forum where any problems or hints you have can be aired. We invite readers to forward any queries or other material to us care of Roger Harrison at ETI.

Note:

In last month's printer on/off routine from an Exidy Basic program we asked you to insert the following lines in your program:

```
0 VE=PEEK(-4095)*256+PEEK(-4096)-47
1 IF VE>32767 THEN VE = VE-65536
```

We omitted to explain why these specific numbers had to be used. Theoretically you could have used another method, e.g. calculating the number (VE) before writing the program and then simply nominating VE with a statement such as VE=12345 or whatever you might have calculated VE to be. However, if you expand your memory or run the program on a different sized system the value of VE changes and your routine will not work any longer.

This is the reason that we used the 'long hand' method. The same principle applies for the following examples.

Hint:

Ever wanted to change the speed of your cursor in the middle of your program (as the Monitor command SE S=10)?

Insert the following lines in your program:

```
0 VS=PEEK(-4095)*256+PEEK(-4096)-48
1 IF VS>32767 THEN VS = VS-65536
2 SP=10
3 POKE VS,SP: REM SP=Speed 0 to 255
```

Naturally, you can now use the value of 'VS' anywhere in your program without having to calculate it again.

Assembler program:

Here now is a listing of a rather useful program which was supplied to us by Claude Almer. He writes:

"It is good to see that ETI have started to publish this column. I am sure it will prove to be very interesting and useful to us Sorcerer owners. Having worked on a similar project myself, I know how good it is to get some feedback from readers. I would like you, if you think it is worth it, to publish the little program below. It must be loaded from F002 (HEX) onwards as the printout shows. When you have keyed it in, "GO F002". You will see that the normal prompt is changed into a question-mark. Also, the TOP OF RAM and STACK BEGINS will be displayed. This is to inform you that the stack has been moved down a bit. When you key in any command in Monitor and want to repeat that same command after completion, simply press "CTRL" and "X" simultaneously. If you want the command to be repeated permanently, key in the command and press "CTRL" and "I". "RUN/STOP" will let you exit this mode.

"For example: SE X=F002 (return)
SA KEYRP F002 F07F "CTRL" & "I"

This will immediately display the same command and then execute it. When finished executing, it will display it again and execute it again and so on until you press "RUN/STOP".

```
ADDR 0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F

F000:          CD A2 E1 FD E5 2A 00 F0 01 D9 FF 09 22 00
F010: F0 E1 CD A2 E1 FD F9 FD E5 D1 01 6E 00 ED B0 21
F020: 3A F0 01 28 00 ED B0 2A 00 F0 FD 75 41 FD 74 42
F030: FD 36 44 3F 21 A7 E3 C3 CB E0 CD 18 E0 28 FB FE
F040: 09 CA 62 F0 00 00 00 00 00 FE 18 C0 CD A2 E1 FD
F050: E5 E1 E5 3E 0D BE 23 20 FC 36 00 E1 CD BA E1 C3
F060: F9 E0 CD A2 E1 FD 36 36 41 76 FD 42 F0 33 33 E1
F070: E5 3B 3B 36 0D C9 CD 15 E0 28 D1 CD A2 E1 18 A7
```

"Locations F044H to F048H are free for the user to insert a compare and jump to his liking."

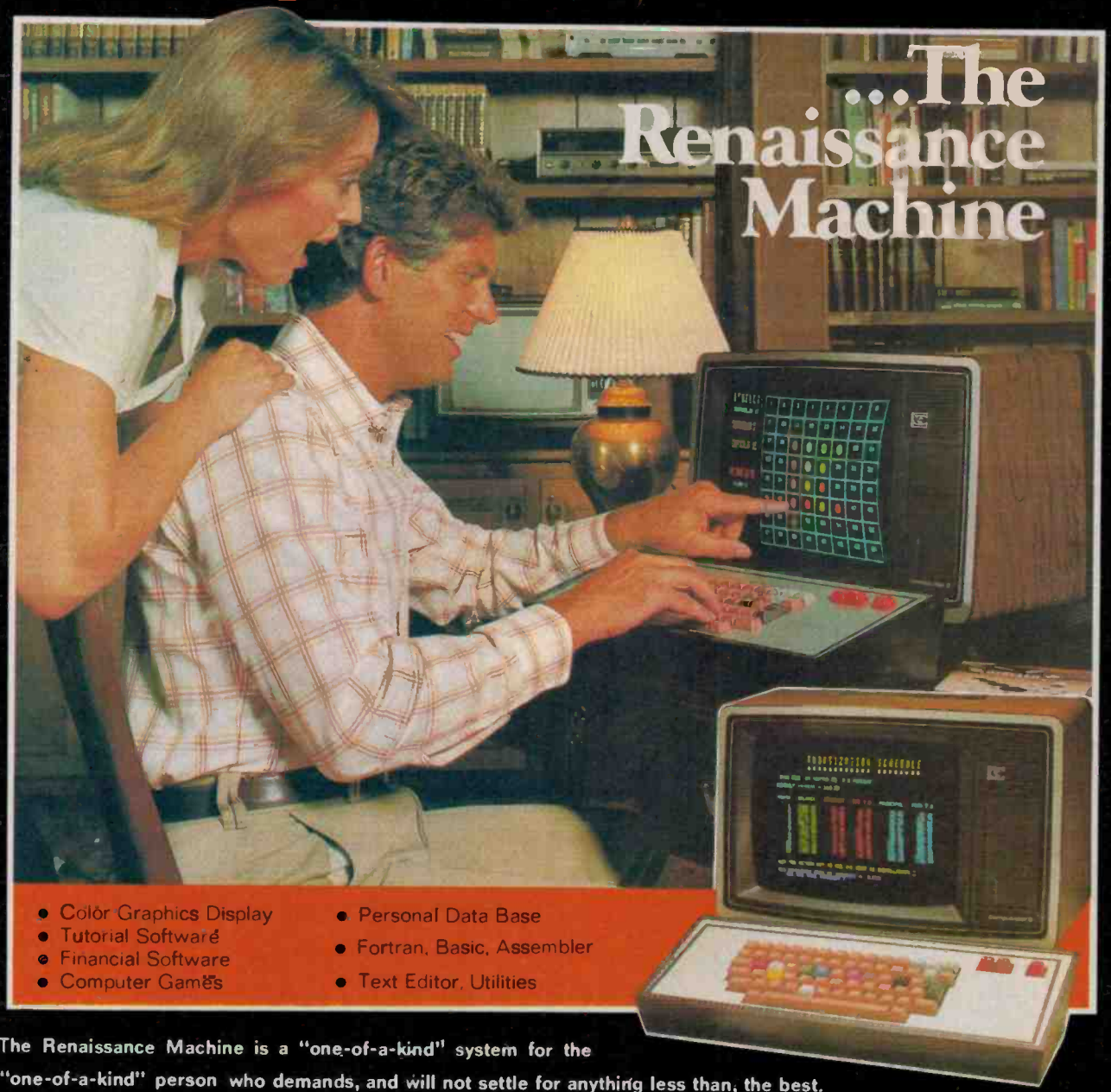
P.S: As long as you don't use the Development Pac or that area of RAM this program will remain there, even after a reset and all you have to do to get it active again is "GO F002".

Claude Almer, Hornsby, NSW

Thanks a lot Claude. We've tested the program, and it seems to work well. Perhaps you could write and let us know in a little more detail just how the program works. As you know, we intend to educate our readers as well as supplying them with little goodies such as your program. Incidentally, it might be worth mentioning to readers that the bytes F000 and F001 must NOT be used, as the Monitor always uses them.

A.P.F. Fry

Color your thinking with Compucolor 11



The Renaissance Machine is a "one-of-a-kind" system for the "one-of-a-kind" person who demands, and will not settle for anything less than, the best.

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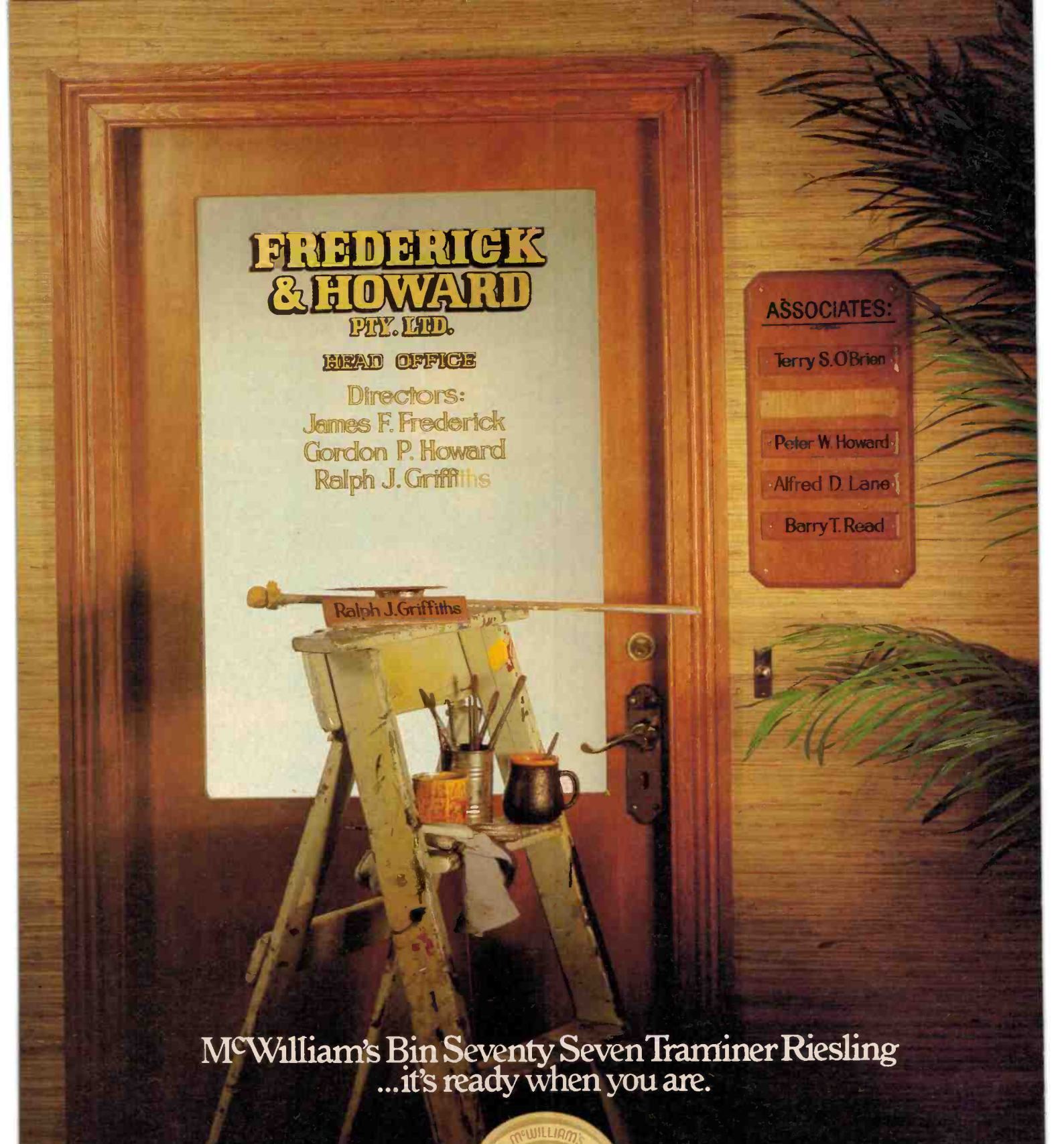

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AB125/80

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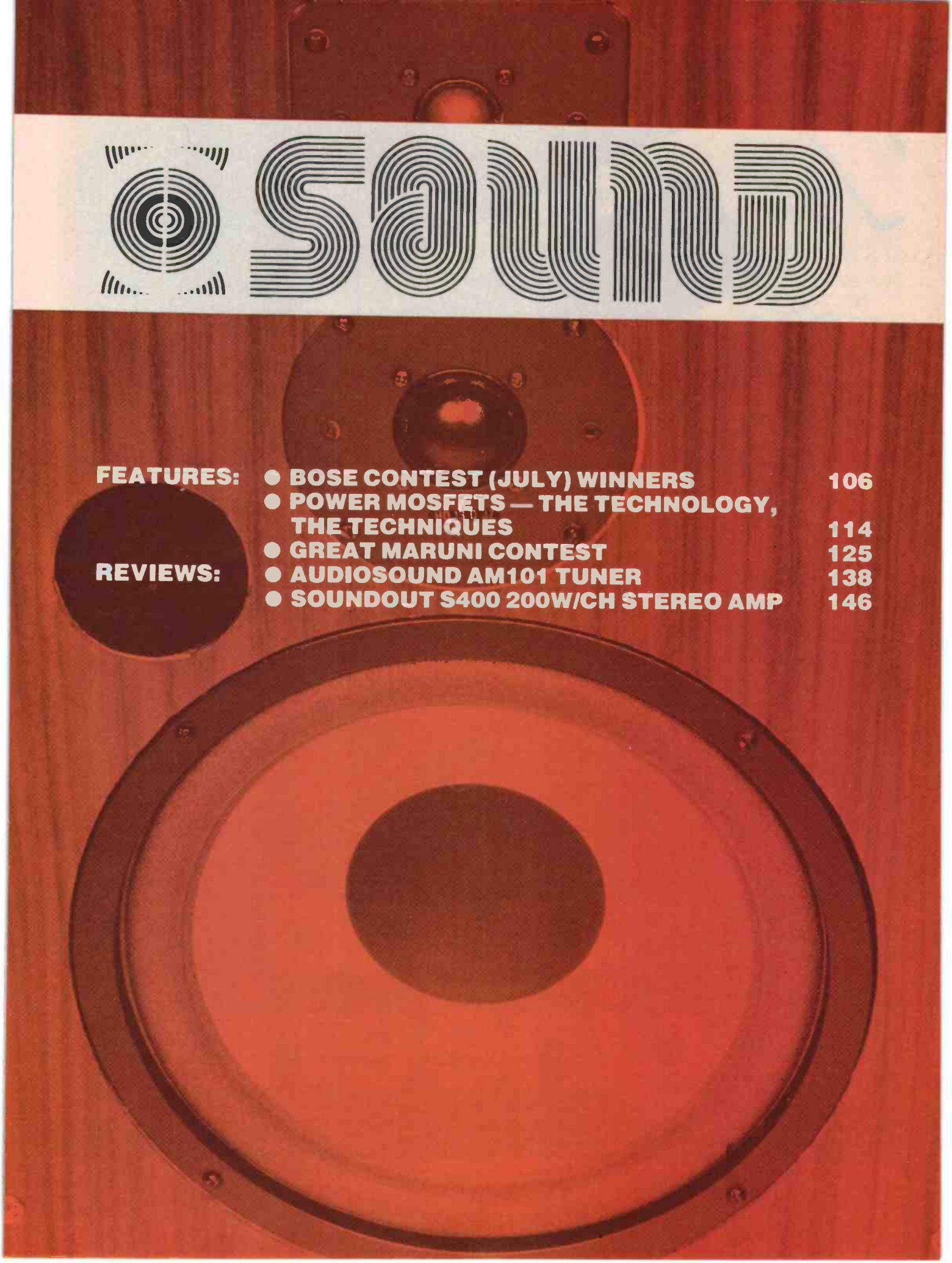

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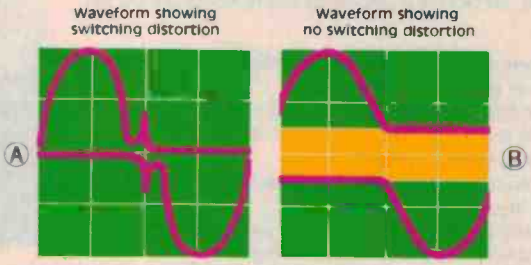
Hitachi's Digital Synthesizer and Super-Linear Circuit

Tuning with quartz stability and power amplification without switching distortion. Together in the HTA-7000 Tuner/Amplifier.

The digital synthesizer tuner is sound engineering. And so is the super-linear circuit. They work together to bring in the correct oscillation and amplify with remarkable clarity. In the Hitachi HTA-7000 Tuner/Amplifier they are the essence of a trend-setting new component package.

The tuner's quartz crystal reference oscillator delivers the most stable frequency standards available. That's the reason so many professional broadcast facilities use them. Hitachi's PLL synthesizer utilizes this advance to achieve a tuner that really stays locked-in to stations — regardless of changes in temperature, humidity or line voltage.



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Graphic illustrations are reconstructed from Hitachi Toyokawa audio laboratory data.

That oscillation accuracy is further amplified by the Hitachi super-linear circuit. It's a totally new way to bias the transistors. Instead of the on/off delay distortion that occurs during signal-phase changes in a conventional system, the Hitachi circuit keeps the transistors idling on alternate half cycles. So the waveform stays smooth. And even at high frequencies the absence of switching distortion makes the sound refreshingly clean.

The Hitachi HTA-7000 Tuner/Amplifier also features a programmable memory. Preset up to six AM and six FM stations for recall at the push of a button. FM band scanning is automatic, so every station is perfectly tuned. Rated amplifier output: 55 watts total RMS with less than 0.02% THD at 8 ohms from 20 Hz to 20 kHz.

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Bose car stereo contest results

Pictured here receiving their prizes of Bose 1401 car stereo systems are two of the winners (and a proxy) of the contest featured on pages 100-101 of our July issue.

Nobody answered all the questions correctly, but five people got all but one correct. Since there were exactly five prizes, the questions proved a perfect filter.

The winners were **Jim Cumming, Geoff Bickham** and **Ian Haynes** from NSW and **Brian Connors** and **Jim Cerini** from Victoria.

The rest of you are no doubt wondering just where you went wrong in your entries, so here's a review of the questions and the correct answers.

Q1: To double the perceived sound level obtainable from a 10 watt car stereo what power would you need?

A: The human ear has a logarithmic response — hence to double perceived sound levels the power has to be increased ten times. Most entrants answered this correctly.

Q2: What is the approximate peak power in watts generated by a one metre diameter bass drum?

A: Measured at three metres from the drum, peak levels approach 115 dB (referenced to the threshold of hearing). This corresponds to a peak power of 25 acoustic watts. About 20% of entrants answered this question correctly.

Q3: Two cars are standing side by side with their engines revving hard. Do they make twice as much noise as one car . . . or?

A: This is of course related to Question 1. The correct answer is less than one and a half times: in fact the increase would be only barely perceptible! Most entrants answered this correctly.

Q4: Some problems occur in reproducing music below certain limiting frequencies in small areas — such as a car interior. Which of the following is the primary problem?

A: The required answer was that "sounds reflecting off far surfaces cancel those heard directly". The equaliser used in the Bose system helps offset this phenomenon. About 25% of entrants got this one right.

Q5: Bose's fundamental speaker design concept is that only a small part of the sound in a concert hall is perceived directly — most is reflected. So they design their speakers to work in the same way. What percentage of sound does Bose feel is direct?

A: 11%. Most people answered this correctly.

Q6: What is the model number of Bose's best known domestic speaker?

A: 901. Almost all entrants answered this correctly. Bose must be delighted!

Q7: What total harmonic distortion level do Bose claim for their 1401 car stereo?

A: 0.09%.

Q8: What was a 'Housekeeper seal'?

A: This was a method of sealing base metals through glass. Its development enabled the anode of a valve to be part of the vacuum envelope, allowing the outer surface of the anode to be cooled directly. This led to the development of high-power transmitting valves. Most entrants were stumped by this question!

Q9: This measuring device was in use during the very early days of electromagnetic communications. What was it called?

