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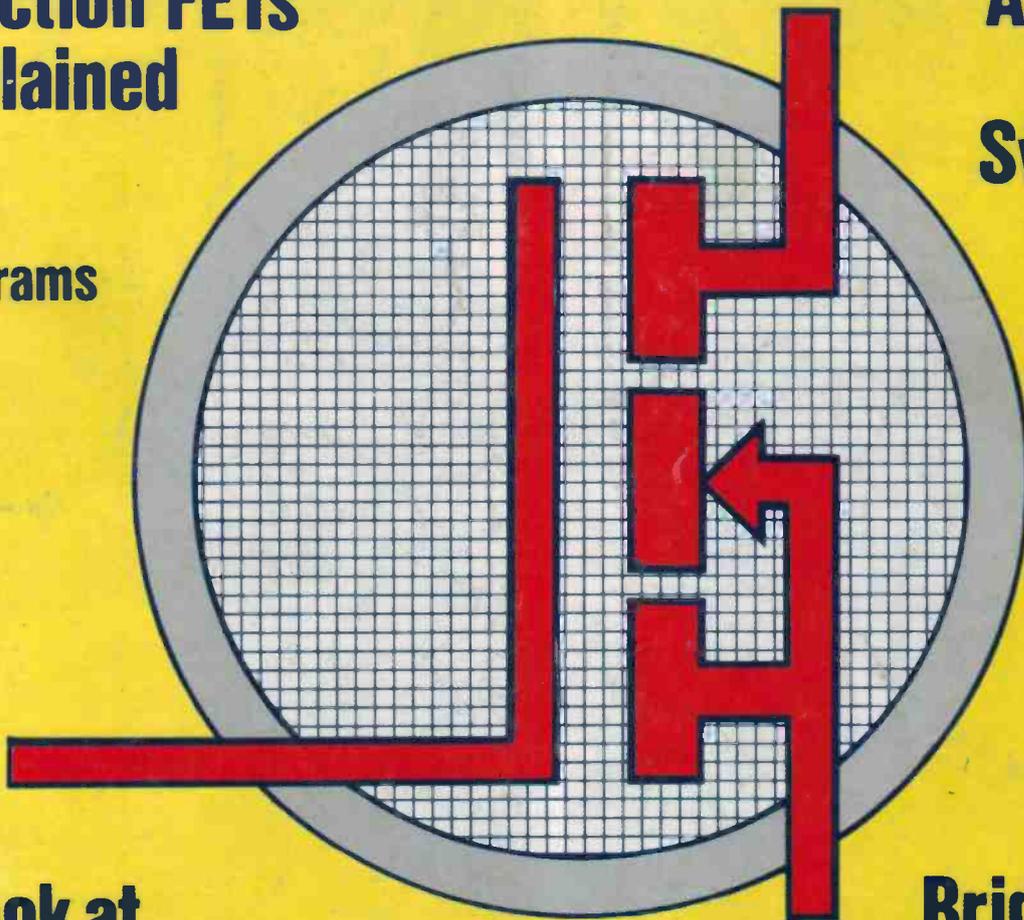
ELECTRONICS TODAY INTERNATIONAL

150 W MOSFET P.A. MODULE

**Junction FETs
Explained**

**More
'660
programs**

**All about
CMOS
Switches**



**Turntable
'computes'**

**A look at
TRS-80 Colour
Computer Software**

**Bridge your
Series 5000
Amp for 300W**

SCOOP! Microcassette Deck Review

Peter Davey comes out of the closet and makes an embarrassing confession.

Peter Davey has music as his absorbing passion. After a successful career as a guitarist he made the eventful decision to go into hi-fi. For three years he worked with leading sound engineers. Then in 1978 he opened Penny Lane Audio. Named in honour of the Beatles, it today is one of the two best hi-fi stores in Australia. Sited in Melbourne's fashionable Toorak Village, Penny Lane's clients come to choose from a superb selection of top quality electronics and the largest range of American speakers in the country. With the choice available to him what equipment then does Peter Davey have in his own home?

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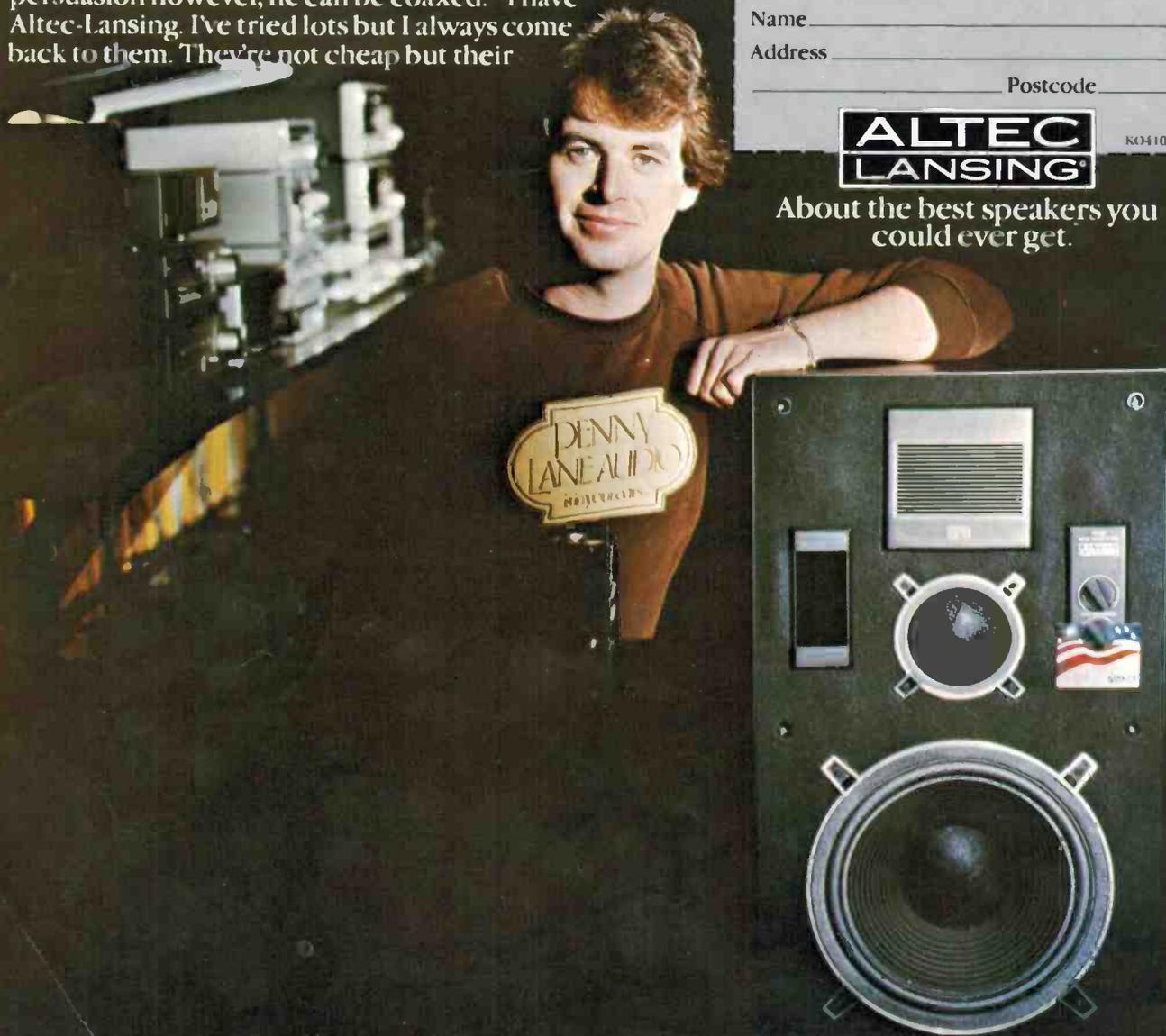
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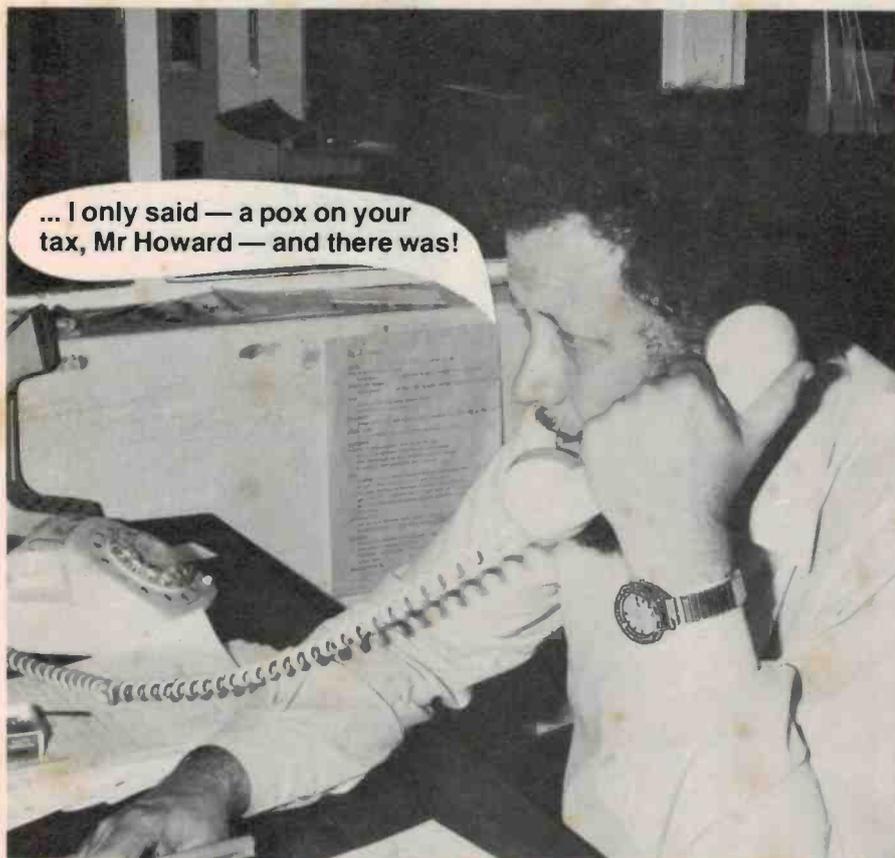
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could ever get.





Roger Harrison

Roger Harrison
Editor

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**ELECTRONICS
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INTERNATIONAL**

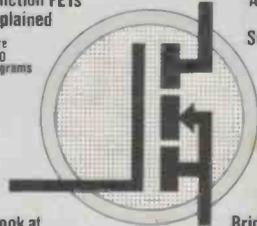


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150W MOSFET P.A. MODULE

Junction FETs Explained

More '860 programs



All about CMOS Switches

Turntable computers

A look at TRS-80 Colour Computer Software

Bridge your Series 5000 Amp for 300W

SCOOP! Microcassette Deck Review

MOSFETs are the 'darling of devices' at present — so what better to put on the cover than a giant MOSFET symbol!

Cover design by Ali White, drawing by David Currie, from an idea by Roger Harrison.

*Recommended retail price only

news

NEWS DIGEST

9

Experiment proves electrons are waves; Fibre optics telecommunications network; Space physics experiment; Data logger rental service; etc.

PRINTOUT

68

Mirror 2000 — new local micro; Now your computer answers back; Instant speech system; New disk systems for Apples; QIT micro design workshop; and more.

SIGHT & SOUND NEWS

115

Sony appeals US ruling on VCR usage; Lasers record loudspeaker movement; Linn tonearms; Improved JR149 cylindrical speakers; etc.

features

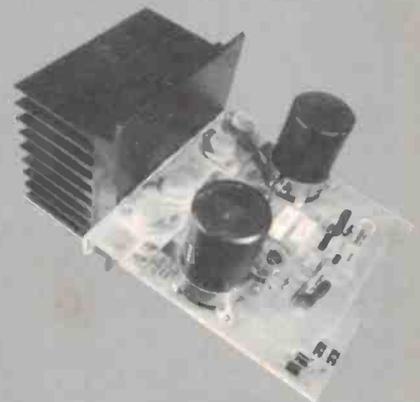


THE JUNCTION FET — ITS HAUNTS AND HABITS

17

The first in a whole family of field effect transistors, the JFET is found in many varied applications. If you're new to electronics or unfamiliar with this device, this article should introduce you to the haunts and habits of the JFET.

projects



499: GENERAL PURPOSE MOSFET AMP

24

This high-power, general purpose power amp module for guitar and PA applications employs reliable MOSFETs in the output.

479: SERIES 5000 BRIDGING ADAPTOR

33

This bridging adaptor converts the Series 5000 power amp into a 300 W mono amplifier.



607F: SOUND EFFECT

42

In the August and September issues last year we published project 607 A to E, which was a series of sound effects ranging from a Bomb Drop and Explosion to a Steam Train and Whistle. 607F continues the series, using the same IC and pc board, with the sound of a propellor aircraft.

computing

COMPUTING TODAY

Handheld micros.

65

MUSIC-MAKING MICROS

This is a tuneful diversion for those who own a System 80 or TRS80.

77



TWO-FINGER EXERCISE

— REVIEW OF THE CASIO FX-702P 84

Although they've sometimes been dismissed as mere toys, an overseas computer magazine recently claimed that pocket computers are in fact the new wave in computer technology. Some are in fact as powerful as third generation standard computers. We review Casio's latest offering in this field, the FX-702P.

TOUCHED BY TOUCH TYPING

88

This program takes an original listing published in the July 1981 issue and converts it very simply into a touch-typing tutor.

INTERFACING WITH THE ETI-685

92

In this second part of the series, Ron Koenig describes how to make use of the flexible interfacing provided on this board, which employs the 8255 PPI chip.

'660 SOFTWARE

96

Addition problems — this program constructs simple addition problems using two randomly chosen numbers between 0 and 127.

SOFTWARE FOR THE TRS80 COLOUR COMPUTER

101

So much software has been released for the TRS80 colour computer that a beginner would be understandably confused by it all — as would many more advanced users. Greg Wilson gives a rundown on the software situation.

CITY IN PERIL

109

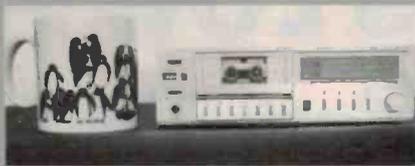
In this game for the ZX80 (1K) it's up to you to save the city from annihilation by alien missiles.

sight & sound

NAKAMICHI'S COMPUTING TURNTABLE

124

No matter what shape your record's in, the new Nakamichi TX-1000 turntable computes the error and compensates!



SANYO RD-MX1 MICROCASSETTE DECK

132

Just as the compact cassette took over from the reel-to-reel in the sixties, so it is predicted that the microcassette will be the barnstormer in the tape market in the eighties. Louis Challis reviews Sanyo's RD-MX1 microcassette deck.

KEF 105 LOUDSPEAKERS

138

After testing the KEF 105 Series II loudspeakers, Louis Challis rated them as "almost indistinguishable . . . from our reference monitors" and as displaying characteristics "bordering on the superlative". Wow!

general

SHORT CIRCUITS

40

Symmetric multivibrator using two inverting gates.

LAB NOTES

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Electronic switching using the 4066B.

IDEAS FOR EXPERIMENTERS

51

Idea of the Month contest and first winner — a cold start booster; Simple method for pc board design; etc.

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next month



TRS80 COLOUR COMPUTER

Review held over due to lack of space — this machine has so many interesting aspects from both the user and design point of view that it required more space than was possible in this issue. One not to be missed!

TAPE RECORDER TECHNOLOGY

Brian Dance throws some light on the technology and techniques employed in modern audio tape recorders — both reel-to-reel and cassette. See where the state of the art is at.

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CIRCUIT FILE

A new technical series, but each article complete in itself, covering applications of fundamental circuit techniques, device applications and design information. Circuit File is written by correspondent Ray Marston, who has provided so many popular Lab Notes features. Circuit File kicks off with power supplies and regulators.

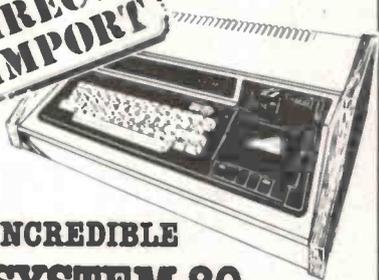
Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

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These are our major dealers, however we cannot guarantee they will have all these items in stock and at the prices advertised.

DSE/A183/PAI

Electrons are waves! —experimentally confirmed

A basic experiment on the wave nature of electrons — an experiment that has eluded physicists for fifty years — has been accomplished at the IBM Research laboratory in Zurich, Switzerland.

The experiment involves the 'tunneling' of electrons through a thin region of empty space — a vacuum — which they could not penetrate if they were the small, hard particles envisioned in classical physics.

The modern view of particles such as electrons, called quan-

tum mechanics, was formulated in the late 1920s. Quantum mechanics treat such particles as having the properties of both particles and waves. As waves, when they encounter a barrier such as a vacuum, they don't just bounce off, but penetrate a short distance into the barrier.

If the barrier is thin enough,

some part of the wave penetrates it and appears on the other side as an electric current. This is called tunneling.

In addition to its scientific interest, electron tunneling in solids is the basis of a number of high-performance electronic devices such as the tunnel diode.

The Zurich experiments have for the first time unequivocally shown tunneling through a vacuum between two electrodes, one a needle point and the other a flat metal sample. Tunneling

through a vacuum is difficult to observe because it occurs only over very small distances — a few angstroms (an atomic diameter is typically about three angstroms). The slightest vibration can ruin such an experiment.

The first experiments are reported in the January 15 1982 issue of *Applied Physics Letters* in a paper by Gerd K. Binnig, Heinrich Rohrer, Christoph Gerber and Edmund Weibel of the Zurich laboratory.

Solar charging controller

The Solar Energy Research Institute of Western Australia (SERIWA) has developed a very low-cost, compact and easy to install combined 'fuel-gauge' and charge/discharge controller for lead-acid batteries, designated 'BEMAC' (Battery Energy Meter and Controller).

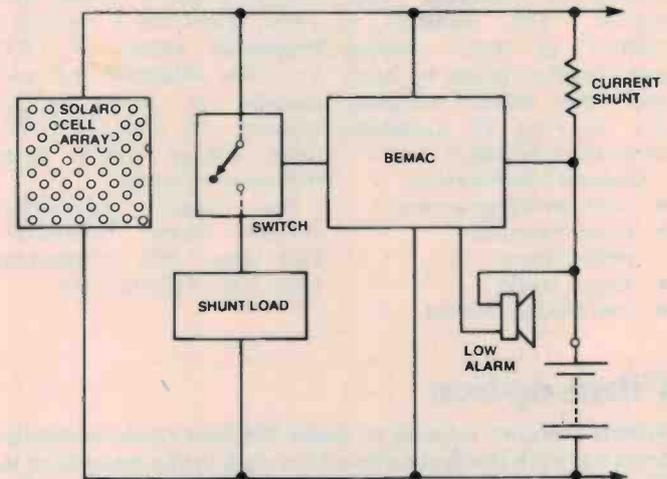
Although the BEMAC was designed for solar applications, specifically photovoltaic battery power systems, it is claimed to be sufficiently general purpose to be used in a wide variety of situations using lead-acid batteries, including electric vehicles. SERIWA claim that at present there is nothing on the market to match the performance of BEMAC at such a low price: one-off component cost is under \$20, with only five integrated circuits.

The unit provides a readout of state-of-charge of the battery, with ten LEDs providing a bargraph indication from discharged to fully charged. When a battery bank is being charged, from whatever source, there is, for any particular percentage charge, a recommended maximum charging current; if greater current is applied the battery may be damaged, cycle-life reduced and excessive gassing occur.

Installation is claimed to be extremely simple, as the only parameters required are battery

terminal voltage and current. There is no need to read electrolyte or ambient temperature. Furthermore, the shunt required to measure current need not be accurate, so that a simple length of wire can be used. The diagram shows the installation configuration for a photovoltaic system. Note that a shunt load is employed to bypass excess charging current; the usual open-circuiting or short-circuiting regulators do not utilise this excess power, which can be a substantial proportion of total system power. Possible shunt loads in a remote homestead are a booster for a hot water heater, refrigerator, air conditioner and a water pump.

As the shunt load is operated in a pulse width modulation mode, the switching transistors consume little power. For use in an electric vehicle, as a state-of-charge readout only, the charge control functions and shunt load are not required, although it is quite feasible to use BEMAC as an open-circuiting regulator, as



would be required in the electric vehicle situation.

Enquiries to SERIWA, Box R1283, GPO Perth WA 6001.

ERRATA

May '81, *Wordsquare* — game for the TRS80, p.108: This program was obtained from our UK proteges and contains an error we didn't spot — brought to our attention by P. Chapman of Auckland, N.Z. Line 550 of the Program Listing should read
 $550 \text{ SS}(R2(I), C2(I)) = \text{MIDS}(WS(W1), I, 1)$
and all should be well.

ETI-723, Feb. '82, 'Selectacal', p.44: For some totally unfathomable reason, the introduction to this project does not actually refer to this project but to commercial 'selcall' systems. Ggaahh! The last two lines of the intro should read: "... then this simple accessory allows you to turn down the volume, notifying you when that 'certain party' calls — no tones or funny noises required".

Series 5000 Preamp, Oct. '81: The 400 Hz oscillator set-up procedure is as follows, not as per page 12 in Dec. '81. Take your multimeter, set to read ac volts, and connect it to one of the output sockets. Set the TAPE switch to OSC. and adjust RV4 to obtain 1.2 Vac (RMS) on the meter.



No-grease silicone transistor insulators

Cho-Therm-R reinforced silicone insulators, available from Amtex Electronics, are said to replace conventional mica plus thermal grease combinations.

The insulators are said to be form-stable, will not bleed or cold flow, and are made entirely of non-toxic substances. The material is claimed to resist cracking and piercing caused by burrs and other surface irregularities, reducing the possibility of electrical shorting.

Claimed advantages are:

- no thermal grease mess
- more consistent performance
- labour saving
- one product stocked

instead of two. Sizes in stock are the T03, T0220, T066, TIP32, D04 and D05, all made of material type 1674, which has a minimum breakdown voltage of 1500 Vac. The insulators are also available in sheets or in material with a higher breakdown voltage and/or lower thermal impedance.

For further information contact Amtex Electronics, P.O. Box 285, Chatswood NSW 2067. (02)411-1323.

Fibre optics

British Telecom intends to make Britain's telecommunications network the first national network firmly committed to the use of optical fibres. At least 100 000 km of optical fibre will be purchased and installed in the 1980s to create a network joining all of the major cities in England, and by 1990 optical fibres will account for about half of the long-distance trunk network capacity and will provide savings in operating costs.

Telecom recently ordered an additional 6400 km of optic fibre costing some £15 million to support the 3600 km already ordered, which is being installed. Already 200 km has been installed between London, Reading and other cities.

The new network includes one mono-mode system using a long wavelength with a 27 km link between Luton and Milton Keynes. This will be the first of its kind in the world when it comes into operation in 1984.

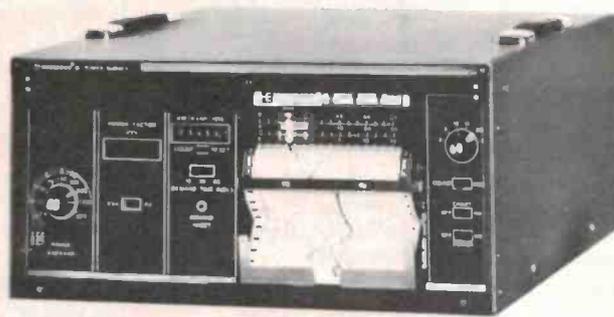
The use of longer wavelengths with mono-mode transmission enables the light to travel 10 to 15 times farther between repeaters than is the case with conventional cable using graded-index fibres. Telecom hopes to increase the interval between repeaters to at least 30 km so that the equipment can all be housed in Telecom buildings, thus eliminating manhole covers and consequently simplifying installation and maintenance. **Brian Dance**

Microwaves made easy

To cope with the shortage of training aids in microwave engineering, the Microwave Products Division of Marconi Instruments, a GEC-Marconi Electronics company, have introduced a new low-cost audio-visual course — 'Understanding Microwave Equipment'. It consists of six C90 cassettes held in a ring binder containing 175 supporting diagrams and photographs.

The six sessions cover a survey of microwave systems and devices, transmission lines and components, solid-state sources, tubes, low-noise receivers, antennas, radar, telecommunications and electronic warfare systems. Further practical training can be obtained from the 6599/2 and 6452A/2 Microwave Education and Antenna Test benches, also available from Marconi Instruments.

This is a fast and cost-effective way to provide training in the rapidly expanding world of microwave technology. The cost of the course is just STG £65 (UK price). For further details contact Harold Read, Marconi Instruments Ltd, Longacres, St Albans, Herts. AL4 0JN, England. Telephone: St Albans 59292.



New family of power survey demand recorders

Two new recorders from Esterline Angus Instrument Corporation allow easy performance of thorough power surveys that formerly required time-consuming calculations or costly single-purpose recorders.

The new Miniservo III 3-pen ac watt/var/demand integrator records combinations and integral measurements that are functions of two or more variables. You can record kW, kVAR, kW demand, kVAR demand, kVA demand, kWh, kVAR hr, kVA hr, dc volts, dc mA, and power factor. By means of accessory jumpers and controls you select which parameters to record and designate which pen to which variable. Both recorders operate on switch selectable 115/230 Vac 60 Hz (50 Hz optional). They have multispeed stepper motor chart drives with speeds of 2, 5, 10, 15, 30 and 60 cm/hr and cm/min. They come with a bench-type case with lab feet and carrying handles. Standard front see-through dust cover is NEMA II drip-proof.

For further information contact Esterline Angus Instrument Corporation, P.O. Box 24000, Indianapolis, IN 46224, USA. The recorder handles

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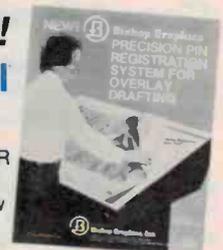
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Space plasma physics experiment

Britain's Science and Engineering Research Council (SERC) has decided to take part in the Active Magnetospheric Particle Tracer Explorers (AMPTE) project planned for launch in 1984. The Council's Rutherford Appleton Laboratory will work with the Mullard Space Science Laboratory to build a free-flying sub-satellite to be known as UKS.

During the launch the UKS will form the structural link between the German and US spacecraft, but afterwards will be positioned within 100 km of the German spacecraft, the Ion Release Module, in order to study a series of barium and lithium ion releases to be made from the latter module. There will be a total of seven such ion releases into the solar wind over the nine months of the mission. The US Charge Composition Explorer satellite will orbit

through the radiation zones close to the earth in order to detect the arrival of the tracer ions. The three satellites will be able to make extensive measurements with unprecedented resolution of the earth's natural plasma environment.

One release of barium ions which is planned near Christmas 1984 will create what will appear from the ground as something like an artificial comet lasting for some 30 minutes and interacting with the

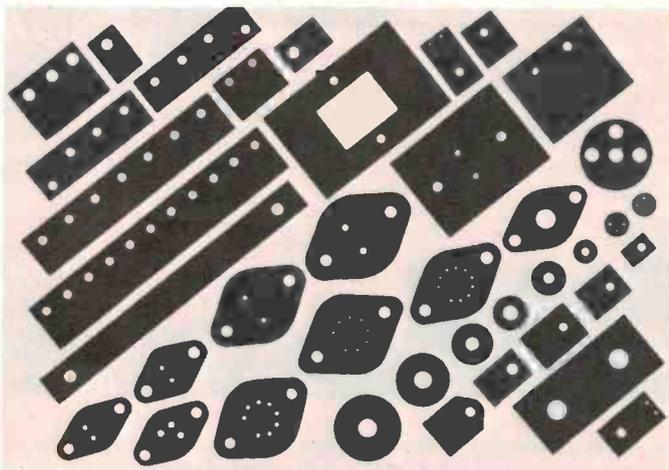
solar wind in much the same way as a real comet, such as Halley's Comet, which is due to return in 1985/6. The ion releases will be mainly visible from North and South America, where a suitable chain of ground observing stations and spotter planes will be made available.

The release of the tracer gases from the module into the solar wind and into the earth's magnetic tail will for the time trace the flow of matter and energy from the solar wind into and through the earth's magnetosphere, while simultaneously examining the complex sequence of plasma processes triggered by such releases. It is expected that a rich spectrum of plasma waves, electron and ion acceleration

and the formation of magnetic cavities will be observed.

UKS will weigh only 69 kg, but is highly complex. It will be controlled using a 12 m dish antenna at the Rutherford Laboratory to keep it within 100 km of the ion release module, using an on-board radar and propulsion system. Instruments in UKS will measure magnetic fields, detect positive ions in the energy range 5 eV to 20 keV, detect electrons in the energy range 40 eV — 25 keV, investigate wave/particle interactions including positive ion and electron modulations, and detect plasma waves by making measurements of the electric and magnetic components at frequencies from 0.1 Hz to 64 Hz.

Brian Dance



Greaseless washer

A new thermally conductive, greaseless solid-state heatsink insulator called SIL-PAD 400 is now available through sole Australian agents Scientific Electronics.

SIL-PAD 400 is a composite of silicone rubber and fibreglass, is flame retardant and is specially formulated for use as a thermally conductive insulator for a wide range of packages. Its primary use is to electrically isolate power sources from heatsinks. It is non-toxic and resists damage from cleaning agents. It is claimed to have excellent mechanical and physical characteristics.

Surfaces are soft and pliable to allow complete surface contact with maximum heat dissipation, and it will not chip or fracture under high compressive stress and does not deteriorate with age.

SIL-PAD 400 is said to be fast, neat and easy to use in production, eliminating the judgement variable inherent with earlier methods of silicone grease and mica or plastic film. Components

Data logger rental service

Tech Rentals Pty Ltd recently announced the availability of a full range of data loggers, with or without trained personnel, for short-term rental.

The range starts with the YEW 3874 24-channel Mini Data Logger, which features normalising for five common thermocouple types, alarm mode, Delta temperature mode, with time and date on the hard-copy print out.

Other loggers available are the Arlunya 7501 (10-100 ch.), Solartron 3430 (30 ch., ac or battery operated), and the new Solartron 3500 Orion Data Logger.

The Orion, said to be probably the most sophisticated portable logger in the world, can support up to 200 channels within its mainframe at scan speeds of up to 500 channels

per second. It features 'soft key' operation for ease of use, inbuilt hard-copy printer, inbuilt cartridge storage for data and programs, powerful data reduction, comprehensive sensor handling (including strain gauge), and mains or external battery operation.

Tech Rentals recently took delivery of the first Orion in Australasia, and the first customer to see it bought it immediately, so impressed was he with its capabilities. More Orions are on their way.

For more information contact Tech Rentals Pty Ltd, 83-87 Wellington Street, Windsor Vic. 3181. (03)51-1303.

mounted with SIL-PAD 400 can be cleaned or sent through soldering, since there is no grease to wash away or contaminate the baths.

SIL-PAD 400 is available for the following packages: T0-3, T0-66, T0-220, T0-202, T0-126, T0-127, D0-4, D0-5,

and can be supplied on special order in a variety of thicknesses from 0.13 mm to 1.15 mm. It is also available with an adhesive coating.

For further information contact Scientific Electronics, 6 Holloway Drive, Bayswater Vic. 3153. (03)762-5777.

How to get in on the action.



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M100EO \$399

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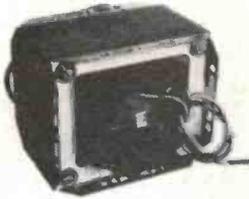
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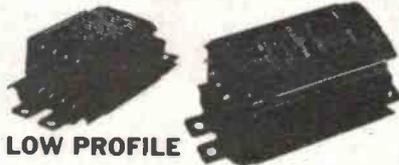
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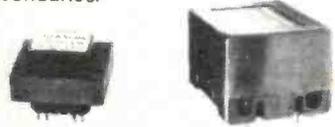
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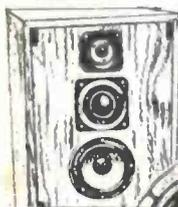
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The junction FET

— its haunts and habits

The first in a whole family of field effect transistors, the junction FET is found in many and varied applications. If you're new to electronics or unfamiliar with the device, this article should introduce you to the haunts and habits of the JFET.

THE JUNCTION Field Effect Transistor or JFET is a small electronic device much like a transistor in appearance which normally has three connections, although a fourth connection is attached to the metal case of some types for high frequency screening. Junction field effect transistors are one of the two main types of field effect transistor, the other type being known as the MOSFET (Metal Oxide Semiconductor Field Effect Transistor) or as the IGFET (Insulated Gate Field Effect Transistor).

Field effect transistors can be used as amplifiers and oscillators as well as for other applications for which an ordinary or bipolar transistor could be employed, but have particular advantages for certain applications. Field effect transistors are also used in the internal circuitry of integrated circuits.

Connections

As in the case of npn and pnp bipolar transistors, junction field effect transistors can be obtained in two polarities, these being known as n-channel and p-channel types. A far wider variety of n-channel types is manufactured than p-channel devices, since they tend to have a better performance, but devices of both polarities are readily obtainable.

The electrodes and circuit symbols for the two types are shown in Figure 1. The current flowing in a channel between the drain and the source is controlled by a voltage applied to the gate electrode. The gate is therefore the input electrode

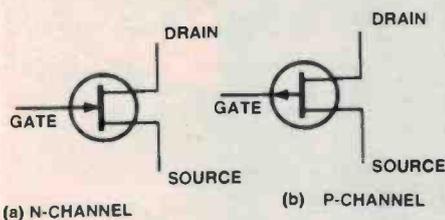


Figure 1. Symbols for n-channel (a) and p-channel (b) junction FETs.

and may be compared with the base of a conventional transistor. Similarly the drain and source may be compared with the collector and the emitter respectively.

One of the main differences between field effect transistors and bipolar transistors is that field effect transistors are essentially voltage amplifiers whereas bipolar transistors are basically current amplifiers. Thus the field effect transistor behaves more like the old thermionic valve in its circuits.

Field effect transistors tend to be more expensive than most of the common bipolar types — probably because the bipolar types are sold in much larger numbers. The economical 2N3819 n-channel field effect transistor is probably the most commonly used type and is very suitable for the readers who wish to carry out their first experiments with field effect transistors. This device is encapsulated in a black plastic or epoxy body and has the connections shown in Figure 2. The 2N3820 is a similar economical p-channel device.

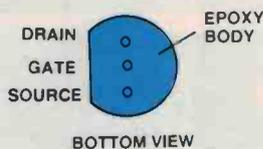


Figure 2. Connections for the common 2N3819 plastic-encapsulated n-channel JFET.

High input impedance

One of the main advantages of a field effect transistor is that it has a very high input resistance and therefore takes very little current from the circuit which feeds it — typically far less than a microamp. This means that it has very little effect on the circuit which feeds it, even if this circuit has such a high output impedance that it can deliver only a very minute current.

In order that an n-channel device shall operate correctly and have a high input impedance at its gate, it must be suitably biased with its gate negative

with respect to the other electrodes. Similarly the gate of a p-channel device has a high impedance when it is positively biased.

Brian Dance

APPLICATIONS

Pierce oscillator

In the circuit of Figure 3 the field effect transistor is employed in a Pierce type of oscillator whose frequency is controlled by the quartz crystal shown. The advantage of using a field effect transistor in this type of circuit is that the gate imposes only a very small load from the crystal and therefore the quality factor or Q factor of the crystal is not appreciably affected, so excellent frequency stability can be obtained.

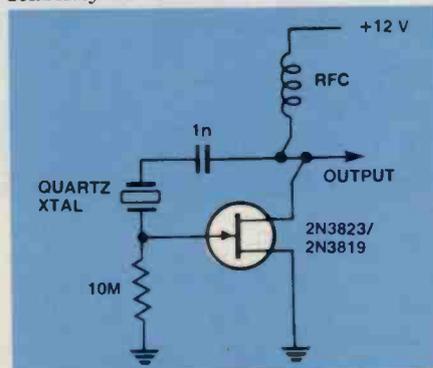


Figure 3. A pierce crystal oscillator (National Semiconductor).

National Semiconductor recommend their 2N3823 n-channel device for use in this circuit, but the more economical 2N3819, which is made by the same type of process, is also suitable. The supply voltage is not at all critical, but the radio frequency chokes used in the supply lead should have a high impedance at the frequency of oscillation.

An advantage of this circuit is that one can change the crystal over quite a wide range of frequencies without making any other changes to the circuit and still obtain a satisfactory performance. The exact frequency range over

which the circuit will operate depends very much on the choke used and to some extent on the circuit layout.

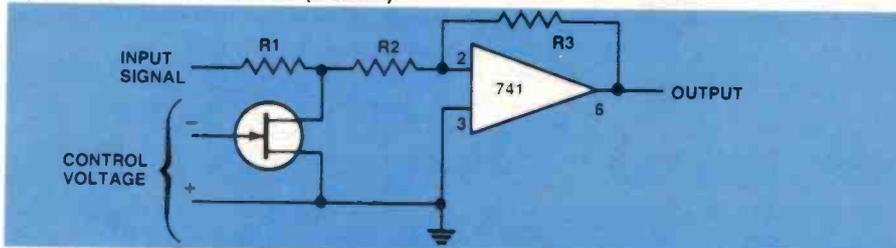
This type of circuit is suitable for use in a crystal calibrator for a receiver. If a 1 MHz crystal is employed, the output may be fed to a radio receiver to produce a signal at 1 MHz and at each multiple of 1 MHz up through the shortwave bands to provide calibration points.

Electronic attenuator

A junction field effect transistor can be used as a variable resistor, the value of which is controlled by the voltage applied to the gate electrode. As the applied bias becomes smaller, the resistance between the drain and source electrodes falls.

This property is used in the circuit of Figure 4 to design an electronic attenuator for audio signals. When the negative control voltage applied to the gate electrode is relatively large, little drain current passes through the device and the circuit behaves as if the field effect transistor were not present. However, as the control voltage falls at the gate electrode, the drain draws current from the junction of R1 and R2 so that the output signal amplitude is attenuated progressively.

Figure 4. An electronic attenuator (Siliconix).