A: This was a bit of a tricky question! The device was called a Cymoscope, a term which covered any instrument which enabled the user to **see** the effect of electrical waves to detect their presence. When the device was held close to a short wave transmitter a spark would jump across the gap, provided the wavelength was appropriately adjusted. The device was **used** by Hertz but was never known as a 'Hertzian loop'. Less than 20 entrants answered this question correctly.

ETI's Editor, Roger Harrison (far left) and David Bell of Bose (far right) present he prizes to Geoff Bickham, Ian Haynes and Steven Williams (for Brian Connors) at a function turned on by Bose just before we went to press.

Q10: "Music has charms to sooth the savage breast — but . . . ". Who said the above?

A: Sorry folks but neither ETI nor Bose give stereos away **that** easily! This question was intended as an eliminator and succeeded very well indeed. Almost all entrants picked William Congreve, but Congreve's version was "Music hath charms to sooth a savage breast, to soften rocks or bend a knotted oak" (some editions read "Music has charms").

The correct answer is Alexander Chase, whose **parody** of the original reads "Music has charms to sooth the savage breast — but not the unmusical one. The quote is from Chase's 'Perspectives' (1966). All the prize winners answered this correctly. Well done!

More efficient headphones

New electrostatic headphones from Sennheiser feature two-part membranes that are claimed to give twice the sound output with no increase in input power and no decrease in quality.

The sound radiating membranes of the Unipolar 2002 headphones have an inner circular section, which radiates preferentially in the middle to high frequency ranges and an outer ring-shaped section which is tuned to lower frequencies.

The purchase price of $345 includes a control unit with two broadband transformers to produce the relatively high voltages needed by electrostatic headphones. Output sockets on the control unit have been specially constructed to prevent non-electrostatic headphones from being inadvertently connected.

Sony's inseparable separates.

Sony's new ST-J55 tuner and TA-F55 amplifier come in elegant matching designs. Separately, they're outstanding. Together, they're out on their own, both in appearance and performance.

TA-F55

ST-J55

The J-55's tuner is frequency synthesized and quartz locked. A neat line of feather-touch switches gives a choice of Memory, Auto, or manual tuning.

The J55's incredible electronic MNOS memory tuning lets you preset your 8 favourite AM/FM stations – including reception adjustments like muting or mode pre-set.

The other half of the team, the 65W F55 Amplifier, features an electronic motor driven volume control, straight signal processing circuit construction, revolutionary Heat Pipe, and Pulse Power Supply, providing extremely clean and noise-free sound quality.

The F55 operates with almost any type of MC and MM cartridge; has gold-plated phono jacks, oxygen-free copper wiring, metallized film resistors and polypropylene capacitors.

You won't find better engineering than these. Not even from Sony.

SONY®

AP 3526

At last — the bionic tonearm!

For reasons best known to themselves, Sony have chosen the name Biotracer for their motional feedback controlled tonearms.

The name, however, is the only silly thing about them. Sony have opted for straight low mass arms made of a special aluminium alloy, eight times stronger than the usual alloys, which allows a 35% reduction in effective mass.

To prevent excessive movement of the arm, the Biotracer has two inbuilt sensors which measure horizontal and vertical velocity, a microprocessor to interpret their signals and two linear motors to apply corrective forces.

Among the benefits claimed for this feedback control system are reduced resonance, better channel separation, lower intermodulation distortion and less wow and flutter from warped records.

A lateral position sensor, (comprising a LED, a slotted plate and a CdS photo-detector) detects the horizontal angle of the tone arm so that the anti-skating force can be varied as it tracks toward the centre of a record.

For those who are disturbed by the noise associated with touchdown and liftoff of the stylus, the Biotracer has a muting circuit which automatically disconnects the audio output during these operations.

But does it make coffee ?

A recently released 'sound centre' unit appears to do just about everything except make "the morning cuppa".

The Model PS 2000, distributed in Australia by Unitrex, incorporates — all in a single unit — an AM tuner, a stereo FM tuner, a stereo cassette deck (with record and playback facilities), a clock radio and an alarm (. . . pause for deep breath).

The unit has two inbuilt speakers for stereo reproduction and provision for external speakers. Power output is rated at 2 W. Two microphones are supplied with the unit for recording, plus you can tape direct from the AM/FM tuner or an external source (tape, turntable etc).

The clock/alarm can be set to wake you with a tone or the radio set to your favourite station (. . . or 2BL with Clive Robertson . . .). You get the usual 'snooze' button too. In addition, you can be soothed into sleep with the radio which will turn off one hour after you set the 'sleep' button.

The PS 2000 will be marketed through department stores and specialist shops. Recommended retail price is a little under $200. More details from Unitrex at P.O. Box 176, Blackburn, Vic 3130. (03) 877-2922

Low cost hi-fi speakers

A new range of L & D loudspeakers came on the market recently.

Designed to give good quality reproduction at a modest price, the range extends from 200 mm three-ways at $199 per pair to 300 mm four-way systems at $399 the pair.

The systems feature horn and dome tweeters, wide dispersion midrange units and bass drivers with high power handling capability. Dividing networks are 6 dB per octave inductive filters.

More details are available from L & D Audio Distributors, 24 Enterprise Avenue, Padstow, NSW 2211; (02) 771-3999.

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demands music
as true as the dream
– Nakamichi

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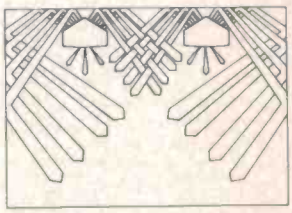
The instant upgrade.

The new Bose® 901® IV Direct/Reflecting® speakers help your stereo sound better.

If you are thinking of upgrading your music system, Bose has the fastest way to do it. The new Bose 901® Series IV speaker.

Since the speaker has more to do with the sound you hear than any other part of your music system, you can improve the quality of your sound by improving your speakers.



The new Bose 901® IV speakers are the answer. You can drive these speakers with as little as 10 watts per channel. And they are durable enough to handle any non-commercial amp. So you can match them to your system, no matter what the system.

The Bose 901® Series IV speaker. The best regardless of size or price.

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The dawn of a new recording era

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Undoubtedly the most advanced and sophisticated cassette recorders in the world today, the ZX Series launches a new era in high-fidelity cassette recording. These revolutionary transports feature exclusive Nakamichi Discrete-Head technology, 4-Motor, Dual-Capstan, Asymmetrical, Diffused-Resonance Transport, Random Access Music Memory, and Auto Azimuth Alignment. For the first time, you can be assured of perfect azimuth alignment – on any cassette – at the touch of a button. Unprecedented frequency response – to 22kHz at standard speed, to 15kHz at half speed! The culmination of Nakamichi's commitment to excellence in the fine art of recorded sound.

Nakamichi

680ZX

The premier Model 680ZX – half-speed response that rivals that of other decks at full speed! And, at standard speed, a full 22kHz! High-resolution wide-range FL level indicators and 18 program RAMM. Choose your speed, choose your program. The 680ZX does it all!

670ZX

Full off-tape monitoring facilities with Double Dolby and two complete sets of electronics. Single-speed operation to an astounding 22kHz! Nine program RAMM and wide-range peak-responding meters. Outstanding performance.

For further information contact Convoy International Pty Ltd 4 Dowling Street Woolloomooloo NSW 2011 Telephone (02) 358 2088

Power MOSFETS — the technology, the techniques

A state-of-the-art MOSFET amplifier project will be the highlight of a forthcoming issue. This introductory article explains what MOSFETs are and how they have developed into high power devices.

Brian Dance

IN 1976 Siliconix startled the semiconductor world with a new type of power MOSFET device. Recently other manufacturers have produced many other types of MOSFET products which are challenging power transistors and Darlingtons.

The name MOSFET stands for Metal Oxide Silicon Field Effect Transistor. Field effect transistors (FETs) are essentially voltage controlled devices, unlike conventional transistors in which the small base current controls a larger collector output current. FETs have very high input impedances so that very little input current is required to control their output current.

The input impedance of MOSFETs is especially high because they have an insulating film of silicon dioxide between the input gate electrode and the channel through which the output current flows. The gate electrode is therefore essentially completely insulated and virtually no input current can flow.

Various types of small MOSFET devices have been available for many years. Internally they contain a very small silicon chip on the surface of which the MOSFET device has been fabricated. Any current passes through these devices in a horizontal direction through the very thin surface layers and therefore the maximum current is quite low; maximum power dissipation in such devices is not normally over 1W.

VMOS devices

In the so-called VMOS devices, developed by Siliconix about four years ago, the current flows vertically through the semiconductor material — hence the name VMOS. This name is also associated with the V-shaped groove formed in the surface of the semiconductor material of such devices. Figure 1 shows a cross-section of a VMOS transistor.

If the gate electrode is connected to the source and the drain contact at the bottom of Figure 1 is made positive relative to the source, no appreciable current will flow from drain to source, since the internal diode formed between the p and n type materials will be reverse biased. If, however, the gate electrode is made positive with respect to the source, the electric field produced by the gate potential creates a channel in the position shown in Figure 1. A current can now flow upwards from the drain through the channel to the source. As the gate becomes more positive, the width of the channel increases and the current from drain to source increases.

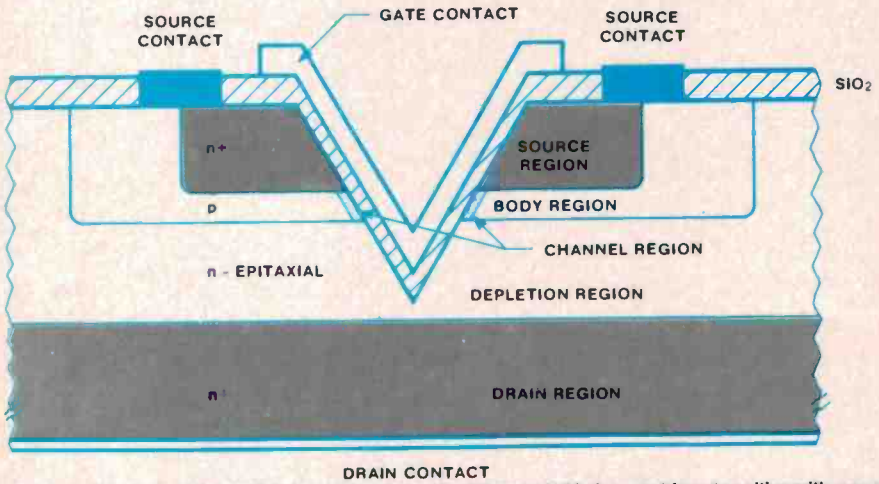


Figure 1. Structure of the VMOS device developed by Siliconix. With the gate biased positive with respect to the source, current flows from the drain region to the source via the channel region indicated. As the gate is biased more positive, the channel region increases, increasing the drain-source current. VMOS FETs are majority-carrier devices and can switch current in less than 10 ns. Bipolar transistors cannot compete as they suffer from minority carrier storage in the base region.

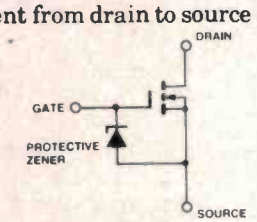


Figure 2. Zener protection of the gate.

If small changes in the gate voltage are to produce the required channel depth, the insulating layer must be extremely thin, which results in an appreciable gate input capacitance (typically some 50 pf). The thin layer also imposes a limit to the maximum voltage which can safely be applied to the gate without the risk of breaking down this thin layer and thus destroying the device. As the gate input resistance is so high (often of the order of a million megohms), it is very easy for small stray electrostatic charges to be picked up on the gate and produce voltages which can puncture the insulating film.

In some devices a small zener diode is connected between the gate and the source, as shown in Figure 2. If the gate to source voltage exceeds the zener voltage, the zener conducts and shorts out the voltage, protecting the MOSFET. However, the maximum zener current is quite small, so the zener can easily be damaged. The maximum input voltage

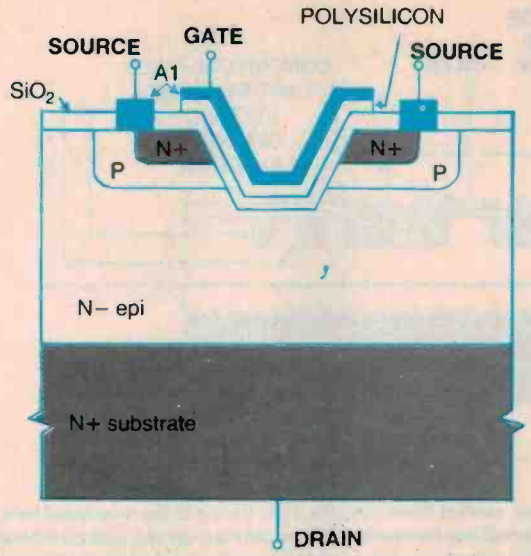


Figure 3. The U-groove device, introduced by Intersil, reduces problems associated with the intense electric field at the edge of the V-notch in VMOS devices. The polysilicon layer prevents migration of sodium impurity ions through the gate oxide layer, a source of chip failure in VMOS.

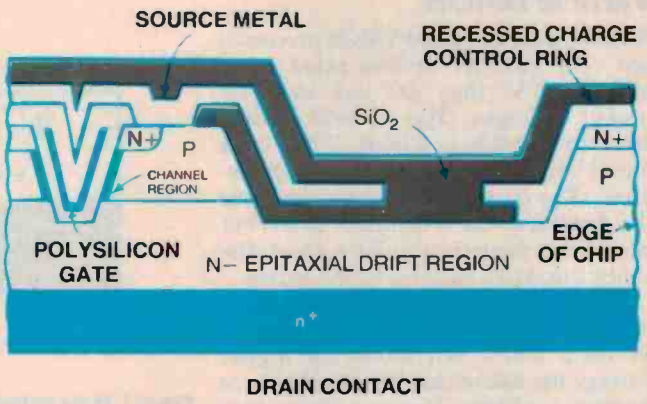


Figure 4. Having introduced power MOSFET technology, Siliconix have gone on to improve the devices. The tri-planar construction shown here allows much higher packing densities on the chip, the smaller size resulting in lower on state resistance. Polysilicon gates are buried in the oxide layers allowing source metallisation to cover a greater fraction of the chip area.

'in circuit' should not exceed the zener voltage so that the zener is used to provide protection against electrostatic charges only.

If the gate becomes more than a fraction of a volt negative with respect to the source, the zener will conduct in its forward direction. If one wishes to operate a MOSFET with the gate voltage negative with respect to the source at any part of the duty cycle, a device not containing a zener should be selected, but then one must take precautions to avoid electrostatic charge pick up.

The first VMOS devices marketed were n-channel devices, with an n-type channel formed in the p-type material shown in Figure 1. Siliconix still only market n-channel devices, but some other manufacturers offer both p-channel and n-channel types.

Comparison with bipolars

As the early VMOS devices could not handle so much current or so much applied voltage as conventional transistors, yet were more expensive than the latter, they obviously had some advantages or their manufacture would not have been a viable proposition.

Ordinary bipolar transistors suffer from the disadvantage of minority carrier storage in the base region. VMOS products are majority carrier devices and can therefore switch a current in less than 10 nanoseconds and operate up to several hundred mega-Hertz. For example, the 2N6657 can switch 1 A on or off in less than 4 ns, this being 10 to 200 times faster than a comparable bipolar device.

'Secondary breakdown' is another problem with bipolar transistors. If the current density increases at one point, the temperature rises in this region, leading to a still greater current density — a positive feedback effect which can lead to the rapid destruction of the device. In VMOS devices, an increase in the current density in the channel produces an increased temperature which results in a *lower* current density in that region, so that the current density automatically equalises itself throughout the chip without the formation of hot spots.

It follows that it is possible to connect two or more VMOS devices in parallel (often without any additional components), since the total current is automatically shared equally between the devices. Any device passing more current than the mean will become hotter and this will reduce the current somewhat in that device.

Apart from their higher cost, one of the disadvantages of VMOS devices is that their saturation voltage (typically 2V, maximum 4V for some devices when passing 1A) is much greater than for bipolar transistors. Although the V-shaped groove utilises the silicon area quite efficiently, the relatively sharp bottom of the groove is a disadvantage, since a strong electric field can be developed at this point between the gate and the drain where the insulating layer tends to be thinner than elsewhere. This results in a limited operating voltage capability owing to the possibility of gate to channel breakdown.

A perfect switching device would have an infinite resistance in the off state, but the drain current of many VMOS devices is in the nA region when in the off state with gate and source voltages equal. The resistance in the conducting state is normally a few ohms instead of the zero resistance of the perfect switch. This on-resistance is greater for devices with higher voltage ratings.

U-groove devices

The problem of the relatively intense electric field at the edge of the V-shaped notch of VMOS devices has already been mentioned. Intersil, followed by some other manufacturers, reduced this problem by producing devices with the structure shown in Figure 3, where the bottom of the groove is flat. Note that there is an additional layer of phosphorus-doped polycrystalline silicon between the gate and the insulating layer of silicon dioxide. This overcomes another problem of the early VMOS devices, namely the migration of sodium impurity ions through the gate oxide layer, which can cause reliability problems.

Other VMOS products

In 1980 Siliconix announced an improved triplanar VMOS process with the device structure shown in Figure 4. The source, the gate and the drain are each fabricated in a different plane. It is stated that this type of structure allows much higher packing densities on the chip and the smaller size will enable lower on state resistances to be obtained. Polysilicon gates are buried under the oxide layers so that the source metallisation can cover a greater fraction of the chip area.

Another major improvement from the triplanar structure arises from the use▶

of thin low-resistivity doped layers and from a re-arrangement of the V grooves for optimum use of the epitaxial layers.

Vertical DMOS

Although the modified VMOS processes are very good for devices rated up to about 150 V, they are not ideal for higher voltages. The vertical DMOS structure shown in Figure 5 has been found very suitable for high voltage devices. The current flows upwards from the drain into the n-epitaxial layer, but then flows horizontally for a short distance through a channel to the source.

Supertex of California use this technique to make devices with ratings of up to about 500 V, but somewhat higher voltage devices of this type are likely to become available. Figure 5 shows how the main junction region is surrounded by a concentric second junction which is in turn surrounded by a third junction. Apart from high voltage capability, this process can produce devices with a very low on-resistance (down to 0.05 ohm). In addition the devices are very fast, owing to the low gate capacitance. For example, a 1A device can operate at about 2 GHz and a 10 A device at about 500 MHz.

The Ferranti Company of Oldham, England have co-operated with Supertex to develop vertical DMOS devices, both n-channel and p-channel, with ratings up to 650 V and drain currents up to 16 A continuous.

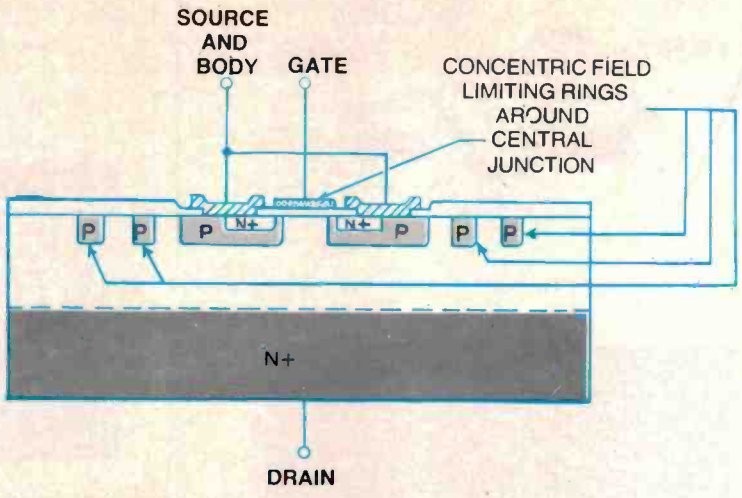


Figure 5. In the vertical DMOS device, current flows from the drain (N+) into the n-epitaxial layer (N−) then flows horizontally through a channel into the source. The concentric rings of p-type material around the main junction help improve the current capability and reduce the on-resistance. This form of construction achieves significantly higher voltage and current ratings compared to prior power MOSFETs.