Tone control

The circuit of Figure 5 is a tone control circuit with bass and treble boost and cut facilities. In this circuit the 2N3684 field effect transistor is used to enable the circuit to have a very high input impedance. It is used as a source follower circuit (analogous to an emitter follower) which provides a low output impedance signal coupled by a 1μ capacitor to the tone control network. This network is in the feedback circuit of the LM301A operational amplifier circuit. The 2N3684 enables a good low-noise performance to be obtained.

Lambda oscillator

A very simple sinewave oscillator is shown in Figure 6; it is essential that one n-channel and one p-channel field effect transistor are used in this circuit. The two source electrodes are connected

together and the gate of each device is connected to the drain electrode of the other device. This type of connection produces a negative resistance region in the current/voltage graph for the circuit with a peak in the graph like a Greek lambda (λ) — hence the name given to this type of circuit.

It is only necessary to connect the dual device circuit in series with a parallel tuned circuit, as shown in Figure 6, to produce oscillations at the resonant frequency of the tuned circuit used. It will oscillate at any frequency from the low audio region up to some tens of MHz, but the gate capacities of the devices used prevent operation in the regions above 100 MHz.

It is interesting to note that two separate parallel tuned circuits may be connected in series with the lambda circuit instead of the single tuned circuit shown in Figure 6. If one of these tuned circuits resonates at an audio frequency and the other at a radio frequency, the output will consist of an amplitude modulated radio frequency oscillation. This is perhaps one of the simplest possible modulated signal generators!

The output voltage from the circuit of Figure 6 is equal to twice the steady

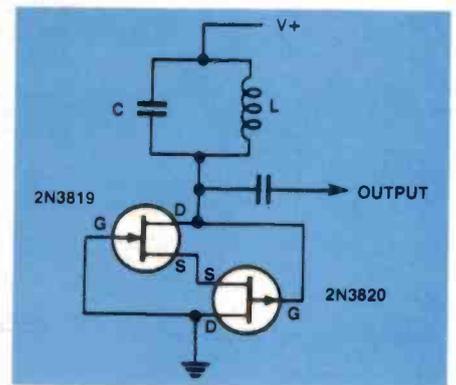


Figure 6. Sinewave oscillator using a 'Lambda' circuit.

power supply voltage applied to the circuit. Therefore this type of circuit can be very useful when one requires an output oscillation whose amplitude is accurately related to a steady applied voltage.

Complementary pairs of field effect transistors used in lambda circuits have other applications apart from simple oscillator uses.

High impedance buffer stage

The circuit of Figure 7a shows a buffer or isolating amplifier which has a very high input impedance and low input capacitance. National Semiconductor recommend a 2N4416 field effect transistor for this circuit because it has a low input capacitance, but this is further reduced by the circuit feedback. The device is used as a source follower, so the voltage gain is about unity.

Although a 2N5139 pnp transistor is specified for this circuit, the 2N3906 plastic encapsulated type is much more readily available and is fabricated by the same process, so it can be used in this application.

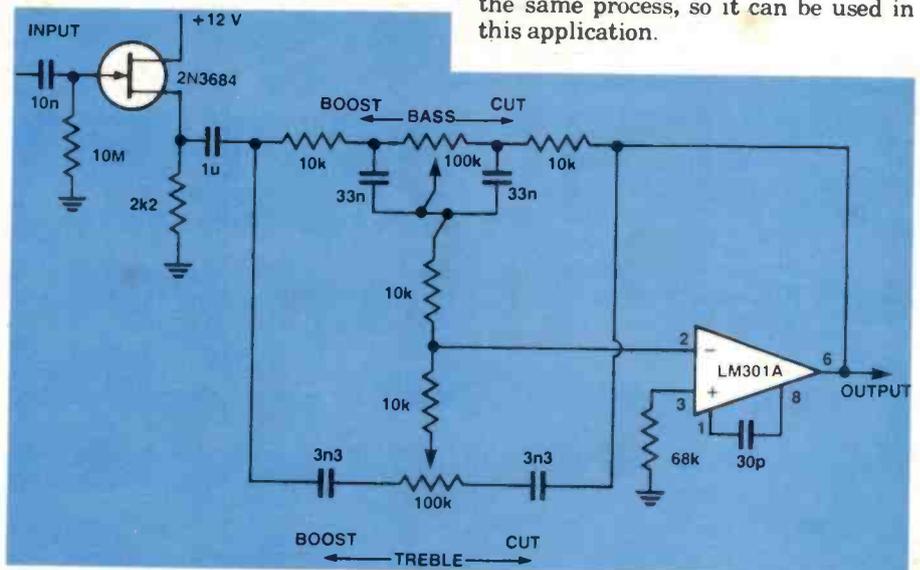


Figure 5. High Input impedance tone control circuit (National Semiconductor).

High impedance amplifier

The circuit of Figure 7b is very similar to that of Figure 7a except that the feedback circuit has been modified so that a voltage gain can be obtained. The circuit provides a gain of $R2/R1$ or 10 with the component values shown. Both the circuits of Figure 7 and of Figure 8 can be operated at high frequencies into the tens of MHz region.

RF amplifiers

Junction field effect transistors are much used in the radio frequency stages of HF, VHF and UHF receivers, since they offer a noise performance equivalent to that of bipolar transistors with improved crossmodulation and intermodulation performance. Crossmodulation is the transfer of the modulation of one carrier onto the carrier of another signal. Intermodulation occurs when two or more signals outside the passband combine in the circuit to form a signal within the passband which causes interference with the wanted signal.

The better linearity of field effect transistors over bipolar transistors is responsible for this improvement. Mullard have quoted a 12 dB improvement in crossmodulation in a narrow-band FM receiver and a 20 dB improvement in a VHF broadcast receiver as having been achieved by the replacement of a bipolar mixer circuit with a junction field effect transistor circuit.

Figure 8 shows a high-performance amplifier using two JFETs connected in 'cascode' (series) with automatic gain control (AGC) applied to the gate of the upper device. The supply is applied to the 'cold' or 'ground' end of L2 via a feedthrough capacitor. Only the L-C values need be changed to operate this stage on other frequencies to the limits of the JFETs.

Simple voltmeter

The high input impedance of a junction field effect transistor is used in the circuit of Figure 9 to produce a voltmeter with an input resistance of over 10M; in some measurements this high input impedance is necessary to prevent the current taken by a conventional voltmeter from dragging down the voltage being measured.

The input voltage being measured is divided by R1 and R2 so that a voltage of +0.2 V is present at the gate electrode when the full scale input voltage is applied for the range in question. In practice R1 should consist of a fixed resistor of a value somewhat less than that shown in the table, in series with a preset potentiometer so that the sen-

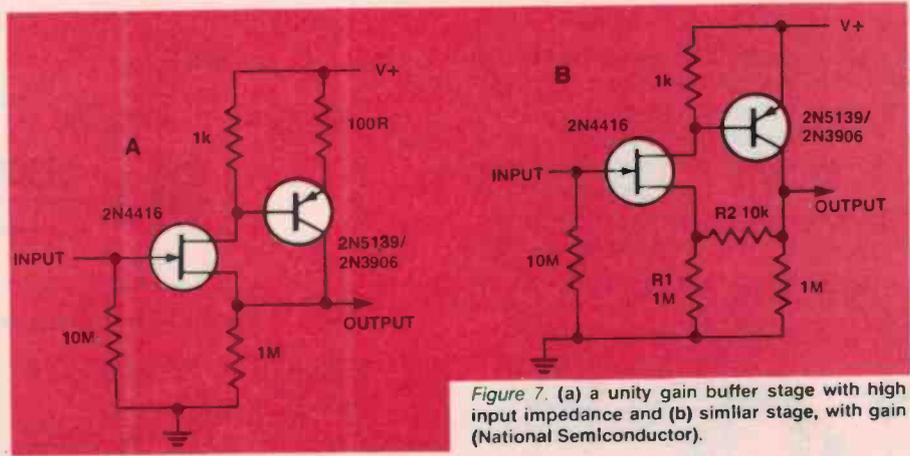


Figure 7. (a) a unity gain buffer stage with high input impedance and (b) similar stage, with gain (National Semiconductor).

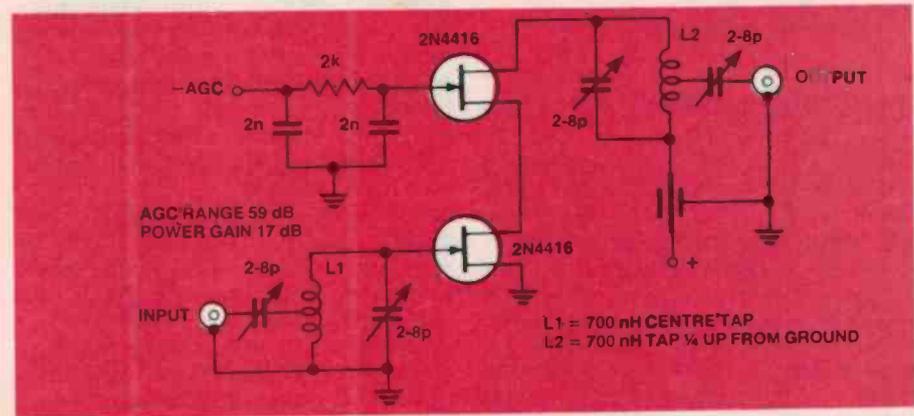


Figure 8. Typical high-performance amplifier stage employing two FETs in 'cascode'. Values given for 200 MHz. A wide variety of RF FETs may be substituted (National Semiconductor).

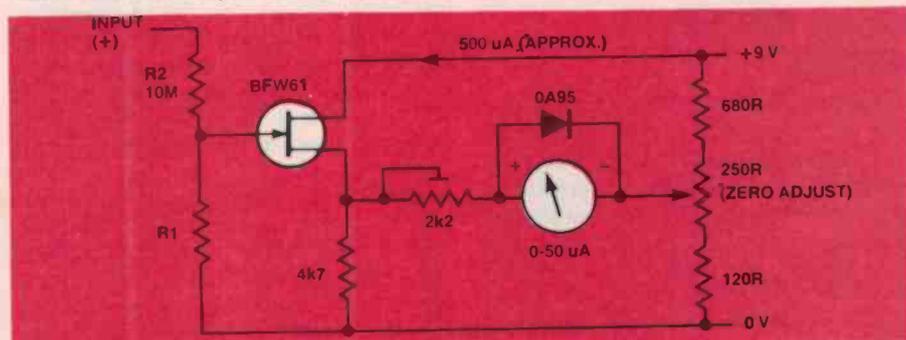


Figure 9. High input impedance voltmeter. Note that a BFW10 could substitute for the BFW61 (Mullard).

Table showing the value of R1 to be used in Figure 9 for various ranges.

Meter range	R1
250 mV	40M
500 mV	6M67
1 V	2M5
10 V	204k
50 V	40k
100 V	20k
250 V	8k
500 V	4k

sitivity of the range can be adjusted. If desired, R1 may be switched to provide a number of ranges.

No two field effect devices have exactly the same characteristics, and the 2k2 resistor in series with the meter enables the full-scale meter current to be adjusted to allow for the characteristics of the particular device used. The diode protects the meter from overloading.

PhotoFET

Photosensitive field effect transistors (photoFETs) can be made which have a window or a lens, so that any light falling on this window affects the junction

tion and hence the drain current of the device in much the same way that light affects a phototransistor. However, photoFETs are not very common devices.

An application of a Teledyne Crystallonics photoFET as a light-controlled variable attenuator is shown in Figure 10. The drain-to-source resistance of the

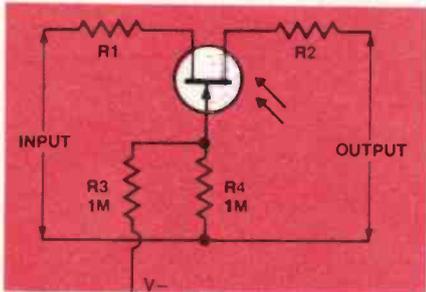


Figure 10. Example of a light-controlled attenuator (Teledyne Crystallonics).

photoFET is a function of the intensity of the illumination, so as more light shines on the device, the output rises. The negative voltage to which the resistor R3 is returned determines the range in which the drain-to-source resistance falls. Like other silicon photosensitive devices, the photoFET is sensitive to the red and near infrared regions of the spectrum, such as the radiation from an incandescent filament bulb.

HOW DO THEY WORK?

An n-channel field effect transistor consists of a channel of n-type semiconductor material between the drain and the source surrounded by p-type material of the gate electrode. Almost all of the devices are made of silicon, but a few special devices are produced in other semiconductor materials. As shown in Figure 11, the gate normally receives a

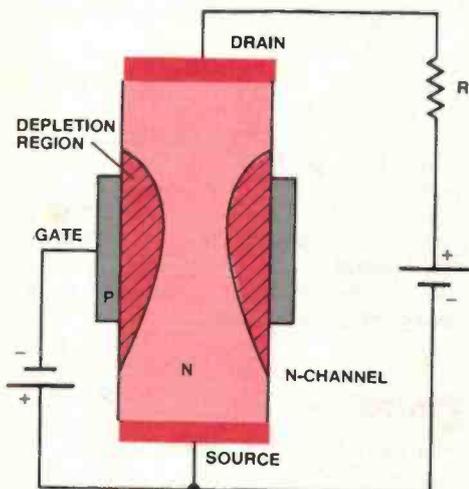


Figure 11. Control of channel width in an n-channel device.

negative bias relative to the source and the drain a positive bias.

As the p-type gate material receives a negative bias, the junction formed between this material and the n-type channel is reverse biased. In any reverse-biased junction, a region which is depleted of charge carriers (electrons and holes) is formed. As this depletion region contains very few mobile charges, it acts almost as an insulator and has a very high resistance.

The gate is normally much more heavily doped than the channel material, since this results in the depletion region spreading fairly deeply into the channel and not very far into the material of the gate. As the drain is normally made positive with respect to the source electrode, the voltage between the drain and the negative gate is larger than that between the source and the gate. The electric field is therefore greater on the drain side of the gate electrode and this results in the depletion region becoming deeper on the drain side and thus producing a narrower channel on this side, as shown in Figure 11.

If the voltage applied to the gate becomes more negative, the depletion region goes deeper into the n-channel material until eventually the channel becomes completely cut off on the drain side of the gate. Very little drain current can then flow through the device. As the gate voltage becomes less negative, the channel opens again and becomes wider as the gate voltage approaches that of the source; the widening of the channel under the control of the gate voltage results in the channel current from the drain to source increasing.

As the gate-to-channel capacitance comprises a reverse-biased pn junction, the gate has a very high input resistance and passes only a very minute current (often in the pA region). However, the gate capacitance is appreciable and therefore an appreciable alternating current may flow to this electrode at high frequencies. Even when the gate and source potentials become equal, there is still a small depletion region and the gate input resistance is high.

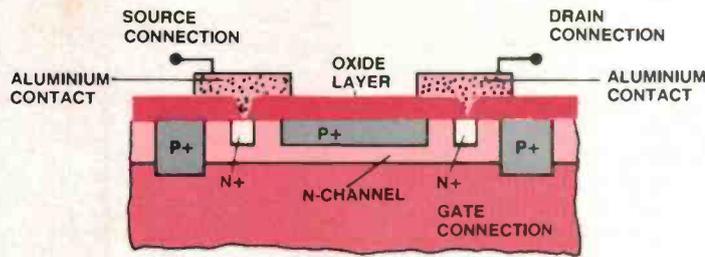


Figure 12. Structure of a silicon planar device (Mullard).

However, if the gate of an n-channel device receives a positive bias of more than about 0.65 V, current can flow in the gate circuit and this current may damage the device.

Structure

The design of a modern field effect transistor is not implemented in the form of Figure 11, which has been used for explanatory purposes, but silicon planar technology is usually employed to produce a structure such as that of the Mullard/Philips BFW11 shown in Figure 12. This has a surface or planar structure which is covered with a protective layer of silicon dioxide at all points except where electrode connections are attached. This oxide layer prevents impurities from contaminating the surface of the material and thus producing unwanted currents.

The aluminium contacts at the source and drain electrodes allow current to flow from them into the heavily doped small n+ regions, which make good contact with the n-channel region. In some devices a number of n-type channels are connected in parallel to enable a larger current to flow at the expense of an increased gate capacitance.

P-channel types

P-channel field effect transistors have the same type of structure as shown in Figures 11 and 12, but the p and n type materials are interchanged. The gate is made of n-type material and must therefore be biased positively, as shown in Figure 13. The drain is normally biased negatively.

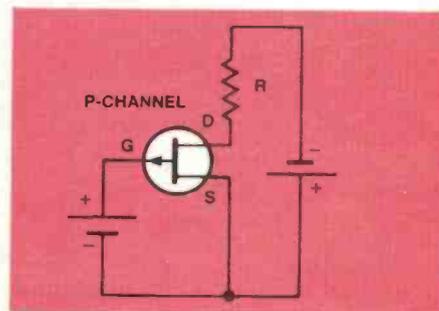


Figure 13. A p-channel device requires supplies of the opposite polarity to those used with n-channel devices.

Limiting voltages

If the bias applied to the gate is taken far beyond that required for normal operation, a point will eventually be reached at which reverse breakdown occurs. Similarly there is a limit to the voltage which should be applied between the drain and the source electrodes. However, junction devices cannot be damaged by the ordinary electrostatic charges which can accumulate on people and clothing and which can damage MOSFET devices.

Testing JFETs

It is relatively easy to check that a junction field effect transistor is able to function correctly. The circuit of Figure 14 may be used for an n-channel device and that of Figure 15 for a p-channel device.

If the gate is initially connected directly to the source (and not as shown), it will be found that the meter provides a reading of a few mA. This current is limited by the 1k resistor in the drain circuit to a safe value.

If the gate electrode is now connected to the 10M resistor as shown, the gate to channel junction is reverse biased. Thus the channel width decreases and with

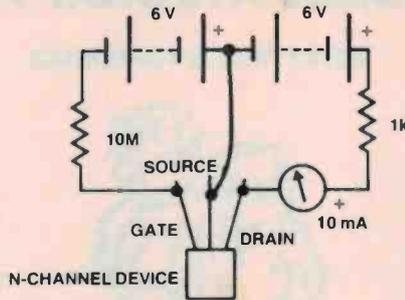


Figure 14. Testing an n-channel device.

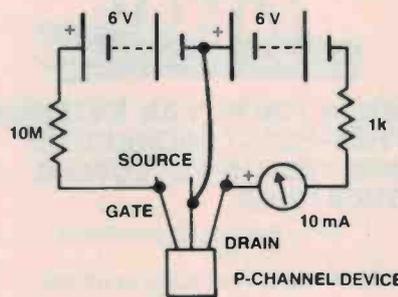


Figure 15. Testing a p-channel device.

most devices the drain current will fall to zero in the circuits shown. As the gate circuit has a very high resistance, the

voltage can be applied to it through a high-value resistor; indeed, it is interesting to note that the human body can be used in place of the 10M resistor shown when testing junction field effect devices.

If one wishes to test a device and does not know the connections, one can first find two connections in which a small current will pass in either direction. These are the source and drain connections.

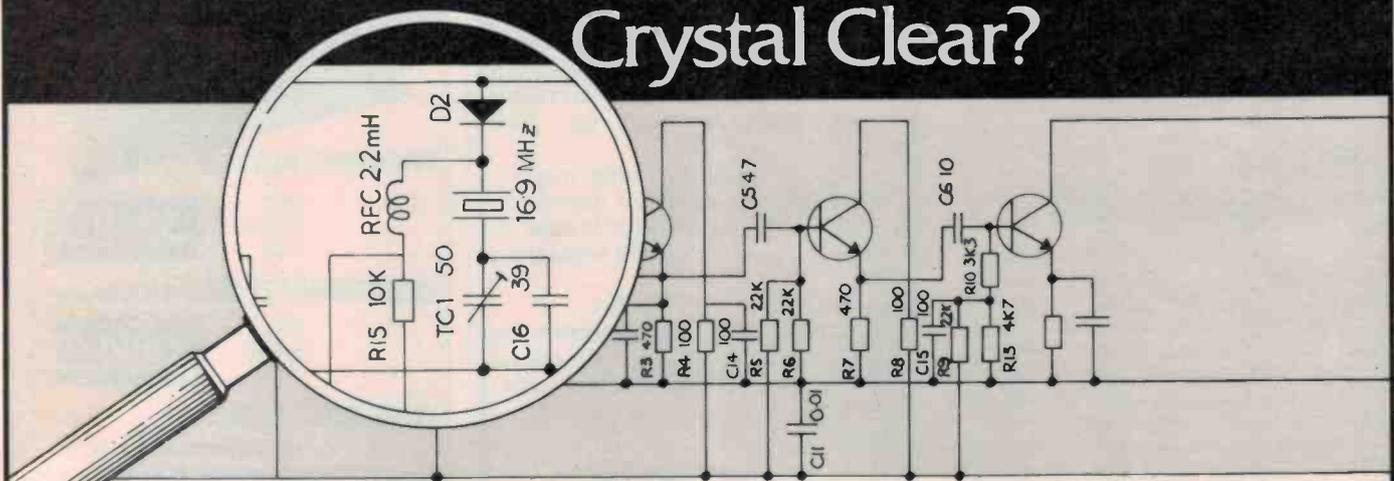
A current should pass from the third electrode, the gate, only in one direction to either of the other two electrodes. If conduction takes place when the gate is positive, one has an n-channel device, whereas if conduction takes place when the gate is negative, the device is of the p-channel polarity.

One cannot easily determine which electrode is the drain and which is the source, but these electrodes are to some extent electrically interchangeable. ●

USEFUL BOOKS

Two very useful books, though difficult to obtain, are: 'FET Databook' from National Semiconductor and 'Field Effect Transistors' from Philips.

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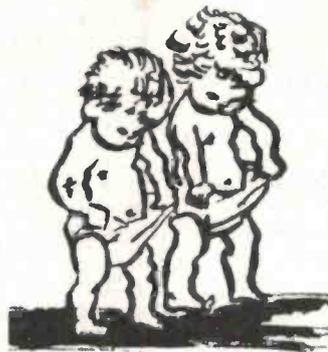
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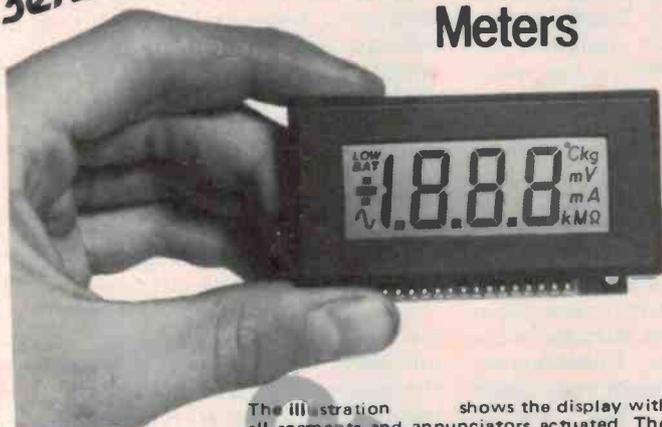
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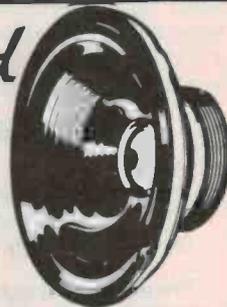
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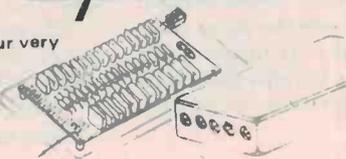
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General purpose 150 W MOSFET power amp module

Here's a high power, general purpose power amplifier module for guitar and PA applications employing rugged, reliable MOSFETs in the output.

David Tilbrook

Geoff Nicholls

SINCE publishing the ETI-477 MOSFET amp in the January, February and March 1981 issues, we have received a continued demand for a general-purpose MOSFET power amp module suitable for guitar or PA applications. The ETI-477 can of course be used but is unnecessarily complex for this purpose. To fill this demand we have developed the ETI-499 module. It produces similar power levels to the ETI-477 (i.e. around 100 W RMS into an 8 ohm load or around 150 W into a 4 ohm load when used with the Ferguson PF4361/1 transformer), but has been designed with constructional simplicity as the foremost consideration. The power supply circuitry is included on the pc board so that the only connections to the board are from the power transformer, input sockets and output termi-

nals. This greatly simplifies construction and installation and ensures that all power supply wiring is done with the necessary high current handling capability. In all transistor amplifiers, but especially with MOSFETs, the resistance between the main filter capacitors and the output devices must be kept as low as possible if low distortion and stability are to be ensured.

The circuit used in the ETI-499 is a development from one published in the Hitachi application notes for these MOSFETs. The original circuit used very high-gain bipolar driver transistors developed especially by Hitachi for use as MOSFET drivers. Unfortunately these devices are at present unavailable in Australia. Since these are an extremely fast device, replacement by more common bipolars limits the open loop bandwidth and causes the amplifier to be unstable. The main departures from the Hitachi circuit are therefore to ensure a stable design with common transistors.

We used the BF469 and BF470 as drivers. These are a complementary video output pair supplying good slew rate and V_{ce0} figures at a reasonable price. The resulting power amp module is fast and stable, with distortion figures completely adequate even for many high fidelity applications. The module is easy to construct and capable of withstanding continued clipping or full-power operation for extended periods when provided with a suitable heatsink.

Why MOSFETs?

The power MOSFET is a relatively recent development and offers several distinct advantages over the more common bipolar transistor. To understand these differences it is helpful to look at some of the characteristics of bipolar output transistors.

Most power amplifiers employ bipolar transistors in a common-collector or emitter-follower configuration. The relationship between the output signal voltage and the input signal voltage is a function of the load impedance and the forward transfer admittance of the particular device. Forward transfer admittance is commonly given the symbol y_{fs} and its non-linear characteristic gives rise to distortion in the output stage. With bipolar transistors, the greatest non-linearity occurs for low input voltages, typically between 0 V and 0.6 V. Once outside this voltage range the forward transfer admittance is high and quite linear. So most of the distortion generated in a bipolar output stage occurs at low signal voltages and is called *crossover distortion* (for a more detailed explanation of crossover distortion refer to the article on the ETI-477 power amp module published in January 1981).

The most common method used to overcome this problem is to make use of bias current. A fixed voltage of around 0.6 V is applied to the bases of the output transistors so that the applied signal voltage does not have to operate the transistor over the most non-linear region. However, a problem arises with this technique because this voltage must be controlled extremely accurately. Even 0.5 V in excess of the correct voltage will saturate the output devices, probably destroying them. Furthermore, as the output devices heat up due to normal operation, the bias voltage must be decreased to maintain the same operating conditions. This is very difficult to do accurately enough, so the power amp is often running either with insufficient bias current or is dangerously close to destruction.

The problem occurs because the bipolar transistor has a positive temperature coefficient. This means that as the

SPECIFICATIONS — ETI-499

Power output

150 W RMS into 4 ohms
100 W RMS into 8 ohms
(at onset of clipping)

Frequency response

20 Hz to 20 kHz, +0 -0.5 dB
10 Hz to 60 kHz, +0 -3 dB
(measured at 1 W and 100 W levels)

Input sensitivity

1 V RMS for full output

Hum

-98 dB below full output

Noise

-114 dB below full output

Total Harmonic Distortion

0.006% at 1 kHz
0.03% at 10 kHz
(measured at 12 W level)

Stability

Unconditional — tested to full output driving 3.5 μ F short circuit at 10 kHz.

general purpose mosfet amp



temperature of the device is increased the collector-emitter current will increase if the base-emitter voltage is held constant. The increased current causes further heating and a further increase in current. This condition is called *thermal runaway* and results in the destruction of the output device.

Another problem with conventional bipolar output transistors is speed. The techniques used in the construction of these devices to ensure broad SOAR characteristics (SOAR stands for Safe Operating Area) usually conflict with those to ensure high speed. Since the output transistors must handle the largest currents they are usually the slowest devices in the amplifier and determine the maximum signal slope that can be handled by the amplifier before distortion results. Distortion generated by this mechanism is called *slew-induced distortion* and *transient intermodulation distortion*. Once unnecessarily high signal slopes have been removed by a suitable filter at the input of the power amp the only solution is to

increase the slew rate of the output devices.

One of the major advantages of power MOSFETs is their extremely high speed. When driven correctly the MOSFETs used in this project can switch a current of around 2 A in 30 nanoseconds! This is roughly *100 times* the speed of commonly available bipolars. Another advantage of MOSFETs is their very high input impedance. Unlike the bipolar transistor, they are a voltage-controlled device and require only enough drive current to overcome their input capacitance. Probably their most important advantage over bipolar transistors, however, is that *they have a negative temperature coefficient*. Heating causes an increase in the resistance of the device, so MOSFETs are inherently self-protecting. If one part of the device attempts to conduct more current it heats up more than the surrounding region, increasing its resistance, which distributes current over the rest of the device. Similarly if several devices are used in parallel, the negative temperature coefficient will ensure that all devices share current equally. In guitar and PA applications the negative temp-

erature coefficient of MOSFETs provides the amplifier with unprecedented reliability, and the high speed helps to eliminate the problem of slew-induced distortion.

On the other hand a disadvantage with MOSFETs arises from their relatively low forward transconductance when compared to a good bipolar transistor. Although the transconductance of bipolars is highly non-linear when the base emitter voltage is below 0.6 V, it increases dramatically once outside this region. The MOSFET, although not as non-linear for small voltages, never achieves the forward transconductance of the bipolar transistor. The distortion generated by the power MOSFETs is therefore higher than that of bipolar transistors and must be reduced to acceptable limits through the use of negative feedback. This is not a real problem, however, since the high input impedance eliminates at least one stage of a conventional bipolar amplifier design. This allows a simpler circuit with fewer active devices and consequently improved stability margins, allowing greater levels of overall negative feedback before oscillation results.

Construction

Construction of the ETI-499 is relatively simple, since all the components mount on the pc board, including the output transistors and power supply components. The design of a good pc board pattern is often as difficult as the design of the original circuit! This is especially true for power amplifiers or any circuit in which both large and small currents are involved. The problem of large currents occurs because of voltage drops across earth return paths, destroying the integrity of earth reference points for small signal currents. To overcome this problem, the pc board must be designed to ensure the

HEATSINKING

The heatsink will need to dissipate around 100 W when the module is run at full output for lengthy periods. A heatsink with a thermal capacity of around 0.65°C/watt is recommended if free-air cooling is contemplated. A 152 mm length of Philips 65D6CB will do nicely (cost — around \$30). Alternatively, the module may be mounted on one of the ETI-designed Series 5000 heatsink panels. In fact, two modules may be mounted on a Series 5000 heatsink panel. The panels are available at some suppliers or direct from us (see page 49).

If fan-forced cooling is contemplated, then a heatsink rated at 1.2 to 1.5°C/watt should be used. A 225 mm length of commonly available extruded 'fan' type heatsink will do the job. This type of heatsink is flat on one side, the other side having two sets of fins fanning out from a central channel. A suitable length will set you back about \$10. A fan will set you back around \$20 to \$30, unless you have one lying around.



Compensation capacitors are required for the two 2SK134 output MOSFETs (Q8 and Q9) to equalise the input capacitances between the n-channel and p-channel output devices. They are mounted under the board as shown here. Solder lugs are placed on top of the mounting nuts and held with another nut each. C6 and C7 mount from these to the pads shown, while C7 mounts between them. Note the resistors mounted under the board also.

Project 499

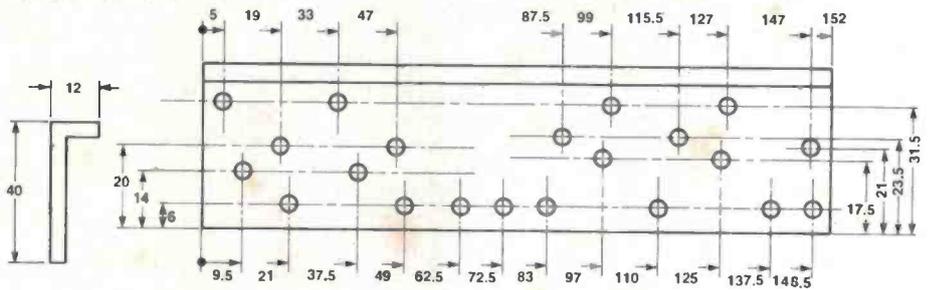
validity of the earthing arrangement. If at all possible, the pc board published should be used, as departures from this design could seriously affect amplifier performance.

Commence construction by soldering all the resistors onto the circuit board with the exception of the four OR22 output resistors. These effectively connect all the sources of the MOSFETs together and make it difficult to locate faults in the mounting of the MOSFETs. Solder the 1 W resistors slightly above the circuit board since these can become hot under certain conditions. The components marked with an asterisk on the circuit diagram are mounted on the rear of the pc board. They should be mounted close to the MOSFETs. Do not solder the resistors to the rear of the circuit board at this stage. These are best left until after the MOSFETs have been mounted.

Solder the capacitors onto the circuit board with the exception of those on the rear of the board and the two large

ALL 4 mm DIA.
MATERIAL 40 x 12 x 3 ALUMINIUM ANGLE EXTRUSION
Drilling details for the heatsink bracket assembly. All dimensions are in millimetres. Suitable aluminium angle stock is available from Alcan Handyman stores.

BRACKET DRILLING DETAILS



electrolytics. The 100u capacitor C3 is the only other electrolytic, so be careful with the orientation of this component. The capacitor is marked to indicate which of its leads are to be connected to a positive or negative voltage. Check the correct orientation on the overlay diagram. This also applies to the diodes and zener diodes used in the circuit, which can be mounted next.

Both the driver and power transistors are mounted on a length of aluminium angle extrusion, which is bolted to the pc board by bolts through the transistor mounting holes. This is shown in the accompanying diagrams. The extrusion is used to conduct the heat generated by the output and driver transistors to the heatsink, which will also be bolted to the extrusion. If you purchase the mod-

PARTS LIST — ETI-499

Resistors	all 1/2 W, 5% unless stated
R1, R2	100k
R3, R11	1k
R4, R5, R18-R21	220R
R6, R7	3k9
R8	22k
R9	680R
R10	10k
R12, R15, R16, R17	100R
R13	33k
R14	10k 1 W
R22-R25	OR22 W
R26	4R7 1 W
R27	1R 1 W
RV1	100R preset
RV2	250R preset
Capacitors	
C1, C9	220n greencap
C2	2n2 greencap
C3	100u/25 V electrolytic
C4	33p ceramic

C5	6n8 greencap
C6, C8	330p ceramic
C7	47n greencap
C10, C11	100n greencap
C12, C13	8000u/75 V electrolytic
Semiconductors	
Q1, Q2, Q3	BC546
Q4, Q5	BF470
Q6, Q7	BF469
Q8, Q9	2SK134 Hitachi MOSFET
Q10, Q11	2SJ49 Hitachi MOSFET
D1-D4	1N914
D5-D8	1N5404
ZD1, ZD2	12 V 400 mW zener
Miscellaneous	
ETI-499 pc board; plastic bobbin (from P26/16 potcore or similar); 5 A fuse (speaker fuse, not	

mounted on pc board); fuse holder; 1 m of 0.8 mm enamel-covered copper wire; 155 mm length of aluminium extrusion, 40 mm x 12 mm, for use as the heatsink bracket; assorted nuts and bolts, hookup wire, etc; two solder lugs.

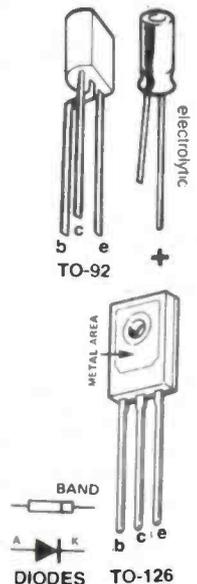
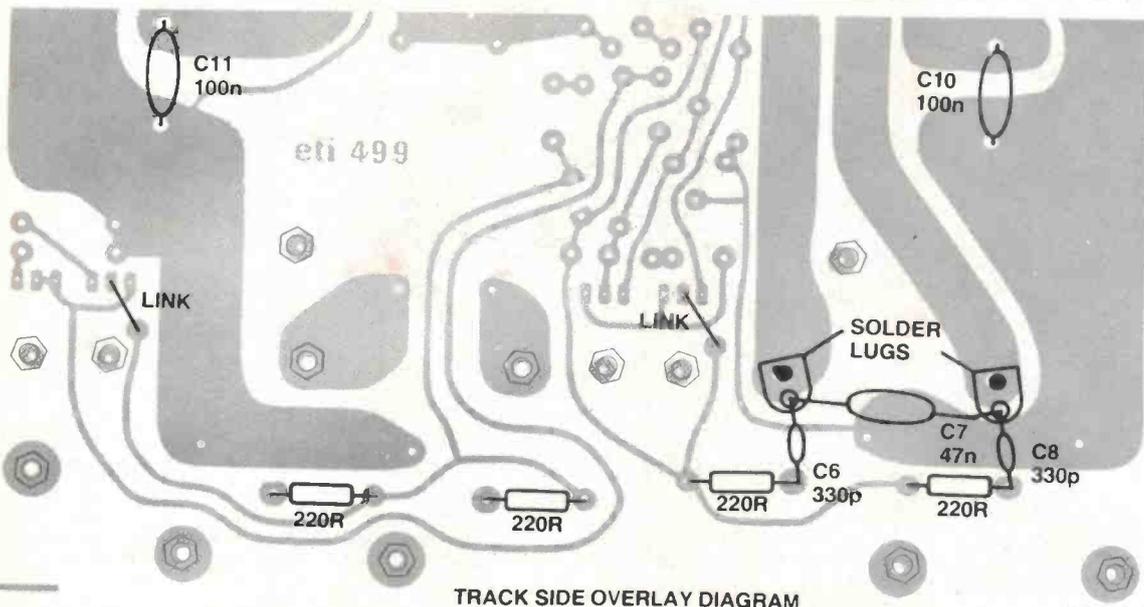
Price estimate

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

\$75-\$85

(heatsink & transformer extra)

Note that this is an estimate only and not a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.



general purpose mosfet amp

ule in kit form from one of the kit suppliers who support our projects, this bracket should be supplied drilled, ready to mount the transistors. If not, drill all the necessary holes before proceeding further. Make certain the holes are free of burrs or shavings that might otherwise cut through the transistor insulating washers. This is best done with a couple of twists of an oversize drill (i.e. around 13 mm diameter).