Hitachi devices

Hitachi has developed a MOSFET device with the structure shown in Figure 6. The gate oxide layer is designed to handle only 20 to 30 V, so a field plate is provided to prevent high electric fields from forming near the gate. This type of device is most suitable for audio frequencies and for operation at up to a maximum of a few MHz. Both p-channel and n-channel types are available with ratings of up to 200 V and 8 A.

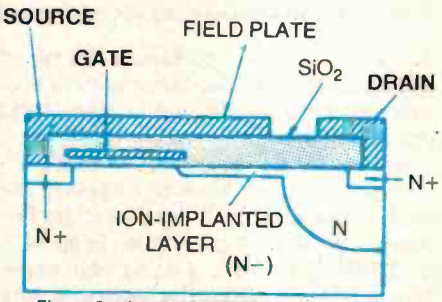


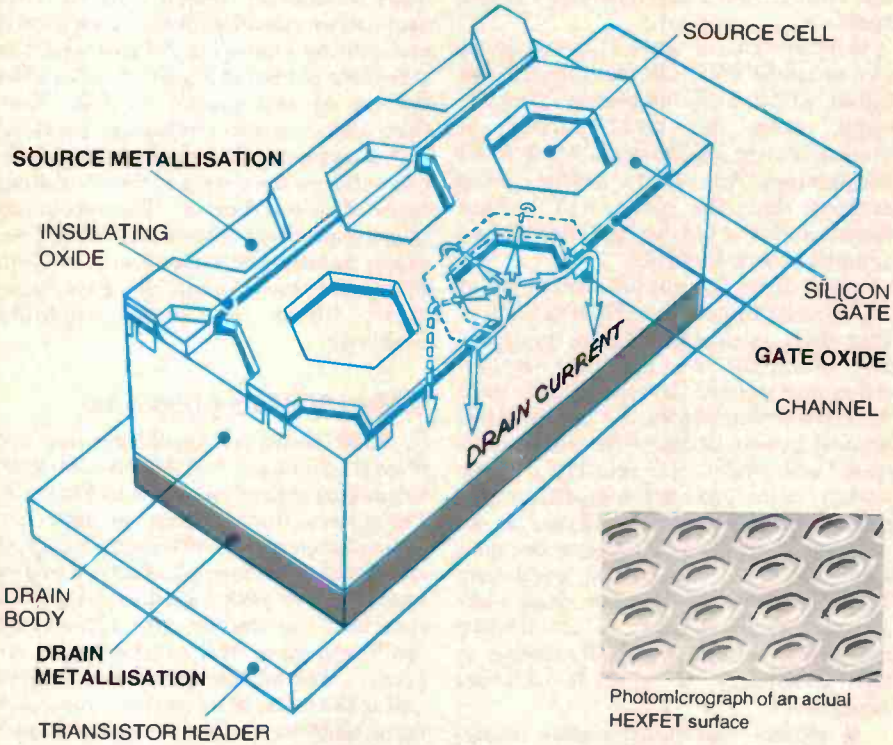
Figure 6. Hitachi MOSFET construction.

HEXFET devices

In mid-1980 International Rectifier introduced a range of devices named HEXFET after the hexagonal structure of the source cells which are connected by a common silicon gate (see Figure 7). The density of these source cells is over half a million per square inch.

HEXFET devices are available in both p-channel and n-channel polarities and can handle high power levels. They have voltage ratings of up to 500 V and continuous current ratings of up to 25 A. Values of channel resistance as low as 0.05 ohm can be obtained in the on state.

Some of the main applications for HEXFETS include servo motor control, RF induction heating, welding control equipment, audio amplification and other uses where the control of high power is required.



Photomicrograph of an actual HEXFET surface

Figure 7. Construction of the HEXFET device introduced by the International Rectifier company in mid-1980. The hexagonal source cells (hence the name) are connected by a common silicon gate. Claimed advantages include high voltage and current ratings plus very low on-resistance.

SIPMOS

The latest technology to emerge in the power MOSFET field is SIPMOS from Siemens of West Germany, which is an extension of the vertical DMOS technique. Siemens have used this technique to fabricate the first 1000 V MOSFET device, the BUZ 54, which can handle 5 A. It is expected to have wide▶

"I have always wanted a really good loudspeaker system."

Today the cost of excellent turntables, cartridges, tape decks and amplifiers has fallen to the point where the average family man can afford equipment of a quality and performance-level that was impossible ten years ago.

But good loudspeakers have remained extremely expensive and, in most domestic hi-fi systems, the rest of the equipment can dramatically outperform the speaker.

Electronics Today International magazine, in co-operation with Philips Elcoma Division, set out to correct this imbalance and designed the ETI 4000/1 speaker system.

The Series 4000/1 is available in kit form which means you save money by assembling it yourself.

A total kit, including:

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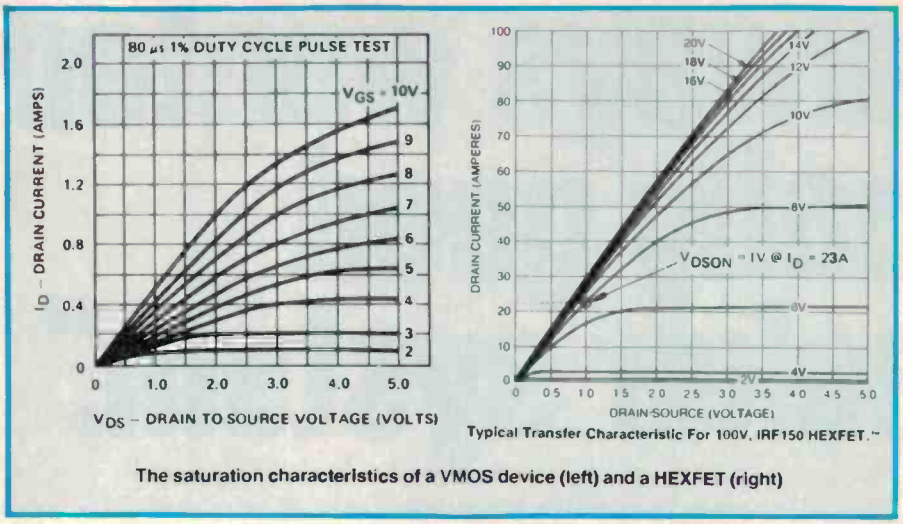

The saturation characteristics of a VMOS device (left) and a HEXFET (right)

uses in switching mode power supplies.

Other SIPMOS devices have ratings in the range of 50 V to 500 V, all being n-channel types. SIPMOS transistors can switch loads of up to 5 kW using inputs to the gate of less than 1 mA at 5 V. Maximum drain currents of up to 30 A can be handled, while on-resistance values can be as low as 0.03 ohm.

Applications

Power MOSFET devices can be used as alternatives to power transistors and power Darlington devices in many applications, but they are generally more expensive than the latter and the circuit designer must decide which types of device are most suitable for his own application.

The use of power MOSFET products is particularly attractive when one can take advantage of their high switching speed or their high frequency capability. Although they may be somewhat more expensive than other transistors, the use of these new devices may simplify circuitry and reduce the overall costs. For example, a conventional power transistor requires a considerable current at its input and one or more driver stages may be required to provide this current, whereas the high input impedance of the power MOSFET enables the latter to operate with such small input currents that power driver stages can usually be eliminated.

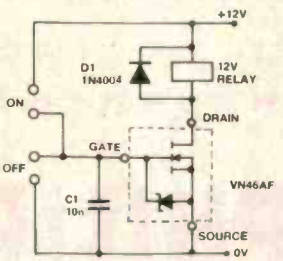

Figure 8. Simple touch switch.

Simple touch switch

The circuit of Figure 8 shows how the very high input impedance of a VMOS power MOSFET can be employed in a simple touch switch. When the circuit is first switched on, the capacitor C1 is normally fully discharged, so the VN46AF VMOS device passes negligible drain current.

When the upper pair of contacts is touched, current flows from the +12 V line through the person's skin and charges C1. The VN46AF device is thus biased to conduction and the relay closes. If a finger is now placed across the lower touch contacts, C1 discharges and the VN46AF is turned off, opening the relay. The diode D1 is used to bypass the transient voltages formed when the current ceases to flow through the relay coil — such voltages can destroy MOSFETs.

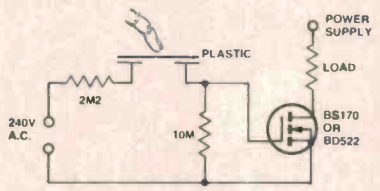

Figure 9. Capacitive touch switch.

Capacitive touch switch

The gate circuit impedance of VMOS devices is so high that circuits can be designed as touch switches in which no part of the circuit is actually touched. In Figure 9 (designed by ITT Semiconductors), the presence of a finger just above the plastic material at the point of separation of the electrodes under the plastic is sufficient to cause current to flow in the load.

The capacitance between each of the electrodes and the finger allows a small alternating current to flow through the 2M2 safety resistor to the gate circuit of the small BS170 or the larger BD522 n-channel device.

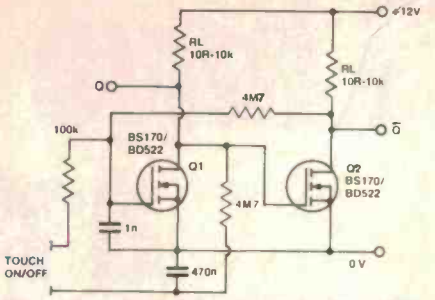

Figure 10. Capacitive touch switch will cycle on and off if finger is held on the sensor.

Figure 10 shows another touch switch designed by ITT Semiconductors, only a single touch point being used for on/off operation. When power is first switched on, T1 will conduct and T2 is kept non-conducting. Touching the sensor contacts will cause T2 to conduct and feedback from the drain of this device through the 4M7 resistor to the gate of T1 will keep the latter device in the non-conducting state. The 470n capacitor now becomes charged.

If the sensor is touched again, the positive potential from this capacitor is transferred to the gate of T1 and the latter device is switched to conduction, whilst T2 is turned off. If the sensor is touched for longer than about one second, the circuit will operate as a relaxation oscillator which changes its state about once per second. The load impedances employed in this circuit need not be identical, any values from about 10 ohm to 10k being suitable.

CMOS Interfacing

The 4000 series of CMOS logic devices can provide only small output currents, but sometimes one wishes to use the output from such a device to control a relay or other load which requires a relatively large current. A VMOS device can conveniently be employed to match the high output impedance of a CMOS device to a relatively low load

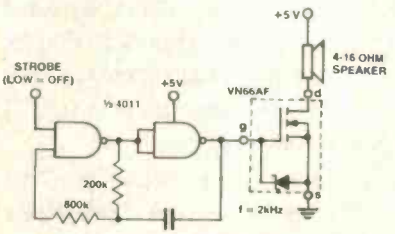

Figure 11. Audio alarm.

impedance such as a tungsten filament lamp.

An example is the audio alarm circuit of Figure 11. Two of the four logic gates of a CD4011 device are connected as a standard 2 kHz oscillator. Any appreciable current taken from the output of this oscillator affects the operation of the circuit, but the VN66AF requires negligible current and forms an ideal

interface bevice between the CMOS oscillator and the loudspeaker.

When the upper input of the left hand CMOS gate is connected to the +5 V line, oscillation takes place, but when this input is connected to ground, oscillation ceases. Thus a high impedance logic output can be used to switch the oscillator on and off through the use of this input to the left hand gate.

Figure 12 is an interesting variation of the circuit of Figure 11 in which the four gates of a 4011 device are used to form two oscillators. The two left hand gates form a sub-audio frequency oscillator which modulates the audio oscillator formed by the two right hand gates of Figure 12. Thus one obtains a much more impressive two-tone alarm sound than with the simpler constant-note circuit of Figure 11.

The timer circuit of Figure 13 is another example of VMOS interfacing between a CMOS device and a relay. In the quiescent state, the upper input to the left hand gate will be low and the output from this gate high. Thus the output from the right hand gate will be low and the relay will remain open.

If the start switch is momentarily closed, the high input applied to one input of the left hand gate will cause the output from this gate to go low, while the output from the right hand gate goes high and switches the VN46AF to conduction. Thus the relay closes.

The capacitor between the two gates charges slowly through the fixed and variable resistor from the positive supply line. When the inputs to the right hand gate become sufficiently high in potential, the output of this gate goes low and by feedback to the left hand gate the circuit switches back rapidly to its quiescent state in which

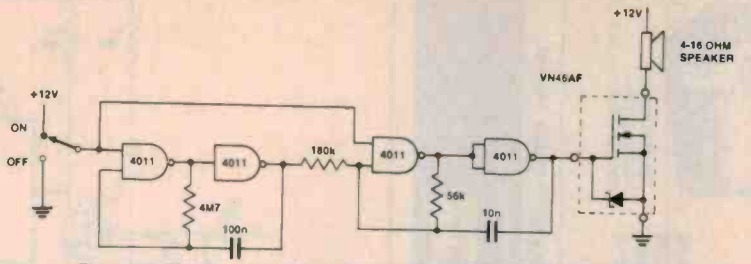

Figure 12. This two-tone alarm is a variation of the Figure 11 circuit.

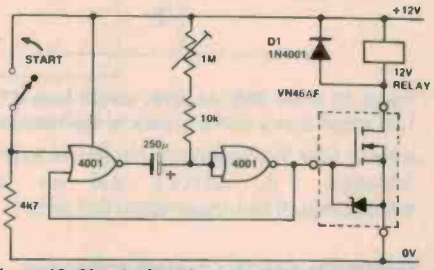

Figure 13. Simple timer has a variable range from a few seconds to a few minutes. The 1M pot sets the time the relay holds in.

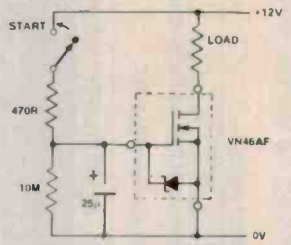

Figure 14. Simple delay timer. The load could be a lamp, relay or whatever.

negligible current passes through the relay. The length of time for which the relay remains closed can be set by the 1M pot or by altering the value of the capacitor connected between the two gates. When the values shown are used, times obtained range from a few seconds to a few minutes as the variable resistor is moved.

Delay switch

A simple VMOS delay switch is shown in Figure 14. When the switch is closed for a moment, the capacitor becomes fully charged and the VN46AF passes current through the load. The capacitor slowly discharges through the 10M resistor, so the gate voltage of the VN46AF will eventually fall to a value where very little current can pass through the load.

Auto applications

The fast switching ability of MOSFET devices renders them very suitable for use in vehicle electronic ignition systems. Timing pulses from a magnetic or other contactless pickup may be fed to an IC which provides a voltage output for the control of a MOSFET device. The latter switches the current through an ignition coil to provide the required high voltage.

An automobile circuit using a SIPMOS transistor as a power switch is shown in Figure 15. As in so many applications of MOSFET devices, the high input impedance of the SIPMOS device is utilised here, since it can be voltage driven by a suitable IC. This circuit is for an automobile alternator voltage regulator and has been designed for a SIPMOS device rated at▶

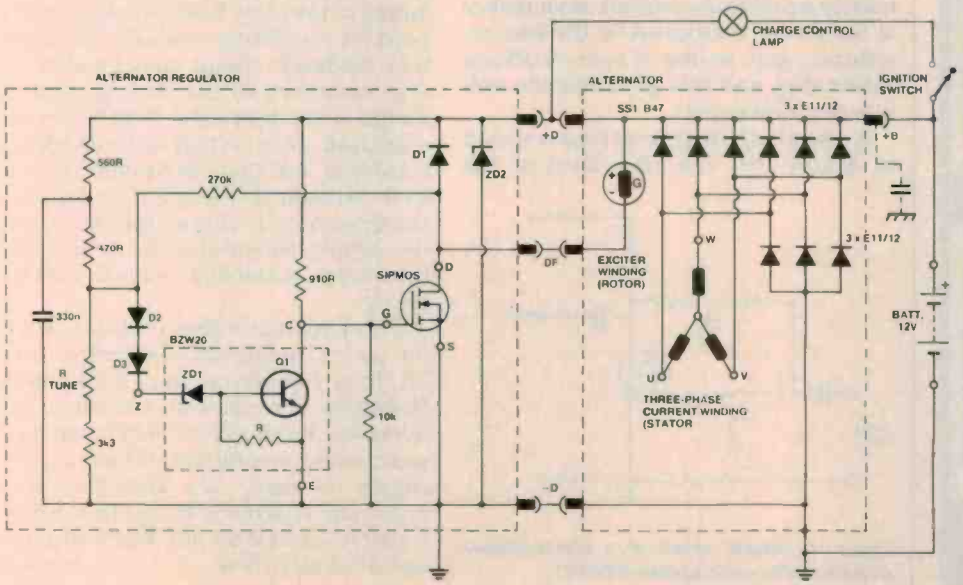

Figure 15. The latest power MOSFET development, SIPMOS, has already found application in automotive electronics. This circuit is an alternator regulator and employs a SIPMOS device rated at 500 V/8 A and an on-resistance not greater than 0.2 ohm.

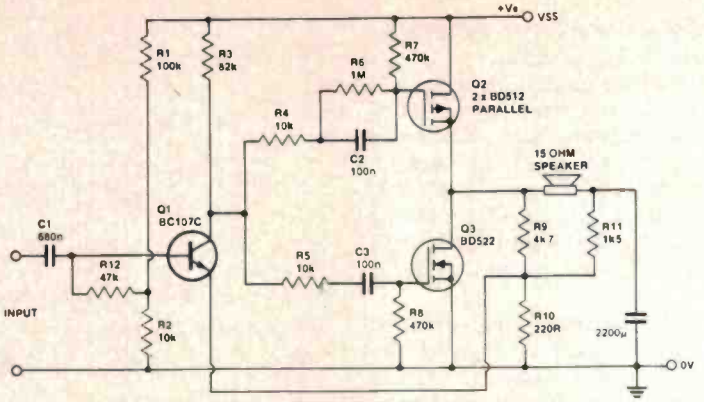

Figure 17. **Class ABC amplifier circuit from ITT Semiconductors is simple but has 3½% distortion at 1.75 W and is only suited to general applications.**

about 500 V maximum drain-to-source voltage, 8 A current and an on-resistance of not more than 0.2 ohm.

Simple audio applications

The excellent linearity of VMOS devices has attracted considerable interest in their possible use in the audio field but the relatively high price of these devices and their previously limited power handling capability retarded their adoption until recently. They may be used in simple, low-power circuits, but moderately high power ultra-low distortion circuits have also been designed using VMOS devices. The very fast switching ability of VMOS devices also makes them very suitable for Class D pulse width modulation circuits.

To operate a VMOS device as a simple class A amplifier, it is only necessary to provide a bias network so that the device operates in its linear region without cutoff. The gate is connected to a tap on a resistive potential divider across the power supply lines and the input signal is capacitively coupled to the gate. The gain will be approximately equal to the mutual conductance of the device multiplied by the load resistance; gain values of over 30 dB are obtainable, and this gain extends well into the MHz region.

A circuit of this general type is shown in Figure 16. The bias level of the VMOS device is stabilised by means of negative voltage feedback from the drain to the gate circuit.

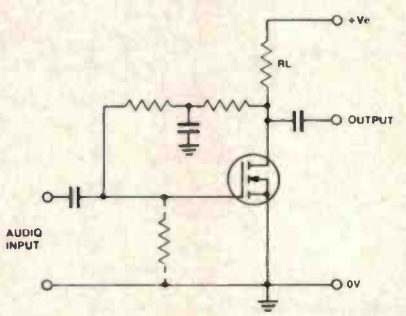

Figure 16. **General circuit of a simple class-A audio amplifier using a power MOSFET.**

Figure 17 shows a particularly interesting circuit from ITT Semiconductors which they call a class ABC amplifier, since it is basically a Class B amplifier, but one of the transistors is more in Class A, while the other is definitely in Class C. It is a simple circuit not designed for particularly low distortion.

The output stage is unusual in that it comprises two BD512 p-channel VMOS devices in one part and a complementary BD522 single device in the other part. This is because hole mobility in the p-channel BD512 is only half that of the electron mobility in the n-channel BD522s so two p-channel devices are required to obtain about the same mutual conductance as that provided by the single n-channel device. As explained earlier, MOSFETs can be connected in parallel without extra circuitry because they automatically share the current.

As the drain electrodes of the VMOS devices in Figure 17 are connected to the device tabs, all of the tabs can be bolted to the same heatsink without the need for insulating washers. The negative feedback circuit compensates for any variations in the biasing requirements of the particular VMOS devices employed. Both ac and dc feedback are employed, but there is heavier dc feedback through R11 and R10 to stabilise the quiescent dc output voltage at half the supply potential so as to ensure a maximum available output voltage swing.

This circuit provides a voltage gain of 30 and a bandwidth extending from 35 Hz to 125 kHz at the −6 dB points. Distortion increases at ultrasonic frequencies above about 25 kHz (as with most audio amplifiers). When a 25 V supply is used, the distortion is a minimum of about 0.4% at about 0.5 W, rising to about 0.8% at 1 W, 2% at 1.5 W and 3½% at 1.75 W.

— to page 135 ▶

Technics SL-10

Quartz-Phase-Locked Control Direct-Drive Turntable with Linear Tracking Tonearm

Sounds Alive

Marking the 10th anniversary of the direct-drive turntable.

It has been 10 years since Technics introduced the world's first direct-drive turntable, the SP-10. When it was introduced this turntable had less wow and flutter and better speed accuracy than the cutting lathes used to make records. And because the drive system did not use rubber parts like belts and idler wheels, it insured that its excellent specifications would be retained for a long time.

Six years after the introduction of the SP-10, Technics brought out an improved version, with higher torque and quartz control. Today, more than 1500 of these SP-10MKII's are used by broadcasters in 27 countries around the world.

In the past two years, Technics has added quartz synthesizer control to various models, permitting the precision of quartz to be retained in speeds above and below the standard 33-1/3, 45 and 78 rpm.

More significant to the consumer, Technics has also developed direct-drive turntables which have a very high degree of precision, yet cost much less than the professional grade models. It is possible to get numerous Technics direct-drive turntables in the popular price range, yet with specifications that were obtainable only in very expensive equipment a few years ago.

With the SL-10, Technics continues to lead the industry in turntable innovation. This new turntable represents as radical a departure from conventional design as did the SP-10 ten years ago.

It has the same width and depth dimensions as an LP record jacket, yet within the compact package are an amazingly precise drive system, a gimbal suspended linear-tracking tonearm, a high-grade moving coil cartridge, plus extensive control systems which permit even a complete hi-fi novice to use the SL-10 without any problem. Nearly every operation is automated, with the upper and lower halves of the cabinet closed during record play. And the tonearm is designed so that the system can be stood vertically without any sacrifice in tracking accuracy. The SL-10 marks as great a step forward in convenience as did the development of cassette tapes versus the open-reel format. Yet there is absolutely no loss in reproduction quality. On the contrary, numerous factors in the SL-10's design will significantly enhance the sound from records.

Technics changes the face of turntable technology . . . again.

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The world of hi-fi owes a lot to the original and continuing innovation of JVC. Few companies, if any, have done as much to help turn records and record-players into the virtual musical instruments they are today . . . or to lead the way in developing so many *firsts* in the more recent concepts of sound amplifiers, cassette decks and computer-designed speaker systems. Hi-fi, as we know it today, had its beginnings in 1956, with JVC's development of the 45°/45° groove for stereo records. The fact that this system still remains as the world standard is, in itself, outstanding testimony to the technology of JVC. The development revolutionised not only the record-*making* industry, in which we've been involved since 1930; it also paved the way for enormous advancement in the design and engineering of record-playing equipment. Now, hi-fi has expanded to

R-S77. Super-A FM/AM Stereo receiver

embrace a wealth of highly-sophisticated electronic equipment; and it's not surprising that JVC has continued to play a leading role in so much of its development.

HR-3660 EA. VHS Colour Video Cassette recorder

THAT WASN'T OUR ONLY FIRST, EITHER.

We also pioneered Japan's television industry, introducing their first TV receiver just over 40 years ago. A more recent innovation is VHS, the home video recording system now gaining world-wide acceptance as *the* system for such equipment. In the course of staying ahead, we've introduced a number of world *firsts* of radical importance: the Quartz Lock turntable is one of them.

THE QUARTZ LOCK TURNTABLE. MANY TIMES MORE ACCURATE.

It stands to reason that if your equipment is at the top end of the range, then your turntable must be capable of comparable performance. Only Quartz Lock ensures this, tying the speed of the turntable to the unvarying pulse of the atom, and providing a level of accuracy far in excess of conventional turntables.

MORE MILESTONES IN HI-FI.

To match the superb quality of Quartz Lock, we produced the S.E.A. graphic equalizer system. Then we refined it to such a degree it even compensates for the effect your furniture has on sound when it leaves the speakers! To expand the capabilities of tape, we designed ANRS and

SEA-80. Stereo Graphic Equalizer

Super ANRS — automatic noise reduction systems which not only reduce distortion and 'hiss' but actually extend the dynamic range of the tape. Similarly, with speakers: at JVC we employ computers in their design to help provide the ultimate in sound reproduction.

AND NOW, SUPER-A.

In its own way, as significant a hi-fi development as the stereo groove. Imagine an amplifier which combines the *best* features of the two recognised amplifier classes (A and B) . . . an amp which combines the *efficiency* of one with the *low distortion* of the other. Some engineers said it couldn't be done; but not those at JVC. Enter the Super-A amplifier . . . the *latest* JVC *first!*

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THE FUTURE.

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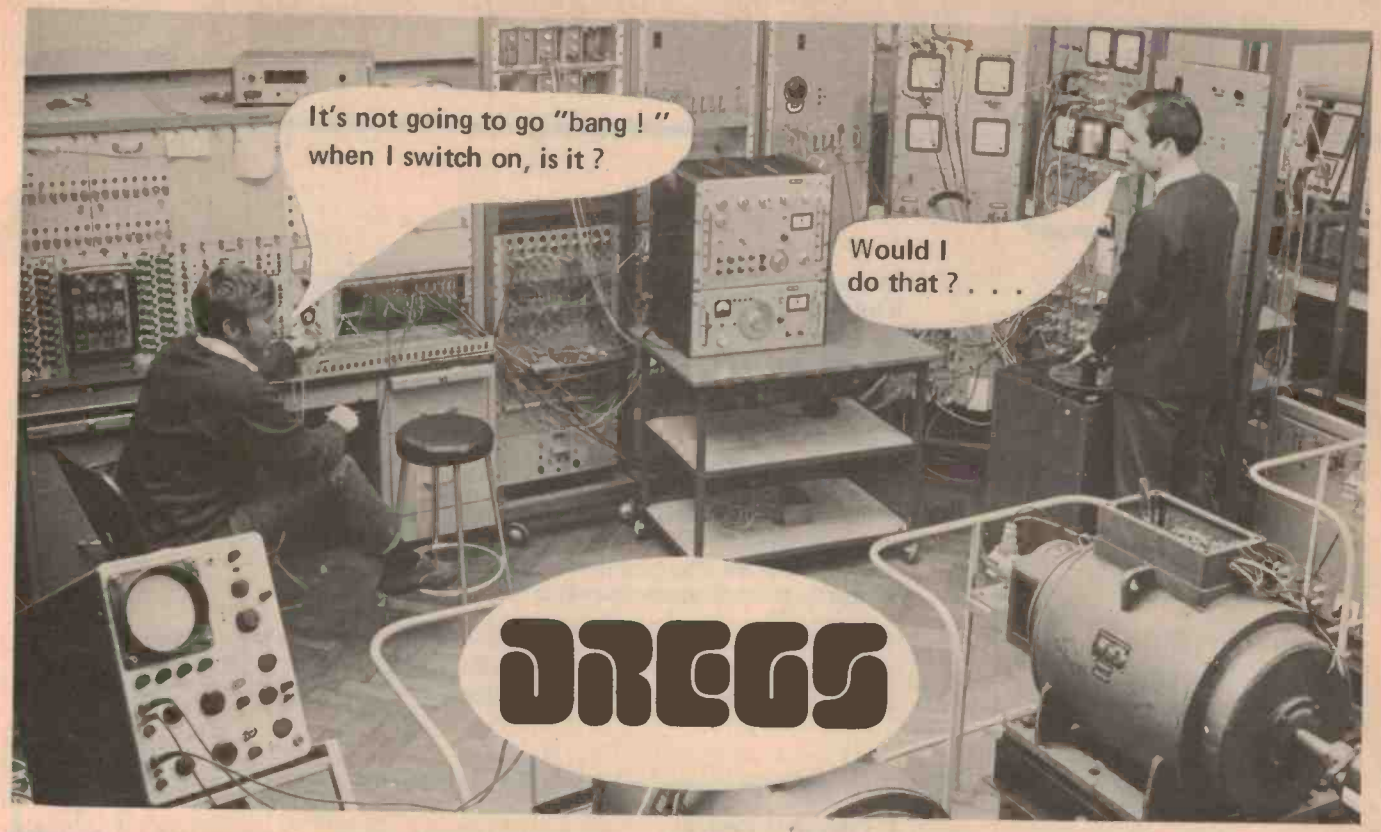

Chicken little rides again!

Our page 8 story (News Digest) on the Earth's magnetic field flipping should bring a rash of 'chicken little' doom predictors out of the woodwork of Nostradamus's coffin. Not because they've read ETI — the original report was in Science News, 117:407, 1980 — but because it's been widely reported in the scientific press and has just begun filtering through the fringe "scientific phenomena" press.

This declining trend in the Earth's magnetic field goes way back to 1830 when Gauss himself had a few words to say on the subject. The geological record certainly registers a long history of magnetic field decline-and-reversals (the science of paleomagnetology covers the field). Coincident with these reversals is geological/paleontological evidence of great biological changes and it is this that sets the doomsayers off. If any readers are around in about 1200 years time, I'd like to know what happens (assuming retrospective communications has been invented — we've already allocated Project Number 435 678 to it).

Two papers in a recent issue of that erudite and widely respected journal, Nature, should send the chicken littles into paroxysms of 'I-told-you-so's. Kenneth Hsu's paper titled "Terrestrial Catastrophe Caused by Cometary Impact at the End of Cretaceous", Nature 285:201-203, 1980, attributes the extinction of large terrestrial animals (dinosaurs to you) to the effects of a cometary impact with the Earth heating the atmosphere and releasing cyanide. What a way to go! The second paper, by Smit and Hertogen, titled "An Extraterrestrial Event at the Cretaceous-Tertiary Boundary", Nature 285:198-200, 1980, takes a look at planktonic and nanofossils (nF?) in the sedimentary record and finds their extinction is coincident with enrichments of iridium and osmium, attributed to an extraterrestrial source such as the impact of a large meteorite.

Let's hope Halley's Comet — due 1985 — isn't off course. We won't know until it gets within the vicinity of the solar system. It returns roughly every 76 years (so far). If Halley's comet remains reliable then perhaps we should start sweating over Tempel 2, due 1988.

Maybe it's all too remote. We've probably got more to worry about at home. Like some radical group getting a homemade atom bomb together. Did you see the April 1979 issue of Analog magazine? Aptly timed was an article on the ins and outs of making your own atom bomb. Precis is — forget it, you should live that long! I note the same article made it into New Scientist earlier this year and is beginning to appear in the fringe press. No doubt Dick Smith (tongue firmly in cheek distorting that well known grin) will shortly offer a kit (say, $20 million?).

If it wasn't for Dregs, Spike Milligan books and The Goon Shows etc, your Editor would have taken up mysticism long ago.

Awful Puns Competition

All you awful punsters out there are giving us a veritable paroxysm in the penultimate page. This contest is so crazy, even the **staff** are entering. William Fisher (see column one, page 8 this issue) contributed one with a real 'electronics flavour': "What do you get if you poke a resistor into each end of a Jelly Bean? — ohm-sweet-ohm!". Sorry William, but this month's penultimate page pun prize goes to young Bruce Harris of Goroke in Victoria, who sent in no less than six, the best/worst being a possible newspaper headline: "Bright Spark Discharged in Power Dispute". A copy of Test Gear 2 is on its way Bruce.

Keep those entries coming. See this page in the July issue for details. Send entries to: The Great Dregs Awful Puns Competition, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

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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 listed here most of the projects published over the last few years which are either available as kits or can still be made up by shopping around for components. Suppliers listed against a particular project will either stocvk it as a kit or stock the pc board plus the other components.

Printed circuit boards

Those suppliers listed against specific projects here are able to supply pc boards for those projects. Printed circuit boards for every project ever published in ETI are available through the following companies (to the best of our knowledge):

RCS Radio
651 Forest Rd
Bexley NSW

Radio Despatch Service
869 George St
Sydney NSW 2000

For current projects and a more comprehensive list of pc board suppliers refer to the Shoparound page in this and previous issues. This list will be updated roughly every four months.

Key to Companies

A Applied Technology Pty Ltd, 1A Paterson Avenue, Waltara, NSW 2077. Ph. (02) 487-2711.

B Electronic Agencies, 115 Parramatta Road, Concord 2137. Ph. (02) 745-3077

C J.R. Components, PO Box 128, Eastwood, NSW 2122. Ph. (02) 85-3385.

D Dick Smith Electronics P/L, Cnr Waterloo & Lane Cove Roads, North Ryde, 2113. Ph. (02) 888-3200.

E All Electronic Components, 118 Lonsdale Street, Melbourne, Vic 3000. Ph. (03) 662-3506.

F Tasman Electronics, 12 Victoria Street, Coburg, Vic 3058. Ph. (03) 354-5062.

J Jaycar Pty Ltd, PO Box K39, Haymarket, NSW 2000. Ph. (02) 211-5077.

K S M Electronics, 10 Stafford Court, Doncaster East, Vic 3109. Ph. (03) 842-3950.

L Ellistronics, 289 Latrobe Street, Melbourne, Vic 3000. Ph. (03) 602-3282.

M Mode Electronics, PO Box 365, Mascot, NSW 2020. Ph. (02) 666-6324.

N Nebula Electronics Pty Ltd, 15 Boundary Street, Rushcutters Bay, NSW 2011. Ph. (02) 33-5850.

O Orbit Electronics, PO Box 7176, Auckland, New Zealand.

P Pre-Pak Electronics, 718 Parramatta Road, Croydon, NSW 2132. Ph. (02) 797-6144.

R Rod Irving, PO Box 135, Northcote, Vic 3070. Ph. (03) 489-8131.

V Silicon Valley, 23 Chandos Street, St. Leonards, NSW 2065. Ph. (02) 439-4655.

W Willis Electronics, 993 Hay Street, Perth, WA 6000. Ph. (09) 321-7609.

Y Trilogy, 40 Princes Highway, Fairy Meadow, NSW 2519.

Project Electronics

041 Continuity Tester ... W,R,D,B,Y,L
042 Soil Moisture Indicator ... R,B
043 Heads or Tails Circuit (Oct 76) ... W,R,D,E,A,F,B,Y,L
044 Two Tone Door Bell (Oct 76) ... W,R,D,E,O,A,F,B,Y,L
045 500 Second Timer ... W,D,E,A,B,Y,L
047 Morse Practice Set ... W,D,O,A,B,Y,L
048 Buzz Board ... W,D,A,B,Y,L
061 Simple Amplifier (Oct 76) ... W,R,D,E,A,B,Y,L
062 Simple AM Tuner (Mar 77) ... W,D,E,B,Y
063 Electronic Bongos ... R,D,A,B,Y,L
064 Simple Intercom (Nov 76) ... W,A,
065 Electronic Siren ... W,R,D,E,O,A,B,Y,L
066 Temperature Alarm (Dec 76) ... W,D,E,A,B,Y,L
067 Singing Moisture Meter ... D,B,Y
068 LED Dice Circuit (Oct 76) ... W,R,D,E,A,B,L
070 Electronic Tie Breaker (Jan 77)
071 Tape Noise Limiter (Jun 78) ... R,E,F
072 Two-Octave Organ (Jun 78) ... W,D,B,Y
081 Tachometer (Mar 77) ... W,E,O
082/528 Intruder Alarm ... W,R,E,A
083 Train Controller ... W,R,E,L
084 Car Alarm ... W,R,D,E,A,B,Y,L
085 Over-rev Alarm ... W
086 FM Antenna ... W
087 Over-LED ... W,E
088 Hi-Fi Speaker ... W

Test Equipment

132 Experimenter's Power Supply (Feb 77) ... E,O
133 Phase Meter (Apr 77) ... E
134 True RMS Voltmeter (Aug77) ... E
135 Digital Panel Meter (Oct 77) ... E
136 Linear Scale Capacitance Meter (Mar 78)
137 Audio Oscillator (May 78) ... W,D,E
138 Audio Wattmeter (Nov 78) ... E,B
139 SWR/Power Meter (May 78)
140 1GHz Frequency Meter-timer (Mar 78)
141 Logic Trigger (Jan 79) ... E
142 High Current Power Supply (Feb 79) ... W,E
143 Curve Tracer (Jan 79) ... W
144 Expanded-scale RMS Voltmeter (Jun 79) ... E
148 Versatile Logic Test Probe (Jul 79) ... E,L

Simple Projects

243 Blp Beacon (Apr 77)
244 Alarm Alarm (Feb 77) ... F
245 White Line Follower (Nov 77) ... F
246 Rain Alarm (Apr 78) ... F
248 Simple 12V to 22V Converter (Jul 78) ... W
249 Electronic Combination Lock (Apr 79) ... E
252 The Passionmeter (Aug 79)
253 Electronic Grenade (Hot Potato) (May 79)
254 Egg Timer (Jun 79) ... W

Motorists' Projects

316 Transistor Assisted Ignition (May 77) ... W,E,O,K
317 Rev. Monitor Counter (Jul 77) ... E
318 Digital Car Tacho (Jul 78) ... W,E,K
319 Variwiper MK II (Sep 78) ... W,E,O
320 Battery Condition Indicator (Apr 79) ... E,L