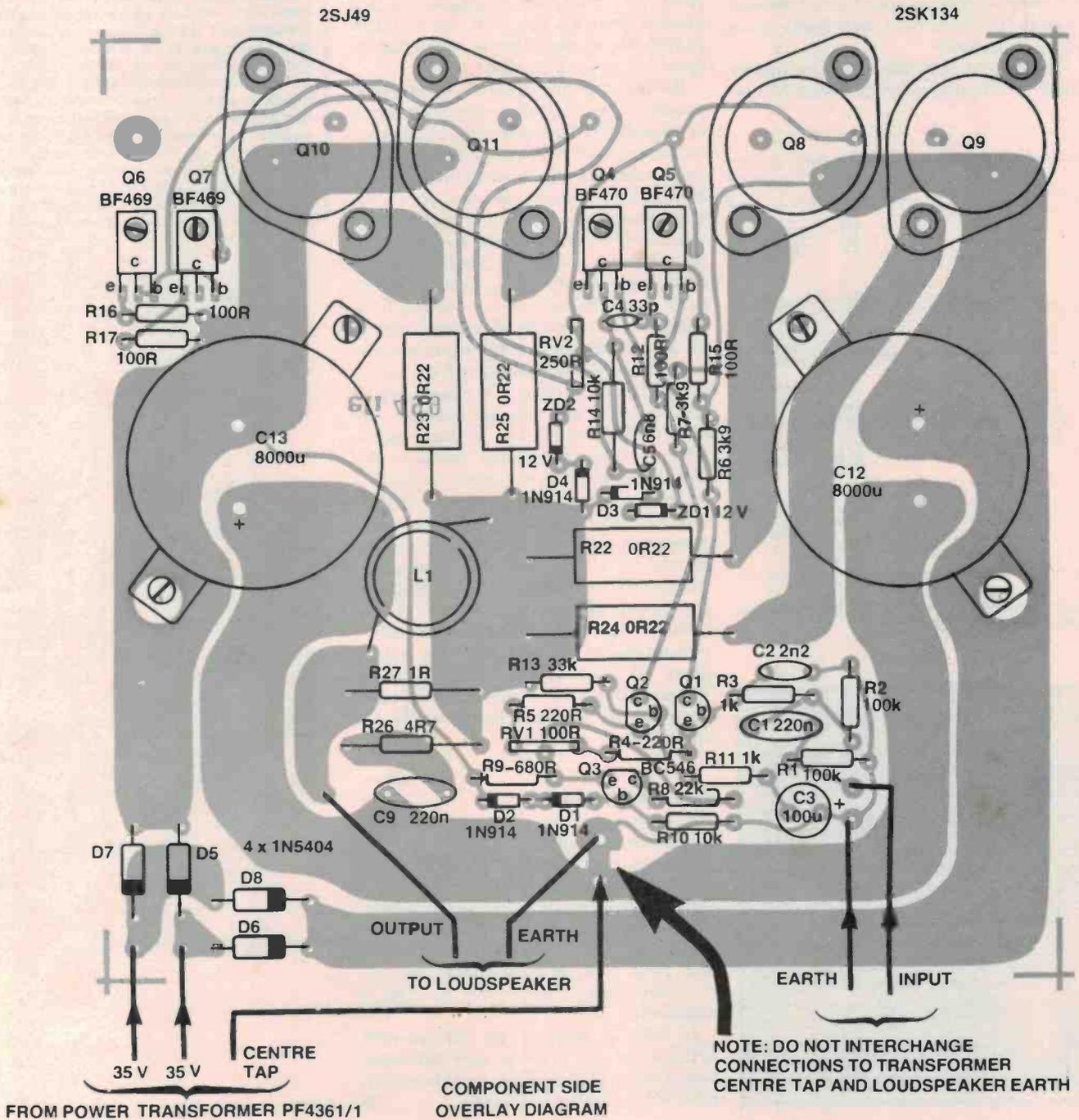
The bolts holding the MOSFETs in place also serve to make electrical connections to the cases of the devices.

These bolts must be insulated from the heatsink bracket, which will be at earth potential. This is done with the use of short insulating sleeves cut from a length of 'spaghetti' insulation. Use a small quantity of heatsink compound on both sides of the transistor insulating washers to ensure good thermal contact. Insert the sleeves in the holes of the heatsink bracket and mount the four MOSFETs as shown in the accompanying diagram.

The four driver transistors can now be mounted. Again, use transistor insulat-

ing washers between the metal sides of the transistors and the heatsink bracket, although insulating sleeves are not necessary.

Once all the transistors have been mounted on the heatsink bracket use a multimeter to check for any short circuits to the heatsink bracket by measuring the resistance from the case of each MOSFET, and from the centre lead of each driver transistor, to the bracket. The measurements should show open circuit on all transistors. If a short does exist the transistor should be ▶



Project 499

removed and remounted, possibly with a new insulating washer. Finally, solder the leads to the transistors.

Once the MOSFETs and drivers have been mounted, the remainder of the components can be mounted on the pc board, including the small signal transistors and the components on the rear of the pc board. Mount the two 8000u electrolytic capacitors last; be sure to bolt the capacitors down, however, before soldering the lugs. Mount the four OR22 resistors now, leaving around 5 mm between the resistor and the board. Ensure that all components mounted on the rear of the pc board are mounted close to the board with their leads cut as short as possible.

The output inductor, L1, is formed by winding 20 turns of 0.8 mm enamel wire

around a 14 mm former. The plastic bobbins supplied for use with the P26/16 potcores are ideal for this purpose.

Powering up

Supply fuses have not been included on the pc board because the resulting resistance necessitates the use of a second set of electrolytic capacitors close to the output devices. To protect the loudspeakers in the case of failure of the power amp a fuse should be used in series with the loudspeaker cable. We will shortly be publishing a loudspeaker protector, with the emphasis on PA applications, for use with the ETI-499. In the meantime, however, use a fuse as specified in the parts list.

Before powering up check all stages of construction, including the orientation of all polarised components. Check that no shorts exist between the cases of the output devices and the heatsink bracket. Mount the heatsink bracket to a suitable heatsink, again using heatsink compound to ensure good thermal contact. Do not connect a loudspeaker at this time. Adjust RV1 to centre and RV2 fully counterclockwise, as viewed from the positive rail side of the pc board. If all is in order, connect the module to the power transformer and switch on. Using a multimeter on the 1 V range, adjust RV2 so that the voltage between the ends of RV2 reads 0.8 V. Now adjust RV1 so that the voltage between the output terminal and ground is as close to zero as possible. Ideally, a digital multimeter should be used for this measurement since most analogue meters do not have the necessary resolution. Adjust RV1 to achieve a dc voltage on the output of less than 10 mV, if possible. If your multimeter does not allow measurement of voltages this small, leave RV1 set at the centre position. When both of these adjustments have been made, the module is ready for operation.

Performance

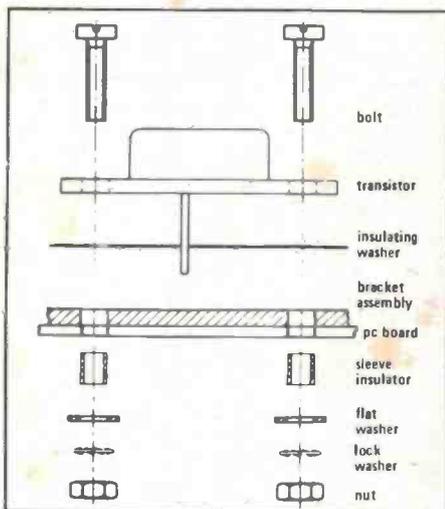
We have tested the prototype into both inductive and capacitive loads and at all times it performed impeccably. The sound is clean and smooth with no sign of the harshness sometimes experienced with transistor power amps. The high speed of MOSFETs helps to ensure freedom from slew-induced distortions and the amp clips cleanly with no sign of instability.

In coming months we will present articles on the loudspeaker protector board and a preamplifier to form a complete PA or guitar amplifier. ●

HOW IT WORKS — ETI-499

The circuit is a development from one published in Hitachi's application notes for these MOSFETs. The original circuit uses driver transistors designed by Hitachi for use as MOSFET drivers. Unfortunately these devices are not available in Australia at the present time, so most of the differences are to ensure stability and low distortion with a more readily available driver. We have used the BF469, BF470 complementary video output pair as used in the 477 module. These transistors provide the necessary speed so as not to degrade the performance of the output transistors.

One of the most difficult stages in the development of an amplifier module of this type is the pc board design. Separation of the large currents flowing to the electrolytic capacitors from signal earth is absolutely imperative if low distortion is to be obtained. An earlier pc board using exactly the same circuit gave distortion figures as high as 1% when driven into 8 ohms at around 10 W RMS! The problem was simply interaction between charging currents to the electrolytic capacitors and the earth reference to the input differential pair. For best performance use the pc board design published with this article and pay special attention to all earth and supply connections. In particular ensure that the connections to the

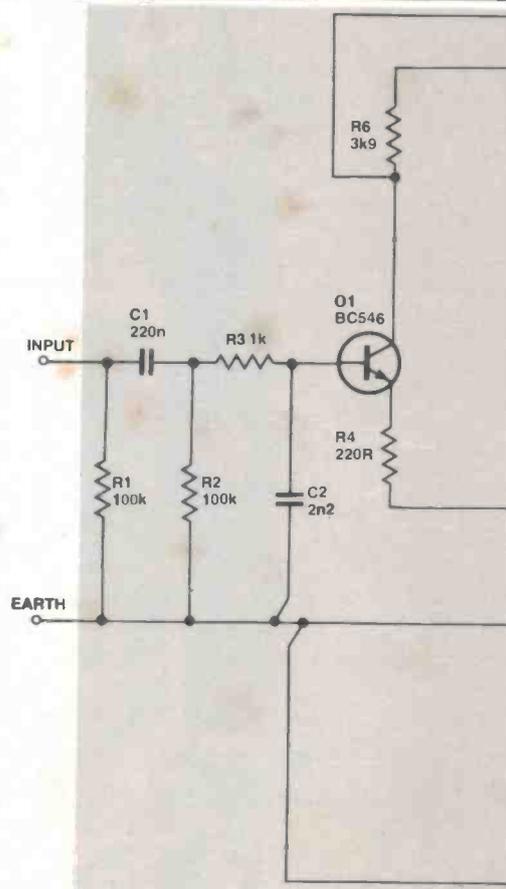


Exploded view of how to mount the output devices to the bracket and pc board.

SOME CAPACITORS AREN'T . . .

For the R26-C29 network to provide an effective high frequency load to the output stage it is imperative that C9 (220n greencap) have low self inductance. From experience, we have found Elna type greencaps and Philips polycarbonates meet this requirement. High frequency instability, if not outright oscillation, may result if this requirement is not met.

To a lesser extent, the same applies to C7, C10 and C11. Note that C7 ac-couples the sources of Q8 and Q9 together, so that the self inductance of the source ballast resistors R22 and R24 is no longer important, preventing high frequency instability in this section of the output stage brought about by the inductance of the wirewound ballast resistors.



general purpose mosfet amp

centre point of the transformer and the loudspeaker earth are soldered into the correct positions on the pc board. Although these two points are immediately adjacent on the pc board they are *not* equivalent electrically due to the slight resistance of the board. If these wires are connected the wrong way around the distortion will be increased possibly by as much as 20-30 dB!

Transistors Q1 and Q2 form an input differential pair. Their function is to compare the output signal with the input signal and drive the voltage amplifier transistors in the driver stage with the necessary correction signal, sometimes called the error voltage or error signal. The base of Q1 is held at ground potential by resistor R2. Capacitor C1 in conjunction with R2, R3 and C2 forms an input filter, which defines the upper and lower 3 dB points of the amplifier. This filter therefore restricts the maximum possible signal slope capable of being driven to the input of the differential pair. This is an essential function since it eliminates slew-induced distortions such as TIM, provided that the rest of the power amp has a slew rate in excess of this limit. For a more detailed description of slew-induced distortions and their remedies see the articles on the 477 MOSFET module published in January, February and March 1981.

The gain of the differential pair is around 17, so most of the open loop gain is done by the driver transistors Q4 and Q5, and their associated current mirror formed by Q6 and Q7. The series RC network C4, R12 ensures stability of the amplifier by decreasing the gain of the driver stage at very high frequencies, while keeping the phase shift produced within 90°.

As stated above, transistors Q6 and Q7 form a current mirror. The purpose of these devices is to ensure the current through the two driver transistors remains identical. At the same time the very high impedance represented by Q7 on the collector of Q5 ensures high open loop gain, and consequently low distortion through the relatively large amount of negative feedback available. RV2 varies the voltage between the gates of the output MOSFETs and therefore the amount of bias current through the output transistors. If the voltage across this preset is set to around 0.8 V the bias current will be approximately 80 mA, which is about right. If the bias current is decreased completely by turning RV2 fully away from the MOSFET end of the board, the MOSFETs will remain off until a signal is fed to the input. This is pure class B operation and results in the coolest operation of the power amplifier. The disadvantage, however, is that a slight in-

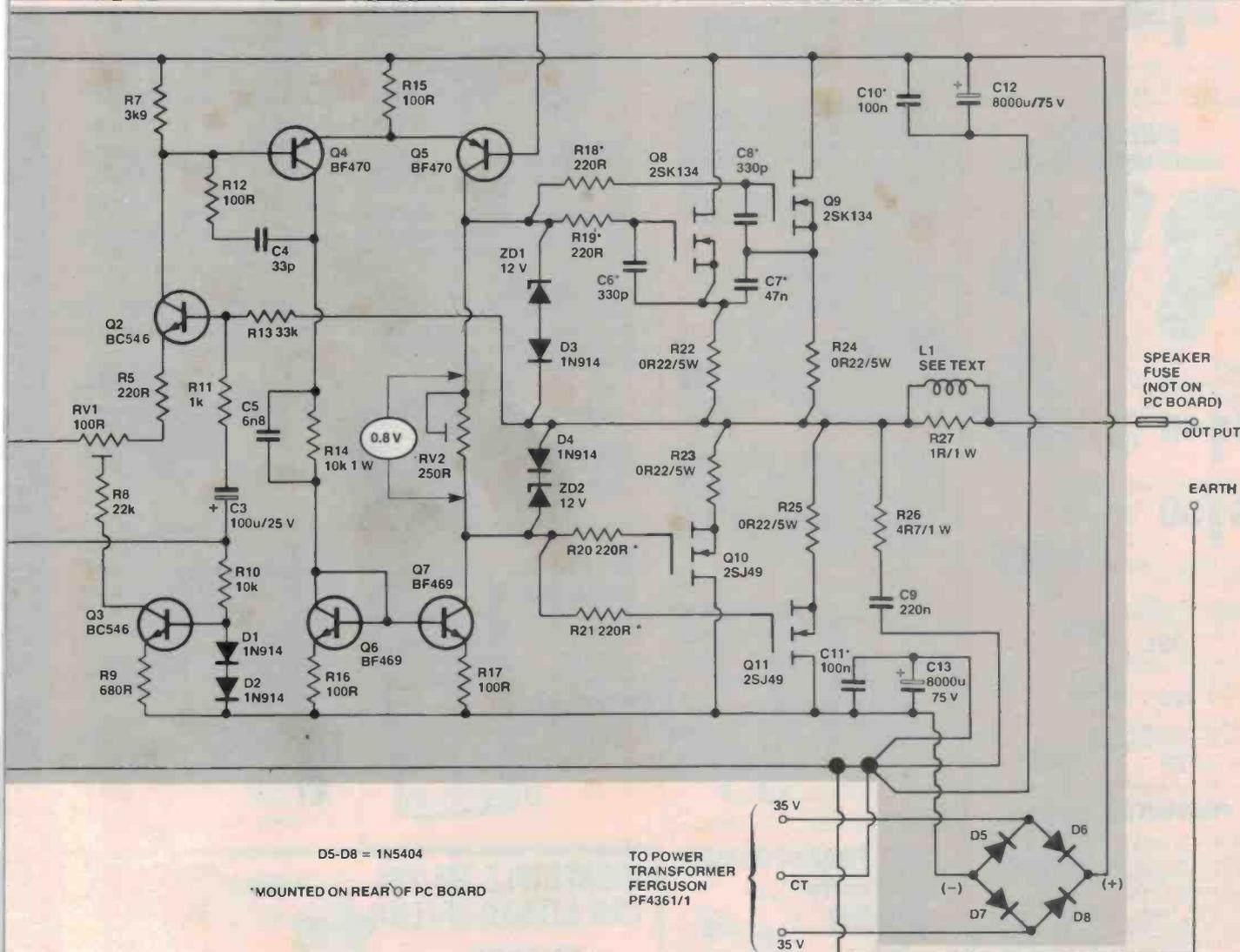
crease in distortion, called crossover distortion, will result. In PA or guitar applications this is not a problem, so the amplifier can be used in this mode without hesitation.

The diodes D3, D4 and the zener diodes ZD1 and ZD2 ensure that the voltage between the gates of the FETs and their sources never exceeds 12.6 V, the most common cause of MOSFET failure.

Capacitors C6 and C8 equalise the capacitive input characteristics of the MOSFETs and make it considerably easier to correctly stabilise the output stage. Capacitor C7 brings the sources of the two 2SK134 MOSFETs to the same potential at high frequencies, and overcomes possible problems that might otherwise be caused by inductance in the source resistors R22 and R24.

The four resistors R22-R25 help to match the differences between the characteristics of the different output devices.

The passive filter network formed by R26, C9 ensures that the module always has a load at high frequencies. If the amplifier is tested with large high frequency sinewaves this resistor will become extremely hot, but this does not indicate a fault condition. The inductor L1 and the resistor R27 help to ensure total stability into capacitive loads, such as when driving extremely long loudspeaker leads.



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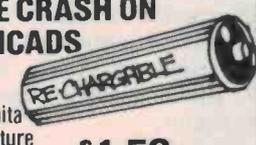
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HF/VHFFET		BF469	\$1.00	DARLINGTON		BU208	4.20
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				BAR/DOT DRVR	\$3.50	LM309K	3.50
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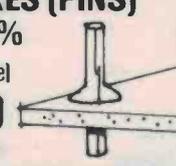
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Bridging adaptor converts Series 5000 Power Amp into 300 W mono amplifier

Here's how to operate the two ETI-477 MOSFET power amplifier modules in the Series 5000 amp in bridge configuration with the addition of a simple, inexpensive module.

Geoff Nicholls
David Tilbrook

THE AMOUNT of power an amplifier can deliver into a certain load is determined by the simple equation:

$$P = V^2/R$$

where V is the supply voltage and R is the resistance of the load. To achieve more power we must either decrease the resistance of the load or increase the supply voltage. Either of these will cause an increase in the amount of current to flow, and this must be catered for in the design. Unfortunately, power transistors are limited by the maximum voltage they can withstand so the supply voltage cannot be increased indefinitely. An amplifier with a supply voltage around 50 V is probably capable of supplying around 40 V peak to the load, the remaining 10 V being dropped by the output transistors, driver transistors and the power supply. This corresponds to a power level of around 100 W RMS into an 8 ohm load. In order to increase this the load could be decreased to 4 ohms, for example. The simple equation above predicts a power level twice that

of the 8 ohm case. In practice this ideal is never met since the increased current causes increased voltage drops. In the case of a MOSFET output stage such as the ETI-477, the relatively high on resistance will cause quite a high voltage drop, decreasing the maximum output power to around 150 W for a 4 ohm load.

In order to increase the power of audio amplifiers it would seem we must increase the supply voltage and design the amplifier so that it is capable of withstanding higher signal currents. A closer inspection of Figure 1, however,

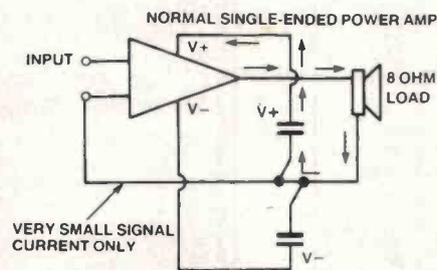


Figure 1. Single-ended power amp showing how current flows in the power supply and the load.

reveals another alternative. The conventional power amplifier consists of the amplifier itself and a power supply, as shown in the diagram. The power supply is represented by the pair of capacitors. These correspond to the main storage capacitors in the power amp. The rest of the power supply has been omitted since its purpose is simply to maintain the necessary dc voltage differential between the ends of the capacitors. In a class B output stage only one of the output capacitors is supplying energy to the load at any given time. The arrows in the diagram indicate the direction of the current flow when the power amp is delivering a positive-going output signal. As can be seen, the large signal current flows from the positive supply capacitor to the power amplifier, through the load and via an earth return path to the electrolytic capacitors. Every wire in this current path has resistance, so voltage drops occur at all points in the circuit. These voltage drops can be extremely significant in the performance of the power amplifier. The distortion figure for the ETI-477 module, usually around 0.001%, can be degraded to worse than 0.3% if the resistance in the power supply leads exceeds a small fraction of an ohm. If extremely low distortion figures are required the entire heavy current path and earth leads should be wired with one of the very low resistance speaker cables available.

We have seen above that at any given time in a class B power amp only one of the capacitors is supplying power to the load. So the load has access to only one of

SPECIFICATIONS OF BRIDGED SERIES 5000 AMPLIFIER

Power output

300 W RMS into 8 ohms
(at onset of clipping)

Frequency response

8 Hz to 20 kHz, +0 -0.5 dB
(determined by passive filters)

Input sensitivity

1 V RMS for 100 W output

Hum and Noise

- 100 dB below full output,
or better

Total Harmonic Distortion

less than 0.003%

Stability

Unconditionally stable.

the supply rails. If both supply rails could be used at the same time the voltage available to the load would be doubled without having to redesign the amplifier, so long as the resulting current were within its capabilities. This is the purpose of the bridge configuration with power amps, sometimes referred to as 'bridging'. The principle is shown in Figure 2. Two identical power amplifiers have been used here, the output of each going to opposite ends of the load. The input signal is fed to the input of the first amp in exactly the same way as in the more conventional approach. The arrows indicate the direction of current flow for a positive-going signal voltage. At the same time, the input signal is fed to the second power amp via a unity gain phase inverter. A positive-going input signal voltage becomes a negative-going signal at the input of the second amp. While the output of the first power amp is swinging positive the output of the second amp is swinging negative, so the load experiences double the supply voltage (neglecting for a moment the increased voltage drop due to increased signal current).

In the 4 ohm case discussed earlier the signal current is doubled, while the supply voltage remains much the same; the maximum power is therefore doubled. In the bridge case, however, the maximum signal voltage is doubled, increasing the current. Since power is given by the product of voltage and current the power increases by a factor of four. In a real amplifier, of course, this power is never achieved. Once again the voltage drops across the output transistors, etc, will decrease the power considerably, and this is especially true when using MOSFET output devices. To make a closer estimate of the power that can be expected of an amplifier when connected in bridge, determine the power delivered into a load of half that used in the bridge and double this value. If the bridge is to be used with an 8 ohm load, for example, determine the power delivered by one amplifier into a 4 ohm load and double this figure. In the case of the ETI-477 module the power into 4 ohms is around 150 W RMS, so the power achieved by two 477s in bridge should be around 300 W RMS. Measurements carried out with the bridging adaptor gave power figures between 280 and 300 W RMS, in good agreement with the estimate.

There are also limitations, however, which must be considered for successful operation of a bridge amplifier. Firstly,

since each amp is effectively driving a load half that of the real load, the load resistance connected to a bridge amplifier must be twice the minimum load specified for individual power amps. Since the minimum load recommended for the ETI-477 module is 4 ohms the minimum load used in bridge should be 8 ohms.

Another problem associated with bridging is that both power amps used should share the same power supply to ensure the integrity of the earthing system. If this condition is not met, the distortion figure and stability margin of the amp will almost certainly be degraded. In Figure 2, two independent power amplifiers are connected in bridge. This is done by joining their earth reference points together and driving the loudspeaker with out-of-phase signal voltages. Current resulting

from a positive-going signal voltage flows from the positive supply through the first power amp and through the loudspeaker to the second power amp, and then to the negative supply rail of the second power amp. The circuit is completed by the connection between the two earth points. The problem is that, since this connection has a finite resistance, a voltage drop will occur across it, varying with the signal voltage and modulating the earth current for the second power amp. The solution is to operate both power amps from a single power supply. Figure 3 shows a pair of amps connected in bridge and using a common supply. Once again, the arrows show the direction of current resulting from a positive-going signal voltage. Notice that in this case the connection between earth reference points has been eliminated and both power amps

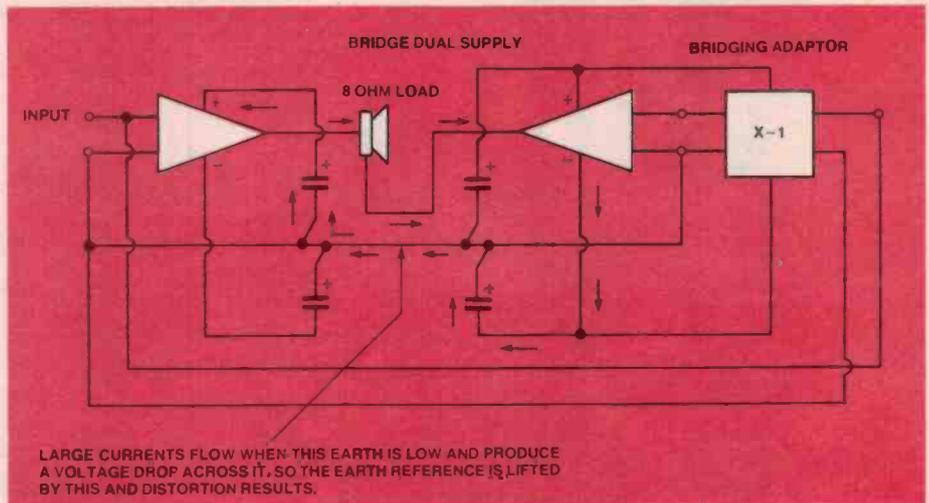


Figure 2. Two separate power amplifiers in 'bridge' configuration showing how the individual power supply currents and the load current flows.

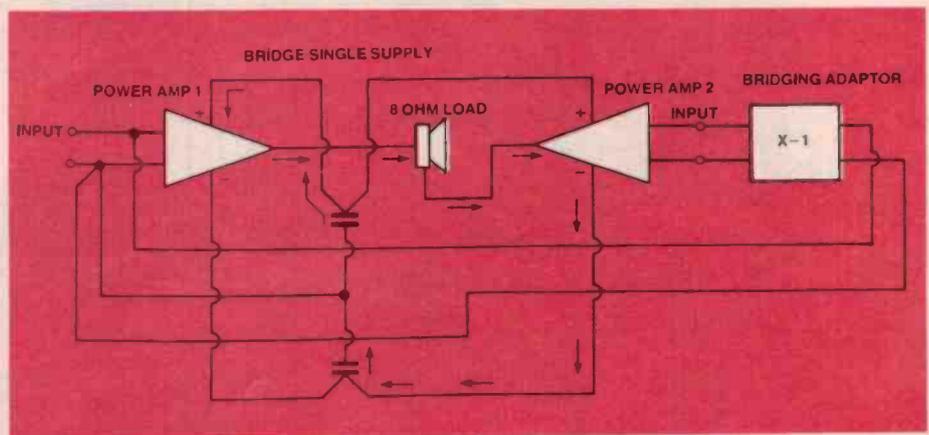
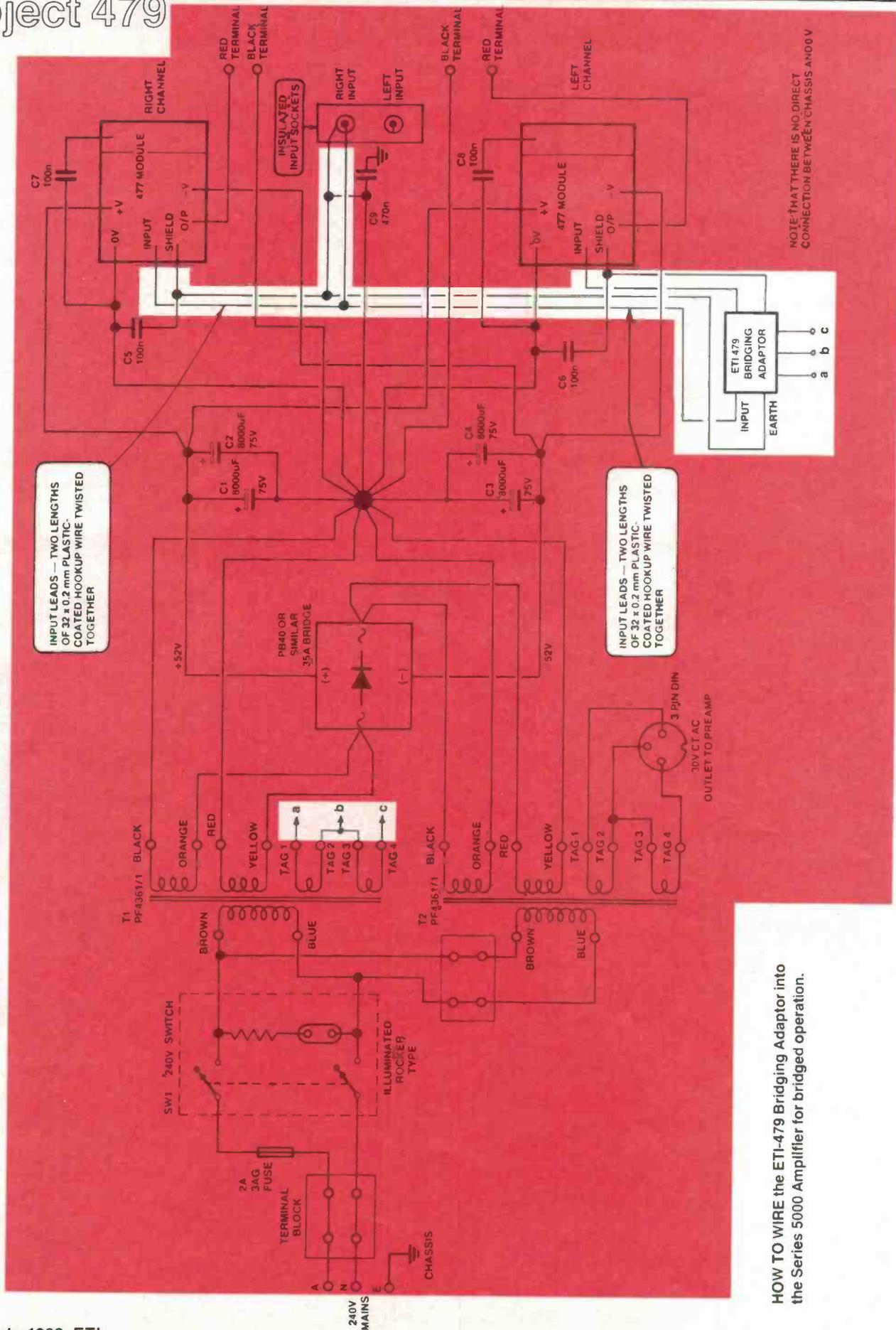


Figure 3. Bridged power amplifier and single supply showing load and supply current flow.

Project 479



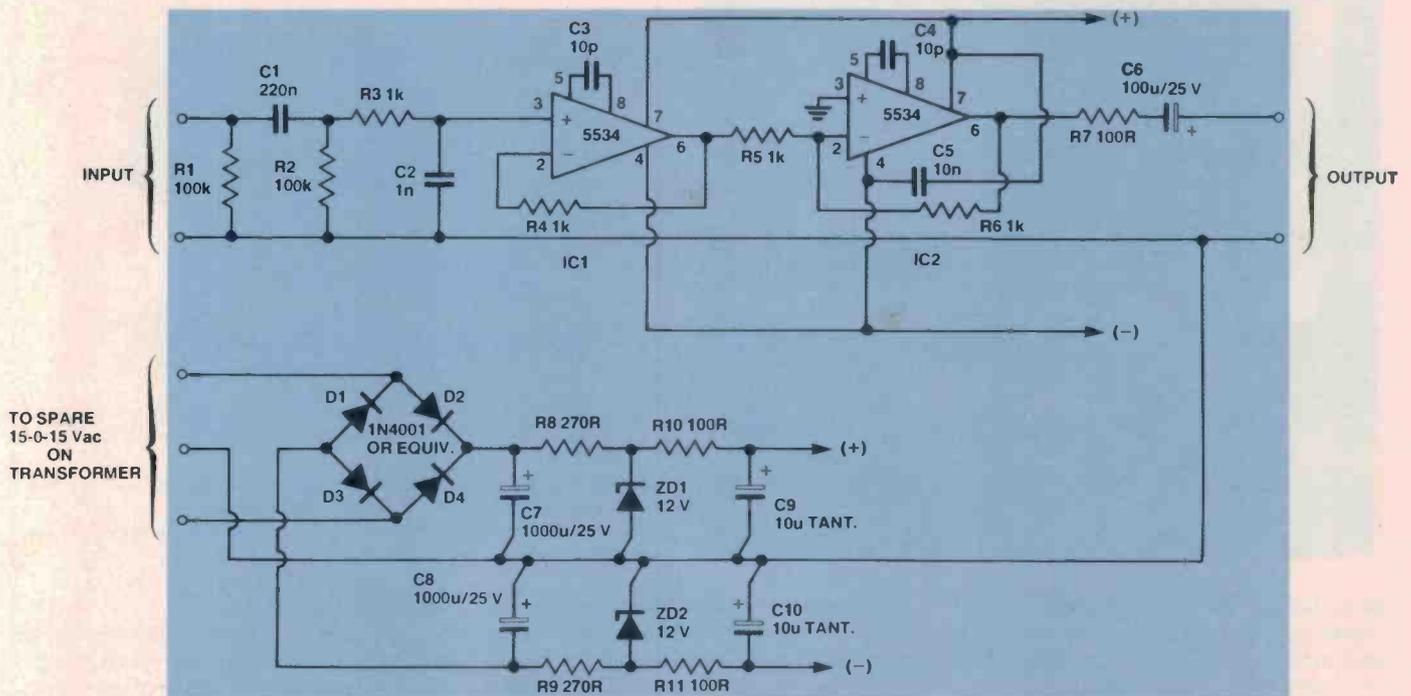
INPUT LEADS — TWO LENGTHS OF 32 x 0.2 mm PLASTIC-COATED HOOKUP WIRE TWISTED TOGETHER

INPUT LEADS — TWO LENGTHS OF 32 x 0.2 mm PLASTIC-COATED HOOKUP WIRE TWISTED TOGETHER

NOTE THAT THERE IS NO DIRECT CONNECTION BETWEEN CHASSIS AND 0V

HOW TO WIRE the ETI-479 Bridging Adaptor into the Series 5000 Ampifier for bridged operation.

bridging adaptor



have access to the same single reference point. This is one of the reasons the Series 5000 power amplifier was configured with a single supply even though two power transformers and a total of four electrolytics were used. The two channels in a stereo power amp should be bridged, forming a mono power amp. For stereo operation two such amplifiers are required.

Bridging adaptor

This project consists of a unity gain phase inverter that can be installed within the Series 5000 power amp. The input to one of the power amps is disconnected from the input socket and is wired to the output of the bridging adaptor. The input of the bridging adaptor is connected in parallel with the input of the other channel. This leaves one of the input sockets unused, although it could be connected to the other input socket if required.

The bridging adaptor must not degrade the distortion figures of the amplifier to which it is connected. Similarly good noise figures and freedom from slew-induced distortions must be ensured through careful design of the unity gain amplifier stages. Unfortunately, amplifiers with a gain of one tend to be the most difficult to stabilise because of the relatively high amounts of negative feedback. To overcome this problem and to maintain good noise

HOW IT WORKS — ETI-479

The Bridging Adaptor is a unity gain (i.e.: gain of 1x) inverting stage that has its input in parallel with one power amplifier module and its output driving the other power amplifier module. Thus the power amp module it drives operates out of phase with the other power amp module.

The bridging adaptor has two stages — a non-inverting input buffer stage and an inverting output stage. The active device in each stage is an NE5534 high performance op-amp. A rectifier on-board provides dual supply rails regulated by two zeners.

Input is coupled to the non-inverting input of IC1 via an RC network consisting of C1, R2, R3, and C2. Resistor R1 provides a dc return for the input line. Resistor R3 is a low value to ensure good noise performance for IC1, and together with C2, a lowpass filter is established to limit the slew rate of incoming signals to prevent slew-induced distortions. Feedback for IC1 is provided by R4, connected between the output and the inverting input. The output

of IC1 drives the inverting input of IC2 via R5. Feedback around IC2 is provided by R6. The feedback constants for both IC1 and IC2 are arranged so that each stage has a gain of one.

The output from IC2 is coupled via R7 and C6, which provide a low frequency rolloff, C6 also providing dc blocking.

The bridging adaptor is powered from the unused 15-0-15 Vac winding on one of the Series 5000 amplifier power supply transformers. Diodes D1 to D4 form a bridge rectifier providing about ± 20 Vdc with respect to the winding centre tap. Capacitors C7 and C8 provide smoothing. Two zener diodes, ZD1 and ZD2, are used to provide regulated positive and negative 12 Vdc supply rails for the two ICs. Resistors R8 and R9 provide current dropping for the two zeners and R10/C9, R11/C10 provide further filtering. Capacitor C5 provides a high frequency bypass for the supply rails. Capacitors C3 and C4 provide frequency compensation for IC1 and IC2 respectively.