Audio Projects

448 Disco Mixer (Nov 76) ... W
449 Balanced Microphone Amp (Nov 76) ... W,D,E,J,F,Y
450 Bucket Brigade Audio Delay Line (Dec 77) ... W,E
451 Hum Filter (Jul 79) ... D,E,F
470 60 W Amp Module (May 79) ... W,R,E,F,B,P,L,A,V
471 High Performance Stereo Preamp Control Unit (Jun 79) ... W,R,E,F,B,P,A,V,L
472 Power Supply — the Series 4000 Stereo Amp (Jul 79) ... W,R,E,F,B,V,L
473 Series 4000 Moving-coil Cartridge Preamplifier ... F,J
480 50-100 Watt Amp Modules (Dec 76) ... A,W,R,D,E,J,O,Y,L
481 12V 100 Watt Audio Amp (May 77) ... R,E
481 High Power PA/Guitar Amp (Jun 77) ... W
482 Stereo Amp (Jan 77) ... O,E
482 Stereo Amp Part 2 (Feb 77) ... O,E
483 Sound Level Meter (Feb 78) ... E
484 Simple Compressor Expander (Jul 77) ... A,E
485 Graphic Equaliser (Jun 77) ... W,E,J,O
486 Howl-round Stabiliser (Nov 77) ... J
487 Audio Spectrum Analyser (Feb 78) ... E
489 Audio Spectrum Analyser 2 (Apr 78) ... E,J
490 Audio Compressor (Dec 78)
491 Simple Graphic Equaliser (Mar 79) ... W,E
495 Transmission Line Speakers (Aug 77)

Miscellaneous

546 GSR Monitor (Mar 77) ... W,E
547 Telephone Bell Extender (Jun 77) ... E
548 Photographic Strobe (May 77) ... W,E
549 Induction Balance Metal Detector (May 77) ... W,D,E,L
550 Digital Dial (Aug 78) ... E,O
551 Light Chaser (Sep 78) ... W,E,O
552 LED Pendant (Sep 78) ... A
553 Tape/Slide Synchroniser (Oct 78) ... E
556 Wind Speed/Direction Indicator (Dec 78)
557 Reaction Timer (Feb 79) ... E
558 Mast-head Strobe (Feb 79) ... E
559 Cable Tester (Mar 79)
575 Portable Fluorescent Light Wand for Car, Camping (Aug 79) ... W
577 General Purpose Power Supply ... J
581 Dual Power Supply (Jan 77) ... W,E,Y
582 House Alarm (Jul 77) ... W,E,O,A,
House Alarm — Installation Instructions (Aug 77) ... W
583 Marine Gas Alarm (Aug 77) ... D,E,M
585 Ultrasonic Switch (Sep 77) ... R,D,E,O,F
586 Shutter Speed Timer (Oct 77) ... E
587 UFO Detector (May 78)
588 Theatrical Lighting Controller (Nov & Dec 77 Jan & Mar 78) ... N
589 Digital Temperature Meter (PCB135) (Dec 77) ... E
590 LCD Stopwatch (Oct 78) ... O,N
591 Up/Down Presettable Counter (Jul 78) ... D,E
592 Light Show Controller (Aug 78) ... E
593 Colour Sequencer (Dec 78)
594 Development Timer (Apr 79) ... E
595 Aquarium Lamp Controller (May 79)

Electronic Music

602 Mini Organ (Aug 76) ... W,D,E,A
603 Sequencer (Aug 77) ... W
604 Accentuated Beat Metronome (Sep 77) ... E
605 Temp Stabilized Log-exponential Converter (Sep 78)

Computer Projects

630 Hex Display (Dec 76) ... E,A
631 ASCII Keyboard (Dec 76) ... W,E,O,A
631 Keyboard Encoder (Apr 77) ... W,E,O,A
632 Video Display Unit (Jan 77) ... A,E,O
633 TV Sync Generator (Jan 77) ... A,E
634 8080 Educational/Prototyping Interface (Jul, Aug 78)
635 Microcomputer Power Supply (Sep 77) ... O
637 Cuts Cassette Interface (Jun 78) ... V,E,A
638 Eprom Programmer (Jul 78) ... W,E,A
639 Computerised Musical Doorbell (Mar 78) ... A
640 S100 VDU (Apr, May, Jun 78) ... W,O,A,V
641 S100 Printer (Sep 78) ... O
642 16k S100 RAM Card (Feb 79) ... K
650 STAC Timer (Nov 78) ... A,E,L
651 Binary to Hex Number Converter (Jun 79) ... E

Radio Projects

712 CB Power Supply (Jun 77) ... W,E
713 Add-on FM Tuner (Sep 77)
714 VHF-Log-Periodic Antenna (Feb, Mar 78)
715 VHF Power Amplifiers (Nov 77)
716 VHF Power Amplifiers (Jan, Feb 78)
717 Crosshatch Generator (May 78) ... W,D,E,A,Y
718 SW Radio (Oct 78) ... E
719 RF Field Strength Indicator (Nov 78)
720 2m VMOS Power Amp (Jan 79)
721 Aircraft Band Converter (Mar 79) ... W,E
722 Antenna for Aircraft Band Converter (May 79)
724 Microwave Oven Leak Detector (Jul 79) ... D,E,B
725 Simple SSB Generator employs Polyphase Network using Standard Components (Aug 79) ... E,L
730 Get Going on Radioteletype (Aug 79) ... E,L

Electronic Games

804 Selectagame (Nov 76) ... O
804 Selectagame (Rifle Project) (Mar 77) ... O
805 Puzzle of the Drunken Sailor (Oct 77)
806 Skeet (Jan 78) ... O
810 Stunt Cycle TV Game (Jun 78) ... D,O
811 TV Tank Game (Oct 78) ... O
812 Wheel of Fortune (Dec 78)
813 Race Track Game (Jan 79) ... O
814 The 'Dinky-Die' (Aug 79)

10

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PREDICTIONS

DECEMBER 1980

These GRAFEX style computer generated predictions are provided courtesy of the Australian Ionospheric Prediction Service, Dept. of Science & the Environment.

Covering 3 MHz to 40 or 60 MHz, these predictions show the times radio contact is possible between the areas designated beneath each graph, as well as the possible 'mode' and reliability. Vertical columns indicate time — commencing at 0000 UT on the left, to 2300 UT at right. For reliable predictions follow the times and frequencies indicated by the F character.

Complete information on using these predictions can be obtained by sending a stamped, self-addressed envelope to:-

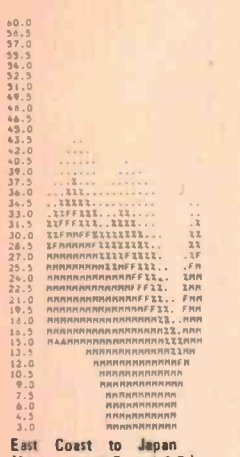
ETI — Predictions
3rd floor 15 Boundary St
RUSHCUTTERS BAY NSW 2011.

KEY TO SYMBOLS

*See page 153 about changes

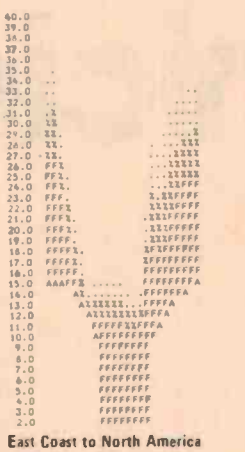
A blank area means no normal propagation is possible.

- ● . . . path open less than 50% of days in month.
- % . . . path open 50-90% of days in month.
- F . . . path open at least 90% of days in month.
- X . . . complex mixture of modes. Expect abnormal propagation.
- M . . . propagation possible by both 1st and 2nd F-layer modes. Expect strong fading.
- S . . . propagation possible by 2nd mode (also 3rd and mixed E and F modes). Expect strong fading, weak signals.
- A . . . High absorption indicated. Expect weak signals.

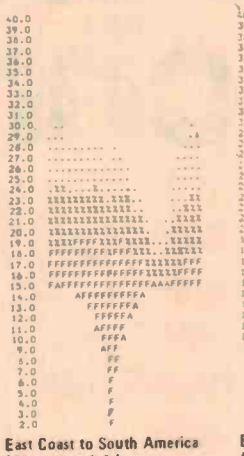


East Coast to Japan (Also serves N.E. and S.C.)

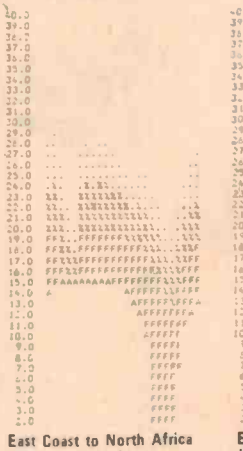
East Coast to South Pacific



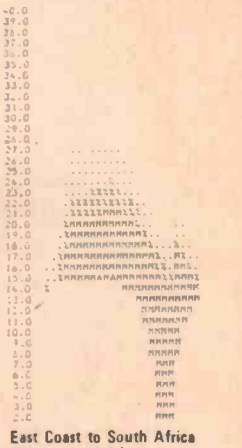
East Coast to North America (Also serves N.E. and S.C.)



East Coast to South America (Also serves S.C.)



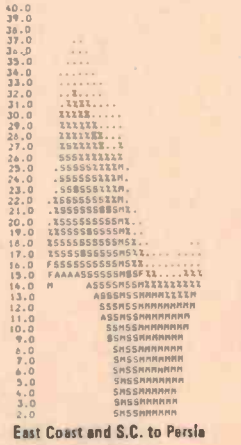
East Coast to North Africa (Also serves S.C.)



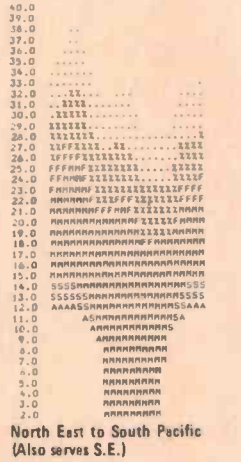
East Coast to South Africa (Also serves S.C.)

East Coast to Europe (Short Path)

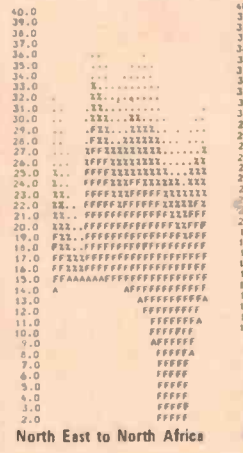
E.C. and S.C. to Europe (Long Path)



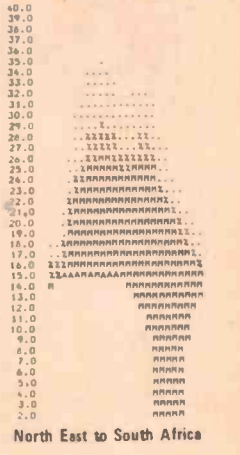
East Coast and S.C. to Persia



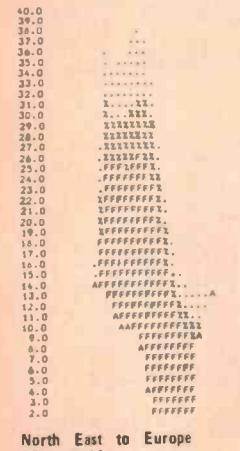
North East to South Pacific (Also serves S.E.)



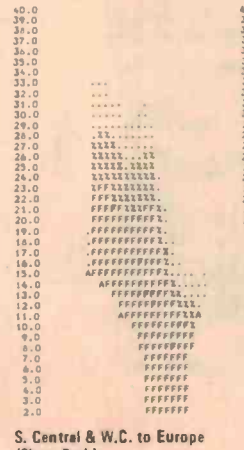
North East to North Africa



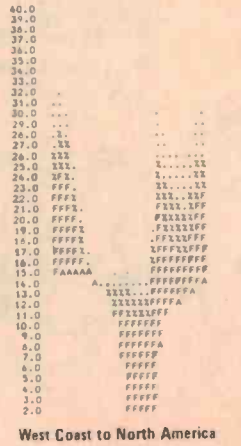
North East to South Africa



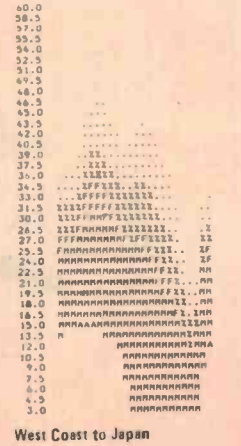
North East to Europe (Short Path)



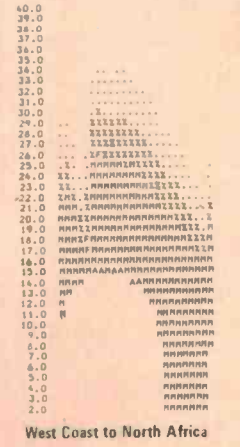
S. Central & W.C. to Europe (Short Path)



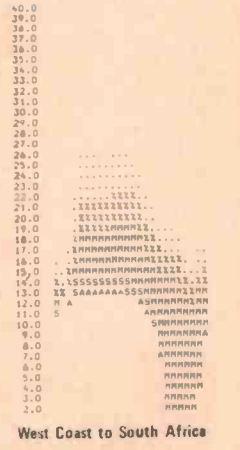
West Coast to North America



West Coast to Japan



West Coast to North Africa



West Coast to South Africa

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- VTVM performance with constant 1MΩ impedance on A.C.V. ranges.
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- Constant voltage IC circuit.
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- Simultaneous measurement of A.C. and D.C. signals.
- A.C. signals may be measured even when mixed with D.C.
- Provides logic pulse analysis facilities with pulse and DCV range.
- Instant L.E.D. indication of pulses exceeding 0.5 RMS 0-30 MHz.

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shortwave loggings

Singapore shake up

Earlier this year, the former Radio Singapore was converted into the new "Singapore Broadcasting Corporation". Recently the SBC has expanded its services in English on shortwave.

Radio Singapore was operated as part of the government structure, under the authority of the Department of Broadcasting in the island republic.

The new Singapore Broadcasting Corporation is a separate statutory corporation, independent of the direct control of the government. The Corporation is still reliant on government finance to a large degree, although this is supplemented by fees from radio licences and commercial advertising over the SBC.

The Singapore Broadcasting Corporation has recently added a new channel on shortwave for relays of the Home Service in English. The new outlet of 15 200 is used in parallel with the usual outlets of 11 940, 5052, and 5010, during the time span 2230 to 1630 daily.

Best reception of the new 15 200 outlet is from sign-on at 2230 up to about 2330, and again during our late evenings.

Best of the other frequencies is 11 940, currently well heard from about 0800, while both 5010 and 5052 sometimes give good signals later in the evenings, from about 1230.

Singapore also has programmes for Malay and Chinese speaking listeners, both of which are relayed on shortwave. The Malay service uses 6155 and 7250 between 2115 and 1630, with best reception noted on 6155 from about 1000 in our evenings.

Meanwhile, the Chinese language network uses 9635 and 6000, between 2230 and 1630, with easily the best reception being on 9635 in the 31 metre band, from fade-in at around 0830 in our early evenings.

The 6000 frequency suffers strong co-channel interference from the Chinese Peoples Liberation Army station in Fuzhou.

English from Bangladesh

Radio Bangladesh in Dacca currently broadcasts to South East Asia in English daily from 1230 to 1300.

Current frequencies for this service are 21 770 and 15 285. Best reception is generally on the former frequency, with 15 285 suffering interference in the crowded 19 metre band. Programmes begin with a bulletin of world and regional news, followed by a news commentary, and features of Bengali music and current happenings

Radio Bangladesh currently has on order two new shortwave transmitters, each of 250 kW, to be used for external service broadcasts. These will be installed at Kabirpur, near the capital, Dacca.

Kathmandu calling

Radio Nepal in Kathmandu operates a daily English language programme which is usually well received in east Australia.

Current schedule for Nepal's English programme is 1435 until 1520, on both 3425 and 9590. Best frequency is the former, as the 31 metre band outlet suffers interference from other, more powerful, transmitters on this crowded band. The main English news bulletin is heard from 1450 until 1505.

Peak time for Bhutan

The very limited time span of broadcasts from this tiny Himalayan kingdom, plus the very low power of the transmitter used, make Bhutan one of the hardest countries to hear on shortwave.

Nevertheless, the summer months are peak reception time here for this choice DX signal.

The station is operated by the National Youth Association of Bhutan (NYAB) in the capital city Thimphu and the transmitter used is a former amateur rig rated at 300 watts. However, due to frequent irregularities in the local power supply, the transmitter power output is often very much lower than this.

Australians have two opportunities to pick up the NYAB station. These occur on Wednesday and Friday evenings, when the Thimphu station operates between 1230 and 1400, on 4692, just below the 60 metre band. The last half hour of these broadcasts is in English.

The northern hemisphere winter months mean that signals from Asian locations such as Bhutan will tend to fade in earlier in our evenings, due to earlier sunset times in most of Asia.

An indication of propagation conditions on any evening from South Asia into your location can be gained by checking the fade-in times for stations such as All India Radio at Hyderabad on 4800, Burma Broadcasting Service (Rangoon) on 5040 and 4725, or Sri Lanka Broadcasting Service on 4940.

Should these stations be well heard by 1200 or shortly after, then conditions should be at an optimum to receive the low powered Bhutan station.

NYAB will verify all correct reception reports with a detailed QSL card, and reports could be sent to: Radio NYAB, Box 1, Thimphu, Bhutan.

Kampuchea in English

The Voice of the People of Kampuchea in Phnom Penh provides reliable signals on most evenings, commencing with an English programme at 1200 until 1215 using both 11 938 and 9695.

Programmes continue with a French broadcast at 1215, then a programme in Thai from 1230 to 1245. There is also an English programme during our mornings, from sign-on at 0000 until 0015, followed by 15 minutes each of French and Thai. This broadcast is not so well heard at present, and reception of the morning programme is usually confined to our winter months.

The Phnom Penh station has recently started to reply to reception reports from listeners world wide. Several DXers in both Australia and in Europe have recently received verification letters from the Head of the Foreign Service in Phnom Penh.

There is currently no mail service direct to Kampuchea, and all mail goes first via Hanoi in Vietnam.

NOTE ! All times are given in Greenwich mean time (GMT). To convert to Australian Eastern Standard Time, add 10 hours (11 hours during Daylight Saving Time, November to February). To convert to Central Standard Time, add 9.5 hours and Western Time add 8 hours.

All frequencies are given in kHz.

These notes are compiled by Peter Bunn on behalf of the Australian Radio DX Club (ARDXC). Further information on DXing or the activities of the ARDXC may be obtained from P.O. Box 79, Narrabeen, NSW 2101, for a 22¢ stamp.

EXTENDED
BY PUBLIC DEMAND!

Woops! We're sorry! We give up! We will extend the deadline!

When we announced our Dick Smith–Yaesu'Win a Fantastic Trip to Hong Kong' competition, we completely forgot about all the new Yaesu models.

Little did we realise that the new models would be so popular that they would sell out immediately: and anyone who waited for the next shipment would be too late to enter!

And then there were the customers who wanted the brand new models: the ones that hadn't even arrived yet!

Scores of customers have asked: 'Hey! What about us. Why should we miss out on winning the trip just because you guys ran out of stock!'

You're right, of course! So to give everyone a fair chance, we've decided to extend the deadline until the end of February 1981. So now you can have your new Yaesu – and still be in the running for the fabulous contest prize!

SO NOW YOU CAN BUY YOUR NEW YAESU: AND STILL BE ELIGIBLE!

NEW FT480

- All mode 2 metre SSB/CW/FM!
- Microprocessor ntrolled!
- Digital display!
- 30 watts PEP

$543.00

OR FROM $63 DEPOSIT AND $26.28/MONTH (24 MONTHS)

This is the one they're all talking about: the fabulous new 2 metre all-mode transceiver from Yaesu. Offering outstanding performance and ease of controls, it must be **the** transceiver of the eightles! Cat D-2887

SAVE ON FT625!

WAS $795.00 . . NOW ONLY

$695.00

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We've knocked an incredible $100 off the price of these popular all-mode 6 metre rigs. There's still plenty of good DX out there on 6 – and the FT-625 is just the transceiver to get it! Cat D-2886

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- All HF bands!
- AM/SSB/CW!
- Tiny Size!
- True digital display
- New WARC bands!

$735.00

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They've been pretty hard to get: and small wonder! The superb FT-707 packs a huge punch from its tiny size: 240W DC! It's the ideal rig for mobile, base or portable work. Cat D-2869

SUPERB FT-207

- Microprocessor controlled hand held giving full 144–148 band!
- Digital display.

$358.00

For today's active ham, this is the set to take with you. Takes up virtually no room, but really gets out! Make contacts wherever you go with the FT-207R.

Cat D-2888

OR FROM $38 DEPOSIT AND $17.52/MONTH (24 MONTHS)

NEW FT107M

- The ultimate!
- WARC bands
- All solid state
- Variable IF bandwidth!
- Speech proc.

$1278.00

OR FROM $138 DEPOSIT AND $38.32/MONTH (48 MONTHS)

It must be every amateur's dream to own one of these! You can: and take full control of the bands. Whatever you want from your transceiver, the FT-107 offers it! Cat D-2871

BUDGET FT-101Z

We throw in a digital display kit worth over $100! This turns the FT-101Z into an FT-101ZD!

More hams have 'cut their teeth' on one of the famous '101' series than any other rig! Rugged and reliable, with all the features you really need. Cat D-2862

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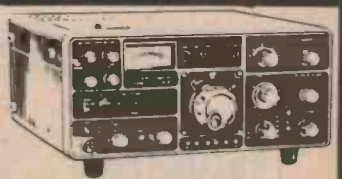

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State of the Art contest results

The revived State of the Art contest, featured on these pages in the July issue, attracted a small band of dedicated entrants and the organisers have deemed the revival a success.

The contest ran over 19 July to 3 August, the scoring period being any 10 days between those dates. The object of the contest is to promote operation on the available VHF/UHF/SHF bands with the object of promoting the more 'difficult' scatter techniques, satellite operation and UHF/SHF activity. Judging by the entries, that aim has been fulfilled.

First place goes to G. MacDonald, VK2YHZ, with 10 230 points all gained from 144 MHz troposcatter contacts. He will receive a $50 open order on Radio Despatch, donated by the organisers, the NSW VHF & TV Group.

Second place goes to Rod Preston, VK4ZRQ, with 8386 points gained from working Oscars 7 and 8, plus 146 and 432 MHz troposcatter.

The entries this time contrast to previous contests which were dominated by 52 MHz meteor scatter operation. The Oscars were well used and the effort by Geoff Campbell, VK2ZQC, is worthy of mention. He gained 1200 points just working Oscar 8. If Oscar 9 had not met such an unfortunate demise earlier this year, things would have been different, I'm sure.

Flying the flag on SHF were Jeff Pages, VK2BYY and Doug Morrison, VK2ZYM who gained 3050 points with contacts on 10 GHz (F3 modulation) over an 18 km path.

That's not a bad result, seeing as the last time the NSW VHF & TV Group attempted to run this contest, there were no entries! Prior publicity was low key and not far in advance, but even so, there was one entry from Queensland.

Dates for next year's contest are to be announced.

Predictions change

The Ionospheric Prediction Service of the Department of Science and the Environment has made a few alterations to their GRAFEX predictions we publish each month.

Firstly, some charts now cover the range from 3 MHz to 60 MHz, extending the top range from the previous limit of 40 MHz. This change has been effected as a result of increased solar activity.

Secondly, a change in the symbols used on these charts has been made. The letter 'B', signifying "propagation possible via E and F layers over 90% of days. (Overrides 'F')", has been replaced by the letter 'X'. This symbol signifies "complex mixture of modes. Expect abnormal propagation."

The latest preliminary monthly smoothed sunspot figures we have to hand at ETI indicate that we may have reached the peak of this cycle early this year, contrary to many reports in the technical press that we passed it October/November last year. The DX is good for a few years yet!

Tiny, synthesised 2m handheld packs a big punch

It is clear from an examination of the products, and their sales success, that when Icom set out to produce a product, they do their homework carefully.

The Icom IC2A 2m FM handheld transceiver is the company's first entry into the 'handheld market'.

There've been many before them — who doesn't remember the famous Ken KP2A? (they still fetch remarkably high prices secondhand). There's been plenty of talk on the air and at club meetings about this rig since it appeared earlier this year. Let's see what Icom have packed into a remarkably small package.

First, the size. The rig measures 65 mm wide by 35 mm deep by 16.5 mm high (depending on which way you hold it!) and weighs a mere 470 grams, depending on the battery pack. Two battery packs are available, the BP-5 which gives around 2 W output, and the BP-6 which gives 5 W output, according to Icom.

It has a 400 channel synthesiser, operated by a thumbwheel switch, with +/−600 kHz repeater offset switching, and a +5 kHz switch (giving '800 channels'). Duplex/simplex switching and hi/lo power switching is also provided.

Standard volume and squelch controls are provided and there are jacks for an external speaker and external microphone. The antenna connector is a conventional BNC socket. The familiar "rubber ducky" antenna is provided with the unit.

I note from the handbook that one model of the IC2A (IC2AT) has a tone encoder pad on the front panel, below the speaker. It's not available here, but it's interesting to note.

Circuit-wise, the IC2A has a PLL 'heart' that provides 72 to 73.9975 MHz to the transmit multiplier stages, and 66.6525 to 68.65 MHz to the receiver 1st mixer. Four diode-switched crystals provide either simplex, +600 kHz, −600 kHz or +5 kHz offsets. The thumbwheel switches program a divider in the PLL feedback chain to select 10, 100 and 1000 kHz frequency increments giving 400 channels between 144 and 147.995 MHz. The modulation is 'true' FM (not PM as is common in other schemes) as the PLL VCO is modulated directly.

The receiver has a cascade bipolar RF stage before the FET 1st mixer, followed by IFs at 10.695 MHz and 455 kHz. A single IC incorporates the 2nd mixer and conversion oscillator, the 455 kHz IF amps, limiter, detector and noise amp for the squelch. The squelch uses four transistors and a single IC audio stage follows.

Overall, the unit contains 43 transistors, three FETs, five ICs and 21 diodes. They sure pack a lot in there!

Receiver performance is quoted as 26 dB SINAD at 1 uV, less than 0.5 uV for 20 dB quieting with a squelch sensitivity of 0.4 uV. On measurement the unit exceeds those specs by more than 6 dB and can quite happily hear the leakage from our HP8654B signal generator (below −130 dBm or 0.07 uV)! Spurious response rejection is quoted as more than 60 dB, which it quite happily exceeds, and audio power output is given as 300 mW.

The transmitter delivered 1.8 W on the BP-5 battery pack supplied but we had no equipment to measure the low power output. Maximum deviation is quoted as +/−5 kHz and spurious emissions as better than 60 dB below carrier, but we had no way to measure either. Frequency stability is given as within +/−1.5 kHz and measured better than 150 Hz.

On the air reports with both solid and slightly noisy signals gave the rig 'good' audio. Using a dipole mounted inside our Rushcutters Bay offices (a 'not good' QTH) I was able to key up four local repeaters plus Wollongong. With a little help from the ETI-720 VMOS power amp (20 W out), the IC2A could just about 'talk' as well as it could 'hear'.

Operation with the flexible antenna is handy, but don't expect much in the way of performance. Still, I was surprised on occasions.

The inbuilt electret microphone takes a little practice to get things 'right', but once you work it out, all goes well. Receiver audio is OK for the tiny speaker in the rig, remarkable when connected to a good external speaker.

The unit is supplied with a plugpack battery charger for the 8.4 V battery pack, but charges from a 13.8 V supply so you can charge from a vehicle battery.

Overall, the unit is delightfully simple to operate but the lack of an S-meter is disconcerting. The IC2A packs a lot of punch for its small size and light weight. At $279, one is sorely tempted!

Our review unit was kindly supplied by Vicom, 68 Eastern Rd, South Melbourne, Vic 3205. (03) 609-6700.

Roger Harrison VK2ZTB

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The use of tip and sleeve sockets may be acceptable in the UK, but most professionals and amateurs in this country prefer XLR connectors. This is not a trivial point because one of the biggest hassles for most rock groups is the plethora of different plugs and connectors they have to cope with.

The most significant attribute of this amplifier is its sensible weight which any professional will quickly appreciate when he compares it to the 'lead lined' amplifiers he is accustomed to carrying around.

Conclusion

The Soundout S400 amplifier is a well designed, rugged and low weight unit with a performance that is better than one could reasonably expect for the modest price, although at a recommended price that works out around $1.7 per watt this is not the cheapest professional amplifier on the market. However, price is not necessarily the most important factor — the overall weight of 16 kg is probably a more important consideration.

Most professionals would be prepared to swallow the small differential in price to save having to lug around an amplifier with almost twice the weight, especially after that late, late show. When you add the sensible protection circuits into the equation this amplifier can be seen to have more than the average number of pluses. ●

SOUNDOUT S400 STEREO AMPLIFIER

Dimensions: 482 mm wide x 145 mm high x 380 mm deep

Weight: 16 kg Price: $680

Manufactured by: Soundout Laboratories Ltd, London UK.

Louis A Challis and Associates Pty Ltd

MEASURED PERFORMANCE OF SOUNDOUT S400 STEREO AMPLIFIER

SERIAL NO. 10814

FREQUENCY RESPONSE:

(-3dB re 1 watt, 0.5V Input to Aux.) Left 3.5Hz to 130kHz; Right 3.4Hz to 115kHz

SENSITIVITY: (for 1 watt in 8Ω)

	Left	Right
Aux.	80mV	80mV

INPUT IMPEDANCE:

	Left	Right
Aux.	6.0kΩ	7.0kΩ

OUTPUT IMPEDANCE: = -16 milliohms (@ 1kHz)

NOISE & HUM LEVELS:

(re 1 Watt into 8Ω) AUX. -70dB(Lin) 82.5dB(A)

(with volume control set for 1 watt output with, 0.5V input (Aux.)

MAXIMUM OUTPUT POWER AT CLIPPING POINT:

(IHF -A - 202)

(20mS burst repeated at 500mS intervals) 88V P-P = 242 Watts

Dynamic Headroom = 1.6 dB (re 200 watts)

TRANSIENT INTERMODULATION DISTORTION: 0.16%

(3.15kHz square wave and 15 kHz sine wave mixed 4:1)

HARMONIC DISTORTION:

(A) (At rated power of 200 watts into 4Ω = 28.3 volts) Left Channel

	100Hz	1kHz	6.3kHz	
2nd	-61.1	-64.7	-63.4	dB
3rd	-60.6	-58.8	-59.0	dB
4th	-73.5	-73.2	-75.2	dB
5th	-	-	-	dB
THD	0.13	0.13	0.13	%

(B) Right Channel

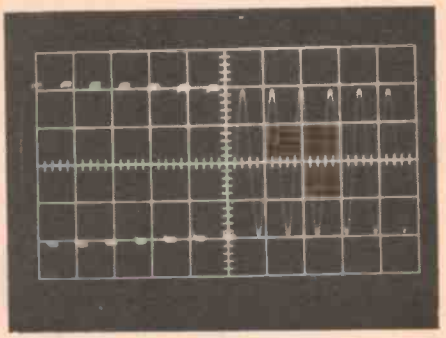
	100Hz	1kHz	6.3kHz	
2nd	-64.0	-74.0	-71.3	dB
3rd	-60.0	-59.3	-59.6	dB
4th	-72.6	-74.3	-71.2	dB
5th	-	-	-	dB
THD	0.12	0.12	0.11	%

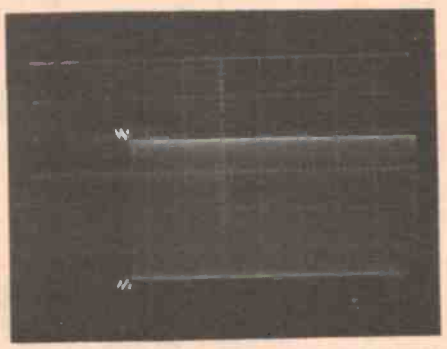
(C) (At rated power of 1 watt into 4Ω = 2.83 volts) Left Channel

	100Hz	1kHz	6.3kHz	
2nd	64.5	79.9	76.9	dB
3rd	68.1	75	71.6	dB
4th	76.1	-	-	dB
5th	78.4	79.8	-	dB
THD	0.07	0.02	0.03%	

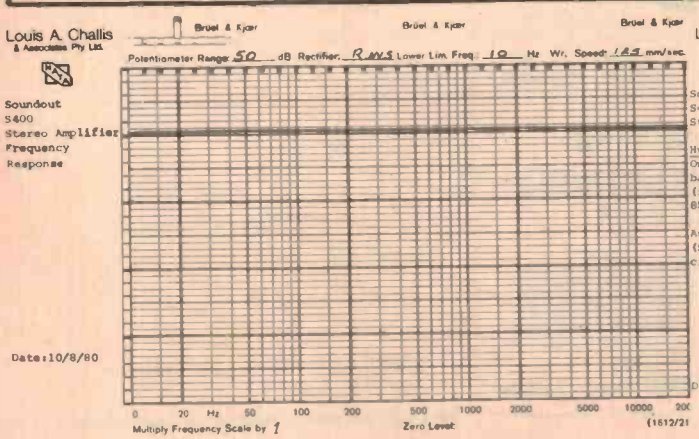
(D) Right Channel

	100Hz	1kHz	6.3kHz	
2nd	67.0	81.8	79	dB
3rd	68.2	68.5	67.5	dB
4th	79.1	88.8	-	dB
5th	74.2	73.4	-	dB
THD	0.06	0.05	0.04%	





Transient overload recovery test (IHF-A-202). Top: 1ms/div., bottom: 50 ms/div. Overload of 10 dB re rated power into 8 ohms, both channels driven. Overload duration: 20 ms; repetition rate: 512 ms.



one that they use in their 200 watt mono amplifier. The result is a classically simple design, using one superior design of transformer and a simple reliable construction which would be particularly hard to beat.

All the electronic components are mounted on a single high quality printed circuit board which is mechanically fixed to the side of the sub chassis, with the filter capacitors braced off the base of the sub chassis to provide positive and effective support. The unit makes use of colour coded wiring harnesses to connect components, sockets and fuses to the transformers and rear panel connections, which is normal practice in professional equipment of this type. All adjustable bias controls are positioned near the tops of the boards, with some wheel type controls that don't need a screwdriver. One fuse on each chassis is located in a rather inaccessible position between the mains transformer and one of the filter capacitors, but this is not a serious drawback because it could easily be replaced by using a pair of forceps or a finger and screwdriver.

On test

The objective testing of this unit revealed performance characteristics which were generally good for a professional amplifier but not as good as would now be called for by most serious or dedicated amateurs.

The frequency response is impeccable, extending from 3.5 Hz to 115 kHz and the sensitivity of 80 millivolts for 1 watt into eight ohms for each channel indicates that 1 volt would be required to produce 200 watts output.

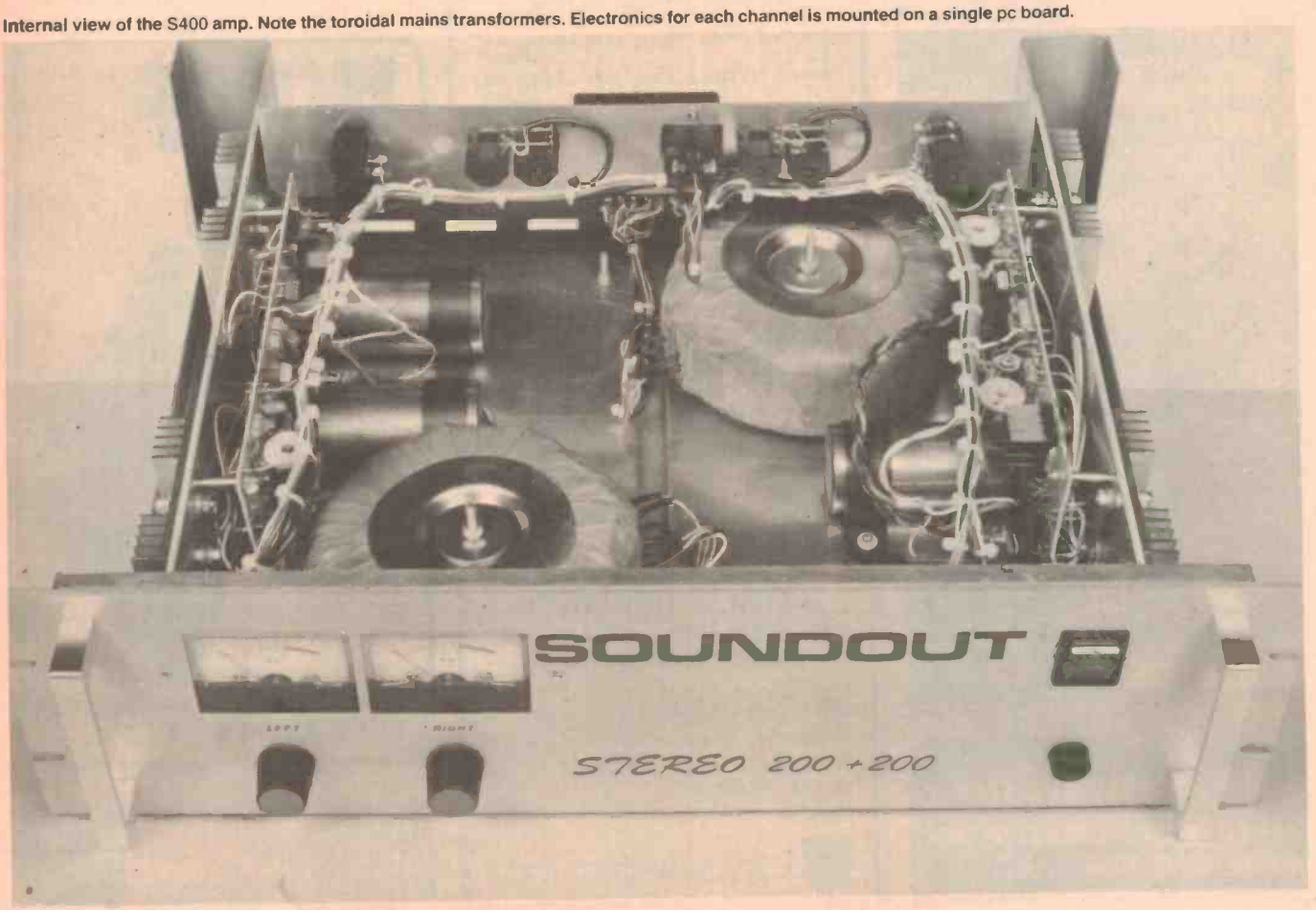
The distortion figures are modest, being typically in the range 0.1% to 0.13% at any of the test frequencies for 200 watts input and 0.02% to 0.07% at the 1 watt level. Transient intermodulation distortion is good at less than 0.16% and the hum and noise levels are −82 dB A-weighted and −70 dB unweighted at the 1 watt level.

At 200 watts the unit has a dynamic headroom of only 1.6 dB and hence is a genuine 200 watt per channel amplifier. There are electronic protection circuits which the makers say preserve the output transistors from destruction in the event of open or short circuit conditions. We tried to disprove this claim but did not succeed.

Subjectively

The performance of the Soundout S400 is typical of a high quality professional amplifier. It can produce rollicking rock and high level classical music into professional speaker systems without distress or audible distortion. Whilst the transient performance is not as good as that of some other amplifiers we have tested, we should point out that these amplifiers cost much more and do not have some of the attributes of the Soundout. ▶

Internal view of the S400 amp. Note the toroidal mains transformers. Electronics for each channel is mounted on a single pc board.