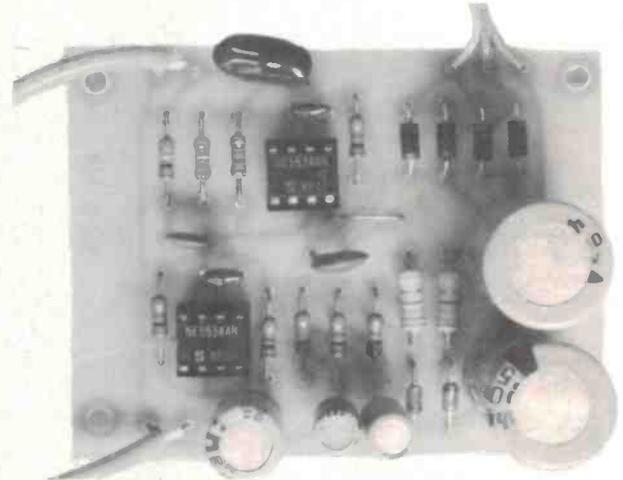
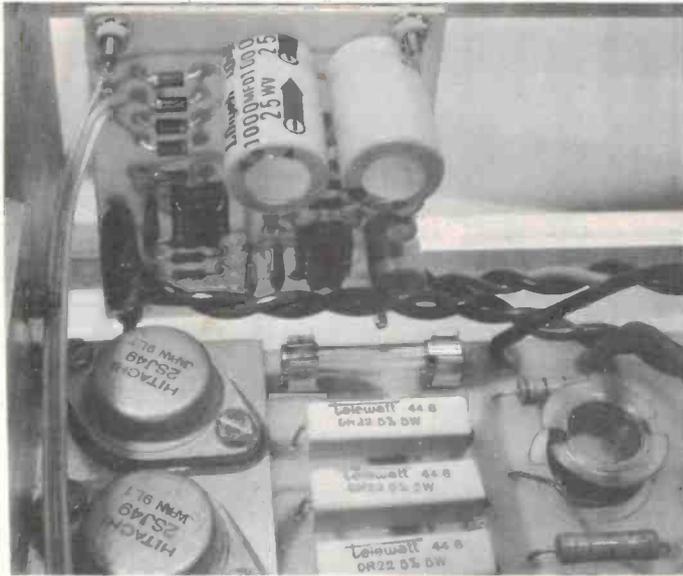
figures, NE5534N op-amps were used in the design. The conventional way to achieve an inverting amplifier is to ground the non-inverting input and insert the input signal into the inverting input via a resistor. In this configuration the inverting input is also connected to the output of the op-amp through another resistor and forms a virtual earth point. The input resistor therefore forms the input resistance of the stage. Since this is connected to the output of the preamplifier the value of this resistor must be high, i.e.: around 10k-100k. Unfortunately, this would

seriously degrade the noise performance. To overcome this problem the bridging adaptor has been broken into two stages. The first is simply a unity gain buffer. This stage has low noise figures and an output impedance low enough to drive the following inverter stage. Since the input resistor has been kept to a small value in the second stage a good noise figure results.

Construction

Construction of the bridging adaptor is not difficult since all components are

Project 479



ABOVE: The bridging adaptor board. Note that we did not use screened cable to install the board in the Series 5000 Stereo Amp.

LEFT: The board is installed in the Series 5000 Stereo Amp at the left hand end of the chassis.

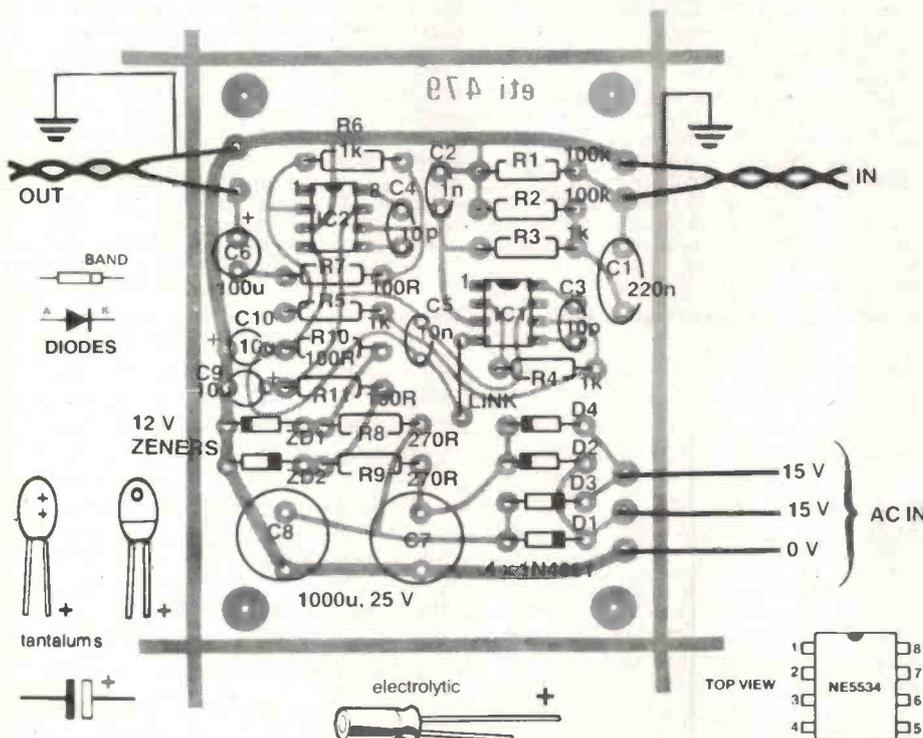
mounted on the pc board. The components can be mounted on the board in any order, although it is probably best to leave the two large electrolytic capacitors until last. As usual, be careful of the orientation of all polarised components such as the electrolytic capacitors, ICs and diodes.

Solder input and output leads to the board and bolt to the side bars on the left hand side of the power amp, as viewed from the front, as shown in the accom-

panying photograph. Use twisted pairs of 32 x 0.2 mm plastic-covered hookup wire, as with the existing input wiring. Solder the output directly to the input of the power amp closest to the bridging adaptor. Solder the input leads of the bridging adaptor to the input socket of the other power amp. Included here is the block diagram of the Series 5000 power amplifier showing suitable modifications to incorporate the bridging adaptor.

Performance

The prototype bridged Series 5000 amp performed favourably and gave distortion figures around the resolution of our THD analyser (approx. 0.003%). Similarly, noise figures were not degraded and the adaptor tested was free of slew-induced distortion. The power output achieved was around 300 W RMS when connected to an 8 ohm load. Connection to a 4 ohm load is *not* recommended for the reasons given earlier in this article. ●



PARTS LIST — ETI-479

- Resistors** all ½ W, 5%
- R1, R2 100k
- R3, R4, R5, R6 1k
- R7, R10, R11 100R
- R8, R9 270R
- Capacitors**
- C1 220n greencap
- C2 1n greencap
- C3, C4 10p ceramic
- C5 10n greencap
- C6 100u/25 V electrolytic
- C7, C8 1000u/25 V electrolytic
- C9, C10 10u/20 V tantalum
- Diodes**
- D1-D4 1N4001 or equivalent
- ZD1, ZD2 12 V 400 mW zeners
- Integrated Circuits**
- IC1, IC2 NE5534N
- Miscellaneous**
- ETI-479 printed circuit board; assorted mounting hardware; hookup wire.

Price estimate

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

\$12-\$14

Note that this is an estimate only and not a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.

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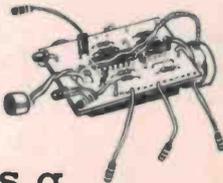
See ETI APR '81

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Symmetric multivibrator using two inverting gates

Dr. Ton Trancong

THIS CIRCUIT provides a frequency fairly independent of supply voltage, the output having a near-perfect 1:1 duty cycle. It is based on the improved astable multivibrator circuit described in *ETI Circuit Techniques Volume 1*, p.68, and is useful when low power consumption and simplicity are the main considerations.

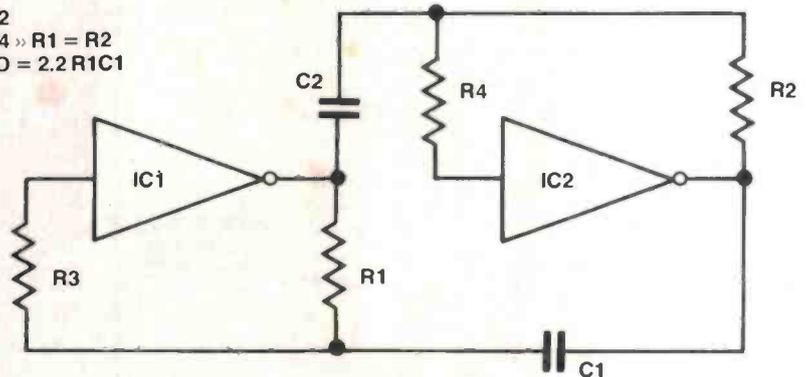
The circuit uses the dual RC relaxation circuits formed by R1C1 and R2C2, and is self-starting as it has no stable steady-state. While astable multivibrators using a single RC relaxation circuit suffer non-unity space-to-mark ratio due to the transfer voltage not being exactly halfway between the supply voltages, this circuit avoids the problem by using a dual relaxation circuit based on two inverter sections on the same IC chip.

The voltages applied to the gates of both inverters relax exponentially until one of them reaches its gate's transfer voltage. Hence the states of the inverters change instantaneously and the cycle repeats with the two inverters swapping their roles.

$$C1 = C2$$

$$R3 = R4 \gg R1 = R2$$

$$\text{PERIOD} = 2.2 R1 C1$$



Resistors R3 and R4 should have a value of more than three times that of R1 and R2 for the RC relaxation circuits to behave as if R3 and R4 were infinite. However, too high values of R3 and R4 may affect the operation of the circuit as the voltages at the inputs of the inverters may then fail to follow the relaxation voltages. The only requirements for proper operation are that IC1 and IC2 must be sections of the same physical integrated circuit chip, and that corresponding components of the dual circuits must have the same nominal values.

In my particular application, I used a 4009 CMOS hex-inverter chip with $R1 = R2 = 300k$ (20% tolerance), $R3 = R4 = 1M$ (20% tolerance), $C1 = C2 = 680p$ (10% tolerance) of the same production batches. The frequency obtained is fairly stable (with only 33% variation when the supply voltage varies between 3.3 V and 15 V) and its duty cycle is almost a perfect 1:1 over the whole permissible range of supply voltage. When the ratio $R3/R1 = R4/R2$ is high, the period of the circuit should have the value of $2.2R1C1$; in my application it is about 400 ns.

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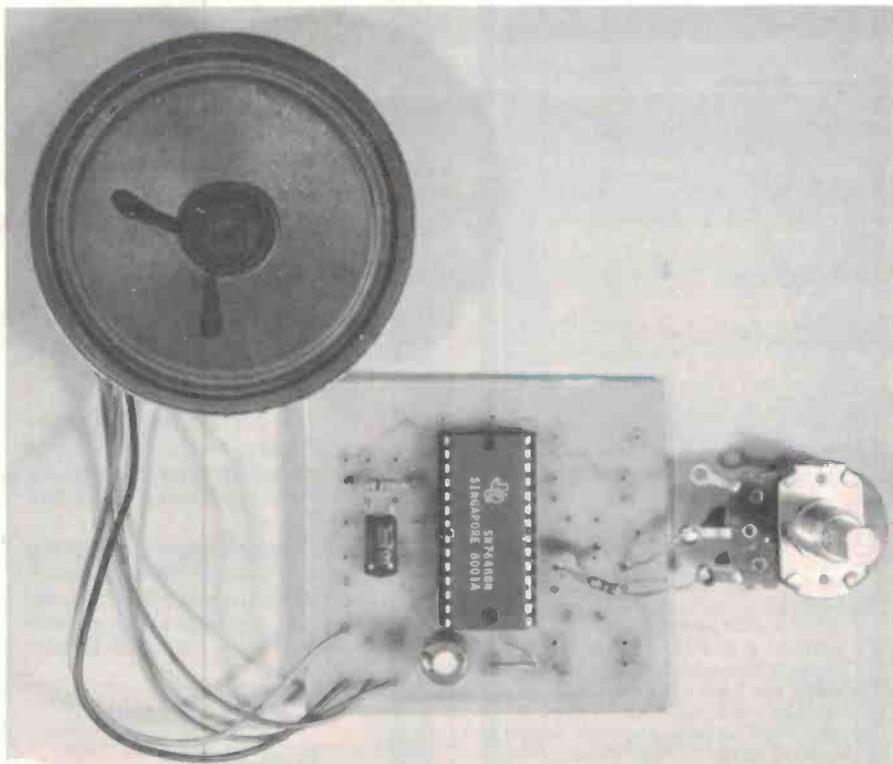
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Propellor aircraft sound effect unit

Roger Harrison

IN THE August and September issues last year we published a series of five sound effects units (Projects ETI-607 A to E) ranging from a Bomb Drop & Explosion to a Steam Train & Whistle. This project employs the same pc board and IC as did the previous five.

The IC is a Texas Instruments SN76488 complex sound generator. A complete description of this chip and how it works was given on pages 48 and 49 of the August '81 issue. At this juncture it should again be pointed out that the SN76488 is available in two different-sized packages — the A pack, a conventional 28-pin package with 15.4 mm spacing between pin rows and 2.54 mm pin spacing, and the smaller NF pack with 10.16 mm spacing between the pin rows and 1.52 mm pin spacing. Accordingly, two pc boards are provided to accommodate the different packs and they are marked 'A pack' and 'nf pack' to suit. Construction and overlay diagrams apply to either board.



Make sure you purchase the correct board to suit the IC pack you have purchased.

'savage' so that low frequency noise predominates. The chop-chop rate may be varied by the potentiometer from 'taxiing' to 'full climb'.

The prop sound

A propellor and engine make a 'chop-chop-chop' sound that contains quite a bit of 'white' noise energy. In this unit the super low frequency oscillator is used to modulate the output of the noise generator/filter — producing the 'chop-chop-chop' sound. The filtering is fairly

Construction

The overlay diagram shows where all the components are located. It is generally easiest to install the resistors, capacitors and link first of all. Watch the polarity of C1 and C3. You may use an IC socket to mount the SN76488 if you

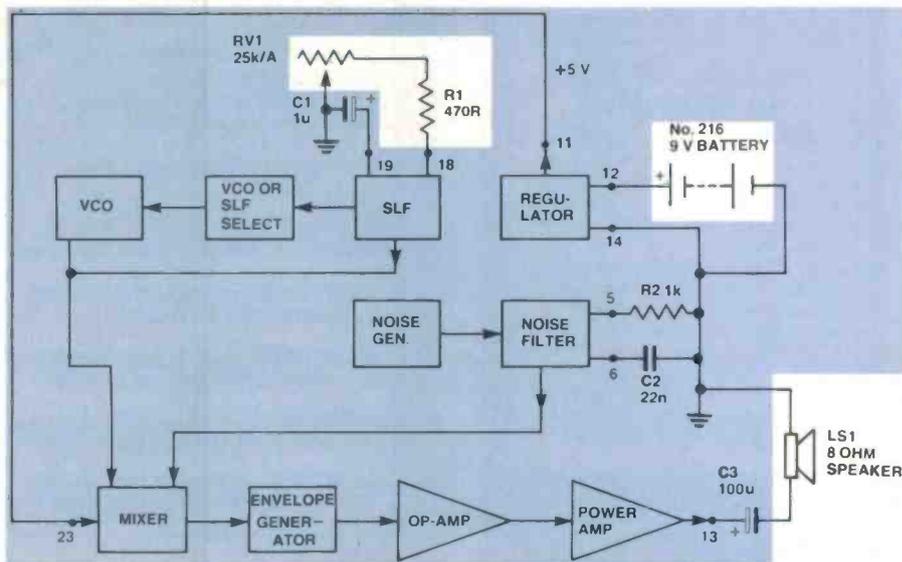
HOW IT WORKS

ETI-607F PROPELLOR AIRCRAFT

This unit is closely related to the Steam Train & Whistle (ETI-607B). The SLF is set to oscillate at a few Hertz and the Noise Generator/Filter output is modulated by this to produce the 'chopping' sound of a propellor and engine.

The broadband noise from the Noise Generator is heavily filtered by the Filter stage so that low frequency noise predominates. Capacitor C2 and resistor R2 set the Filter cutoff frequency somewhat below 2 kHz. The SLF oscillates at a rate determined by C1 and R1 + RV1. This rate may be varied by RV1, ranging from less than 20 Hz to more than 1200 Hz.

Pin 23, the 'C' select input of the Mixer, is connected to +5 V (pin 11 of the regulator) and this selects the SLF/NOISE mixing function. The output of the mixer passes to the audio output via the envelope generator — not used here — the speaker being driven by pin 13 via C3, a 100u dc blocking capacitor.





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wish, or just solder it to the board. Watch you get its orientation correct.

Last of all, solder up the leads to the battery connector (you may add a switch to turn the unit on and off if you wish), the loudspeaker and the potentiometer. Note that R1 mounts from one lug of the potentiometer.

The unit may be mounted in a jiffy box with the speaker and potentiometer mounted on the lid and the pc board and battery held in the base with double-sided sticky pads. That's just one suggestion; we'll have to leave the details up to you as individual requirements will vary — let your ingenuity loose! ●

PARTS LIST — ETI 607F

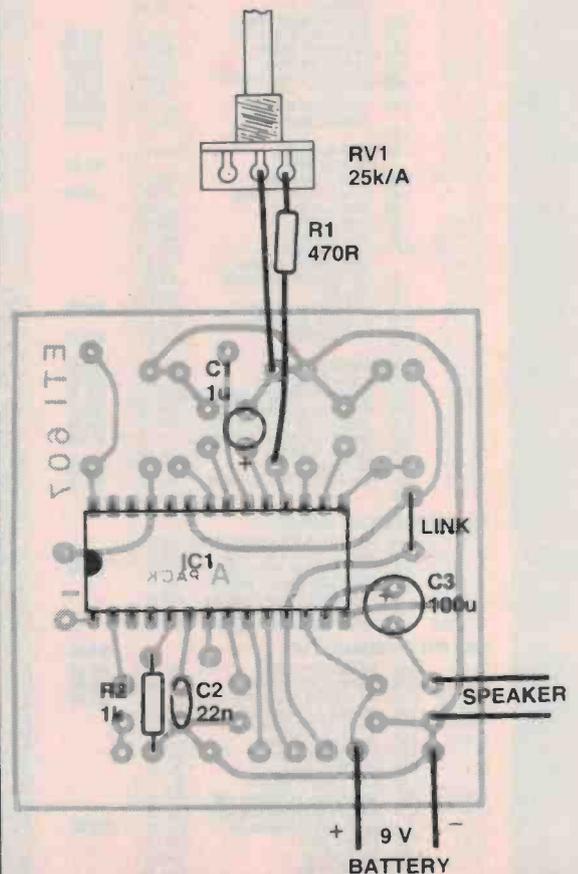
- Resistors** all 1/2W, 5%
 R1 470R
 R2 1k
 RV1 25k/A 1in. pot.
Capacitors
 C1 1u/10 V tant.
 C2 22n greencap
 C3 100u/16 V RB electro
Semiconductors
 IC1 SN76488
Miscellaneous
 ETI-607 pc board; 50 mm diameter 8 ohm speaker; No. 216 9 V battery and clip; switch (if needed).

Price estimate
\$10-\$14

NOTE: ERRATA PROJECT 607, p.49, August '81.

It only recently came to our notice that Table 1, Mixer Select Logic, top of page 49, is erroneous. It was reproduced directly from the Applications Note provided by Tandy with their bubble-packed SN76488 ICs. The SLF and SLF/NOISE logic should be transposed and the VCO/NOISE and SLF/VCO should be transposed. The table is correctly reproduced herewith.

Mixer Select Inputs			Mixer Output
C (Pin 23)	B (Pin 25)	A (Pin 24)	
L	L	L	VCO
H	L	L	SLF/NOISE
L	H	L	NOISE
H	H	L	SLF/VCO
L	L	H	SLF
H	L	H	SLF/VCO/NOISE
L	H	H	VCO/NOISE
H	H	H	INHIBIT



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PCB PRICE	DESCRIPTION	DATE	KIT PRICE	DESCRIPTION	DATE	PRICE	DESCRIPTION	DATE	PRICE	
ET 014	4.50 Dual Voltage Power Supply	Dec 71		ET 547	3.50 Telephone Bell Extension	June 77	80LS12	3.50 SELECTALOTT	Dec 81	\$22.00
ET 043	2.00 Head or Tail	Oct 76	\$3.50	ET 549A	2.90 Metal Detector	May 77	80LBR12	2.90 Light Beam Relay	Nov 80	\$13.00
ET 044	1.90 Two Tone Doorbell	Oct 76	\$4.50	ET 560	1.90 240V Mains Locator	May 80	80MA4	2.50	Apr 80	
ET 047	1.90 Morse Practice Set	Dec 76	\$3.50	ET 561	2.90 Metal Detector	Mar 80	80PC4	2.90 Power Heat Controller	Apr 80	
ET 048	1.90 Buzz Board	Dec 76	\$3.50	ET 562	3.90 Geiger Counter	Apr 80	80HHS6	2.50 Power Haw Siren	Jun 80	
ET 061	2.20 Simple Audio Amp	Oct 76	\$5.50	ET 563	3.50 Nicad Fast Charger	July 80	80PC7	3.50 Piecaver Induction MTR	Jul 80	
ET 062	2.50 Simple AM Tuner	Oct 76	\$3.50	ET 566A	2.90 Pipe & Cable Locator	Apr 80	80FB12	2.90 Guitar Fuzz Box	Feb 81	\$10.50
ET 063	2.50 Electronic Bongos	Mar 77	\$8.50	ET 566B	2.90 Pipe & Cable Locator	Apr 80	80G6	5.90 Musical Tone Generator	Jun 80	
ET 065	2.20 Electronic Siren	Nov 79	\$8.50	ET 567	3.50 Core Balance Relay	Apr 81	80GPS3	2.90 Voltage Regulator MTR	Mar 80	
ET 066	1.90 Temp Alarm	Dec 79	\$4.50	ET 568	2.90 Photo Flash Trigger	Oct 80	80AD12	3.00 Autodim Light Dimmer	Dec 80	
ET 068	2.20 Lead Dice	Dec 79	\$4.50	ET 570A	2.90 Infrared 'Tnp' Relay TX	Jan 82	80AU3	3.50 Hi Fi Auto Turn Off	Mar 80	
ET 071	2.50 Tape Noise Limiter	Oct 76	\$9.50	ET 570b	2.90 Infrared 'Tnp' Relay RX	Jan 82	80AW4	4.50 Receiver All Wave	Apr 80	
ET 072	1.90 Two Octave Organ	Jan 79	\$8.50	ET 572	4.90 Digital PH Meter	Dec 80	80TMB8	5.90 Digital Engine Analyser	Aug 80	\$48.50
ET 083	1.90 Train Controller	Dec 79	\$8.50	ET 573	3.50 Universal Timer	Oct 79	80TM6B	2.50 Digital Engine Analyser	Aug 80	
ET 084	2.50 Car Alarm	Jan 77	\$12.00	ET 576	5.90 Electromyogram	TPV 6	80PP7A	6.50 Erom Programmer	Jul 80	\$72.00
ET 085	1.90 Car over Rev Alarm	Oct 79		ET 577	3.50 General Purpose Power Supply	TPV 6	80PP7B	2.50 Erom Programmer	Jul 80	
ET 130	1.90 Temp/Volts Converter	Feb 76		ET 578	2.90 Simple Nicad Charger	June 80	80RF5	2.90 Rumble Filter	May 80	
ET 132	2.90 Experimenter Power Supply	Feb 77		ET 581	2.50 15V Dual Power Supply	June 76	80RH12	2.90 Cylon Voice Simulator	Dec 80	\$10.50
ET 134	2.90 R.M.S. Voltmeter	Aug 77		ET 583	2.90 Marine Gas Alarm	Aug 77	80S33	4.90 Playmaster Stereo Amp	Mar 80	?????
ET 135	2.50 Digital Panel Meter	Oct 77		ET 585R	1.90 Ultrasonic Receiver	TPV 6	80CH7	6.50 240 V.A.G. Light Chaster	Jun 80	
ET 136	2.50 Linear Scale Cap. Meter	Mar 78		ET 585T	1.90 Ultrasonic Transmitter	TPV 6	80RAM12	3.90 Ram Expansion for Dream	Dec 80	\$9.00
ET 137A	3.90 Frequency Meter Lcd	May 78		ET 585	3.90		80PA6	7.50 Playmaster 300W amp. Module	Jun 80	\$83.00
ET 137B	3.90 Audio Oscillator	May 78		ET 591A	2.90 Up/Down Digit Counter	July 78	80CL4	3.50 Time Controller	Apr 80	
ET 138	1.90 Power Meter	May 78		ET 591B	2.90 Up/Down Digit Counter	July 78	80TRS11	2.90 TRS 80 Printer Serial In.	Nov 80	\$15.00
ET 147	3.50 Electronic Dummy Load	Oct 80	\$80.00	ET 596	2.90 White Noise Generator	Nov 81	81DC2	2.20 Le Gong Doorbell	Feb 80	\$18.00
ET 149	3.50 2 Tone Generator	Jul 80	\$34.00	ET 598	2.90 Touch Switch	Feb 81	81DT5	3.00 Dream Tape Controller	May 81	
ET 152	2.90 Capacitance Meter	Feb 80		ET 598B	2.50 Touch Switch	Feb 81	81G43	11.50 Colour Graphic Analyser	Mar 81	\$88.00
ET 157	4.50 Crystal Marker	Oct 81	\$34.50	ET 599A	2.50 Infra Red Remote Control TX	May 80	81UC8	4.50 Universal Timer and Stopwch.	Aug 81	
ET 158	3.50 Low Ohms Meter	Nov 81	\$28.50	ET 599B	2.50 Infra Red Remote Control	May 80	81MPS	2.90 Microprocessor Power Sup.	Jun 81	
ET 245	2.90 10-15V Exp. Scale Voltmeter	Dec 81	\$23.00	ET 599C	2.20 Infra Red Remote Control	May 80	81IRA	4.90 Infra-Red Relay	Apr 81	\$39.00
ET 250	2.90 White Line Follower	Nov 77		ET 599D	2.20 I.R. Remote Cntrl Power Supply	May 80	81IR4B	2.90 Infra-Red Relay	Apr 81	
ET 250	2.90 House Alarm (262)	Aug 80		ET 603	4.90 Metronome	Spt 77	81SP1	2.90 RS232 TRS80 System 80 In.	Jan 81	
ET 255	2.90 Thermometer	Nov 80		ET 604	6.04 Electronic Tuning Fork	Nov 79	81S13	7.90 TRS80/System 80 Serial In.	Mar 81	
ET 256	2.90 Humidity Meter	Nov 80	\$10.50	ET 606	3.90 Sound Effects Generator	Aug 81	81SW1	3.90 Moving Coil Preamp	Jul 81	
ET 257	2.50 Universal Relay Board	May 81	\$12.50	ET 607A	2.90 Sound Effects Generator	Aug 81	81MC7	2.90 Moving Coil Preamp	Jul 81	
ET 258	2.50 Mini Drill Speed Controller	Jul 81	\$ 8.00	ET 607rf	2.90 Sound Effects Generator	Aug 81	81RM2	2.50 Digital/Analog Store. Cra.	Mar 81	\$100.00
ET 259a	2.50 Versatile 'Incremental' Timer	Jan 82	\$39.00	ET 607rf	2.90 Sound Effects Generator	Aug 81	81DC3B	8.50 Digital/Analog Store. Cra.	Mar 81	
ET 259b	2.60 Photo Lamp Flasher	Dec 79		ET 631-2	7.50 Keyboard Encoder	Apr 77	81DC3A	9.50 Digital/Analog Store. Cra.	Mar 81	\$43.00
ET 261	2.90 Fog Horn	Dec 79		ET 635	3.90 Train Steam Whistle	Apr 81	81WS10	2.90 Wind Speed Indicator	Oct 81	\$43.00
ET 262	2.90 Intercom	Dec 79		ET 636	16.90 7 Slot \$100 Mother Board	May 80	81P6	2.90 Pool/Lotto Selector	Jun 81	\$24.00
ET 263	2.90 Simple Egg Timer	Dec 79		ET 637	4.90 Cassette Interface	Jan 78	81AD10	3.50 Audio Test Unit Cass Deck	Oct 81	
ET 264	2.90 Simple Siren	Mar 80		ET 638A	4.90 Erom Programmer	July 78	81AD10	3.50 Audio Test Unit Cass Deck	Oct 81	\$47.00
ET 316	3.50 Transistor Assisted Ignition	May 77		ET 640	65.00 Memory Mapped VDU	Nov 78	81MCS	9.50 Musicour IV	Aug 81	\$78.00
ET 317	3.50 Car Rev Monitor	May 77		ET 650A	4.50 Stac Timer	Nov 78	81SG9	4.20 Led Sandglass	Sep 81	\$22.50
ET 324	3.50 Led Tacho	Aug 80		ET 650B	4.50 Stac Timer	Nov 78	81P19	4.90 Digital Clock Thermometer	Sep 81	\$80.00
ET 325	2.50 Car Auto Electric Probe			ET 650C	4.50 Stac Timer	Nov 78	81C19	4.90 Digital Clock Thermometer	Sep 81	\$80.00
ET 326	2.50 Exp. Scale Led Voltmeter	Spt 80	\$12.50	ET 660	19.00 Learners Microcomputer	Oct 81	81S11	4.90 Slide Cross Fader	Nov 81	\$88.00
ET 327	2.90 Turn/Hazard Indicator	Oct 80	\$22.00	Key Set (18) To Suit ET660			81GAS	3.90 Photon Torpedo Game	Sep 81	\$28.00
ET 328	2.90 Led Dil Temp Meter	Jan 81	\$15.50	ET 682	69.00 Versatile Erom Card	Mar 81	81UC8	4.90 Universal Timer	Aug 81	
ET 329	2.50 Exp. Scale Vehicle Ammeter	Feb 81	\$10.00	ET 708	2.90 Aerial Amp	Mar 76	81MC7	9.50 Moving Coil Preamp	Jul 81	\$17.50
ET 330	3.90 Car Alarm	Jul 81	\$27.50	ET 713	4.90 FM Tuner add on	Spt 77	81SW7	2.90 Train Steam Whistle	Jul 81	
ET 332	2.90 Electronic Stethoscope	Aug 81	\$34.00	ET 717	4.50 Crosshatch Generator	May 78	81SM7	2.90 Bagatelle	Jul 81	
ET 363	3.50 Reversing Alarm	Jan 82	\$10.00	ET 726	3.50 R.F. Amp 70W 5/10 Meter	Feb 80	81VM2	2.90 High Impedance DC Voltmtr	Feb 81	
ET 417	2.90 Overload Indicator	Aug 73		ET 729	5.90 UHF TV Masthead amp	Apr 81	81HB4A	7.50 Heart Rate Monitor	Apr 81	\$84.00
ET 438	2.90 Led Level Meter			ET 730	4.50 UHF TV Converter	May 81	81HB4B	7.50 Heart Rate Monitor	Apr 81	
EET 440	8.50 25 Watt Stereo AMP	Mar 75		ET 731	4.50 Teletype Modulator	Oct 79	81MA4	2.50 Touch Sensitive Alarm	Apr 81	
ET 445	2.20 General Purpose Preamp	July 76	\$8.00	ET 735	3.90 UHF to VHF Converter	May 81	81RCA4	3.50 Infra Red Remote Control	Apr 81	
ET 446	3.50 Stereo Limiter	July 76		ET 760	2.50 Video Mod. To Suit 660 Micros	Spt 81	81RCA2	2.50 Infra Red Remote Control	Apr 81	
ET 449	2.90 Mike Amplifier	May 77		ET 824	2.90 Slot Car Power Supply	Dec 81	81RCA3	2.75 Infra Red Remote Control	Apr 81	
ET 450A	3.50 Bucket Brigade	Dec 77		ET 825	5.90 Slot Car Controller	Dec 81	81SP5	2.50 Sound Pressure Meter	May 81	\$37.00
ET 450B	3.20 Bucket Brigade	Dec 77		ET 1501A	2.50 Negative Ion Generator	Apr 81	81OR7	9.50 Electronic Decoration	July 81	\$88.00
ET 452	2.90 Guitar Practice Amplifier	Jan 80		ET 1501B	2.50 Negative Ion Generator	Apr 81	81CH12	3.50 Christmas Organ	Dec 81	\$18.00
ET 453	2.90 AMP Class B. Gen Purpose	Apr 80		ET 1501C	1.50 Negative Ion Generator	Apr 81	81fm10a	4.90 500MHZ Digital Freq.Mtr.	Dec 81	\$138.00
ET 454	3.50 Fuzz Box	Apr 80		ET 1503	3.90 Battery Charger	Aug 81	81fm0a	4.90 500MHZ Digital Freq.Mtr.	Dec 81	\$138.00
ET 455	3.90 Loud Speaker Protector	Mar 80	\$25.50	Dream 6800 12.50			81fm0b	3.50 500MHZ Digital Freq.Mtr.	Dec 81	
ET 457	2.90 Scratch & Rumble Filter	Spt 80		Dream 6802 12.50			81td12	3.90 Led Bar Graph Display	Dec 81	
ET 458	4.90 Led Level Meter	June 81	\$27.00	Power Supply to Suit Dream Micro Kit			82epi	3.90 Easy to use Erom Programmer	Jan 82	\$39.00
ET 459A	3.50			HEX Keypad 19 keys			82wd1a	2.50 With Plugpac	Jan 82	\$81.50
ET 466	7.50 300W AMP Module	Feb 80	\$83.00	75CD7	3.50		81wd12a	2.50 Metronome (Low Current)	Jan 82	\$18.00
ET 467	6.90 4 Input Mike Preamp	July 80	\$27.00	75L11	2.50		81wd12b	2.50 Wind Direction Indicator	Jan 82	\$24.50
ET 470	2.90 60 Watt AMP Module Series 4000	TPV 6	\$29.00	76E04	1.00					
ET 471	9.50 Audio Preamp Series 4000	TPV 6	\$48.00	76PC9	5.50					
ET 472	2.90 Power Supply For Series 4000	TPV 6	\$24.00	78TMA	2.90					
ET 473	5.90 Moving Coil Preamp Series 4000	TPV 6	\$84.00	78C5	4.90					
ET 474	2.90 Interface 60W Amp	Jan 80		78A06	3.90					
ET 475	4.90 AM Tuner	Spt 80	\$80.00	78N6	3.50					
ET 476	6.90 Series 3000 AMP 25W Stereo	Nov 80	\$84.00	78T3	4.50 Photo Timer	Mar 78				
ET 477	4.90			78NG4	2.90 Pmw/White Noise Gen.	Apr 78				
				78UT4	4.50 Low Cost VDU Keyboard	Apr 78				
				78UP10	9.50 2650 Extra Ram	Oct 78				
				79SB10	3.90 Bass Filter	Oct 79				
				79FE11	2.50 Photo Flash Exposure MTR	Nov 79				
				79PC9	3.90 Pulse Generator	Sep 79				
				79SE3	3.90 Train Model Sound	Mar 79				
				79T11	2.90 Transistor Assisted Ign	Nov 79				
				79PS11	2.90 Experimenters Power Sup.	Nov 79				
				79PC12	2.90 Fan Speed Control	Dec 79				
				79SF10	2.50 Photo Slave Flash	Oct 79				
				79SF9	2.90 Photo Sound Trigger	Sep 79				
				79UP26	2.50 Universal Power Supply	Jan 79				
				80ST10A	3.50 Styhus Timer	Oct 80				
				80ST10B	2.50 Styhus Timer	Oct 80				
				80TC12	2.90 Bipolar Train Controller	Dec 80				
				80CMSA	4.50 Digital Capacitance MTR	Mar 80				
				80CMSB	2.50 Digital Capacitance MTR	Mar 80				
				80PG6	6.50 T.V. Pattern Generator	Jun 80				
				80TV8	3.90 T.V. Ctr Adapter	Aug 80				
				80F3	3.20 Audio Prescaler	Jul 80				
				80PP3	2.50	Mar 80				
				80LL7	2.90 Leds & Ladders	Jul 80				
				80B7	2.50 Beat Frequency Oscillator	Jul 80				
				80BM10	2.90 Car Battery Monitor	Oct 80				</

Lab Notes

Electronic switching — using the 4066B

There are many applications where mechanical switches and relays just won't do the job you want. The answer? — an electronic switch. The most popular and versatile is the 4066B quad bilateral switch — a CMOS package containing four electronically actuated single-pole single-throw (SPST) switches.

Ray Marston

THE 4066B CMOS IC is described in the manufacturer's literature as a 'quad bilateral switch', a pretty fair description since the device contains four independent electronic switches, each capable of passing signals in either direction and being controlled (turned on or off) by a single high-impedance terminal. The switches have a very high off impedance, an on impedance of about 90 ohms, and can be used to switch both analogue and digital signals.

Basic 4066B circuits

Figure 1 shows the outline and pin notations of the 4066B, which can be used with any supply voltage in the range 3 to 18 V. Note that, since the switches are of the bilateral type, either switch terminal can be used as the input or output.

Figure 2a shows the basic way of

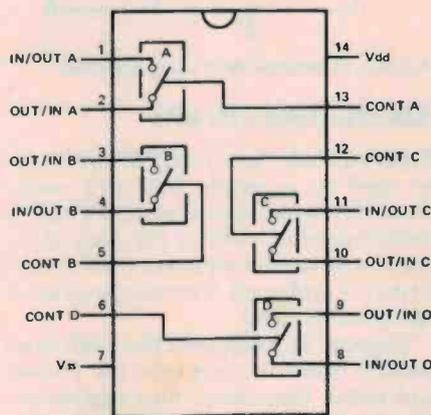


Figure 1. Outline and pin notations of the 4066B quad bilateral switch.

using the bilateral switch; each switch can be turned off (open circuit) by taking the control terminal to V_{SS} or turned on by taking the control termi-

nal to V_{DD} . In digital switching applications (Figure 2b) the IC can be used with a single-ended supply, with V_{SS} at 0 V and V_{DD} at the desired positive supply. In analogue switching applications (Figure 2c), a split power supply (either true or effective) must be used, with the positive rail to V_{DD} and the negative to V_{SS} ; in this case, of course, the maximum supply limits are restricted to ± 9 V. Typically, the bilateral switch introduces less than 0.5% signal distortion when used in the analogue mode.

Certain simple precautions must be observed when using the 4066B. First, the switch signals must in no circumstances be allowed to rise above the V_{DD} voltage or fall below the V_{SS} voltage. Each unused switch in the 4066B package must be disabled (see Figure 3) either by taking its control terminal to V_{DD} or V_{SS} (as most convenient), or by taking all three terminals to V_{SS} . ▶

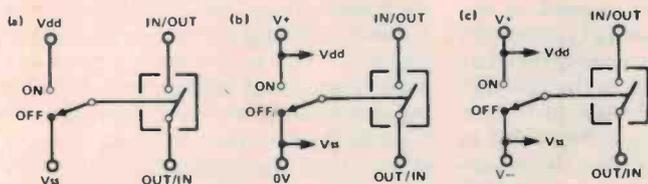


Figure 2. (a) The basic bilateral switch is turned off by taking the control terminal to V_{SS} and turned on by taking the control to V_{DD} . (b) In digital switching applications, V_{DD} is $V+$ and V_{SS} is 0 V. (c) In analogue switching applications where a split power supply is used, V_{DD} must go to $V+$ and V_{SS} to $V-$.

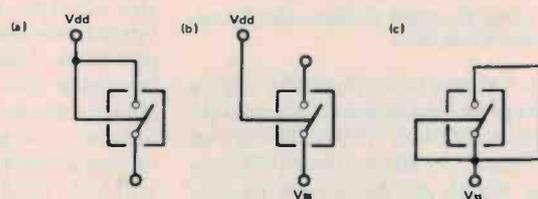


Figure 3. Unused bilateral switches must be disabled, either by taking the control terminal to V_{DD} and one of the switch terminals to V_{DD} (a) or V_{SS} (b), or by taking all three terminals to V_{SS} .

Lab Notes

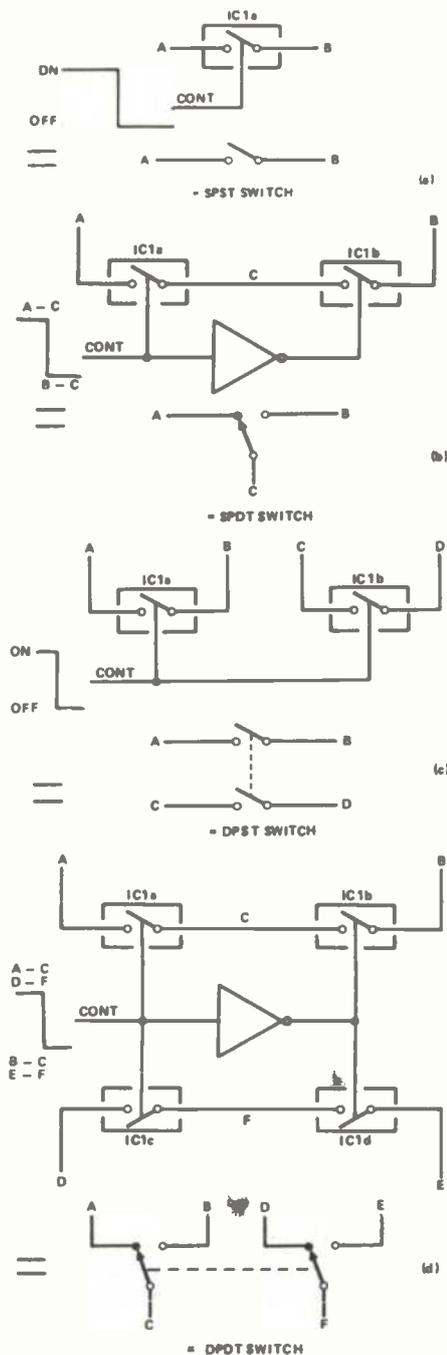


Figure 4. Using the 4066B to implement the four basic switching functions.

Figure 4 shows how the 4066B can be used to implement the four basic switching functions of SPST, SPDT, DPST and DPDT. Figure 4a shows the SPST connections, which we have already discussed. The SPDT function is implemented by wiring an inverter stage (a 4001 or 4011, etc) between the IC1a and IC1b control terminals as shown. The DPST switch (Figure 4c) is simply two

SPST switches sharing a common control terminal, and the DPDT switch (Figure 4d) is two SPDT switches sharing a common inverter stage in the control line.

Note that the basic switching functions of Figure 4 can be expanded or combined in any desired way by simply adding extra switches/4066B packages, as appropriate. Thus, a 10-pole double-throw switch can, for example, be made by using five of the Figure 4d circuits and joining their control inputs together.

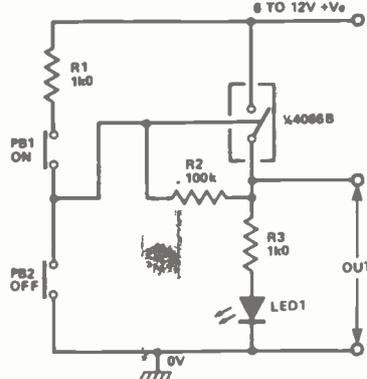


Figure 5. Pushbutton latch using the 4066B.

Six latching circuits

Figure 5 shows how a 4066B switch can be used as a simple but very useful press-button activated latch; the LED is merely used to indicate the state of the latch, and can be replaced with a short circuit if preferred. Circuit operation is easily understood.

Suppose initially that the latch is off (switch open). In this case the output, and hence the control bias applied via R2, will be zero, so the switch will maintain its off state. If PB1 is now momentarily closed the control voltage will go high and turn the switch on, thus driving the output high and maintaining the control drive high (switch on) once PB1 is released. This new state will be maintained until PB2 is closed, at which point the switch will latch into the off state again. R1 is used in the circuit to ensure that a supply short will not occur if both buttons are pressed at the same time; with R1 in the position shown, the switch will turn off if both buttons are pressed at once.

The Figure 5 circuit has a couple of interesting characteristics. First, the control bias resistor can be given any desired value up to practical limits.

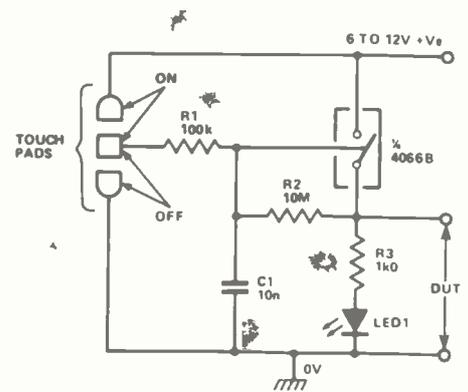


Figure 6. A latching touch switch.

Figure 6, for example, shows how the value can be increased to 10M to make a latching touch switch that can be activated by placing a finger across the upper or lower set of touch contacts. R1 and C1 are used to suppress hum signals and ensure positive switching.

Another useful feature is that, since the on resistance of the switch is only 90 ohms or so, the voltage loss across the switch can be quite low (90 mV at 1 mA); in practice, the on current should be limited to 10 mA maximum. Figure 7

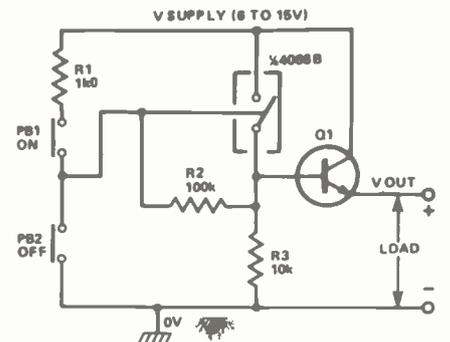


Figure 7. This pushbutton activated power switch can be used to replace a conventional slide or toggle switch.

shows how this low-loss effect can be used to connect or disconnect the power supply to a piece of electronic equipment (amplifier, test gear, etc).

When the switch is off, Q1 is cut off and the circuit consumes a typical standby current of less than 1 uA. When the switch is on, Q1 acts as a voltage follower with its base tied to the positive line via IC1a, so the output voltage is high. The actual voltage drop between the output and the supply is equal to the IC1a drop plus the base-emitter drop of Q1 and typically ranges from 600 to 800 mV. The available output current depends on the gain and current rating of Q1, but currents of a few hundred milliamps are readily available from a single transistor.

A slightly more efficient version of

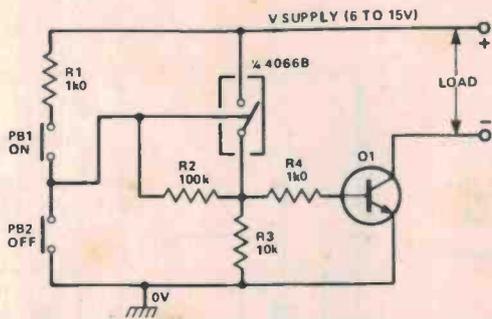


Figure 8. An alternative version of the pushbutton power switch.

the pushbutton power switch is shown in Figure 8. In this case the load is wired between the collector of Q1 and the positive supply rail. The voltage drop in this circuit is determined only by the saturation characteristics of Q1 and may typically be in the range 200 to 600 mV.

Figure 9 shows how the above circuit can be modified for use as a 'close-to-activate' burglar, panic or fire alarm, in which Q1 output feeds directly to a heavy duty 'alarm' relay which, in turn, actuates an external bell or siren. Any number of normally open sensors/switches can be wired in parallel in the 'PB' positions. The circuit consumes only a microamp or so when in the 'ready' or off mode.

Figure 10 shows the 4066 used in a multiplexer application where two inputs to a LED display (a pair of LM3915s) are switched alternately to provide a readout of 'average' and 'peak' signal levels. This was employed in our

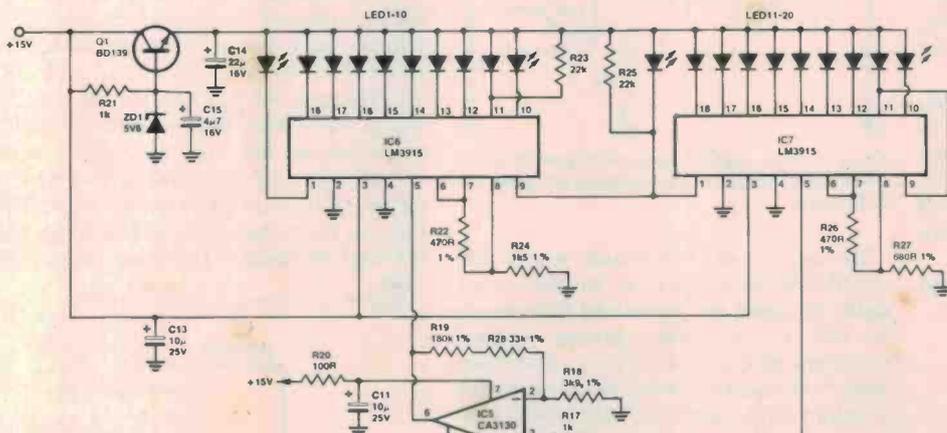


Figure 10. The 4066 used in a multiplexer application. This is the portion of the ETI-458 LED Level Display that multiplexes the peak and average values of a signal onto a 20 LED log display.

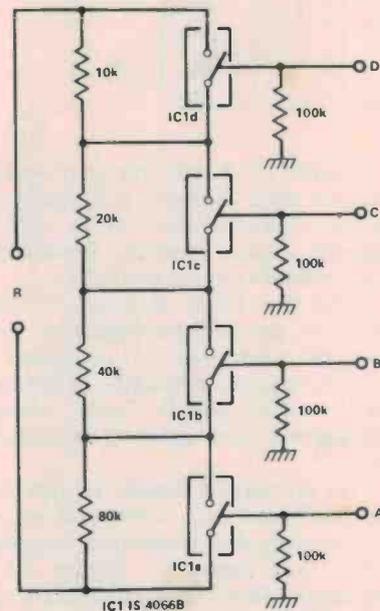
ETI-458 LED Level Meter, which, featured 'twin-dot' display — the 'upper' dot showing peak signal level, the 'lower' one showing average. As the

4066 toggles between the two inputs the dot-mode display changes in like fashion. Because the toggling speed is so rapid (a few hundred Hertz), the persistence of vision makes the display seem to have two dots rather than one dot at a time. Two gates act as the multiplexing switches and two gates are arranged as an oscillator to drive them.

Digital control

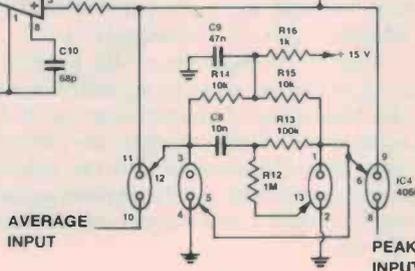
The 4066B can be used to digitally control or vary resistance, capacitance, impedance, amplifier gain or oscillator frequency in any desired number of discrete steps. Figure 11 shows how the four switches of a single 4066B can be used to vary the effective value of a resistance in 16 digitally controlled steps of 10k each. In practice, of course, the

step magnitudes can be given any desired value (determined by the value of the smallest resistor) so long as the four resistors are kept in the ratio 1-2-4-8, and that the on-resistance of 90 ohms is kept in mind.

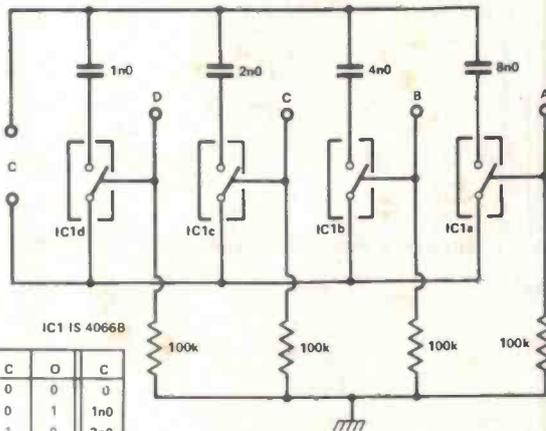


A	B	C	D	R
0	0	0	0	150k
0	0	0	1	140k
0	0	0	1	130k
0	0	1	0	120k
0	0	1	1	110k
0	1	0	0	100k
0	1	0	1	90k
0	1	1	0	80k
0	1	1	1	70k
1	0	0	0	60k
1	0	0	1	50k
1	0	1	0	40k
1	0	1	1	30k
1	1	0	0	20k
1	1	0	1	10k
1	1	1	1	0

Figure 11. This circuit gives 16-step digital control of resistance. R can be varied from zero to 150k in steps of 10k.



Lab Notes



A	B	C	D	C
0	0	0	0	0
0	0	0	1	1n0
0	0	1	0	2n0
0	0	1	1	3n0
0	1	0	0	4n0
0	1	0	1	5n0
0	1	1	0	6n0
0	1	1	1	7n0
1	0	0	0	8n0
1	0	0	1	9n0
1	0	1	0	10n0
1	0	1	1	11n0
1	1	0	0	12n0
1	1	0	1	13n0
1	1	1	0	14n0
1	1	1	1	15n0

Figure 12. A similar circuit to that of Figure 11 gives 16-step digital control of capacitance. C can be varied from zero to 15n in steps of 1n.

Figure 12 shows how four switches can be used to make a digitally controlled capacitor that can be varied in sixteen steps of 1n each. (Input capacitance is only around 8-10 pF).

Note that in the Figures 11 and 12 circuits the resistor/capacitor values can be controlled by operating the 4066B switches manually, or automatically using simple logic networks, microprocessors, up/down counters, and so on.

The circuits of Figures 11 and 12 can be combined in a variety of ways to make digitally controlled impedance and filter networks. Figure 13, for example, shows three different ways of using the circuits to make a digitally controlled first-order lowpass filter.

Digital control of amplifier gain can

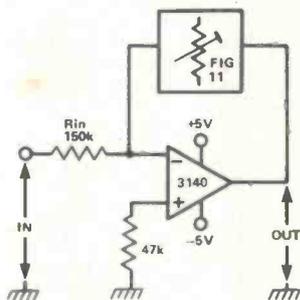


Figure 14. Digital control of gain using the Figure 11 circuit. The gain can be varied between zero and unity in 16 steps.

be obtained by hooking the 'resistance' circuit of Figure 11 into the feedback or input path of a standard op-amp inverting circuit, as shown in Figures 14 and 15. The gain of such a circuit is equal to R_F/R_{IN} , where R_F is the feedback resistance and R_{IN} is the input resistance. Thus, in the Figure 14 circuit, where the controlled resistance is in the feedback loop, the gain can be varied from zero to unity in 16 discrete steps of 'one fifteenth' each, i.e.: giving a sequence of 0, 1/15, 2/15, 3/15, ..., 14/15, 15/15.

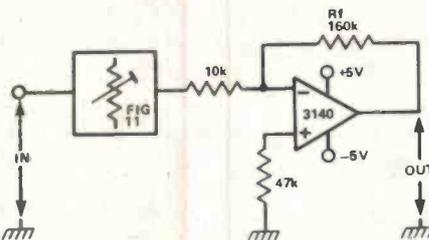


Figure 15. This application of the Figure 11 circuit gives digital control of gain between unity and x16 in 16 steps.

In the Figure 15 circuit, where the controlled resistance is in the input path, the gain can be varied from unity to x16 in 16 steps, giving a gain sequence of 1, 2, 3, 4, 5, 6, ... Note that in both of these circuits, the op-amp uses a split power supply so the 4066B control voltage must switch between the negative and positive supply rails.

Figure 16 shows how the Figure 11 circuit can be used to digitally control the frequency of an oscillator in 16 discrete steps. In this example the circuit is that of a 555 astable, but the general control principle can be applied equally well to many other types of oscillator circuit.

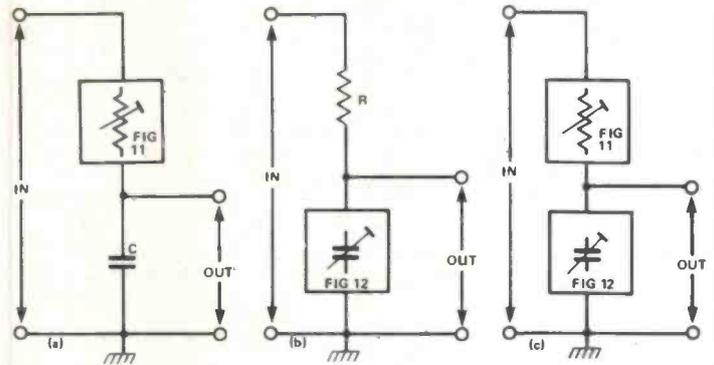


Figure 13. Three ways of using the circuits of Figure 11 and Figure 12 to make a digitally-controlled first-order low pass filter.

Figure 17 shows how a trio of 4066B switches can be used to implement digital control of the decade range selection of 555 astable. Here, only one of the switches must be turned on at any time. Naturally, the circuits of Figures 16 and 17 can be combined to form a wide-range oscillator that can be digitally controlled by a computer, for example.

Synthesised multi-gang pots

The synthesising principle is quite simple and is illustrated in Figure 18, which shows the circuit of a synthesised four-gang 10k-100k rheostat for use at signal frequencies up to about 15 kHz.

Here, the 555 is used to generate a 50 kHz (nominal) rectangular waveform whose mark/space ratio can be varied from 11:1 to 1:11 by RV1, and this waveform is used to control the switching of the 4066B stages. All the 4066B switches are fed with the same control waveform, and each switch is wired in series with a range resistor (R_A , R_B , etc), to form one gang of the 'rheostat' between the pairs of terminals, as shown.

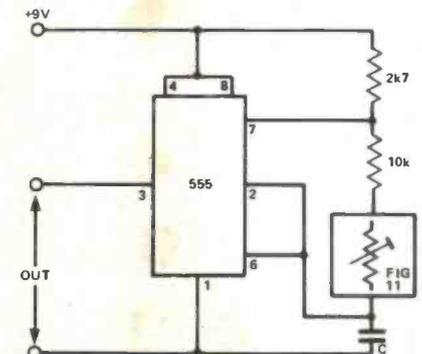


Figure 16. Digital control of the frequency of a 555 astable. The frequency can be varied in 16 steps.

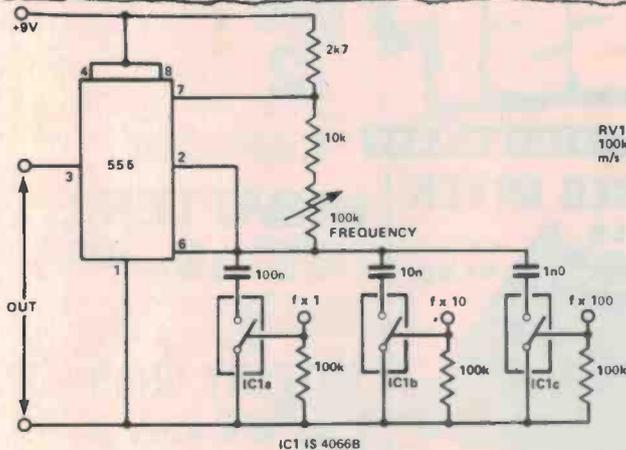


Figure 17. Digital control of decade range switching of a 555 astable.

Remembering that the switching rate of this circuit is very fast (50 kHz) relative to the rheostat's maximum signal frequency (15 kHz), it can be seen that the mean or effective value of the 'rheostat' resistance can be varied with mark/space ratio control RV1. Thus, if IC2a is closed for 90% and open for 10% of each duty cycle (mark/space ratio of 9:1), the apparent (mean) value of the resistance will be 10% greater than RA, i.e. 10k. If the duty cycle is reduced to

50%, the apparent RA value will double, to 18k2. If the duty cycle is further decreased, so that IC2a is closed for only 10% of each duty cycle (mark/space ratio 1:9), the apparent value of RA will increase by a decade, to 91k. Thus, the apparent resistance of each 'gang' of the 'rheostat' can be varied by RV1.

There are some important points to note about the Figure 18 circuit. First, the circuit can be given any desired number of 'gangs' by simply adding an

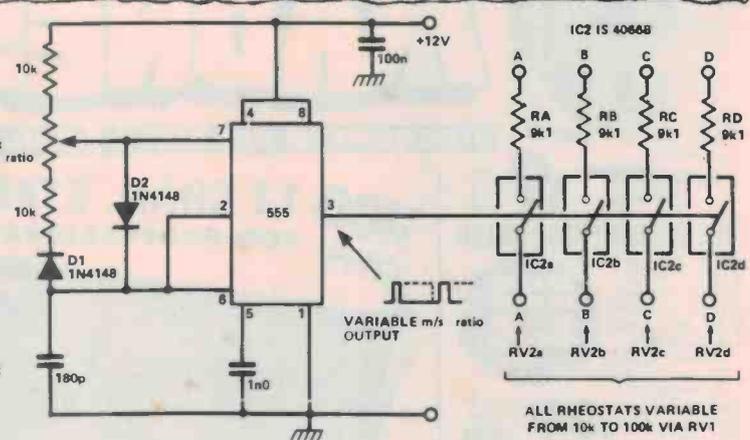


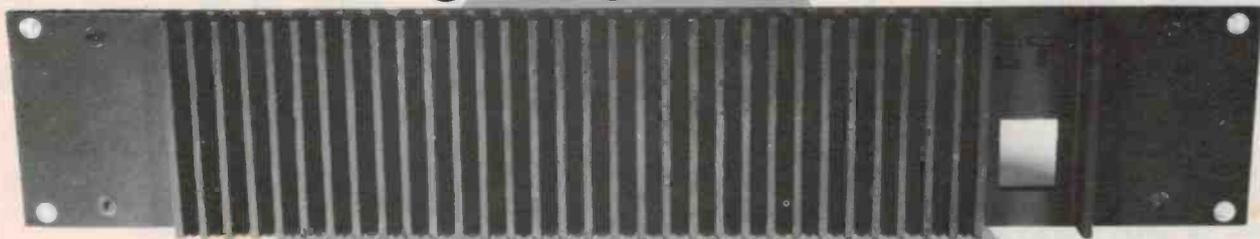
Figure 18. Synthesised precision four-gang rheostat.

appropriate number of switch stages and range resistors. Since all switches are controlled by the same mark/space ratio waveform, perfect tracking is automatically assured. Individual gangs can be given different ranges, without affecting the tracking, by giving them different range resistor values. The sweep range and the law of the rheostat can be changed by changing the characteristics of the mark/space ratio generator.

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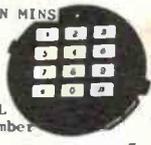
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Ideas for Experimenters

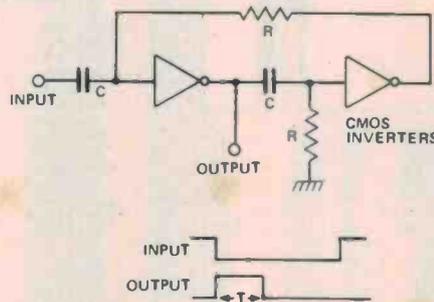
These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.

Monostables

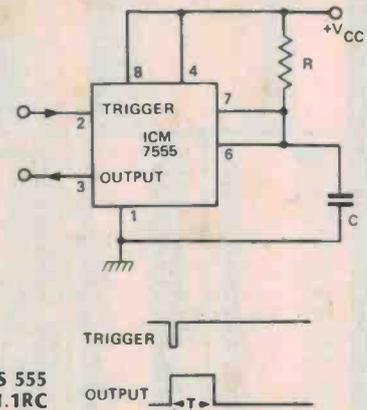
A commonly-used circuit block is the monostable. There are several convenient ways to realise one and these two general circuits show how. Suitable CMOS inverters for the upper circuit would be 74C04, 4009, 4049 and 4069. Inverters can be made by tying the inputs of NAND gates together, don't forget. 'Rule of thumb' timing equations are given.

The ICM7555 is a CMOS version of the ever-popular 555. In this application the input is pin 2, output is pin 3.

It couldn't be simpler, could it?



CMOS inverters
 $T = 1.38RC$
 Keep R greater than 47k



CMOS 555
 $T = 1.1RC$

Simple method for printed circuit design

This idea, from R.N. Sinclair of NSW, is an old one but a good one that bears repeating.

Want to make prototype printed circuit boards quickly and easily? The following is a method I have used for many years now and provides reasonable accuracy of layout and speed of production where use of 'Bishop Graphics' is not warranted. The first thing to do is make a scale drawing of the desired layout on graph paper in pencil (0.1" grid is

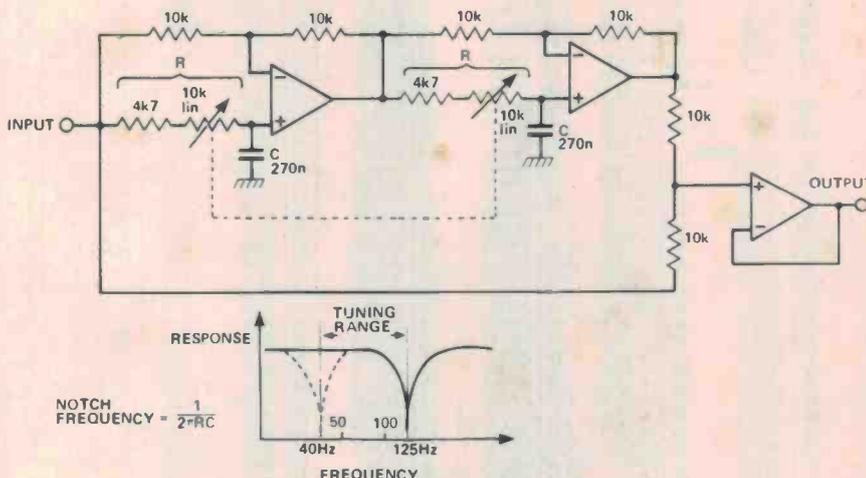
ideal for integrated circuits), marking all points where holes are to be made.

Next clean your printed circuit board blank with a light abrasive and be sure it is clear of grease and dirt, then place a sheet of blue carbon paper face down on the copper board. Now place your layout drawing so that the back of the drawing is face up (therefore a reverse copy of the original) on the carbon paper and trace all the connecting lines, not forgetting to mark the points where holes are to be drilled.

At this point note that it is very important to keep the artwork rigid and in the same position in relation to the copper board, and it is much easier if a

red pen is used for the tracing to avoid missing a section.

Now you have a carbon copy of the circuit layout on your board, and can simply use a clear or lightly coloured nail polish as a resist and etch in the normal manner. One the board is etched the holes must be drilled using the previously marked points, after which the nail polish can be removed with acetone (nail polish remover). Using the above method I can prepare a board ready for parts in 45 minutes, depending upon the complexity of the layout. It gives me a layout sketch for Bishop Graphics artwork and it provides a neat-looking circuit board as compared to Veroboard.



Notch filter

An audio notch filter has many and varied applications. This circuit will provide a very 'deep' (high attenuation) notch in the input-to-output response at a frequency set by the value of the ganged-pot sections. With the circuit values shown, it is tuneable over a range from about 40 Hz to 125 Hz. Varying the value of C will shift the range up or down the audio spectrum. If you use internally compensated op-amps then no extra frequency compensation will be required. Types such as the NE5534 (N or AN) or TL071 are suitable, or multi-op-amp packs such as the LM324 or TL074 may be employed. Note that C should be a good-quality film or polycarbonate capacitor.

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4001A	74C10	.40	LM358	.70	LM7555	1.80	7496	.80	
4001B	74C14	.90	LM373	4.10	Mc10116L	.95	7497	2.50	
4002	74C20	.40	LM374	5.40	LF13741	.69	74107	.80	
4006	74C30	.40	LM376	.70	LF1374-1H	.70	74109	.60	
4007	74C32	.40	LM377	2.90	DS75452	.60	74116	2.20	
4008	74C42	1.10	LM379	5.70	76477	4.90	74121	.60	
4009	74C48	1.55	LM308 8PIN	1.30	75451	.60	74122	.65	
4010	74C73	.70	LM380	.75	75491	1.40	74123	.80	
4011	74C74	.70	14PIN	1.50	75492	1.40	74125	.55	
4012	74C76	.75	LM318A-N	2.40	TTL (s)		74126	.60	
4013	74C83	1.40	LM318N	1.80	74500	.80	74132	.80	
4014	74C85	1.20	LM382N	2.00	74502	.80	74141	1.10	
4015	74C86	.80	LM383	2.70	74504	.80	74145	.85	
4016	74C90	.80	LM384	2.40	74510	.75	74147	2.00	
4017	74C93	1.40	LM386	1.00	74511	.75	74148	1.40	
4018	74C95	.95	LM387	1.30	74532	.75	74150	1.20	
4019	74C107	.70	LM391	1.80	75551	.75	74151	.60	
4020	74C150	3.40	LM393	.80	74574	1.20	74152	4.90	
4021	74C151	1.00	LF398	5.00	74586	1.40	74153	.70	
4022	74C160	.90	8038	6.00	745112	1.20	74154	1.20	
4023	74C192	.90	NE530	1.10	745135	2.20	74155	.90	
4024	74C164	1.10	LM350	9.90	745138	3.20	8728	3.00	
4025	74C173	1.00	555	.40	745157	2.95	9310	.65	
4026	74C174	.80	556	1.10	745158	2.95	9311	1.00	
4027	74C175	1.00	LM565	1.30	745182	3.30	9312	1.35	
4028	74C192	1.20	LM565CH	2.00	7400 SERIES		74156	1.50	
4029	74C195	1.00	NE566	2.50	7400	.40	74157	.50	
4030	74C221	1.90	LM567	1.50	7401	.40	74161	1.00	
4031	74C373	1.80	NE571	6.50	7402	.40	74162	1.00	
4034	74C374	2.00	LM709 14PIN	.70	7403	.40	74163	.85	
4035	74C901	.90	UA710CA	.60	7404	.40	74164	.60	
4039	74C902	.90	LM710-CH	.90	7405	.50	74165	.60	
4040	74C905	11.20	711	.80	7406	.50	74174	.50	
4041	74C906	.90	UA711-H	.85	7407	.50	74175	.90	
4042	74C907	.80	UA716HC	6.25	7408	.40	74176	1.10	
4043	74C915	1.50	723	.50	7409	.40	74177	1.10	
4044	74C922	3.80	LM723CH	1.10	7410	.40	74180	.90	
4046	74C923	5.00	LM725	3.90	7411	.40	74181	2.38	
4047	74C925	7.80	LM733	1.20	7412	.40	74184	.40	
4048	74C926	7.80	UA739	2.00	7413	.50	74184	3.75	
4049	74C927	5.90	741	.25	7414	.70	74185	1.20	
4050	74C932	5.50	LM741-H	1.20	7416	.50	74190	1.00	
4051	80C SERIES		UA747	1.00	7417	.60	74191	1.50	
4052	MM80C95	.90	UA747HC	2.20	7420	.40	74192	1.70	
4053	80C96	.90	UA748	.50	7421	.40	74193	.80	
4060	MM80297	.90	UA748HC	1.25	7423	.50	74194	1.10	
4066	80C98	.90	UA753	1.80	7425	.45	74195	.65	
4068	LINEAR		UA760HC	4.10	7426	.40	74196	.85	
4069	LM0002	9.50	UA777	2.40	7427	.40	74197	1.10	
4070	LM0022C0	16.60	UA777HC	2.65	7430	.40	74198	1.10	
4071	LM0042CH	8.60	9334	1.70	7432	.40	74199	1.30	
4072	LM0070	12.70	UA743	1.80	7437	.40	74201	.90	
4073	LM0071	12.70	UA760HC	4.10	7438	.50	74202	.90	
4075	TL071	1.00	UA796HC	1.70	7440	.50	74203	.90	
4076	TL072	1.50	LM802	1.10	7441	1.00	74204	.90	
4077	TL082	1.50	LM3130N	2.40	7442	.50	74205	.80	
4078	SAK140	2.20	1408	.90	7443	1.40	74206	1.00	
4081	UA1170	3.50	LM1458	6.00	7444	1.20	74207	1.00	
4082	UA1180	3.50	UA1488	1.50	7445	1.10	8196	1.80	
4089	1.00	TC4220	2.20	UA1489	1.50	7446	1.00	9314	1.30
4093	LM301	.50	MC1495	7.30	7447	1.00	9368	1.75	
4503	LM301-H	.50	MC1496L	11.40	7448	1.00	9370	2.00	
4510	LM304-H	1.70	LM1558	1.50	7450	.50	74LS00	.40	
4511	LM305-H	.80	LM1596	1.40	7451	.50	74LS01	.40	
4512	LM307-CN	.40	LM1380	3.10	7453	.40	74LS02	.40	
4514	LM307-H	.90	LM2902	1.40	8126	2.20	74LS03	.40	
4516	LM308	.70	LM2917	.90	9300	.60	74LS04	.40	
4518	LM308-H	1.20	8PIN	2.80	9307	1.80	74LS05	.40	
4519	LM310-N	2.20	LM2917	3.10	9308	1.20	74LS08	.40	
4520	LM310-H	2.60	CA3028	1.80	7454	.60	74LS09	.40	
4522	311	.60	LM3039	.90	7472	.60	74LS10	.40	
4527	LM311	.60	CA3046	1.70	7473	.60	74LS11	.40	
4528	LM311-H	1.20	3065	.45	7474	.60	74LS13	.50	
4529	LM318	2.80	LM3080	1.20	7475	.60	74LS14	.90	
4539	LM322	3.90	LM3089	3.90	7476	.60	74LS15	.40	
4541	LM324	1.20	CA3130T	1.40	7480	.65	74LS20	.40	
4543	LM325	3.10	CA3130E	1.80	7482	1.80	74LS21	.40	
4553	LM329-DZ	1.40	CA3140	1.40	7483	.80	74LS22	.40	
4555	LM334-Z	1.30	3401	.70	7485	.80	74LS26	.40	
40097	LM335	12.40	3611	1.10	7486	.60	74LS28	.40	
40098	LM336-Z	3.20	LM3900	.90	7489	2.60	74LS30	.40	
40175	LM339	.90	LM3909	1.00	7490	.70	74LS32	.40	
74C SERIES	LM348	1.10	LM3914N	3.90	7491	.55	74LS33	.40	
74C100	LM349	1.80	4136	1.40	7492	.60	74LS37	.50	
74C02	LF351-N	.70	LM4250	1.75	7493	.60	74LS38	.50	

OIP SWITCHES SPST			18 Pin		22,000uf		25V		12.90	
P/N	No. Switches	Price	20 Pin	1.80	1.60	22,000uf	40V	23.00		
SD3	3	1.60	22 Pin	1.90	1.70	27,000uf	35V	23.50		
SD4	4	1.70	24 Pin	2.00	1.80	33,000uf	16V	23.50		
SD5	5	1.90	28 Pin	2.20	2.10	68,000uf	16V	21.50		
SD6	6	2.30	36 Pin	2.60	2.40	100,000uf	10V	20.50		
SD7	7	2.40	40 Pin	2.90	2.70					
SD8	8	2.50								
SD9	9	2.70								
SD10	10	3.00								

WIRE WRAP 3-LEVEL			COMPUTER GRADE ELECTRO.		MULTISTRAND RIBBON CABLE		
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14 Pin	1.10	10-25	6800uf	16V	6.40	10 Way	.80
16 Pin	1.20	1.70	10,000uf	16V	9.00	12 Way	1.00
			10,000uf	25V	9.50	16 Way	1.20
			10,000uf	40V	11.90	20 Way	1.70
			15,000uf	40V	12.00	40 Way	3.20

74LS40	.50	81LS97	2.10	2N5874	1.40	TIP32C	1.00	8295	25.00
74LS42	.75	TRANSISTORS		2N5961	.30	TIP33A	1.10	DM8578	3.50
74LS47	.85	2N301	2.20	2N5963	1.10	TIP34A	1.20	Av-5-2376	19.56
74LS48	1.00	2N657	.60	2N6027	.60	TIP24B	1.50	8748A	99.00
74LS49	1.00	2N930	.60	3N201	.90	TIP42B	1.10	8755A	99.00
74LS51	.40	2N1613	1.10	AC127	.70	TIP110	1.30	MCT2	.80
74LS54	.50	2N1711	.50	AC128	.70	TIP120	1.30	MCT6	3.30
74LS55	.55	2N1893	1.00	AC187	.70	TIP2955	1.20	MCT275	1.50
74LS58	.65	2N2219A	.60	AC188	.70	TIP3055	1.20	MCC671	3.00
74LS73	.55	PN2222	2.00	AD149	2.50	VN88AF	2.50	4N28	.85
74LS74	.60	PN2222	.30	AD161	1.70	MICRO CHIPS		4N33	1.20
74LS75	.45	2N2463	.35	AD162	1.70	ADCO 800	12.00	4N26	.85
74LS76	.50	2N2484	.65	BC318	.30	DACO 080	2.00	MM80C95	.90
74LS78	.50	2N2646	.70	BC319	.10	2012 200 NS2.00		80C96	.90

Ideas for Experimenters

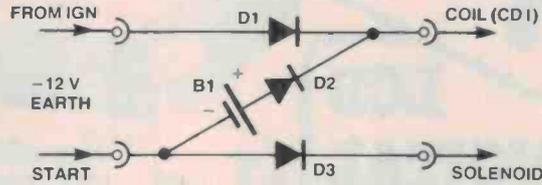
The cold start booster

If you're a skiing enthusiast and you've been caught in sub-zero temperatures with a reluctant ignition then you'll appreciate this little circuit. Originally designed to cure cold starting problems encountered with a CDI kit, it adds an extra six volts to the ignition circuit potential just at the time when the battery voltage is likely to be at its lowest. The circuit uses a diode switching network to provide an alternative starting circuit to the ballast resistance and low resistance coil circuit found in various makes of cars.