Soundout S400 stereo amplifier

Low weight, modest price and effective protection circuits make this professional 200 W per channel amplifier an attractive item.

THE PROBLEM with most high powered amplifiers for professional use is that they weigh too much, have questionable reliability and many other less obvious deficiencies that only show up in the field.

Like most manufacturers, Soundout Laboratories of the UK are aware of these problems and they have tackled them in a sensible and pragmatic manner. The Soundout S400 stereo amplifier is a particularly good example of how some of the usual drawbacks can be avoided by adopting a good engineering approach.

Design

The amplifier is designed for mounting in a standard 19 inch (48 cm) rack and features a brushed satin finish aluminium front escutcheon with two lifting handles on either side. The escutcheon contains two rectangular VU méters for the left and right channels, with the associated input level controls located immediately below. On the right hand side of the panel is a large illuminated main switch, below which is the mains fuse.

The chassis is an unusual all-welded monocoque construction with ventilation slots along sides and rear and a recess at the back which houses the input and output jacks and the IEC mains socket. A separate ventilated steel cover screws onto the chassis, making the whole structure extraordinarily rugged.

The sockets for input and output are all tip and sleeve to standard IEC and Post Office dimensions. Each input socket is actually a parallel pair of sockets to allow parallel feed into other equipment and there are two output sockets for each channel for multiple speaker connections.

The inside of the unit is a trifle unconventional. First of all the mains transformers are toroidal types, which really reduce the weight problem so that the S400 weighs far less than other amplifiers in the same power range and less even than many rated at half the power.

Another feature that cuts down on weight is the heatsink system, which for each channel consists of an L-shaped aluminium sub chassis onto which the output stage finned heatsinks are directly mounted. This results in a far more effective power dissipation and a consequent overall reduction in weight. Each sub chassis is directly attached to the main chassis, which further improves the thermal dissipation characteristics and reduces the weight.

Soundout have exercised a little lateral thinking and designed each sub chassis so that the same standard module is used for both channels. This of course keeps the price down, all the more so because this module is also the

NEW NEWS!

Australian Business is not written with an ohm and watt.

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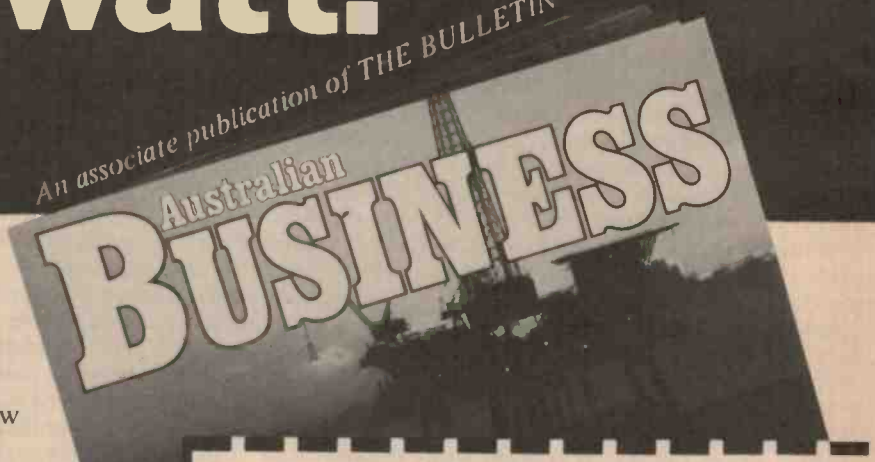

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J596

— from page 139.

manufacturer, should this be required.

Low noise field effect transistors are used in the mixer and BF494 transistors in the IF stages. The detector stage is followed by a 9 kHz whistle filter which provides effective attenuation of the beat frequency components between distant stations transmitting on adjacent frequencies. This feature is particularly important at night.

In the lab

Objective testing proved to be a little more complex than we expected. Firstly, the balanced coupling requirements for the input aerial tuning plug are a little different from the normal 75 ohm or dummy aerial configurations which have been the basis for our receiver testing over the last 25 years. As a result of this, some measurements may appear to be different from the manufacturer's. Audiosound do not provide a specification for the dummy aerial configuration used in sensitivity testing, so we resorted to connecting our signal generator directly to the aerial terminals.

With 30% modulation the tuner has a 1.6 microvolts sensitivity in the sharp position and 7.2 microvolts sensitivity in the broad position, for a 6 dB signal to noise ratio. The corresponding figures for a 26 dB signal to noise ratio are 25 microvolts and 60 microvolts. At 60% modulation the 26 dB signal to noise ratio is achieved at a 10 microvolts sensitivity in the sharp position.

Intermediate frequency rejection is a very satisfactory 53 dB and the image rejection is 46 dB. The maximum signal level that the tuner can cope with is 52 millivolts, at which point severe overloading occurs. Signals at or above this level would require an attenuator at the aerial input.

The distortion characteristics of the unit are quite good, being less than 1% for 30% modulation and well under 2% for 60% modulation. We had some difficulty in obtaining these figures because our signal generator was designed in a bygone era when distortions of less than 5% were regarded as more than adequate for AM reception.

The bandwidth in the broad position is 12 Hz to 7.6 kHz and in the sharp position it is 12 Hz to 2.6 kHz. The notch frequency of the whistle filter is 8.98 kHz, which is near enough to the specified 9 kHz.

The circuitry contains one other unusual feature which is worthy of comment. This is the incorporation of a simulated stereo output stage. The designers provide very little information apart from five lines in the well presented 15 page handbook, which describe this circuitry as being "an elegantly designed, 90° all-pass phase network designed by Thiele". This simulated stereo stage is apparently intended to provide a spatial distribution of the monaural AM sound when the output of the tuner is fed into a stereo amplifier.

To the ear

My subjective evaluation of the tuner proved that the manufacturer's statements and his faith in the quality of AM transmission are well founded. On a simple A-B comparison test anyone can tell the difference between conventional ereo receivers and the Audiosound AM101 (even in the sharp selectivity setting). Obviously that test is too easy.

A more difficult subjective test was to compare the quality of an ABC station on AM and FM. Here the extra bandwidth of the FM station gave it the edge, but there was not such a significant difference as I would have expected between the signal to noise ratios. The FM stations have signal to noise ratios of only about 50 dB (although with effective quieting this may approach 60 dB).

The Audiosound AM101 provided signal to noise ratios of better than 46 dB in my home during the day and slightly less at night when more distant stations were received on long distance skip propagation.

The quality of the sound produced by the AM101 tuner was particularly good and the ability of the aerial to either selectively receive or selectively reject signals and stations was particularly gratifying. Even the simulated stereo effect was a success and would generally satisfy most listeners. ●

AUDIOSOUND AM101 AM TUNER

Dimensions: 357 mm wide x 108 mm high x 280 mm deep

Weight: 4.5 kg *Price: $249;+ $38 for 'stereo'.*

Manufactured by: Audiosound, NSW.

AUDIOSOUND AM101 AM TUNER

Tuning Range: 560-1750kHz

Sensitivity:

Signal to noise measured at 760kHz. Modulation 30%.

Signal to noise Ratio	Sharp	Broad
6dB	1.6µV	7.2µV
10dB	2.9µV	14µV
20dB	10µV	25µV
26dB	25µV	60µV

at 60% modulation 26dB occurs at 10µV

IF Rejection: 53dB

Image: 46dB

Maximum Signal Input: At 760kHz 52mV

Distortion:

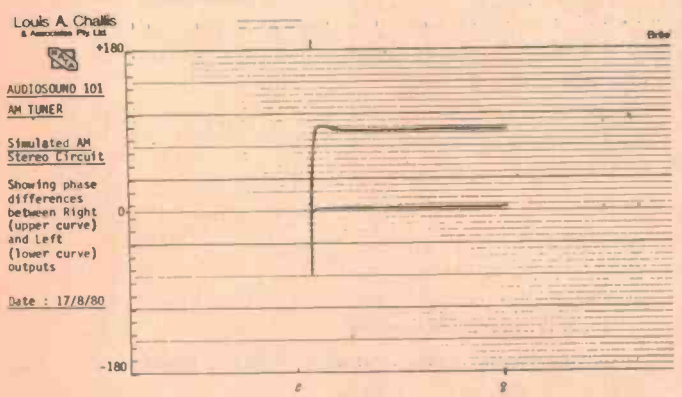
30% modulation "Sharp" <1% "Broad" <2%

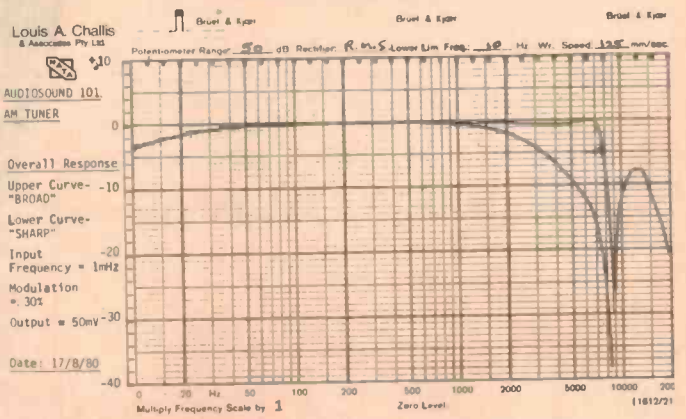
Output at set: 30% modulation 50mV

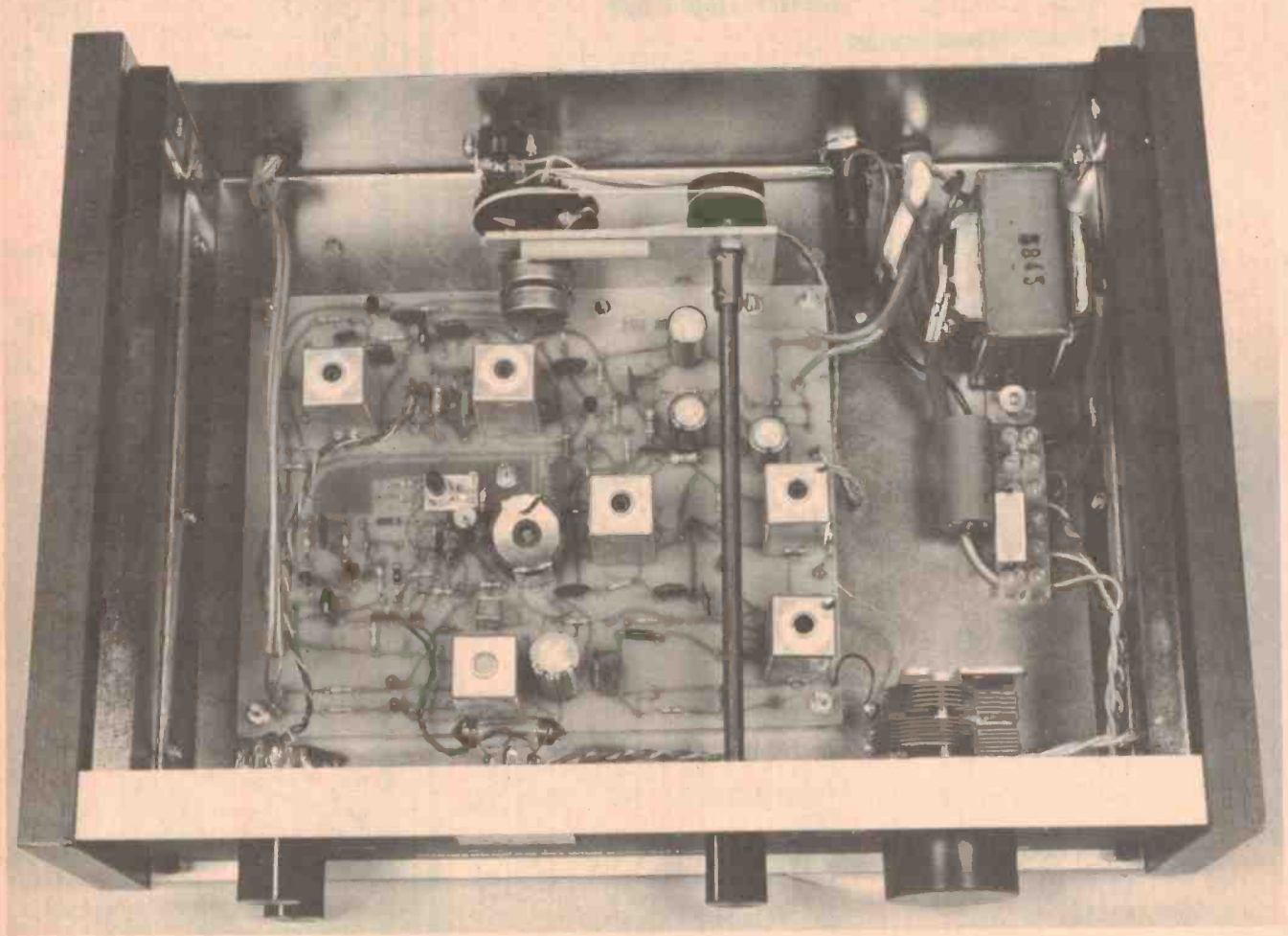
Whistle Filter dip frequency: 890Hz

Audio Bandwith response (-3dB):

"Broad" 12Hz-7.6kHz "Sharp" 12Hz-2.6kHz







panel. At the top left is a selectivity control for nominal bandwidths of 30 Hz to 9 kHz in the broad position and 30 Hz to 2.5 kHz in the narrow band position. Below the sensitivity switch is a rotary mains on/off switch and to the right of this is the sensitivity meter, which has five calibration levels with the range 2.5 to 4.5 marked in black to indicate the preferred area of operation. To the right of the signal strength meter is the gain control and next to this is a vernier tuning dial covering the range from 560 kHz to 1750 kHz. The vernier control on the dial provides a simple but effective 1.5 to 1 magnification of the rotational movement, making accurate tuning quite easy.

At the rear of the tuner are a mains lead, a fuse holder, a permanent one metre long output signal lead terminated in two RCA coaxial sockets and a balanced, low noise antenna socket for which an antenna is separately provided. The antenna works on the same principle as the simple tuning loop directional antenna developed over 50 years ago for radio direction finding. It overcomes some of the limitations of the integral ferrite loopstick antenna found in virtually all tuner and tuner/amplifier units manufactured today. Its major advantages are a better signal strength capture radio, general freedom from electrostatic field induction and the fact that the loop can be made smaller or larger as a means of controlling the pickup level to suit any given situation.

The antenna is cleverly designed in the form of a simple figure eight cable with the outer ends electrically connected. By opening out the gap between the ends of the leads it is possible to create any size loop within the limitations of the length of antenna cable supplied. The box even contains a number of drawing pins with which the cable can be fixed to the wall or furniture and precise instructions on its installation and optimisation. Conceptually the idea is novel, although we doubt whether many people will find it aesthetically appealing.

The external aerial is supplemented by an input filter trap-tuned to 455 kHz and connected directly to the rear of the aerial socket inside the tuner. The appearance of this filter unit is a little ungainly but it performs its task very well and we were unable to fault it.

The main circuitry is neatly laid out on a quality printed circuit board and has the professional appearance of the other Audiosound products that we have previously reviewed. The circuitry is simple, featuring a two-gang tuning capacitor with oscillator and mixer stage (no RF stage), three very carefully designed intermediate frequency stages and sufficient space for servicing and alignment by either the owner or the ▶

— to page 143.

Audiosound AM101 AM tuner

Designed in Australia to suit the unusually wide bandwidths of our AM broadcast stations, this tuner was much appreciated by our reviewer, Louis Challis.

IN THE LAST few months Australia's capital cities have seen the introduction of a number of new FM stations. In Sydney for example there are almost twice as many as there were at the beginning of the year. This is good news for people with FM tuners and receivers who are able to appreciate the medium, but it further emphasises AM's status as broadcasting's 'Cinderella'.

AM transmissions in this country have bandwidths of up to 15 kHz, much wider than in most countries of the world. Equally important, the quality of most AM broadcast studios is excellent — the majority of those that I have observed are vastly superior both acoustically and architecturally to the new breed of FM studios being built right now.

The second class status of AM has come about largely because the overseas manufacturers, who produce most of our receiving equipment, design tuners and receivers to meet the technical performance requirements of the world's less fortunate countries, where the airwaves are truly crowded with stations and the maximum practical bandwidth is invariably more restricted than it is here.

So the majority of Australians are tricked into believing that the quality of sound being transmitted by our AM stations is vastly inferior to what is produced by the FM stations and that consequently we must have FM if we want to listen to high quality transmissions.

AM broadcasting does suffer from some limitations, notably its susceptibility to electrical interference and the tendency of some of the newer and less august stations to use an unreasonable degree of peak compression (to get the maximum signal to noise ratio on rock and pop music). However the ABC and some other stations still produce excellent programmes with sound quality rivalling that of the best FM stations and radiated power levels which all but swamp out electrical interference.

Audiosound and a few other equipment manufacturers have realised this problem and have responded to the market requirements. Or maybe they have read my continuing complaints and criticism of imported tuners in this magazine!

Design

The AM101 is a neatly designed free standing or stacking type unit with a black anodised front escutcheon with white stencilled lettering, framed at top and bottom by strips of aluminium moulding. The sides of the unit are wood veneered particle board and the ventilated metal top has a simulated wood grain finish.

There are only four controls and a signal strength meter on the front

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William Lam
Product Manager
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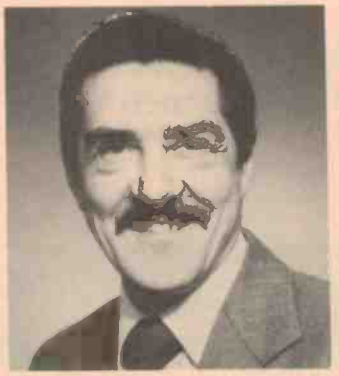

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TDK8073

— from page 120

High fidelity

In 1976 Siliconix published a circuit for a high quality 40 W amplifier using VMOS devices, but each half of the output stage required three VMP12 (now designated 2N6658), 90 V TO-3 devices in parallel. Thus, twelve of the devices were required in a stereo amplifier providing 40 W per channel. Rather cumbersome — and costly. However, distortion at the mid-frequency range was only about 0.04% at the 40 W level and about 0.025% at the 1 W level. Only 22 dB of feedback was needed to obtain a response flat to 4 MHz and the slew rate was 100V/μs!

One of the advantages claimed for VMOS amplifiers is the lack of transient intermodulation (TIM), because the power bandwidth exceeds the small signal bandwidth. For any frequency below 500 kHz, the amplifier simply overloads before TIM appears.

Taking things a step further, the circuit in Figure 18 is a simple power amplifier first published in the Hitachi MOSFET application notes. The 2SK133 and 2SJ48 have an on-resistance of roughly two ohms, so that at 7 A peak output current you can expect a voltage drop of about 14 V across each device. With the power supply voltages shown the circuit is capable of around 50 W.

Transistors Q1 and Q2 form an input differential pair that compares the input signal with the output signal of the amplifier. The difference between these two signal voltages is fed to a second differential pair, Q4 and Q5. This ensures that the open-loop voltage gain of the amplifier is high and allows a fairly high feedback factor when negative feedback is applied. A relatively large amount of negative feedback is essential when using MOSFETs like this in audio amplifiers to linearise the MOSFET characteristics which have, on average, *10 times* the distortion of a typical bipolar transistor of similar power capabilities.