It works as follows. The battery voltage, B1, is switched in series with the car battery when the starter solenoid is energised, providing the extra boost. Diode D1, being reverse biased, isolates the boosted voltage from the rest of the car's 12 V circuitry. Diode D3 prevents B1 discharging via the coil (or CDI) and

IDEA OF THE MONTH WINNER

John Blyth, Mordialloc, Vic.



D1, D2, D3 400 V, 5A 1N5625 or sim.
B1 6 V lantern battery type 509 or 609
Reverse all polarities for +ve earth

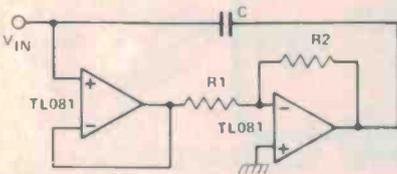
the starter solenoid. Diode D2 prevents B1 being charged via the starter solenoid.

Fail-safe operation is assured because if B1 fails the ignition circuit is energised the normal way via D1. In my circumstances I had a lantern battery on hand which fitted snugly under the dash and was connected via alligator clips for easy replacement. I used automotive terminals for the connections to the car's electrics, enabling the booster

circuit to be inserted between the ignition switch terminals and the normal leads.

A possible modification for those who wish to use a rechargeable battery would be to add a bleeder resistor in parallel with D2 to trickle-charge B1 while the car was running.

The circuit has been running reliably since last winter with sure-fire starts every time.



Capacitance multiplier

When an audio circuit calls for a large-value capacitor — such as in a filter — then this circuit can substitute for those very difficult to get, expensive, high-value capacitors. The circuit only synthesises the required impedance, it will not store energy.

The input, at V_{IN} , looks like a capacitor (C_{IN}) and you can calculate its value from:

$$C_{IN} = C(R1 + R2)/R1$$

Note that TL071 or NE5534 op-amps could be substituted for the TL081 specified.

★ 'IDEA OF THE MONTH' CONTEST ★

Scope Laboratories, who manufacture and distribute soldering irons and accessory tools, have offered to sponsor a contest with a prize to be given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI. Each month we will be giving away a Scope Panavise pc board holder, model 333 — as described in News Digest, p.8, October '81 issue. Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, worth about \$70, each winner will be paid \$10 for the item published. You must submit original ideas of circuits which have not previously been published. You may send as many entries as you wish.

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Scope Laboratories, Murray Publishing, Offset Alpine, Australian Consolidated Press and/or associated companies.

Closing date for each issue is the last day of the month. Entries received within seven days of that date will be accepted if postmarked prior to and including the date of the last day of the month.

The winning entry will be judged by the Editor of ETI, whose decision will be final. No correspondence can be entered into regarding the decision.



Winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries.

Entrants must sign the declaration on the coupon that they have read the above rules and agree to abide by their conditions.

COUPON

"I agree to the above terms and grant Electronics Today International all rights to publish my idea in ETI Magazine or other publications produced by them. I declare that the attached idea is my own original material, that it has not previously been published and that its publication does not violate any other copyright."
* Breach of copyright is now a criminal offence.

Title of idea
Signature
Name
Date
Address
Postcode

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

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P&P \$4.00

Still only **\$49⁵⁰**

27MHz TX/RX TESTER



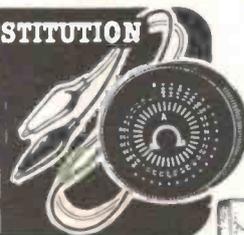
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This set has been specially developed for the servicemen to facilitate the location of faults in hand held transceivers etc. Now everyone can afford this luxury! This compact portable unit is a must for every amateur enthusiast. Call in and check out the tremendous features it has to offer!

RESISTANCE SUBSTITUTION WHEEL

Much cheaper than decade box - and just as useful!

Cat. Q-1410 **\$17⁹⁵**



LOGIC PROBE

A superb time-saving tool for the hobbyist, technician etc. Hooks onto the circuit under test for its power. Many other features.

Cat. Q-1272 P&P \$3.00



\$28⁵⁰



AT LAST! An affordable FREQUENCY METER 600MHz — 7 Digit

Don't be confused by the size and weight of the unit — it is NOT a toy! In fact it is a sophisticated piece of test equipment that every hobbyist can afford. Consists of a full 7 digit counter, with variable gating times and 3 ranges — 6MHz, 60MHz and 600MHz. Battery operated so it's with you wherever you go. A must!

\$205

Cat. D-3000 P&P \$5.50

SUPERB VALUE!

100MHz PROBE SET

Normally used for CROs, but ideal for above counter on a x1 scale. At a bargain price compared to other probes.

\$35⁵⁰

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PRO QUALITY FOR THE KEEN AMATEUR!

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P&P \$2.00



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Cat. Q-1010 P&P \$2.00

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LOOK AT THIS FANTASTIC Syringe action hook probe

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MINI ALLIGATOR CLIPS Fully insulated with plastic shroud, easy to solder to. Two colours available **28c each**

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Cat. W-4572

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A pair of red and black leads, one metre long with matching IC test clip at each end.

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OSKER BLOC This is a truly professional instrument that uses the Through-Line principle. Covers 3MHz to 200MHz. Each unit is individually calibrated with a chart attached to the instrument. **\$91⁵⁰**



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Cat. Q-1200 **\$72⁰⁰**

P&P \$4.00

For the professional who wants the lowest circuit loading. incredible 10M imp. (DC) even has centre zero range!

PRICES & MONTHLY SPECIALS MEANS THAT THE TIME TO BUY!

**SUPERB
VALUE!**

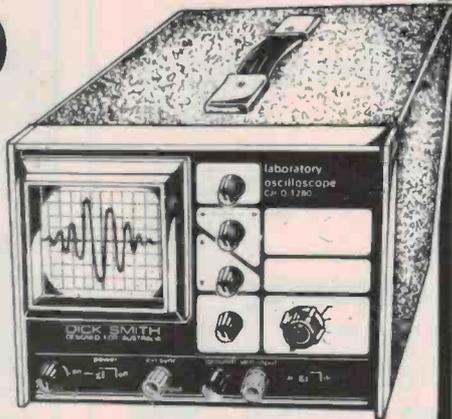
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**6.5MHz
75mm**

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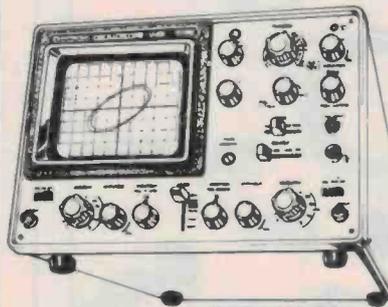
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HITACHI CRO



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TWO TOP METERS FROM DICK SMITH

Q-1140 PRO QUALITY METER

This handy little unit is virtually a test bench in one small package! Not just a sensitive (100k/V) multimeter.

This one checks transistors and measures capacitance etc. Fuse and diode protection of the movement. If you want a multimeter that will do just about anything. — look no further! Complete with battery, test leads, and full instructions.

\$74⁵⁰

Cat. Q-1140 P&P \$4.00



59⁰⁰

This unit is similar to the one above except for a few minor differences i.e. does not have capacitance checking facilities, nor does it have a 250mV DC position. But the really good news is that it's CHEAPER!!

Everything else is much the same, so it is up to you — the money or the best!

**UNBELIEVABLE
VALUE!!!**

**SUPERB
VALUE!**

100MHz CRO PROBE

This incredibly versatile probe set is so good we thought we'd mention it twice! Ideal for any CRO and comes with an abundance of accessories!



Cat. Q-1245
P&P \$3.00

\$35⁵⁰

CRO Adaptor

Plugs into the Dick Smith CRO enabling accessories from more expensive sets to be used.

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Cat. Q-1281



HANDY METER CARRY CASE

This offers more than just protection for your valuable meter. Also keeps your leads and instructions tidy and gives you room to store notes etc. Suits models Q-1136, Q-1140 & Q-1024.



\$14⁹⁵

Cat. Q-1137 P&P \$2.00

Multimeter RF Probe

Extend the useful range of your multimeter with this neat probe.

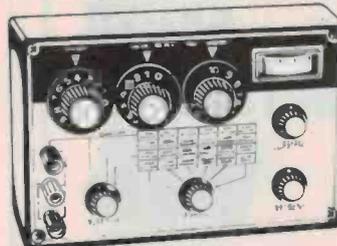
\$17⁹⁵

150kHz — 30MHz P&P \$2.00



Cat. Q-1138

HIGH ACCURACY AC BRIDGE



Better than a multimeter... with this Bridge you can accurately and easily measure inductance, capacitance, resistance, compare unknown components etc. Easy to use and very affordable!

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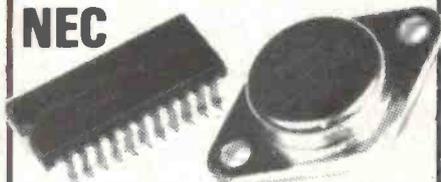


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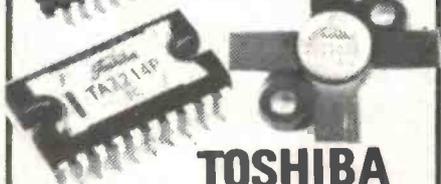
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SANKEN



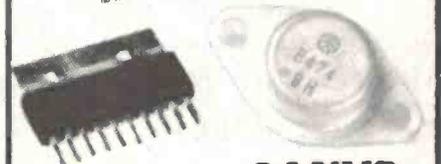
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'BLUEPRINT'

The standard 5000 pre-amp is available at \$245 — no more than others but still better.

It is pleasing to see that many, many hundreds of Australians appreciate a quality kit when they see IT. The 5000 MOSFET P.A. and Pre-amp are so good they are attracting International interest. (We will be exporting our first shipment of these to - would you believe an Asian country - as you read this). Many people still can't comprehend their current performance specs make them the BEST amps in the WORLD.

WRITE FOR A FREE LEAFLET Specs aren't needed when you can say 'BEST'

Sub-Woofer Sensation



Many of you have followed the recent articles in EA regarding the design of vented loudspeaker enclosures. The natural progression of this discussion was a description of a vented speaker system. At the same time we were concerned that the most critical component, the low frequency driver must be of high quality with consistent Qt and Vas. Jaycar has had such a speaker model The unit has been specially manufactured for us to our specs. It is ideal for subwoofer applications based on the work of Thiele, Small and Snyder.

SPECS: Diameter 10" (250mm) cast frame * QT = 0.39 * VAS = 631 * Power Handling: 100W (RMS) * Voice Coil = 2" (51mm) dia. * Magnet Assy. = 3kg (6.6lbs).

Because of bulk buying we have been able to bring this unit to you at an unbelievable price. Normally this unit would sell for well over \$100 (they are overseas).

THE INTRODUCTORY PRICE FOR THIS UNIT? ONLY \$79.50 A FREE SUBWOOFER CABINET DESIGN IS PROVIDED WITH EACH UNIT!

ONLY \$79.50 ea

New EA FUZZ BOX \$19.50

Ref: EA Feb '81

COMPLETE KIT

The engineers at Jaycar have come up with a great version of this versatile kit. The kit features a heavy duty footswitch — a must for the serious stage muso.

ETI 158 LOW OHMS METER Ref: Nov '81 ETI \$29.50

This extremely handy kit is now available from US. Even capable of testing dry solder joints!! Complete kit inc. case & large meter.

Drum Synthesiser Kit



As used by WARREN CANN of "ULTRAVOX"

Original design from the UK magazine "Electronics and Music Maker" April 1981. Self-contained unit produces a variety of fixed and falling pitch effects. Trigger by tapping the unit itself or by striking a drum to which the unit is attached. The Jaycar "SYNTOM" comes complete with high quality pre-drilled moulded all ABS box 152 x 80 x 47mm with professional silk-screened front panel.

FEATURES: Decay from less than 0.1 second to several seconds, pitch control, sweep control and volume on/off.

\$36.50

EA dual tracking P/S



\$84.50

1% resistors used NOT 2%.

Ref: EA March '82

At last!! A dual-tracking power supply with fixed +5V reg. at a reasonable price!!

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More Yaesu FRG-7's are in use throughout the world than any other communications receiver. Check these outstanding features

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- Operates from 100/120/220/240V AC or 13.5V DC
- Weighs only 2kg, size 34 X 15 X 29cm.
- 21C, 22 transistor & 16 diode circuitry

D-2850

~~WAS \$499~~ **LAST YEAR!**

ONLY \$359⁰⁰
SAVE \$40

DICK SMITH Electronics
Australia's largest supplier and Yaesu factory approved distributor & service centre.

Yaesu's brilliant FRG 7700/SW



There's not much we need to say about this outstanding receiver: let the features speak for themselves

- 2MHz - 30MHz continuous!
- All mode - including FM (great with converters)
- Digital frequency readout, with digital clock.
- Superbly easy to operate: set pre-selector, then tune!
- Timer for tuning receiver on/off, plus control of external equipment eg. (tape recorder)

D-2841

EXCLUSIVE TO DICK SMITH

NEW ONLY \$499⁰⁰

OPTIONAL MEMORY UNIT

Gives you single button recall of any of 12 chosen frequencies. Great for monitoring, 'skeds' etc. Simple connection, instructions inc. **\$149⁸⁰**

D-2842

The FRG 7700 is an ultra compact antenna tuner. Designed to operate from 150kHz - 30MHz, it will provide the proper impedance for the receiver, rejecting unwanted signals. Also has a built-in 60dB max. attenuator plus a two-section lowpass filter aid for rejection of strong signals above 2MHz.

Antenna Tuner \$81⁸⁰

D-2843

FRV 7700 VHF 2-6 metre converter

Increase the listening range of your FRG-7700 with this high performance frequency converter. You'll be able to listen to all the amateur activity 'up top', plus aircraft & land mobile stations, etc. Makes great VHF listening!

ONLY \$124⁸⁰

D-2844

NEW! NEW! NEW!

VHF Handy FM Transceiver FT-208R

The FT-208R transceiver brings a new flexibility to today's active 2M operator. An easy to read LCD display is coupled with a 4-bit microprocessor, bringing 10 memories & a scanning function. Only with Yaesu can you get these features at such an economical price. Check it out NOW!

ONLY \$368

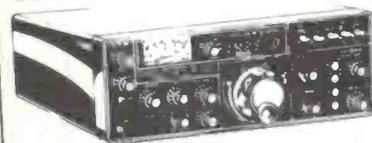
INC. CHARGER

Cat D-2889



TEN MEMORIES & SCAN FACILITIES

TOP OF THE RANGE SSB/HF transceivers



FANTASTIC FT-107 DMS

This has to be Yaesu's finest transceiver. A masterpiece of solid state engineering you only have to take the cover off to see the thought & care that has gone into its design. Full band coverage, of course - in all modes (FSK included). A massive 240W PEP input, with features like RF speech processor, variable bandwidth, superb noise blanker PLUS 12 channel memory. The FT-107 is everything you want from a transceiver and a little bit more.

D-2871

ONLY \$1328

Antenna Coupler FC 107



D-2873

Problems with antenna mis-match on your FT-107? Not with this superb coupler. Designed to match the 107 styling, but just at home with any transceiver. Huge meters for power output and SWR. Superb quality!

ONLY \$205

FT-902D our most popular HF transceiver



D-2853

The FT-902D has just about everything you've ever wanted in a transceiver. All modes (yes, even FM - great with transverters), & all bands from 160 to 10M (including WARC). You get digital readout, RF speech processor, rejection tuning, 180W PEP input etc etc. So come in to one of our stores & check it out & ask for your free brochure.

ONLY \$1195

Antenna Coupler FC 902



D-2855

This coupler can feed anything from a random length of wire to a beam. Match the load perfectly so you can deliver more power up there where it's wanted! Suits all bands, has built-in SWR/pwr meter as well. 50 or 75 ohm system, 500W rating.

ONLY \$265

D-2855

MOBILE CHARGER

D-2894



The Yaesu PA-2 is a mobile charger, come pwr supply. Suited for the FT207R & FT208R. Uses the power from your 12V battery when mobile. Also recharges nicads in your battery pack.

ONLY \$29⁹⁵

NEW! NEW

2 METRE PORTABLE

FT 290R



ALL MODE
FM/SSB/CW

The FT-290R is a highly sophisticated compact multi-mode transceiver for the 2M amateur band. Featuring PLL synthesis in 100Hz, 1KHz, 5KHz, or 10KHz steps. The FT-290R utilizes a Liquid Crystal Display for digital readout for the operating frequency. 10 memories, scanning of the band or memory channels, two VFOs, & receiver offset tuning makes the FT-290R a significant breakthrough in technology.

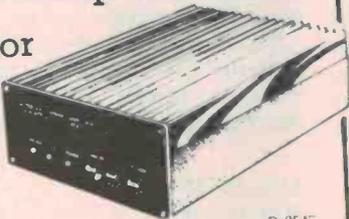
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NEW! NEW

VHF Power boosted

linear amp FL-2050

Ideal for
all 2M
rigs



D-2547

Add this to your hand held for real mobile power. Also suitable for SSB, CW, AM etc. Operates from 13.6V DC up to 15W input for maximum power. Includes 12dB receiver pre-amp, with automatic transmit receive control.

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DICK SMITH WILL BEAT ANY
GENUINE PRICE ON
YAESU EQUIPMENT

Mobile or base



D-2869

FT707

Yaesu has used the 'state of the art' technology & put it into such a tiny package. Yes, it's the brilliant FT-707. This little wonder contains all the outstanding features that most big rigs lack. It's a full power, all HF band (inc. WARC) multi mode transceiver. You get digital readout, LED S/power meter, push button operation all the things the amateur needs for safe reliable operation. You've waited a long time for a rig like this, so take the splurge now, it's well worth the money.

ONLY \$795

Antenna Coupler

Get the most from your FT-707, use the Yaesu FC-707 antenna coupler & ensure your transceiver always delivers the power it should. Has all the features you need. pwr/SWR meter, in-built dummy load, all band coverage (including WARC), less than 0.5dB insertion loss.

D-2875

ONLY

\$149⁸⁰

Base operation?

Just add the FP-707 mains supply & you're away. You get fully regulated 13.5V at 20A. Has plug-in connections so you can't cause problems, plus you get an extra speaker - for greater clarity. D-2895

ONLY

\$175

Digital VFO



Long n' slim - intended to sit under the 707. 12 memories, up/down scanning in 10Hz steps & receiver offset tuning. Power by FT-707. D-2896

ONLY

\$299⁸⁰

Mobile bracket

Don't let your valuable 707 jump all around the car. Fit it in this superb mounting bracket for safety & security. Also holds the digital VFO. A must for the serious mobile operator. D-2897

ONLY
\$36

Yaesu's top 2 metre

FT 480R has

FM/CW & SSB

10% OFF



Yaesu call this their 'total performance VHF computerised transceiver.' And total performance it is! As the top-of-the-line Yaesu 2M family you'd expect a lot. You get FM, SSB CW over the full 2M band, with two VFO's, four memory channels, scanning, digital readout, hi/lo power switch & much, much, more. To sum it up in one word, superb!

D-2887

ONLY \$525

NEW!

FT 101Z FM

The famous FT101Z plus
FM at a bargain price! **\$885**

D-2872

DC-DC Inverter

Want to go mobile? Add this superb DC/DC inverter to your car battery (13.5V nominal). Don't tie yourself to your shack - get out to where the DX is great!

D-2864

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FL-2100Z 1.2kW Linear Amp

If you want a linear amp, built like a 'power house', that gives you a clean, strong signal, try the new WARC FL-2100Z. Australian amateurs can be assured that at our maximum legal limit of 400W PEP the FL-2100Z is just 'coasting' resulting in years of extra life. It features twin cooling fans for reliable operation & gives plate voltage, VSWR & DC readings from its two large meters. Suits virtually all amateur transceivers on the market.

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D-2548

DSE/A180/PA1

AMATEUR CALLBOOKS

Foreign Radio (Not incl. USA)

The Foreign Callbook contains over 300,000 licensed radio amateurs in countries all over the world, giving call letters, name and address. Ideal for DXers. **\$21.95**
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Shoparound

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

ETI-607F Prop. aircraft

Another project in the ETI-607 Sound Effects series. The printed circuit board is common to each project in this series — all you have to do is obtain the pc board appropriate to the package for IC1 (SN76488) in the project. As explained in the article, these ICs come in two sizes — the A pack and the NF pack. The pc board appropriate to each pack is marked in the same way.

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Fairfield. NSW.

ETI-499 MOSFET PA

Components and kits for this project should be widely available. The 2SK134 and 2SJ49 MOSFETs have been available from a wide variety of suppliers for at least a year now — and prices have been coming down. The Elna 8000u/75 V electrolytic capacitors used for power supply filtering are also widely stocked. When originally introduced, these were around 100 mm tall but were subsequently reduced to 60 mm by the manufacturers. We recommend you use the latter.

You may find heatsinks a little harder to get than the rest of the components for this one. However, we have found Philips' 65D6CB heatsink stocked by Rod Irving Electronics in Melbourne, plus Electronic Agencies and Jaycar in Sydney. Series 5000 heatsink panels are currently on special at \$20 — see page 49.

ETI-479 Bridging module

Another project using 'common-as-dirt' components. We'd be very surprised if you had trouble finding components for this one. Note that either NE5534N or NE5543AN ICs may be employed, but there's no advantage in using the more expensive 'AN' types.

York Street Smorgasboard!

The Town Hall end of Sydney's York Street will turn into an electronics enthusiasts' smorgasboard this month! Electronic Agencies and Jaycar will both move in. Dick Smith's store is centrally located at 125 York Street. Immediately on the left hand side is David Reid Electronics and a few steps further on is a Tandy store — both at 127 York Street. Electronic Agencies will now occupy 123 York Street, to the right of Dick Smith, and Jaycar will occupy 125 York Street, immediately above.

In future, in this column, when we say "... parts obtainable in York Street, Sydney ...", you'll understand what we mean!

PC Boards, panels etc.

Almost every pc board ever published by ETI may be obtained from the following firms:

RCS Radio
651 Forest Rd
Bexley NSW 2207

All Electronic Components
118 Lonsdale St
Melbourne Vic. 3000

In addition, many of our boards are stocked by Radio Despatch Service or, if they haven't got your requirements in stock, can have them made to order for you. Here they are:

Radio Despatch Service
869 George St
Sydney NSW 2000

The same three firms can provide front panels for our projects, too.

For the projects we've done over the past three or four years, many (if not most) pc boards and panels may be obtained through the following firms:

Mini Tech
P.O. Box 9194
Auckland N.Z.

James Phototronics
522 Grange Rd
Fulham Gardens S.A. 5024

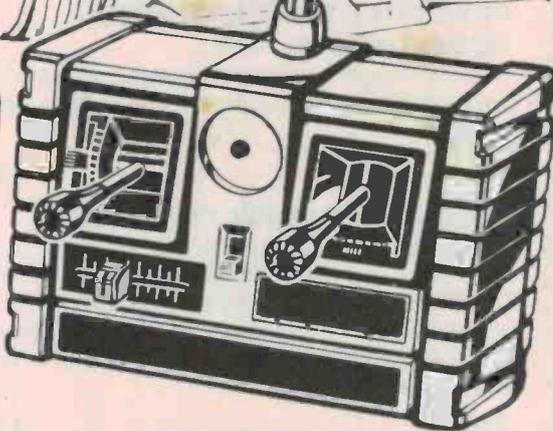
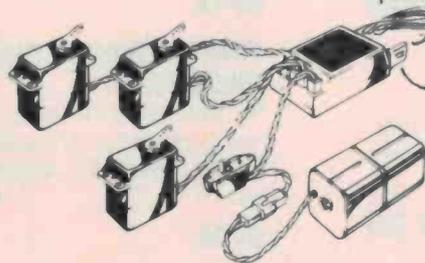
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NOW the low cost answer to model control

The DICK SMITH three channel digital proportional radio control



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

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

GET INTO RADIO CONTROL MODELS NOW!

**A MASTERPIECE IN
STATE-OF-THE-ART RADIO
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Complete with transmitter;
receiver, battery holder, 3 servos

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\$100 BARRIER**

only \$99

Cat Y-1230

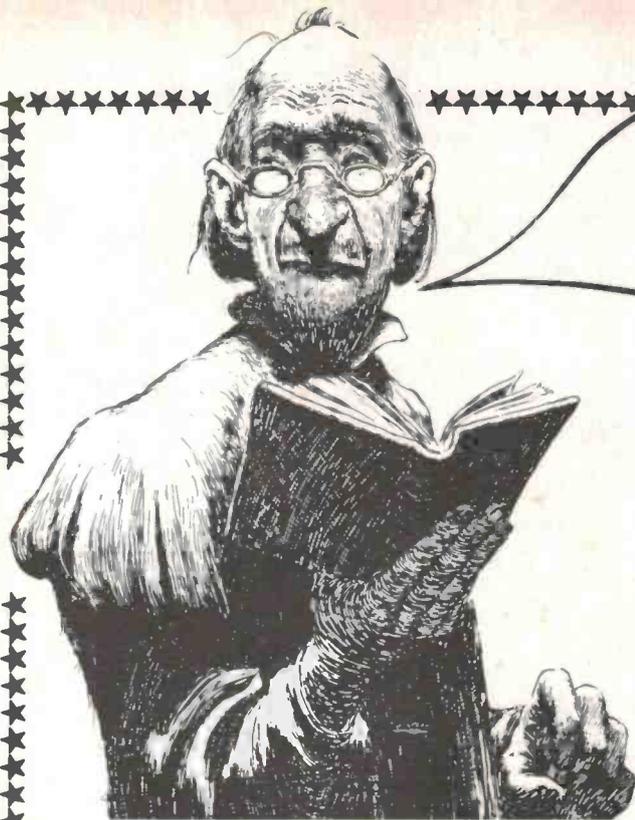
P&P \$4

DSE/A182/PAI

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Electronics



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"I must not read Babani Books
in class."**

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NOVELTIES FOR HI-FI**

Circuits for audio power meter, stereo phone adaptor, multi-channel mixers, gain control, contour network etc. etc.

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A number of novelty projects using modern ICs and transistors. Includes Optomin — a musical instrument played by reflecting a light beam with your hand, water warbler for pot plants, music tone generator, LEDs and ladders game, touch switch, electronic roulette wheel, etc.

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Introduction to digital ICs (mainly TTL7400). Besides simple projects, includes logic test set to identify and test digital ICs. Also includes digital counter-timer.

225 **\$4.20**

**HOW TO BUILD ADVANCED
SHORT WAVE RECEIVERS**

Full practical constructional details of receivers with performance equal to commercial units. Also add-on circuits of Q meter, 5 meter, noise limiter etc.

226 **\$4.05**

**BEGINNERS' GUIDE TO BUILDING
ELECTRONIC PROJECTS**

Enables total beginners to tackle electronic projects. Includes component identification, tools, soldering, building methods, cases, legends etc, etc. Practical basic projects are included.

227 **\$4.20**

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& TRANSMITTING TUBE &
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Equivalents book for amateurs and servicemen. More than 18 000 old and new valves from UK, USA, Europe, Japan et al. CV (military) listings with commercial equivalents included.

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Data on devices not included in BP1. This book supplements BP1, i.e. no data is duplicated.

BP14 **\$4.05**

**FIRST BOOK OF PRACTICAL ELECTRONIC
PROJECTS**

Full constructional data, circuits, components lists for many practical projects including audio distortion meter, super FET receiver, guitar amp, metronome, etc.

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**GIANT CHART — RADIO, ELECTRONICS,
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Identify those symbols at a glance. A must for beginners and advanced enthusiasts alike. Professionals can always hide it in their desks! A steal at only . . .

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Equivalents and pin connections of popular user-oriented digital ICs. Details of packaging, families, functions, manufacturer and countries of origin. Includes Fairchild, Ferranti, Harris, ITT, Motorola, National, Philips, RCA, Signetics, Sescocem, SGS-Ates, Siemens, SSSI, Stewart Warner, AEG-Telefunken, Texas, Teledyne. Companion volume to BP41.

BP40 **\$8.45**

**LINEAR IC EQUIVALENTS
& PIN CONNECTIONS**

Similar to BP40 but deals with linear ICs.

BP41 **\$9.25**

IC555 PROJECTS

One wonders how life went on before the 555! Included are basic and general circuits, motor car and model railway circuits, alarms and noise makers plus section on subsequent 556, 558 and 559s.

BP44 **\$6.45**

HOW TO BUILD YOUR OWN SOLID-STATE OSCILLOSCOPE

Project divided into sections for builder individually to construct and test — then assemble into complete instrument. Includes short section on scope usage.

BP57 **\$5.05**

SECOND BOOK OF CMOS IC PROJECTS

Leading on from book number 224 '5U CMOS IC PROJECTS', this second book provides a further selection of useful circuits mainly of a fairly simple nature. Contents have been selected to ensure minimum overlap between the two books.

BP59 **\$5.05**

ELEMENTS OF ELECTRONICS

This series provides an inexpensive intro to modern electronics. Although written for readers with no more than basic arithmetic skills, maths is not avoided — all the maths is taught as the reader progresses.

The course concentrates on the understanding of concepts central to electronics, rather than continually digressing over the whole field. Once the fundamentals are learned the workings of most other things are soon revealed. The author anticipates where difficulties lie and guides the reader through them.

BOOK 1 (BP62): All fundamental theory necessary to full understanding of simple electronic circuits and components.

BOOK 2 (BP63): Alternating current theory.

BOOK 3 (BP64): Semiconductor technology leading to transistors and ICs.

BOOK 4 (BP77): Microprocessing systems and circuits.

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This series constitutes a complete inexpensive electronics course of inestimable value in hobby or career.

Books 1/2/3 **\$7.60 (each)**

Books 4/5 **\$9.95 (each)**

SINGLE IC PROJECTS

Simple to build projects based on a single IC. A few projects use one or two transistors as well. A strip board layout is given for each project plus special constructional and setting up info. Contents include low level audio circuits, audio power amps, timers, op-amps and miscellaneous circuits.

BP65 **\$5.05**

REMOTE CONTROL PROJECTS

Covers radio, infra-red, visible light, ultrasonic controls. Full explanations are provided so that the reader can adapt the projects for domestic and industrial as well as model use.

BP73 **\$6.60**

POPULAR ELECTRONIC CIRCUITS — BOOK 1

Yet more circuits from Mr Penfold! Includes audio, radio, test gear, music projects, household projects and many more. An extremely useful book for all hobbyists offering remarkable value for the designs it contains.

BP80 **\$6.60**

ELECTRONIC PROJECTS USING SOLAR CELLS

Well-known author Owen Bishop has designed a number of projects that benefit from solar power and obviate the problems encountered with batteries, such as weight and bulk, frequency of replacement, and failure when batteries are exhausted.

BP82 **\$7.15**

DIGITAL IC PROJECTS

Companion to No. 255 Practical Introduction to Digital ICs and BP61 Beginners' Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included. The more ambitious projects have been designed to be built and tested section by section to help the constructor avoid or correct any faults that may occur.

BP84 **\$6.40**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE

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

BP85 **\$9.95**



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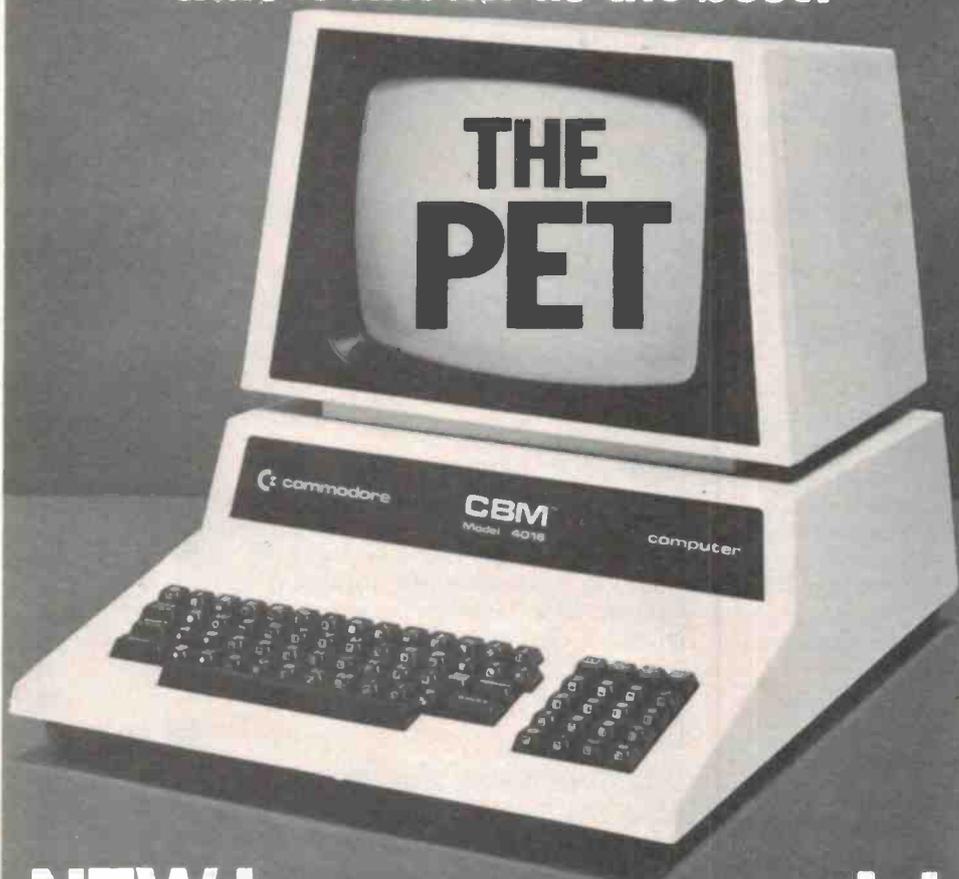
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**NEW large screen model.
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Stop fooling around with mere toys! Get a real computer for the same price or even less. Get a Commodore PET Computer.

New generation PET Computer has all the features and more of the previous top-selling model that revolutionised the computer world. Your new PET has large crisp characters on a 12 inch green phosphor screen - no more eye strain! Other new features include an electronic end-of-line bell; the ability to erase all or part of a line; screen tabulation; and extra repeating keys.

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For details of your local dealer send to:

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PET 4016

FEATURES

The PET 4016 offers an IEEE parallel port and an IEEE-488 bus for disk and printer communications. Also included is an eight bit parallel user port with "handshake" lines. The PET supports two Commodore C2N cassette ports for external cassette input and output. Each PET 4016 includes 18K of ROM containing BASIC and a machine-language monitor. The BASIC interpreter is activated when you turn on your PET 4016 - no loading is necessary.

12" SCREEN

40 characters wide by 25 lines long.
128 ASCII plus 128 graphic characters
8x8 dot matrix characters
Green phosphor screen.
Brightness control.

KEYBOARDS

74-key professional keyboard.
Separate calculator/numeric pad.
Upper-case alphabetic characters.
Shift key gives 64 graphic characters.

MEMORY

PET 4016: 16K (15359 net) random access memory (RAM).

POWER REQUIREMENTS

Volts: 240v
Cycles: 50HZ
Watts: 100

SCREEN EDITING CAPABILITIES

Full cursor control (up, down, left, right).
Character insert and delete
Reverse character field
Overstriking
Return key sends entire line to CPU regardless of position

INPUT/OUTPUT

Parallel port
IEEE-488 bus
2 cassette ports
Memory and I/O expansion connectors

FIRMWARE

18K of ROM contains:
BASIC (version 4.0) with 9-digit floating binary arithmetic
Tape and disk file handling
Machine language monitor

PHYSICAL SIZE

Height: 14"
Width: 16.5"
Depth: 18.5"
Shipping Weight: 46lbs

COMPUTING TODAY

Grab for the handheld market

Tandy, Matsushita, Sharp and Mitsubishi have all launched powerful new handheld micros in recent months, presumably aimed at the business and professional market.

The Sharp PC 1500 is a more powerful version of their PC 1211, having 2.6K of RAM and 16K of ROM, RAM being expandable to 16K with 4K modules. It has a 7 x 156 dot matrix liquid crystal display and includes an extended BASIC interpreter. The unit has a 65-key alphanumeric keypad with six programmable function keys, 18 soft keys and 10 preprogrammed command keys.

The display can show up to 26 upper and lower case alphabetic characters, numbers and graphics, as well as special characters. Other features include a built-in real time quartz clock, 60-pin I/O buss connector and an add-on RS-232 interface.

A printer/plotter, which includes a cradle in which the micro may sit, is said to include the ability to plot full X/Y/Z graphics in full colour and print text in nine different character sizes ranging from four to 36 characters per line using 2.25-inch-wide paper. Point-plotting resolution was given as approximately 200 x 500 points.

Sharp is 'private-labelling' the new Tandy handheld, called the PC-2. Tandy say the BASIC interpreter in the handheld has programming features equivalent to their Model III TRS80. They also say software for the PC-2 will be provided both on standard audio cassettes — with the printer/plotter interface capable of handling up to two tape decks simultaneously — and on the plug-in modules.

The PC 1500 from Sharp and the PC-2 from Tandy-Radio Shack should be available around mid-year.

Matsushita finally released their handheld, called the 'Link', last November, having introduced it almost two years earlier. It will be marketed here through The Compu-



The unusual Mitsubishi handheld computer.

ter Company (a subsidiary of Singer), and should be available very shortly.

The unit has six interface slots for the attachment of peripherals — which include a modem, a video adaptor (to drive a VDU) and a printer.

Measuring only 227 by 30 by 95 mm and weighing just 397 grams, the Link has a 6502 microprocessor running at 1 MHz. Prominent features include:

- 5-key keyboard with two-key rollover.
- Uninterrupted storage of all user programs and other data through use of a unique 'power-down' circuit.
- 2K of programmable memory, expandable to 4K internally or any practical limit (up to a theoretical limit of 4M) externally, by adding programmable memory peripherals.
- 16K of internal ROM (read-only memory) with sockets for four program capsules containing up

to 64K of application programs or data (additional ROM, up to a theoretical limit of 4M, can be added externally).

- A built-in nickel-cadmium battery pack.
- An internal set of application programs that includes a four-function calculator, a free-form file system and editor, and several other functions.

In addition, the capabilities of the Link are greatly extended by an integrated system of intelligent peripherals that include:

- A buss expander through which other modules are connected.
- A portable thermal printer capable of 16 characters per line.
- A ROM extender for an additional four program or data capsules.
- A programmable-memory extender.
- A 110/300 bps modem and telecomputing program through which the Link can act as a remote terminal to other computers and

to large information utilities and databases.

- A cassette interface module that transfers data to a microcassette recorder at 1200 bps.
- A colour television interface that allows a display of 16 lines of 32 characters each or up to 48 by 64 pixel (picture element) graphics in eight colours and black.

When connected, all the above peripherals can fit in a custom case the size of an average attache case, or they can be interconnected to make a flat, rigid, easily portable combination. With the exception of the colour television interface, the Link and the peripherals can operate without connections to any outside power source.

The largest of the new handhelds is the Mitsubishi, being about the same size as a portable transistor radio. It employs an 8-bit microprocessor and incorporates 30K of RAM and 1M of plug-in bubble memory.

Weighing less than 1.5 kg, it features separated alpha and numeric keyboards and a 40-character, 5 x 7 dot matrix display. The alpha keyboard has an 'a-b-c' layout — presumably more easily learned and operated by non-typing personnel.

The Mitsubishi handheld computer is already in extensive use in the US, according to John Barsing of The Computer Company.

Applications for it include stock control, van sales activities and meter reading by public utilities.

In use by several US gas companies, information can be down-line loaded into the computer from a mainframe detailing instructions to meter readers. Meter data can either be captured for later mainframe processing and invoice generation or, using a portable printer, an invoice can be produced on the spot.



APPLIED TECHNOLOGY



Do you want to know why **MicroBee is the best investment in personal micros available today? Then you need our 32 page 'Ideas Book'.**

The Ideas Book, published as an insert in February 'Your Computer' magazine is now available separately. Just send 50¢ to cover post and packing, and we'll rush your copy to you. The book shows how MicroBee works, how it can be programmed using its fantastic 16K BASIC, as well as a variety of software ideas which illustrate the power and usefulness of the MicroBee. If you want to know about the most advanced kit Micro around, you owe it to yourself to find out about MicroBee.

MicroBee - Superbly Expandable

The problem with most personal micros, such as the TRS80 and APPLE lies not such much in the basic machines, but in the cost of expansion. Once you have mastered the base machine, getting it to do any more is very expensive. MicroBee gets around this by having a special plug-in top board. We call it the Core Board. The MicroBee is supplied as standard with a Core Board which takes up to 32K RAM (16K supplied), 16K ROM BASIC, and a further 12K ROM (for Monitor Program, Networking ROM, or your own custom ROM programs). A factory change fits a new Core Board so you have 48K RAM, an 80x24 screen format, and are ready to run CP/M 2.2 with disc drives. MicroBee is a new generation design. It is designed to grow painlessly in the ways we have found most computer enthusiasts will want to move.

Software Growth.

Because it's Z80 based, MicroBee has a huge software base. And its a base which we're improving all the time. MicroBee runs all the MicroWorld BASIC software, plus material specially developed for it. New releases for March include:-
Editor Assembler in ROM. Write machine code software on your MicroBee. BEEBUG monitor lets you examine and modify memory. Supplied with full operator's manual. Preprogrammed ROMs fit straight onto your MicroBee **\$49.50**

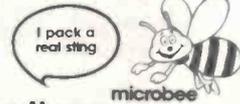
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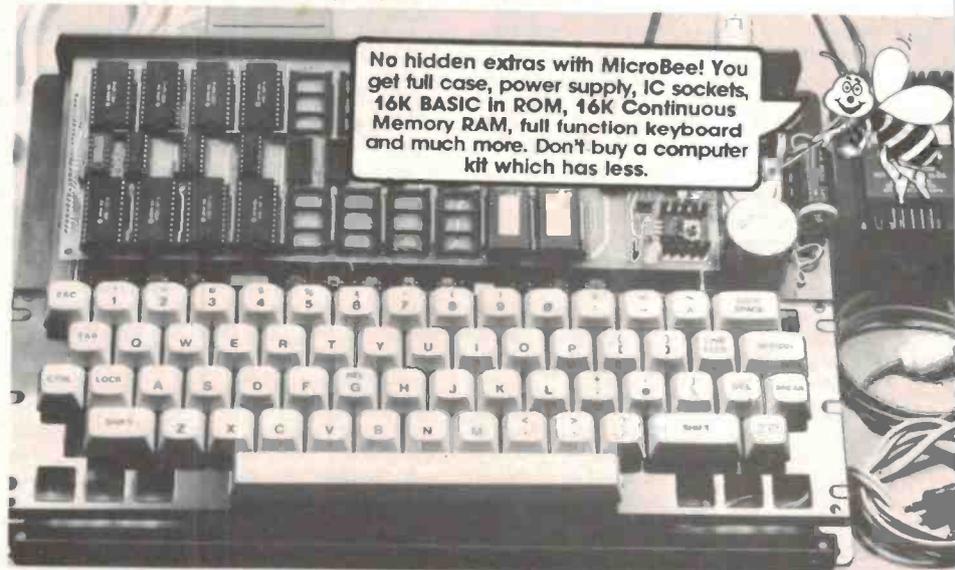
- Cassette Software** The following programmes are supplied in machine code on cassette. All are \$6.95 each.
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- Chatterbox** Experiment with artificial intelligence as the computer answers your questions and actually carries on a meaningful conversation.
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- Target** The computer screen comes alive with enemy aircraft and you have to blast them out of the sky.
- Trek** Take command of the USS Enterprise and destroy Klingons from surrounding galaxies.

ORDER DETAILS

- MicroBee kit with 20K RAM (16K user)
- 16K BASIC in ROM. Full manuals for assembly and programming. **\$399.00**
- Cassette Recorder **\$35.00**
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- 32K RAM upgrade kit includes sockets, powerdown ICs. **\$120.00**
- Editor/Assembler in ROM with manual. **\$49.50**
- All cassette software (see above under the heading 'Software Growth' for descriptions). **each \$6.95**
- Blank C10 computer cassettes **\$1.00**

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commands, we have developed VDUBUG, a system ROM for your DGZ80.

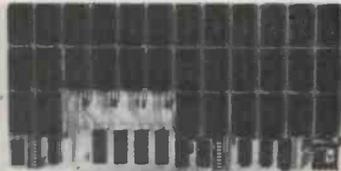
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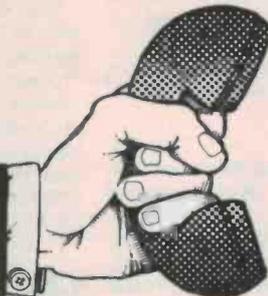
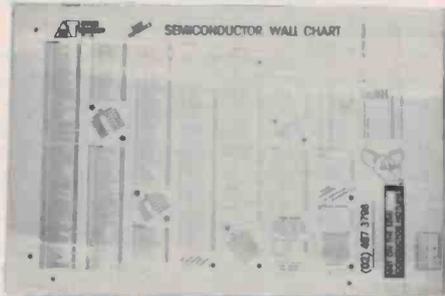
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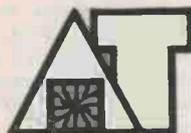
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Mirror 2000 — new local micro



Victorian-based Mirror Systems has commenced production of a new locally designed microcomputer featuring high resolution point graphics.

The Mirror 2000 employs a 6502 microprocessor running at 1 MHz, includes 8K of RAM and 12K of ROM. The video format is 16 lines of 44 columns as standard, programmable to 32 lines of 44 columns with 5 x 7 dot characters or other user-selected formats.

The graphics format is 128 x 256 pixels standard, user programmable to 256 x 256. A sound port is included, having a three-octave range using a programmable shift register and a free-running oscillator. The board also includes a cassette interface and an RS232 port. The

on-board keyboard features 56 keys plus two user keys. There is a socket for an external RCA type keyboard.

For memory expansion and the addition of peripherals a 40-pin socket is provided. Video output is direct and an external modulator would be required to permit attachment to a standard TV set. No case or power supply is supplied. The Mirror 2000 should cost around \$400. An optional expansion board is under development, but an 8K memory expansion board and colour video output is ready now.

More details from Mirror Systems, P.O. Box 922, Geelong Vic. 3220.

EXORset upgraded

Rank Electronics, the Australian agents for Motorola Microsystems, recently announced the new EXORset 30A Microprocessor Development System.

This product is an upgrade of the original EXORset system that has been marketed successfully for over a year. The EXORset 30A Development System now features software development support for all of Motorola's 8-bit microprocessor families, including the M6800, M6801, M6805 and the M6809. In addition, floppy disk storage capacity has been increased, and improvements have been made in

its disk operating system, text editor and BASIC-M interactive compiler.

For more information contact Rank Electronics: Sydney — John Minicz — (02)449-5666; Melbourne — David Ednie — (03)541-8444; Brisbane — Peter Andresen — (07)44-0251; Adelaide — Bruce Linn — (08) 295-0211; or their Perth agent, David Basell, at Industrial Micro-products, (09)381-7277.

Low-cost industrial control/display device

A new, low-cost control/display device was recently introduced in Australia by Termiflex Corporation of Nashua, USA.

According to the company, this new handheld or bracket-mounted unit can replace the lights, readouts and buttons associated with conventional control and display panels. At the same time, the HT/20 is claimed to provide better communication between operators and microprocessor based systems. Readings, warnings and prompting instructions are presented on the 16-character display, while the 96 ASCII set may be generated from

the 20-key pad for system set-up, service or operation.

Designed for the industrial environment, the HT/20 is one of eleven different models available from Termiflex Corporation. For detailed information, write or call the local Termiflex distributor in Australia: Mr. Peter Watkins, Australian G. E. (Sales) Ltd, 17 Leicester Ave, Glen Waverley Vic. 3150. (03) 233-7711; telex: AA37058.

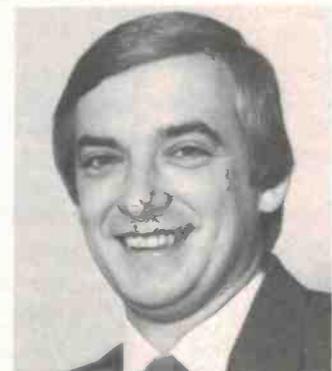
Confederates storm over Horizon!

According to NorthStar there were over 28 000 Horizon computer systems in use worldwide as at June last year, varying in application from scientific through education to general business.

Now NorthStar are hoping to gain an even bigger share of the market with the release of the Advantage microcomputer with quality graphics capability.

The Advantage, which may be obtained from distributors ADE for \$4495 plus tax, is said to offer a complete business system, comprising data processing, word processing and graphics. According to Mr. Robert E. Lee, ADE Systems Manager, "Although the price of the Advantage puts it in the hobbyist computer market, it is definitely not a toy. Our complete range of business software means that many small businesses who have had to forego the benefits of computerisation can now afford to take advantage of them."

The Advantage is supported by one of three different operating systems: the Application Support Program (ASP), which allows random file management interface for NorthStar's business application packages; Graphics CP/M, which allows the user the graphics capabilities of the Advantage plus use of all CP/M software; and Graphics



Basic/Graphics DOS, NorthStar's proprietary floppy disk operating system.

The Advantage is a single-user entry level system, whereas the Horizon may be added to for multi-user purposes.

ADE have put together an introductory offer of a package containing an Advantage micro, an OKI Microline ML82A (120 cps) 2K buffer and cable for \$5595 plus tax.

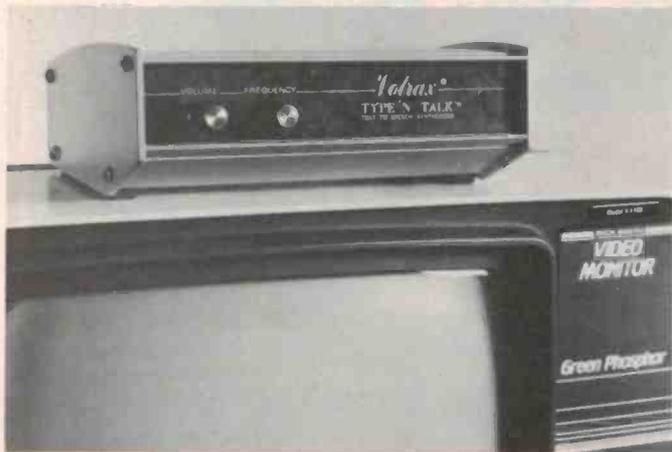
For further information contact ADE, P.O. Box 422, Clayton Vic. 3168. (03)544-3444.

Quotable PETs

Do you own a PET computer and find it disconcerting that apostrophes have to be used whenever you need quotation marks? Mr. Ben Van Praag of Bondi did, and sent us the following program to cure the situation.

```
10 A$ = CHR$(34)
20 PRINT A$ "QUOTE" A$
RUN
"QUOTE"
READY
```

Thanks, Ben.



Now your computer can answer back . . .

The Votrax 'Type-n-Talk' speech synthesiser may well be the most advanced unit of its type available outside research laboratories. Available from Dick Smith Electronics, it enables your computer to talk to you simply and clearly, and is claimed to have an unlimited vocabulary (!).

By adding a flexible and easy to use speech facility to any computer, 'Type-n-Talk' opens up many fields of application: computers for the blind, language teaching, computer-aided teaching for small children and the illiterate, etc. In teaching, the computer with 'Type-n-Talk' can tell students when they're right or wrong and even praise a correct answer, and of course it's great fun for admonishing you of danger, praise, reminders, etc, in computer games.

'Type-n-Talk' has its own built-in microprocessor and a 750-character buffer to hold the words

you've typed. It doesn't have to use the host computer's memory or tie it up with time-consuming text translation. English text is automatically translated into electronically synthesised speech, and ASCII code from the computer's keyboard is fed to 'Type-n-Talk' through an RS232C interface to generate synthesised speech.

The Votrax (cat. no. X-3290) is supplied complete with 240 V power supply and user manual. The user has to supply only a speaker and a cable to connect it to the computer/terminal. Cost is \$525.

Computer industry group formed

The Nationwide Computer Retailers and Resellers of Australia has been formed as a trade group for computer retailers and resellers.

The main aims and functions of this group are:

- to act as a forum for computer retailers and their problems
- to act as a lobbying group with government departments to protect the interest of this segment of the computer industry
- act as arbitrators in disputes between members as well as disputes between members and non-members
- act as a clearing house for overseas suppliers and local distributors looking for sales outlets
- act as a 'certifying' body for those stores and resellers able to meet

set standards, thus enabling these outlets to present themselves to the public as companies who have met certain business standards of a recognised trade group.

The Chairman of this group is Gary Wayne Alpert, Managing Director of Computer Country, one of Victoria's largest microcomputer retailers.

Inquiries are invited from retailers and resellers desiring to become members. Contact Nationwide Computer Retailers and Resellers of Australia, c/o Computer Country, 338 Queen St, Melbourne Vic. 3000. (03)329-7533.

InfoSoft distributors

InfoSoft Systems Inc, the systems software house, recently announced that AED Microcomputer Products is the exclusive agent for the entire line of InfoSoft's microcomputer software products in Australia, New Guinea and New Zealand. The emphasis will be on InfoSoft's family of operating systems.

InfoSoft's fully CP/M compatible family of operating systems includes: Multi/NET (networking facility), Multi/OS (multi-user operating system), UNI/OS (single-user operating system) and I/OS (single-user operating system).

InfoSoft's other software products are WpDaisy (word processor), Daisy (screen editor), MailMerge (for mail lists), I/TERM (communi-

cations package), I/SAL (structured assembler), SAL Tools (program development tools), NorthStar BASIC Interface and InfoSoft's 'C' Compiler.

For additional information please call or write to Wayne Wilson, AED Microcomputer Products, 130 Military Road, Guildford NSW 2161. (02)681-4966; telex: AA70664.

Portable computer available

As computerisation becomes more widespread in factories, showrooms, etc, computing capability is often needed outside its original place in the office or workshop. The answer to this need is portable computers.



Toyo Telesonics Co. Ltd have released the AVC-777, which is a portable computer with built-in 5" graphics CRT, 5" floppy disk drive (double-sided, double density), 5" graphics thermal printer, and other built-in interfaces. It is designed for the CP/M operating system and may be easily expanded up to 2 Mbytes of floppy disk storage. It can also accept an external printer, acoustic coupler and many other devices.

The AVC-777 is based on a 4 MHz Z80, and for those with special re-

quirements the buss is available on an external connector. Memory configuration is 64K as standard, and composite video gives large screen capability externally.

With all these features the unit only weighs 11 kg and may be carried anywhere. An optional inverter (AVS-150) allows it to be powered from a car battery.

For further information contact W. Fiala, Alfatron Pty Ltd, 1761 Ferntree Gully Rd, Ferntree Gully Vic. 3156. (03)758-9551.



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V-202	DC-20MHz	DUAL-TRACE
V-152B	DC-15MHz	DUAL-TRACE
V-151B	DC-15MHz	SINGLE-TRACE

Hitachi Mini Portable Oscilloscopes

V-509	DC-50 MHz	DUAL-TRACE-DELAYED SWEEP	215(W)X110(H)X350(D)mm 5kg
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U28	Forth — 2 tapes only	\$34.95
U29	Forth — 2 tapes & 3 books	\$49.95
T6	Forth — 3 books only	\$19.95
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D3	Rocket To The Moon (2½ min. action display)	\$7.95
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E17	Hangman (spelling game)	\$9.95
E18	Life Expectancy	\$9.95

SAMPLE OF OHIO HARDWARE:

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H25	Power Supply Unit 5V, 5 Amp, Reg.	\$59.00
EP1	PASCAL - 2 x EPROM (Mother Board)	\$39.00
EP2	DABUS (Monitor ROM) — Cursor Controls & Single Key Basic	\$25.00

SAMPLE OF OHIO BOOKS

K1	Hardware Catalogue (incl. P&P)	\$1.00
K2	Software Catalogue (Incl. P&P)	\$1.95
T1	The First Book of OSI	\$16.95
T2	Aardvark Journal Subscription	\$10.95
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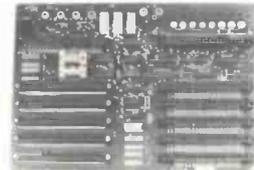
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Developments in speech technology from Texas Instruments

Texas Instruments recently broadened its range of speech technology products and enhanced several existing items. New products include a speech development system, evaluation board and three additional speech ROMs, and current evaluation kits for the TMS5100 and TMS5200 series voice-synthesis processors have been upgraded.

TI's 'Solid State Speech' technology is said to provide a revolutionary approach to man/machine interface, and its high intelligibility, reliability and low cost make its applications virtually limitless. The 'Multi-AMPLUS' development system and a new data collection processor allow customers to develop custom vocabularies and to perform editing and analysis in-house.

Additional ROMs and larger vocabulary capabilities now expand TI's TMSK101A and TMSK202 speech-synthesis evaluation kits, each kit allowing customers to incorporate speech during project conception

or to upgrade existing products.

The TMS5100 series evaluation board is a handheld, battery-operated unit with a self-contained speaker which allows users and potential users to evaluate TI's speech-synthesis products first-hand. It can speak phrases or words at the touch of a button, and a rotary dial allows selection of up to eight phrases.

Additional information on all TI's speech-synthesis products may be obtained from TI's Asia/Pacific Division sales offices in Sydney, Melbourne, Perth, Singapore, Hong Kong, Taipei, Manila and Seoul.



Archives computers in Australia

The range of Archives computers and ancillary products is now being distributed in Australia by the newly formed Archives Computers (Aust.), headed by Mr. Gower Smith, who brought Archives to Australia for its previous distributors, CGF Electronics. The new company is based in South Melbourne.

The company will handle both wholesale and retail sales in Victoria, and sell through a chain of 22 retailers and OEMs to provide national representation. There is already an in-house software tailoring and support service.

The Archives III, with 5.75 Mbytes of storage, has attracted strong interest in the industrial and scientific fields, but Archives will also be aiming at commercial interests with its locally configured complete office management and accounting software.

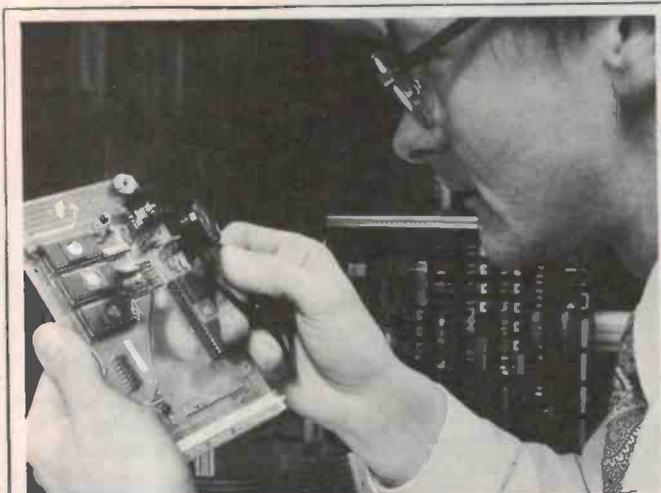
More than 20 Archives are already installed in Australia, and the company expects to have over 300

installations by the end of 1982.

According to Mr. Smith, the Archives offer an extremely flexible approach for small business, with the 23 programmable function keys and the locally enhanced configuration of Wordstar making the system one of the best word processors on the market.

The company also distributes and supports Qume daisywheel printers and a range of professional dot matrix printers.

For further information contact Mr. Gower Smith, Archives Computers (Aust.) Pty Ltd, 163 Clarendon St, South Melbourne Vic. 3204. (03)699-8377.



INSTANT SPEECH SYSTEM FROM BRITAIN

This speech synthesiser is able to electronically simulate any language and dialect and can be plugged into a wide range of equipment, including security systems and industrial monitoring devices, to give messages tailored to the user's own requirements.

Called the TDS 910, the 'instant speech' circuit board is shown being examined by British electronics designer Peter Rush, who has developed the system to fit onto a standard Eurocard format for wide acceptance in the electronics industry.

The system can be used effectively for giving specific information in situations where complex monitoring is essential, such as in factories and on offshore oil rigs. It is possible for warning messages to be automatically relayed by telephone to a manager's home in the case of emergencies, giving exact details such as 'fire in engine room', 'flood in basement' or 'safe opened'.

The speech synthesiser is supplied fully programmed with the user's own vocabulary. This is simply carried out by the words being spoken into a microphone attached to a specially designed computer which assimilates speech and allows any necessary changes to be made to the voice pattern before it is finally relayed to the synthesiser's memory.

The individual components — speech synthesiser, speech memory and integrated circuits — can also be supplied as a low cost chip set for self assembly.

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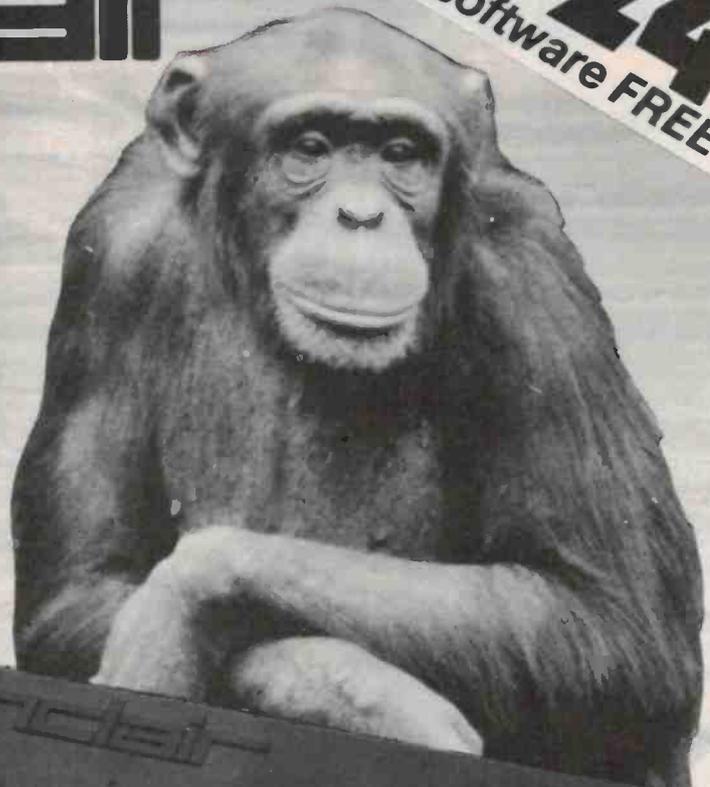
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QIT MICRO DESIGN WORKSHOP

The Department of Electrical Engineering at the Queensland Institute of Technology is organising a two-day workshop dealing with various aspects of hardware and software design of 6502 and 6809 microcomputer systems. The workshop is intended for scientists, engineers, engineering associates and scientific and technical officers who are actively involved with, or who are seeking to become involved with, 6502 and 6809 systems. Industry support is being provided.

The workshop will consist of a series of papers and demonstrations, plus tutorials involving practical use of these microcomputer systems.

The keynote speaker will be Professor 'Lux' Luxemburg, of the California State University, who is the editor of *Sym-Physis*. There will be presentations of papers by Bob Tripp, the editor of *Micro* (the 6502 magazine) and by Rodney Zaks, the author of several microprocessor books published by Sybex. It is hoped that Rockwell will provide a speaker. Other papers will be presented by Australian workers with considerable experience in this field.

The workshop will include the following subject matter:

- The State of the Art — a review of recent technological developments
- Hardware Design — the principles of system design, including dual ported memory techniques, and economic considerations
- Software Design — techniques for optimising software, monitor usage, and building an executive
- System Design — scaling, sensing techniques, system integration, and practical examples.

Venue: Rooms 0603/0604
Mechanical Engineering Building
Queensland Institute of Technology
George Street, Brisbane.

Date and Times: Wednesday 14 April 1982 9 a.m. — 5 p.m.
Thursday 15 April 1982 9 a.m. — 5 p.m.

Cost: \$50 per person, including light refreshments and a smorgasbord dinner

Organiser: Dr. C.J. Chesmond,
Department of Electrical Engineering,
Queensland Institute of Technology,
Box 2434, GPO Brisbane 4001

Registration: Applications to register, enclosing the \$50 fee, should be made in writing to the organiser, to arrive no later than 31 March 1982.

The Atari Computer Enthusiasts' Group has been in operation in Victoria for about three months, and has an extensive program exchange for members, who come from all states of Australia. Anyone interested in joining should contact Atari Computer Enthusiasts (ACE), P.O. Box 246, Northcote Vic. 3070.

New disk systems for Apples

Computer Country recently became the sole distributor in Australia for Micro-Sci disks for Apple micros, and has introduced two Apple-compatible disk sub-systems — the A-40 and the A-70.

A-40 has 40 tracks and 163K of data storage, as compared with the Apple Disk II, which has 35 tracks and 143K of data storage. A-40 is completely compatible with the Apple Disk II and can read and write diskettes with complete switchability. A-70 has 70 tracks and 286K of data storage.

Both A-40 and A-70 are claimed to have track-to-track disk access 300% faster than Apple Disk II units, and also to have smaller power requirements when they are not in use. This reduces heat build-up in

the power supply and in the computer itself.

The Australian price for A-40 is approximately 15% less than for the Apple Disk II equivalent, and the A-70 costs only 10% more than the Apple Disk II despite having twice the capacity.

A-40 and A-70 are now available from all Computer Country stores, franchises and agents throughout Australia and New Zealand. For further information call Computer Country, 338 Queen St, Melbourne Vic. 3000. (03)329-7533.

New video board from SSM Microcomputer

SSM Microcomputer Products Inc, a leading manufacturer of board-level products for the IEEE 696/S100 buss, has introduced a new video board for the computer system.

Designated the VB3A, the new board is an enhanced version of SSM's VB3, and incorporates all of its predecessor's features. The VB3A replaces the older product and offers additional operating features, as well as extended applicability to the wide variety of CRT/monitors.

Among the features of the new board is a smaller, 6 x 7 upper and lower case character EPROM that retains descenders, while opening up the screen for more text. Thus in one mode the VB3A allows users a

display of 24 lines by 80 characters on a standard P4-phosphor monitor. Additionally, a second mode adds a 25th line used for status updates. The EPROM also permits up to 50 lines by 80 characters to be displayed on a monitor with a P39 (long-persistence) screen.

For more information contact the agents, Acoustic Electronic Developments Pty Ltd, 130 Military Rd, Guildford NSW 2161. (02)681-4966; telex: AA70664.



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SERIES 5000

As designed by ETI



SERIES 5000 PREAMPLIFIER — SPECIFICATIONS

Frequency response:	High-level input: 15Hz- 130 kHz, +0, - 1 db Low-level input — conforms to RIAA equalisation, ± 0.2 dB
Distortion:	1kHz < 0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N noise:	High-level input, master full, with respect to 300 mV input signal at full output (1.2V): > 92 dB flat > 100 dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input, 50 ohm source resistance connected: > 86 dB flat > 92 dB A-weighted. MC input, master full, with respect to full output (1.2V) and 200 μ V input signal: > 71 dB flat > 75 dB A-weighted.



N.B. Picture is only of original heatsink supplied with this project. Our one is tapped from the rear so that no screw heads are visible. New picture next month.

Please note that the "Superfinish" Heatsink for the power amp was designed and developed by Ron Irving Electronics and is being supplied to other kit suppliers. This product cost \$1,200 to develop so that your amplifier kit would have a professional finish as well as sound. We also have a new range of rack mounting boxes which will be released soon.

SERIES 5000 POWER AMPLIFIER — SPECIFICATIONS

Power output:	100W RMS into 8 ohms (± 55 V supply).
Frequency response:	8 Hz to 20 kHz, +0 - 0.4 dB 2.8 Hz to 65 kHz, +0 - 3 dB NOTE: These figures are determined solely by passive filters.
Input sensitivity:	1V RMS for 100W output.
Hum:	- 100dB below full output (flat).
Noise:	< 0.001% at 1 kHz (0.0007% on prototypes) at 100 W output using a ± 56 V supply rated at 4 A continuous. < 0.003% at 10 kHz and 100 W.
2nd harmonic distortion:	< 0.0003% for all frequencies less than 10 kHz and all powers below clipping.
3rd harmonic distortion:	Determined by 2nd harmonic distortion (see above).
Total harmonic distortion:	< 0.003% at 100 W. (50 Hz and 7 kHz mixed 4:1).
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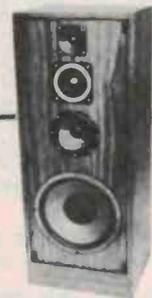
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*All parts available separately for both kits

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 - Again as with the power amp we are offering this kit A & T at a price which we do not believe there is a commercial unit available that sounds as good. Same delivery as the P.A.
- All the above for only \$309.00



SERIES 4000 SPEAKERS FROM ETI

SERIES 4000/14-WAY SPEAKERS

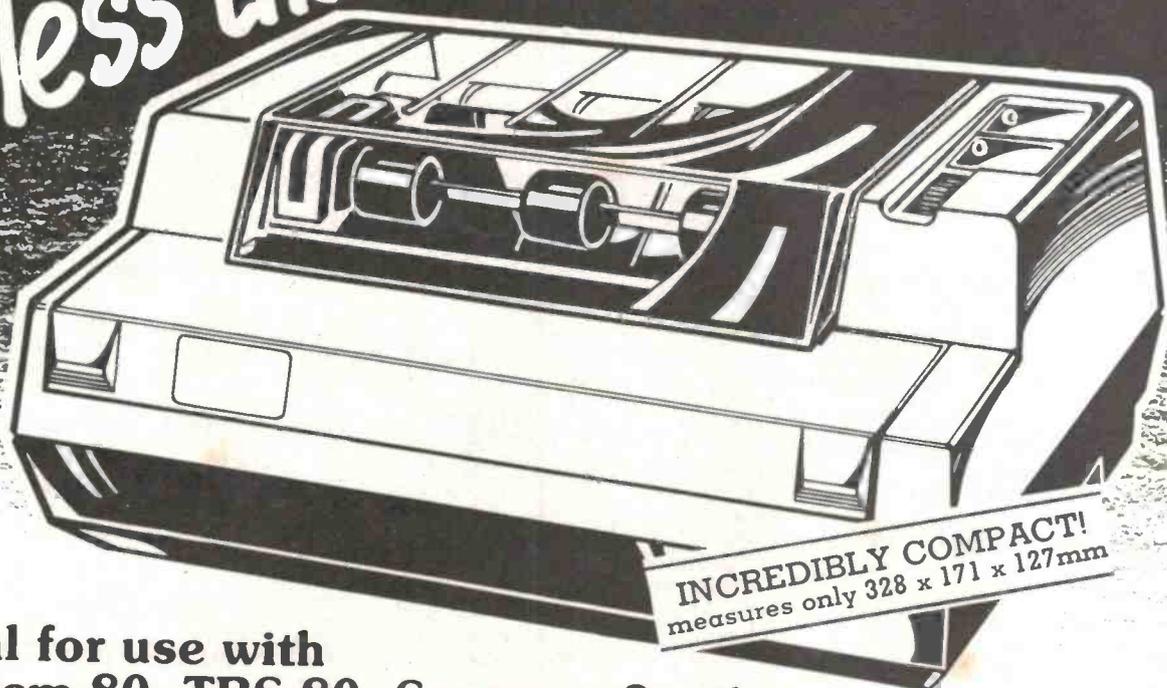
A no compromise, top-line system designed by David Tilbrook and described in the February 1980 ETI. Those who own them or have heard them universally praise them for clarity of sound, superb stereo imaging and smoothness of response. Employing Philips' latest range of low distortion drivers and a specially-designed crossover network (another Tilbrook masterpiece) these speakers are the equal of other systems costing up to three times the price. The 4000/1 will handle 100 W continuous, up to 400 W peak. PLEASE CHECK PRICES AND AVAILABILITY

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DSE/A181/PAI

Music-making micros

Here's a tuneful diversion for those who own a System 80 or TRS-80. Soothe that savage beast.

D.S. Peckett

IF YOU'VE EVER become bored while looking at your computer's display in stony silence, you might have thought of trying your hand at computer-generated music. Failing that, you might at least want to generate the bleeps, bloops and blips which help to make some games so addictive.

Some computers have built-in loudspeakers, but that makes life too easy. With others, like the TRS-80, you can drive (for example) the cassette I/O port into a soundbox; given the right signals, that can make some interesting noises. A few computers, and the System 80 is an excellent example, make life much more complex, however.

Although the System 80 is in some ways like the TRS-80, its built-in cassette means that the Tandy trick will not work. True, it has a cable for a second cassette port, but have you ever tried controlling it via machine code? It's not as easy as it might be. I know that you could buy a sound kit, but that's the coward's way out.

In this article, I'll outline the simplest way of generating music with a micro, and describe how, if you're lucky, you can modify the TV you're already using as a monitor so that it can also act as a soundbox. We'll then explain one way in which you can make the System 80 talk to that, or any other, soundbox via its second cassette interface.

To complete the picture, there's a short machine-code subroutine and an accompanying Level II BASIC program that will actually produce a tune from a System 80 or a TRS-80. Don't expect Beethoven though — the simple approach described generates a square wave signal which will normally be filtered by the TV's rotten amplifier and loudspeaker into something approaching a mixture of sinewaves.

Making noises

The simplest and cheapest way to get notes out of a micro is to use the system to generate an audio frequency square wave. A computer can produce a square wave much more easily than a pure sine

wave — it's a digital device, and switching a signal line backwards and forwards between '0' and '1' at regular intervals will do the job. The trick comes when we consider how to generate a signal of the right frequency and duration.

Since we are looking for the simplest possible system, the easiest way to get the frequency and duration is via a pair of nested loops in a short program. Figure 1 is a flowchart that shows the principle. The inner loop, which generates the note, is controlled by counter Y, which is initialised to a value such that the inner loop runs for exactly half the period of the desired note. For a note of frequency 'f', the length of this inner loop ('t') is given by:

$$t = \frac{1}{2f}$$

At the end of each Y-loop, the output level is flipped — two flips and the computer has generated a single cycle of the waveform.

The duration of the note is controlled by the X-loop, which directly controls the number of cycles generated. For a half-second of A' (440 Hz), X would have an initial value of 220, less any allowance for the routine's incidental activities. It is not so easy to calculate what value of Y to use for any given note, since this will depend on minor factors such as the program used, what micro it runs on, the system's clock speed, etc. Later in this article we'll describe a Z80 routine to do the job, with timings for a TRS-80 or System 80.

Why is it acceptable to produce a square wave instead of the sinewave that would presumably be the optimum answer? After all, an elementary knowledge of Fourier analysis (!) tells us that a square wave is made up of many notes, all multiples (harmonics) of the basic frequency (the fundamental). In fact, the technique relies on two phenomena.

In the first place, unless you are using a very hi-fi system as a soundbox, it will greatly attenuate frequencies above

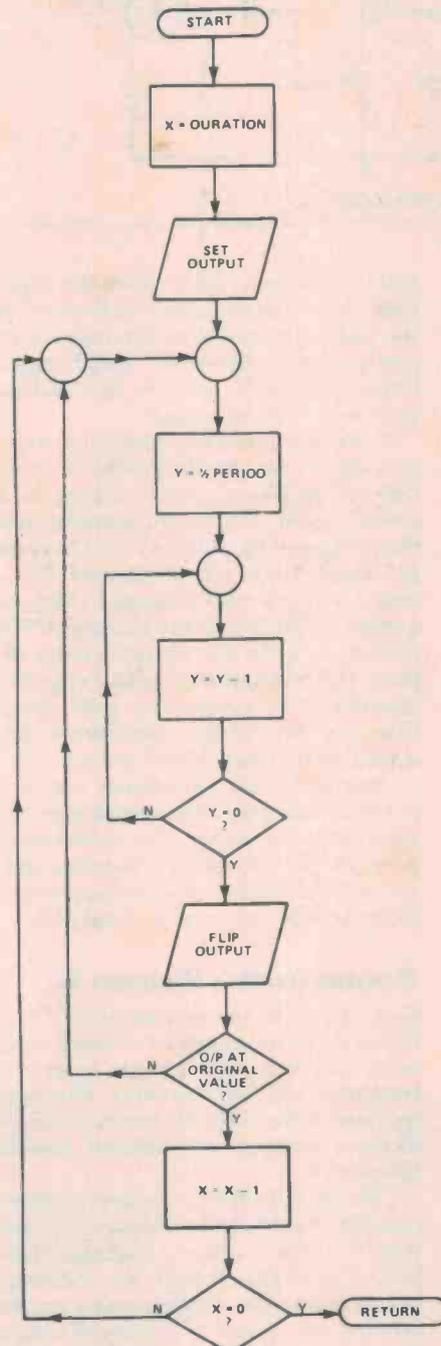


Figure 1. The 'nested loop' method of note generation in flowchart form.