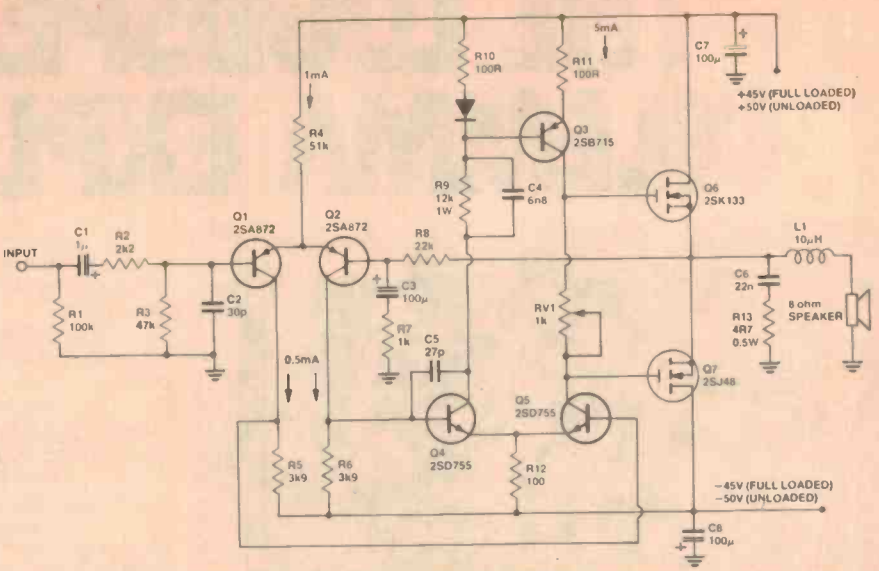

Figure 18. Circuit of a 50 W hi-fi amplifier from the Hitachi MOSFET application notes. Performance is quite good but dependent on the driver transistors.

The transistors forming the driver stage, Q3 and Q5, have been specially designed by Hitachi to drive MOSFETs. They're superb devices, having a V_{ceo} of 100 V and a typical gain (h_{FE}) of around 500. With these transistors the distortion characteristics shown in Figure 19 can be expected. Unfortunately, these transistors are not available in Australia at the present time and substituting alternative available transistors degrades performance considerably. A BD139/BD140 complementary pair for instance, with typical h_{FE} of around 50, is not capable of providing the necessary open-loop gain, especially at high frequencies. An experimental circuit we built with BC177s and BD139/BD140s gave less than 0.02% at 1 kHz at full power, rising to as much as 0.1% or more at 20 kHz. So, MOSFETs with all of their advantages have disadvantages too — mainly due to the fact that the forward transconductance is only a fraction of that of a good bipolar transistor.

In order to design an extremely high quality amplifier employing MOSFETs, we are really faced with a new set of problems to solve, but with the promise of performance that makes it worthwhile. Such a design is coming off our drawing board as you read this. Don't miss it! (This section on Figure 18 inserted by David Tilbrook . . . Ed.). ●

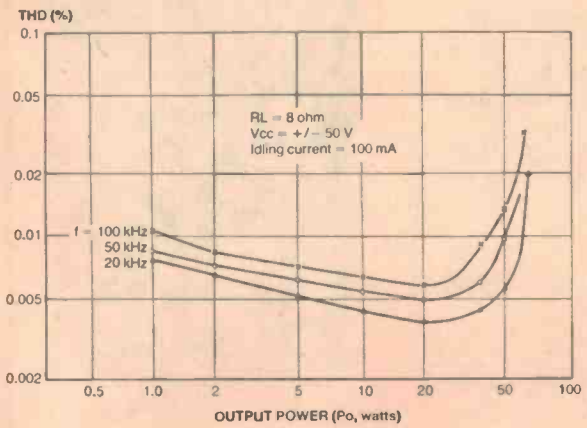

Figure 19. Distortion characteristics of the circuit in Figure 18.

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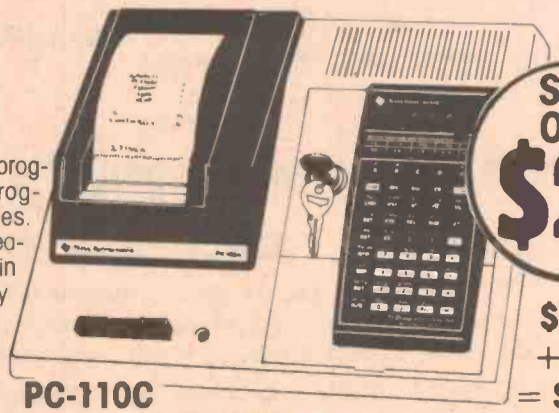

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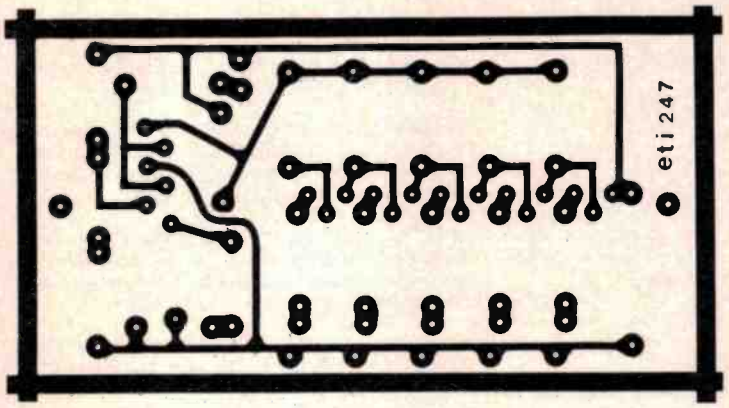

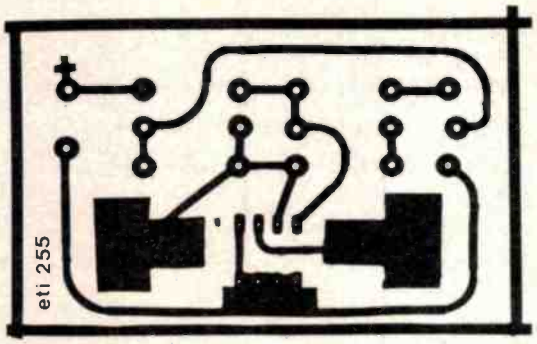

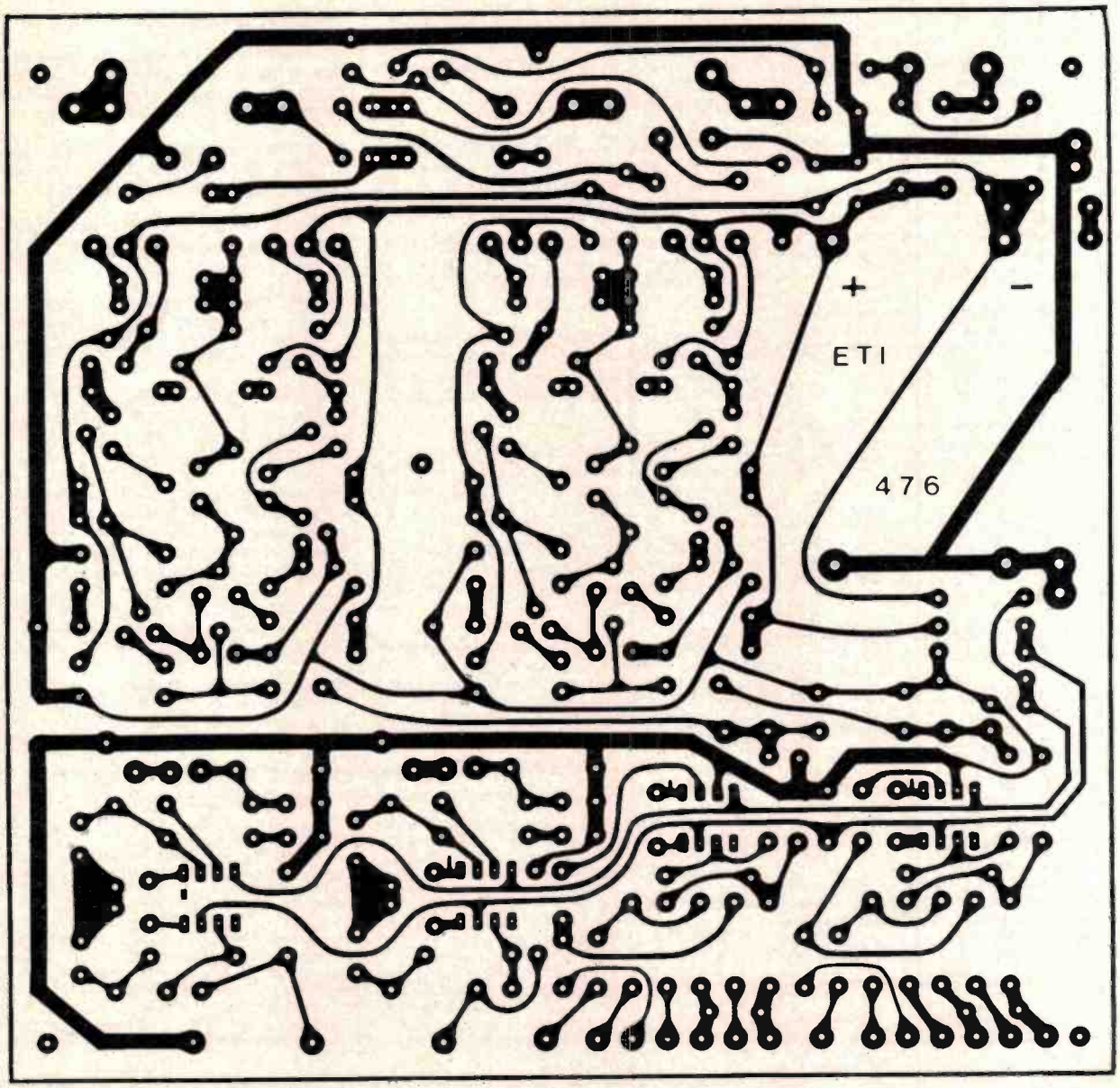

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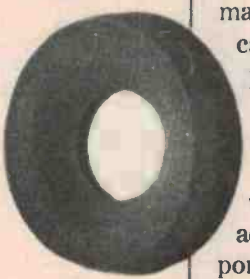

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Please read the contest rules carefully, especially if sending in multiple entries.

This contest is jointly sponsored by ETI and Maruni Corporation — who have generously donated the prizes.

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Maruni Corporation, Modern Magazines (Holdings) Ltd, K.G.Murray Ltd, Australian Consolidated Press, Wilkes Pty Ltd and/or associated companies.

Entries should be addressed to ETI/Maruni Contest, Electronics Today Int., 15 Boundary St, Rushcutters Bay, NSW 2011.

Closing date for the contest is 31 December 1980. Entries received within seven days of that date will be accepted if postmarked prior to and including 31 December 1980.

The contest will be judged by the Managing Editor and Editor of ETI whose decisions will be final. No correspondence can be entered into regarding their decisions.

In the event of one or more tied results the finalists' entries will be thoroughly mixed and then drawn by the Managing Editor.

Winners will be advised by registered letter the same day the results are declared. The names of the winners, together with the answers will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in States where local laws prohibit entries.

Entrants must sign the declaration, accompanying this contest, that they have read the above rules and agree to abide by their conditions.

(1) The superhet receiver pioneered a boom in AM broadcasting in the 1930s, as the technique made available stable, cheap, sensitive receivers for mass production. During that era the techniques of FM transmission for broadcasting and communications were developed. Who was the man associated with both developments ?

.....

(2) What was his title ?

.....

(3) The following quote, about an early stereo sound demonstration, has been taken from an Australian publication. What year did that demonstration take place ?

"At the Plaza Theatre, Sydney, on Sunday, April 10, a special demonstration arranged by Mr Ray Allsop, M.Inst. R.E.(Aust), F.S.M.P.E. (USA), and made possible by courtesy of Raycophone Ltd., was given as part of the proceedings of the World Radio Convention.

"Almost 2000 guests were present at the Plaza Theatre to hear for the first time in Australia electrical reproduction of an orchestra, possessing effects in the aural field similar to stereoscopy in optics.

". . . Pick up was effected by binaural microphone technique, employing separate telephone transmission channels, and finally reproduced over separate amplifying and reproducing systems."

.....

(4) Microphones may be divided into two basic groups: pressure- and velocity-operated types. Into which group does the Maruni DM901 fall ?

.....

(5) In what units is the output voltage rating of a microphone quoted ?

.....

(6) There are seven basic different types of headphones. List them.

.....

.....

.....

(7) In fifty words or less, tell us why you would like to win a Maruni microphone and pair of headphones as offered in the prizes for this contest.

.....

.....

.....

.....

Name .....

Address .....

..... Postcode .....

I have read the contest rules and agree to abide by their conditions

Signed .....

Date .....

Facts from Fluke on low-cost DMM's

Investigator at work: The shortcut to continuity checking.

At times like this, every minute matters. You could spend hours searching for a single short or open.

You could pack a continuity checker around with all your other gear. Or you could make your life a lot simpler and get the new 8024A Investigator from Fluke.

The Investigator is the only DMM on the market with nine functions including a built-in continuity/level detector. With 3½-digit resolution, 0.1% basic accuracy and a full line of accessories, it's the most versatile handheld DMM you can buy.

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For active circuit checking, the level detector's "up" arrow indicates voltages above a threshold level, the "down" arrow shows signals below that point. And a pulse stretcher captures and displays signals that other analog or digital meters would never see.

Other Investigator exclusives you'll appreciate are the peak hold feature – a short-term memory that captures and holds transient signals until you can turn back to read the display – and the ability of the 8024A to deliver direct temperature readings via any K-type thermocouple. Plus conductance lets you measure leakage and high resistance to 10,000 Megohms. All this performance at a low price.

For all the facts on the new 8024A Investigator, call or contact your Fluke stocking distributor, sales office or representative.

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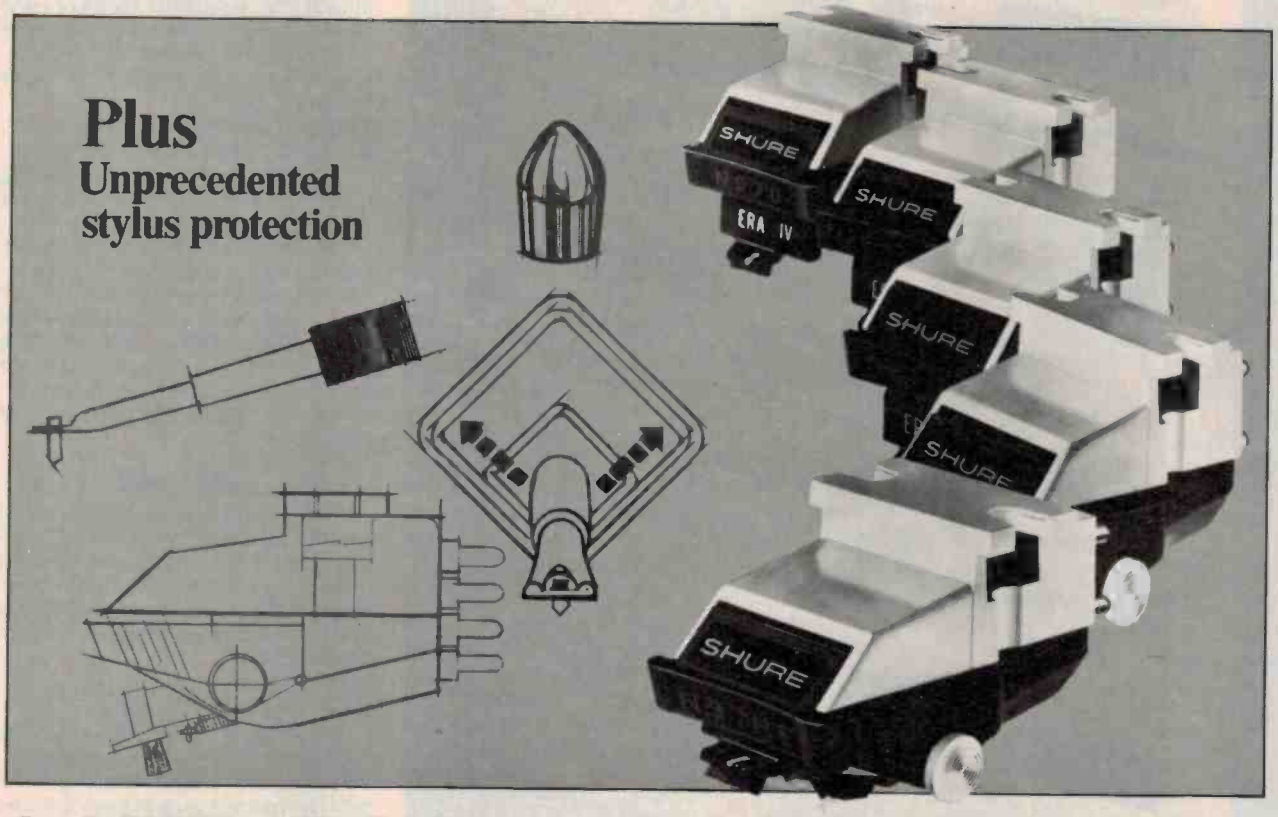
On sale now at newsagents and selected specialist suppliers. If sold out (highly likely), you can obtain a copy from **Electronics Today International, Subscription Department, 3rd Floor, 15 Boundary St, Rushcutters Bay NSW 2011.** *Send $3.95 plus 65 cents post and handling.*

fact: five new Shure Cartridges feature the technological breakthroughs of the V15 Type IV



the M97 Era IV Series phono cartridges

Model	Stylus Configuration	Tip Tracking Force	Applications
M97HE	Nude Hyperelliptical	¾ to 1½ grams	Highest fidelity where light tracking forces are essential.
M97ED	Nude Biradial (Elliptical)	¾ to 1½ grams	
M97GD	Nude Spherical	¾ to 1½ grams	
M97EJ	Biradial (Elliptical)	1½ to 3 grams	Where slightly heavier tracking forces are required.
M97B	Spherical	1½ to 3 grams	
78 rpm Stylus for all M97's	Biradial (Elliptical)	1½ to 3 grams	For 78 rpm records.

Shure has written a new chapter in the history of affordable hi-fi by making the space-age technological breakthroughs of the incomparable V15 Type IV available in a *complete line* of high-performance, moderately-priced cartridges: the M97 Era IV Series Phono Cartridges, available with five different interchangeable stylus configurations to fit every system and every budget.

The critically acclaimed V15 Type IV is the cartridge that astonished audiophiles with such vanguard features as the Dynamic Stabilizer—which simultaneously overcomes record-warp caused problems, provides electrostatic neutralization of the record surface, and effectively removes dust and lint from the record—and, the unique telescoped stylus assembly which results in lower effective stylus mass and dramatically improved trackability.

Each of these features . . . and more . . . has been incorporated in the five cartridges in the M97 Series—there is even an M97 cartridge that offers the low distortion Hyperelliptical stylus! What's more, every M97 cartridge features a unique lateral deflection assembly, called the SIDE-GUARD, which responds to side thrusts on the stylus by withdrawing the entire stylus shank and tip safely into the stylus housing before it can bend.

NEW! M97 Series Era IV Phono Cartridges . . .
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MARANTZ ST600
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This model incorporates a built-in oscilloscope that affords the most precise means possible to determine optimum reception, even from weak or distant stations. The functions of the oscilloscope extend well beyond those of conventional tuner meters.

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AM/FM STEREO TUNER

A large, fuss-free Vacuum Fluorescent readout clearly displays the selected frequency and Electronic Gyro-Touch with Servo-Lock guarantees drift-free, razor-sharp tuning every time. Uncompromising quality through and through.

MARANTZ ST300
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