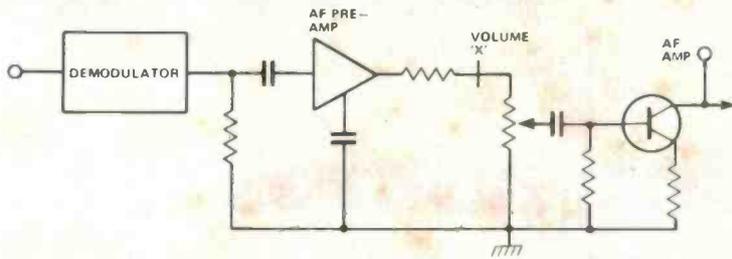


Figure 2. The block diagram of the TV audio chain.

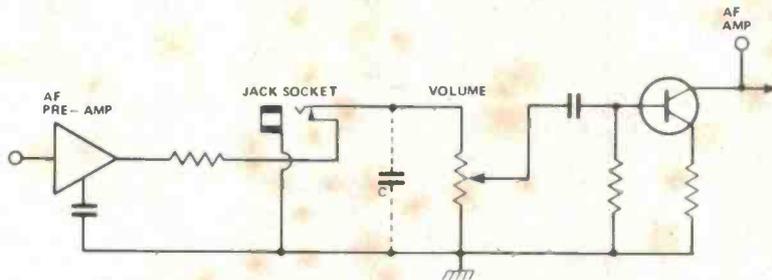


Figure 3. Where you need to break the chain for the jack socket.

around 4-5 kHz. This will filter off the higher harmonics but won't do much for the lower ones, which contain most of the distortion anyway.

The second, and more important, reason relates to the way that your ears and brain work. If you listen to a square (or any other) wave, you perceive only the fundamental. You do not hear the harmonics as discrete notes, but only as a harshening of the fundamental (the hi-fi buff's harmonic distortion).

You have probably realised that I have only skimmed the surface of a very complex subject, but I hope that I have made the point that it is not difficult, in theory, to generate music of a sort with a micro. Let's get on with the practical part now.

Making a TV into a soundbox

First, a vital word of warning — TVs can be lethal. Unless you are absolutely certain what you are doing, do not attempt to modify a TV.

Having said that, it is possible to modify many portable TVs to act as audio amplifiers without affecting their ability to display the output from a computer.

If you study the set's circuit diagram, you will see that, in the audio chain, there is a block of circuitry similar to that shown in Figure 2. The output from the audio demodulator passes, via an amplifier, to a potentiometer which acts as the volume control. The pot's output goes to the AF power amplifier which, in turn, drives the loudspeakers.

Break the circuit at 'X' and insert a 3.5 mm jack socket as shown in Figure 3. The TV will then work normally until

you insert a jack, upon which the output from the AF demodulator is broken and the jack is connected to the input of the power amp. Drive a small signal (around 200 mV) into the jack and you will hear it at the speaker.

If you use a chassis-mounting socket you should be able to mount it on the side of the TV, all ready to plug in an audio signal. When you actually plug the computer in, you may find that you get more than you bargained for. A micro is a splendid source of video frequency noise, which the audio lead may radiate into the TV, giving a noisy display. If this happens, a small capacitor (around 22n) across the jack should filter out most of the interference. This capacitor is shown dotted in Figure 3.

Once again, do *not* attempt to modify a TV unless you understand precisely what you are doing. The modification relies on the set having an *earthed* chassis. A TV with a floating chassis could blow up your computer ... and you.

Sound from a System 80

Now, if you have modified your TV, or if you have an alternative small audio amp, you can take signals from your computer and hear the effect. This is not too hard with a TRS-80, but how can you drive a System 80's second cassette interface?

Like the TRS-80, the System 80 drives cassette recorders via I/O port 255; specifically, it uses the three least significant bits of the eight-bit port. Bit 2 (decimal '4') switches the cassette relay on and off, and bits 0 and 1 (Figure 4) control the level of the audio signal to the recorder.

The standard TRS-80 way of generating noises is to toggle bit 0 up and down to drive an amplifier, but the System 80 is not quite that simple. As well as switching on the cassette motor, the relay also isolates the cassette's I/O connections. Thus, before you can drive any outputs, bit 2 of port 255 must be set to, and held at, 1 in order to close the relay.

The actual output level depends on the data in bits 0 and 1. Table 1 shows the dc voltage that my System 80 produces for the four possible combinations.

OUTPUT DATA	DC OUTPUT (mV)
4	210
5	430
6	12
7	190

Table 1. Corresponding voltage values for varying bit values at the output port.

You can therefore select the right pairs of data values to give a suitable signal amplitude for your amplifier. For my modified TV, I toggle between 6 and 7 to give a signal swing of 178 mV peak-to-peak.

Right, let's try something simple. Connect your System 80 to your amplifier and input this program:

```
10 OUT 255,6
20 OUT 255,7
30 GOTO 10
```

and RUN it.

Chances are that you hear nothing but, if you look, you'll see that the 'CASSETTE' indicator light has come on. What's wrong?

It turns out that the System 80 drives both cassettes from the same I/O port, and contains internal latches to decide which one to use. The default condition is Cassette 1, but somehow we have to drive Cassette 2.

BREAK the program and enter OUT 254,16. This selects the second cassette; that is where any cassette data will go until the first cassette is reselected. To reselect Cassette 1, you can either use

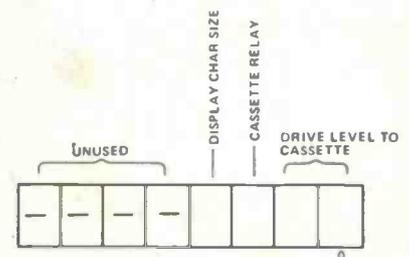


Figure 4. Which bits do what in the output port.



an instruction which addresses it explicitly (eg: PRINT #-1.), or you can use OUT 254,0.

RUN the program again. You should hear a disgusting buzz. It's not very musical but at least it's a sound. That's a good place to stop for the moment.

Making 'Proper' music

You have probably realised from what we've done so far that BASIC alone is not enough to generate pleasant music.

We have to use a machine code subroutine before we can advance further. At this stage we should look for one to play a simple, single-voice melody. Barber-shopping sounds nicer, but is much more complicated. We saw earlier, in Figure 1, a flowchart of a suitable procedure — it only remains to convert it into suitable code.

Listing 1 is a Z80 assembly language subroutine, suitable for a TRS-80 or System 80, which implements Figure 1. It expects to find the half-period count ('Y' in Figure 1) in register D, and the duration count ('X') in HL. The routine starts with a CALL to 0A7F hex, which is the computer's built-in subroutine to transfer HL to a machine code segment from BASIC.

The BASIC program will pass the value of D by POKEing it directly into the correct point in the subroutine; List-

ing 1 therefore shows D being loaded with 'DUMMY', just to reserve a byte. The two 'OR A's in the inner loop simply pad out its duration to give a reasonable range of notes.

You will probably have noticed that, although the routine is totally relocatable, it has been assembled into memory locations 405E to 4079 hex. This makes use of a block of RAM from 405C to 407F hex that the TRS-80 and System 80 only use during a cold start. This is a handy spot to put short machine code segments like this since it avoids the needs to set the memory size, etc.

Before we can make music, we have to know what sort of numbers go into D and HL to give specific notes. Given a knowledge of the number of clock cycles required by each instruction, and of the computer's clock frequency, this is a straightforward, if tedious (let the computer do it) calculation.

To save you the bother, Table 2 shows values of D to give a useful range of three octaves with a (roughly) equal-tempered scale. It also gives the values of HL needed for a half-second note at each pitch. You may wonder why HL is not exactly half each note's frequency — it's different because of the effect of the outer loop's instructions, and because the need for integer values of D gives

only approximations to each note. You should also be aware that the numbers in Table 2 are only right for the standard TRS-80/System 80 clock rate; other computers will need the different values.

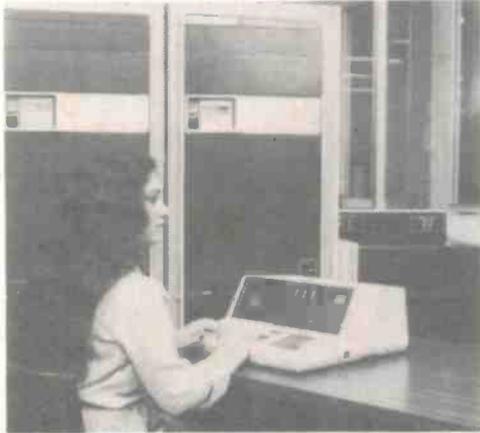
Print Period - 120

NOTE	FREQ (Hz)	D	HL	NOTE	FREQ (Hz)	D	HL
C	131	252	65	F [♯]	370	88	184
C [♯]	139	238	69	G	392	83	195
D	147	225	73	G [♯]	415	78	206
D [♯]	156	212	78	A [♯]	440	74	218
E	165	200	82	A [♯]	466	70	231
F	175	188	87	B [♯]	494	66	245
F [♯]	185	178	92	C [♯]	523	62	259
G	196	168	98	C [♯]	554	58	274
G [♯]	208	158	103	D [♯]	587	55	291
A	220	149	110	D [♯]	622	52	308
A [♯]	233	141	116	E [♯]	659	49	326
B	247	133	123	F [♯]	698	46	345
C	262	125	130	F [♯]	740	43	365
C [♯]	277	118	138	G [♯]	784	41	386
D	294	112	146	G [♯]	831	38	409
D [♯]	311	105	155	A [♯]	880	36	433
E	330	99	164	A [♯]	932	34	458
F	349	94	173	B [♯]	988	32	485

Table 2. Note, Frequency and the corresponding values for the D and HL registers.

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IMPORTANT NOTICE

The Australian Beginning Pty. Ltd. (previously known as The Australian Source Pty.Ltd.) has undergone a name change.

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The Australian Beginning Pty. Ltd. is an Australian company, with Australian based computer facilities, using the Australian Telecommunications network to offer Australian clients Australian information services and software.

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The AUSTRALIAN BEGINNING can be accessed through a number of 'approved' personal computers, and terminals, by use of an acoustic coupler or modem.

Users will receive a number of benefits which will include:

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Members will have access to a number of information sources which will include the latest news, sports results, financial reports, and farm information.

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Playing the tune

How do we use the machine-code segment? Listing 2 is a short BASIC program that brings all the pieces together.

Once the program has read the machine code routine and put it into RAM, it reads the tune's SPEED from a DATA statement. This approach gives an easy way of changing the tempo

without altering all the individual notes' durations. Double the value of SPEED and you halve the length of each note.

Before the tune is actually played, the OUT 254, 16 in line 260 sets the cassette selection latch. Alternatively, you could do this in immediate mode. Line 260 is not needed for TRS-80s, which will output the tune from their normal cassette port.

From here, the BASIC program reads values of PITCH (D) and PERIOD (HL) from DATA statements to play the tune. PERIOD is scaled by SPEED before it goes into HL.

A zero value of PITCH ends the tune, and a negative value gives a call to a BASIC subroutine to generate rests. With SPEED set to 1, a value of -240 gives a half-second pause to match the half-second notes of Table 2.

When the tune has been played, the program offers you the choice of playing it again — if you take this up, then the OUT 254, 16 out of line 260 is not needed. At the end of the program, the OUT 254,0 in line 560 reselects Cassette 1.

Obviously, this is just a demo program with a fixed tune, but it could serve as a good basis for experiment. For example, try writing a musical scribbling pad which holds the pitch and duration data in arrays, and which includes code to write and manipulate those arrays. That, and anything else you may think of, I leave to you, but here are a few tips.

Because a single byte is used to time the frequency loop, PITCH cannot be larger than 255. For lower notes, put more dummy operations in the machine code's inner loop.

The result of the calculation in the USR brackets, which defines the note's duration, must be a signed 16-bit integer, allowing a maximum of 32767. In all honesty this should be long enough for anyone, but be warned that larger values will crash the program.

A simple program like this cannot play harmonies. Neither can it vary a tune's amplitude. The best sort of music to play is therefore straightforward solo songs. If you really want to experiment, how would you go about generating harmonies via this basic approach? ●

Program Listing

```

405E CD 7F 0A MUSIC CALL 0A7F GET HL
4061 16 00 LD D,DUMMY DUMMY TO
                                SET TONE
4063 3E 06 LOOP1 LD A,6 INITIAL VALUE
4065 D3 FF LOOP2 OUT(255),A OUTPUT TO
                                CASSETTE
4067 42 LD B,D GET TONE DELAY
4068 F6 00 LOOP3 OR 0 DUMMIES FOR..
406A F6 00 OR 0 ..PAUSE
406C 10 FA DJNZ LOOP3 1/2-CYCLE DONE?
406E EE 01 XOR 1 FLIP LSB OF A
4070 FE 06 CP 6 FULL CYCLE DONE?
4072 20 F1 JR NZ,LOOP2 IF NO, BACK AGAIN
4074 2B DEC HL DEC DURATION
4075 7C LD A,H IS..
4076 B5 OR L ..HL..
4077 20 EA JR NZ,LOOP1 ..ZERO?
4079 C9 RET FINISHED
    
```

Listing 1. The Z80 code subroutine to implement the program shown in Figure 1.

```

100 DEFUSR=8/6478
200 REM**LOAD MACHINE CODE
210 FOR X=16478 TO 16505:REM**405C TO 407E HEX
220 READ X1:POKE X,X1
230 NEXT X
240 POKE 16526,94:POKE 16527,64:REM**SET USR
    START ADDRESS
250 READ SPEED:REM**VARY TO CHANGE TEMPO
260 OUT 254,16:REM**SET CASSETTE#2 LATCH
300 CLS
310 PRINT "READY - PRESS ANY KEY TO START"
320 IF INKEY$="" THEN 320:REM**KEY NOT PRESSED
330 READ PITCH
340 IF PITCH=0 THEN 510:REM**END OF TUNE
350 IF PITCH<0 GOSUB 2000:GOTO 330:REM**PAUSE
360 POKE 16482,PITCH:REM**NOTE INTO M/CODE
370 READ PERIOD
380 A=USR(PERIOD/SPEED):REM**PLAY THE NOTE
    
```

```

390 GOTO 330:REM**NEXT NOTE
500 REM**WRAP-UP ROUTINES
510 PRINT:PRINT "PLAY IT AGAIN, SAM?"
520 QS=INKEY$:IF QS="" THEN 520
530 IF QS="Y" THEN GOSUB 1000:GOTO 330
540 IF QS<>"N" THEN 520
550 OUT(255),0:REM**RELAY OFF
560 OUT 254,0:REM**CLEAR CASSETTE#2 LATCH
570 END
999 REM**RESET THE DATA POINTER TO THE START
    OF THE TUNE
1000 RESTORE
1010 REM**CLEAR THE M/CODE DATA OUT OF THE WAY
1020 FOR X=1 TO 29:READ X1:NEXT X
1030 RETURN
1999 REM**GENERATE A PAUSE
2000 FOR XX=PITCH/SPEED TO 0:NEXT XX
2010 RETURN
10000 REM**DATA FOR M/CODE
10010 DATA 205,127,10,22,0,62,6,211,255,66,246,
    0,246,0,16,250,238,1,254,6,32,241,43,
    124,181,32,234,201
20000 REM**DATA FOR MUSIC
20010 DATA .5:REM**SPEED
20020 DATA 225,36,168,49,168,73,178,23,168,49,133,
    61,133,61,149,55,112,73,112,73,112,109,125,
    32,133,61,149,55,133,123,-30
20030 DATA 225,36,168,49,168,73,178,23,168,49,133,
    61,133,61,149,55,112,73,149,55,149,82,178,
    23,178,46,200,41,225,73,-30
20040 DATA 112,73,112,73,112,73,168,49,125,65,
    133,61,133,61,149,55,-20,112,73,112,73,
    112,73,168,49,125,65,133,61,133,61,149,
    55,-20
20050 DATA 99,82,99,82,99,82,112,73,125,65,133,
    61,125,130,149,55,133,31,125,32,112,110,
    168,24,168,49,149,55
20060 DATA 133,123,-60,99,123,99,41,99,82,112,
    73,125,65,133,61,125,130,149,55,133,31,
    125,32,112,110,168,24,168,49,149,55,168,
    98,0
    
```

Listing 2. A BASIC program for the System 80 with the machine code built in. It'll play you a tune if you get it right.

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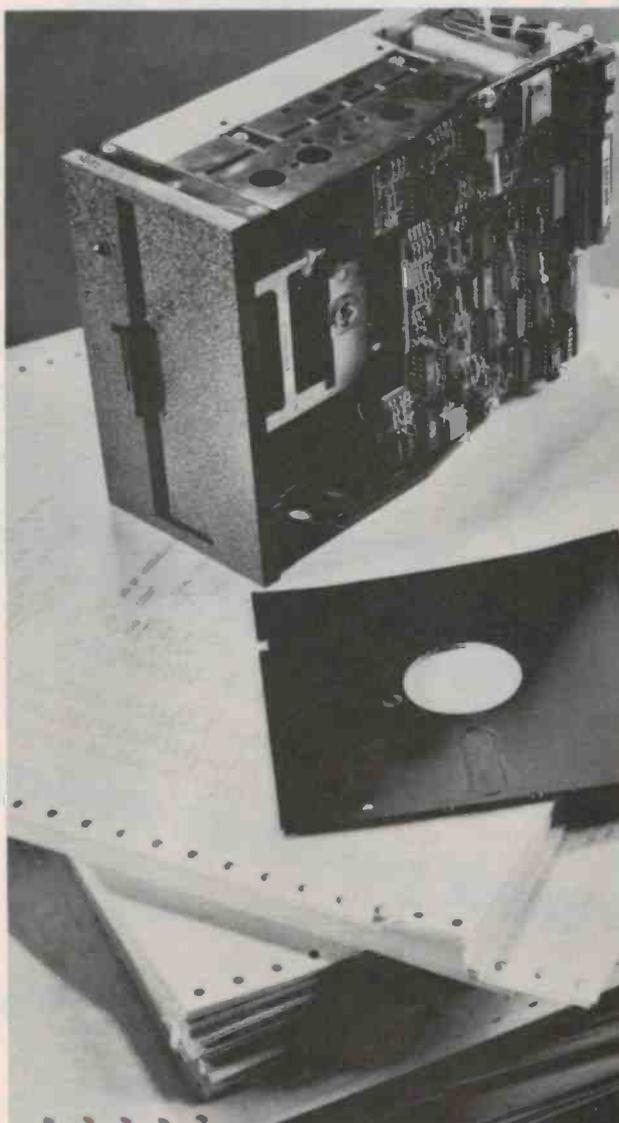
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Two-finger exercise —



a review of Casio's new pocket computer

Tom Moffat

Although they've sometimes been dismissed as mere toys, an overseas magazine recently claimed that pocket computers are in fact the new wave in computer technology that will eventually supersede the desktop machines. They could even make inroads into the mainframe category. Judging from the latest entry into the pocket computer field, that prediction may be closer than we think.

CASIO has released a little beauty called the FX-702P, a 176 gram package containing a full-blown BASIC interpreter, LCD alphanumeric display, a 65-key keyboard, and an optional cassette interface and printer. All in all, a rather elegant package, but with one sore spot from my point of view: the keyboard.

The alphabet keys are laid out in A-B-C-D-E etc order instead of the usual Q-W-E-R-T-Y series. For one used to typing on a standard keyboard, this is most frustrating, and you find yourself back to the old 'hunt and peck' system, laboriously searching for each key. This system resulted in much spirited swearing during evaluation of the computer. However... non-typists will find it easier to use. My wife, who hates typewriters, entered several lines of data and pronounced the keyboard "terrific... the only sensible layout for a keyboard". It would be nice if Casio saw fit to release two versions of the computer, one with a QWERTY keyboard and another with the ABCDE version; then everyone could be satisfied.

That funny keyboard isn't as bad as it first sounds; the computer uses a system like the Sinclair ZX-80/81 that allows one-key entry of BASIC keywords and mathematical functions. There are two function keys, so most of the alphabet keys do three jobs; for instance, pressing (FUNCTION 1)-C gives 'EXP', (FUNCTION 2)-C gives 'GOTO', and of course C on its own gives 'C'. So once you learn where the keywords are, program entry becomes easier.

Power to the people

Now to the guts of it: computing power. In evaluating a machine like this it's natural to compare it to known quantities, in this case the Tandy/Sharp pocket computer already reviewed in this magazine. It would be fair to say that the Casio is aimed slightly more up-market than the Tandy. It's got a slightly larger amount of memory — 1680 program steps — and the BASIC interpreter has a few more features, especially in string handling.

It has LEN, allowing the calculation of the length of a character string, and MID, allowing you to extract a portion of a string (that's one I really miss on the Tandy). In the array area, the Casio caters for two-dimensional arrays, say a table three wide by four high. Tandy is limited to one dimension, for instance a table twelve items long.

There are a few extra mathematical functions: FRAC removes the integer portion of a number and leaves only the fraction (X-INT X). RND rounds off a number, instead of simply truncating it. RAN# gives the output of a built-in pseudorandom number generator. RPC

and PRC allow conversion from rectangular to polar coordinates and vice versa. There is also a whole series of special statistical functions.

There are several commands that provide for direct control of the LCD display format. CSR is a cursor that sets the start of an output a given distance along the display. WAIT can be programmed to cause the computer to display its output for some variable time, and then kill it and go on to the next step. On the Tandy, PAUSE gives the same effect, but the time of the display is fixed at about one second. There's even a little contrast control on the back of the CASIO to vary the intensity of the display.

Program writing and editing

The Casio's memory can be divided up into ten separate program areas, so there can be ten programs in it at once, each beginning with line 5 or whatever. To run one of them you simply hit (FUNCTION 1) and then 3, and PROGRAM 3 is off and away.

To work on one of the programs without affecting the others you go into the 'WRITE' mode and call it up; you can then list it or change a line, etc. It's also possible to tape load or dump one of the programs, ignoring the rest. Or you can load or dump the whole memory.

When you call up a program in the WRITE mode the display shows which other program numbers are assigned, as well as a continuous readout of the total memory remaining free. All programs share the memory 'on demand'; that is, you can have one very long one and nine short ones, or ten of about the same length.

There is a password system that lets you write a program, and then prevent other people fiddling with it if they don't know the password. It also means you can dump a passworded program onto tape and give (or sell) it to another Casio owner. He can run the program, but he can't find out how you wrote it.

One feature in the programming department is most impressive: if you type 'LISTALL' the computer begins with PROGRAM 0, lists it, then does program 1, and right through the series. It then lists the contents of all the variables. If it comes to a passworded program it simply says 'PASS' and skips over that one.

For writing and editing program lines, the Tandy seems to be ahead in convenience. Casio lets you enter a line, delete characters from a line, or rewrite a line. But I could find no way to drop a missed character into an existing line like you can do on the Tandy. It means if you left out one character you have to delete the whole line and then type it in again.

Speed

A recent Casio press release claimed that the FX-702P was up to ten times as fast as other pocket computers. I decided to put this to the test, with a simple program that generates 100 pseudorandom numbers, and prints out the 100th one. It gives a good jiggle to the computer's number-crunching functions, a traditional time-consuming procedure. The program was designed to run in all the machines without changes.

```
10: X = .5
20: FOR Y = 1 TO 100
30: X = ((π+X) ↑ 5) - INT((π+X) ↑ 5)
40: NEXT Y
50: PRINT X
60: END
```

The Casio took 1 min 11 sec to get through the program; the Tandy took 2 min 36 sec. Just for comparison, an Apple running Applesoft BASIC took 12 seconds to run it.

The printer

The printer is contained in its own little case, with a cable and plug hanging out the back. It can plug into the cassette interface, which fits onto the computer Tandy-style, or the interface can be dispensed with and the printer can be plugged directly into the computer.

The printer uses paper 35 mm wide of the electrosensitive type, instead of the plain paper and ribbon system used by Tandy/Sharp. This means the paper costs more, but of course there are no ribbons to buy. The print quality is absolutely beautiful, nice dark 5x7 matrix characters on a silver background. The printer is very quiet, making a 'swish-swish' sound as each line is printed. It's also very quick, at two lines a second.

In Summary

After reading all this, and the previous articles on the Tandy/Sharp system, you're probably asking, which is 'best', which do I buy? They've both got their good and their bad points, and they both have similar retail prices, although the Tandy machine has been advertised at a discount lately.

For someone into statistics, the Casio is the natural choice. For the 'average' user, it's a toss-up. The Casio has a few more features in its BASIC interpreter, and the ability to store ten programs is nice, although the Tandy can do much the same thing in the 'defined' mode.

I found the Tandy a slightly 'friendlier' computer, mostly because of previous familiarity with it, but also because the keyboard is much easier to get along with (if you're used to keyboards). So one is not 'better' than the other. Only you can make the choice, but be sure you try before you buy. ●

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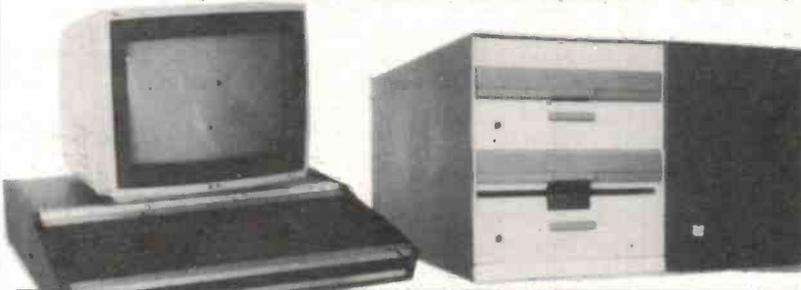
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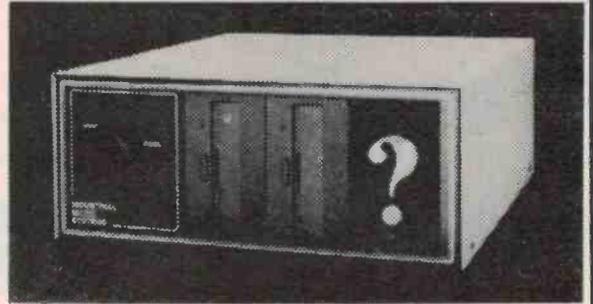
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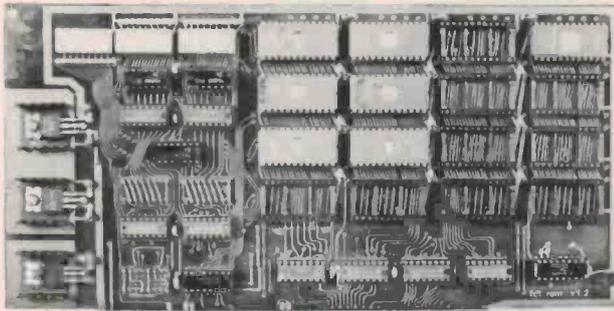
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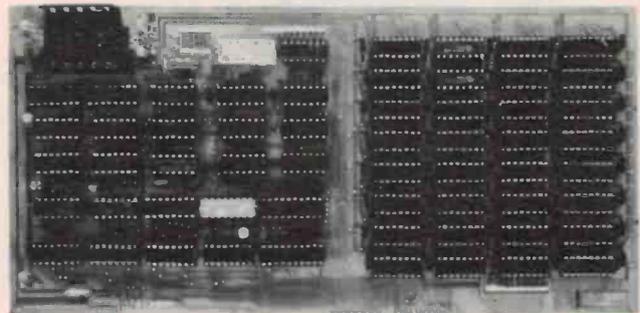
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Touched by touch typing

J.E. Hutchinson B.Sc, B.Ed., M.A.C.E.

HAVING RECENTLY been involved with developing and writing two programs to assist in typing keyboard skills and accuracy, I was understandably attracted to the article by Malcolm Banthorpe in the July 1981 edition of ETI (and with an 'OHIO' at hand, the urge to 'punch it in' was too much).

An analysis of the original listing shows it to be a quite useful example to assist those interested in 'purposeful' computer graphics on Ohio, using fundamental routines. Additionally, the author prompts and invites the reader to expand and/or modify the original listing to their own purpose. The following, however, is no expansion whatsoever — and only a minor modification of the basic presentation for those who may wish to use the program in a teaching mode.

The teaching of typewriter keyboard skill is based around the four ten-key rows:

1	2	3	4	5	6	7	8	9	0
Q	W	E	R	T	Y	U	I	O	P
A	S	D	F	G	H	J	K	L	;
Z	X	C	V	B	N	M	,	.	/

and the last key (/) varies on *some* typewriters.

As typists would know, the fingers 'rest' on the home keys ASDF and JKL; in the third row.

The original program listing does not include the semi-colon key, which for the above reason must be considered very important. (The comma, full stop and slash also complete the ten-key fourth row). The addition of these key representations has a further important psychological effect, in that as originally listed, keys such as J, K, L, N, M, etc. 'feel' to be too far to the right (at least they did to me!). For these reasons I made the changes below, and although perhaps the whole thing should be rewritten more elegantly, the modifications are presented here in simple form to accommodate those who may have already put the program to tape.

```
110 P= 53476: POKE 11,34: POKE 12,2
```

and

```
290 P= 53508
```

(instead of 53478 and 53510 respectively)

moves the whole keyboard a little bit to the left to allow for the new keys.

Lines 185, 220, 255 all read 'GOSUB400'.

Since we are now handling ten keys for each line, we can use this subroutine incorporating the original routine 350. Lines 200, 205, 235, 240 and 270 have slight modifications to 're-frame' the keys:



The section of the program 280-325 is concerned with the random selection of keys to be pressed and the sensing of correct key closure by the operator. This is essentially the same as the original, but line

```
280 C= INT(RND(1)*47 + 44)
```

now allows C in the range 44 to 90 (to include 44, the decimal ASCII value of a comma).

The unchanged line:

```
285 IFC > 57 AND C < 65 THEN 280
```

deletes unwanted ASCII characters 58 to 64 inclusive.

But we *do* want C = 59 (corresponding to ;) and don't want C = 45 (corresponding to ,). These are taken care of by:

```
283 IF C = 45 THEN 280
```

and

```
284 IF C = 59 THEN 290
```

Finally the data line 365 needs to be changed to include the new keys in the correct sequence (note how the comma is contained within inverted commas: ",").

With these additions the VDU presentation gives a fuller impression of the keyboard and also yields practice with the important semi-colon, comma and full stop keys.

In passing, the USR function 'poked' into start location \$0222 (546 dec) by lines 110/115 represents an extremely useful technique which calls up the 'polled' keyboard routine already resident in ROM (FD00) and saves a great deal of somewhat 'rude' peeking and poking!

dec	32	0	253	141	128	2	96
Hex	20	00	FD	8D	80	02	60

0222	20	00FD	JSR				;ROMSUBFD00
0225	8D	8002	STA	\$0280			;STORELOC640dec
0228	60		RTS				;RETURN

Program Listing

```

OK
LIST: TOUCH TYPING
100 REM TOUCH TYPING
105 FORX=0T029:PRINT:NEXT
*110 P=53476:POKE11,34:POKE12,2
115 FORX=546T0552:READC:POKEX,C:NEXT
120 POKEP,221:Q=P+1
125 FORX=1T09:GOSUB340:NEXT
130 POKEQ,148:POKEQ+1,222
135 P=P+32
140 POKEP,149:Q=P+1
145 FORX=1T09:POKEQ,X+48:POKEQ+1,149:Q=
Q+2:NEXT
150 POKEQ,48:POKEQ+1,149
155 P=P+32
160 POKEP,220:Q=P+1
165 FORX=1T09:GOSUB345:NEXT
170 POKEQ,217:POKEQ+1,215:POKEQ+2,222
175 P=P+33
180 POKEP,149:Q=P+1
*185 GOSUB400
190 P=P+32
195 POKEP,220:Q=P+1
*200 FORX=1T09:GOSUB345:NEXT
*205 POKEQ,217:POKEQ+1,215:POKEQ+2,222
210 P=P+33
215 POKEP,149:Q=P+1
*220 GOSUB400
225 P=P+32
230 POKEP,220:Q=P+1
*235 FORX=1T09:GOSUB345:NEXT
*240 POKEQ,217:POKEQ+1,215:POKEQ+2,222
245 P=P+33
250 POKEP,149:Q=P+1
*255 GOSUB400
260 P=P+32
265 POKEP,220:Q=P+1
*270 FORX=1T09:POKEQ,148:POKEQ+1,215:Q=
+2:NEXT
275 POKEQ,148:POKEQ+1,223
*280 C=INT(RND(1)*47+44)
*283 IFC=45THEN280
*284 IFC=59THEN290
285 IFC>57ANDC<65THEN280
*290 P=53508
295 Q=P
300 IFPEEK(Q)=CTHEN315
305 Q=Q+1:IFQ-P<21THEN300
310 P=P+65:GOTO295
315 POKEQ,32
320 X=USR(X)
325 IFPEEK(640)=CTHENPOKEQ,161:GOSUB355
:POKEQ,C:POKE280,0:GOTO280
330 GOSUB355:POKEQ,C:GOSUB355:GOTO315
335 END
340 POKEQ,148:POKEQ+1,217:Q=Q+2:RETURN
345 POKEQ,217:POKEQ+1,215:Q=Q+2:RETURN
350 READA$:POKEQ,ASC(A$):POKEQ+1,149:Q=
Q+2:RETURN
355 FORX=0T0100:NEXT:RETURN
360 DATA32,0,253,141,128,2,96
*365 DATA0,W,E,R,T,Y,U,I,O,P,A,S,Q,F,G,H
,J,K,L,Z,X,C,V,B,N,M,"","/
*400 FORX=1T010:GOSUB350:NEXT:RETURN
OK
LOAD

```

* Indicates changes to original

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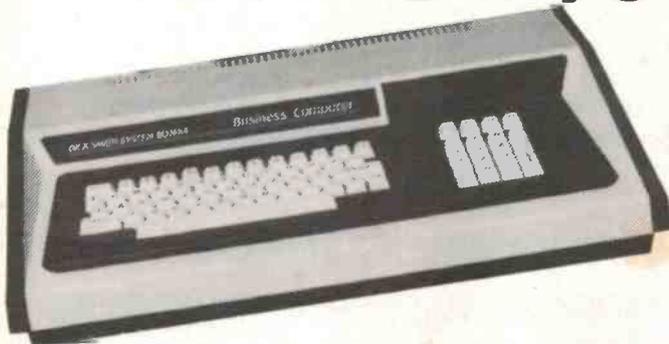


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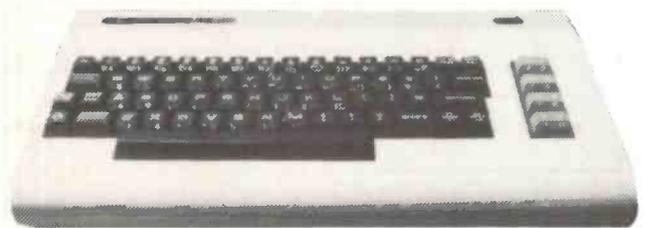
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Interfacing with the ETI-685 2650 S100 computer board

Part 2

How to make use of the flexible interfacing provided on this board, which employs the 8255 programmable peripheral interface chip.

Ron Koenig

The PPI in Mode 0 operation

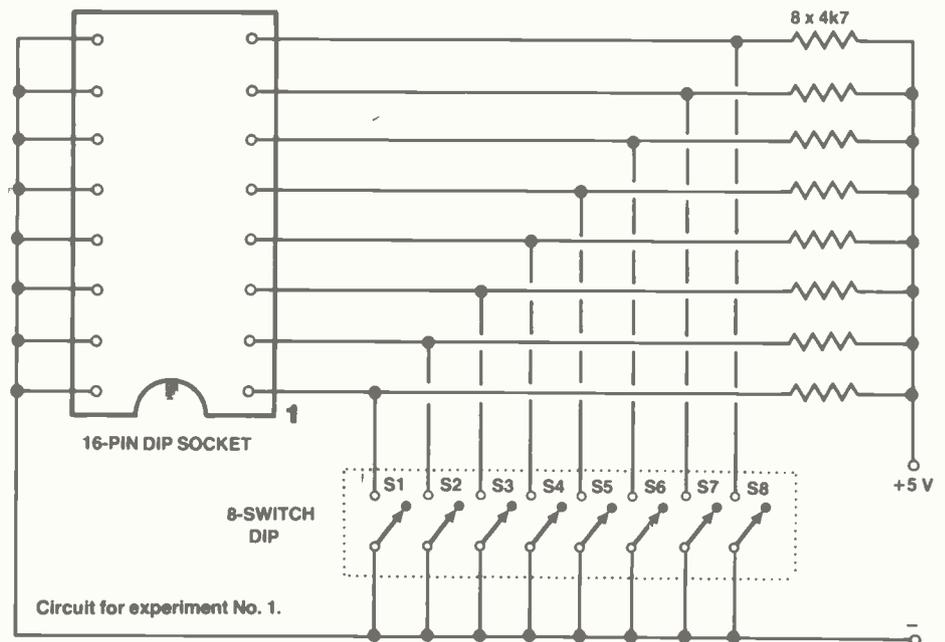
For the moment, let us examine the 8255 PPI in its 'simple' Mode 0 format. You will recall from the previous article that when the PPI is operating in Mode 0 all three 8-bit ports (A, B and C) are available for data transfer. In this basic mode there is no 'feedback' between the microcomputer and the external device. The peripheral device must therefore be ready at all times to supply the data that is required by the computer, or to receive the data that is being sent to it.

A form of handshaking can be established by allocating several data lines from one of the ports and generating the required interface signals under program control. Typically, this function is performed by data lines from Port C, where the Bit Set/Reset feature can be used to activate individual bits quite simply.

In summary, Mode 0 provides the following features:

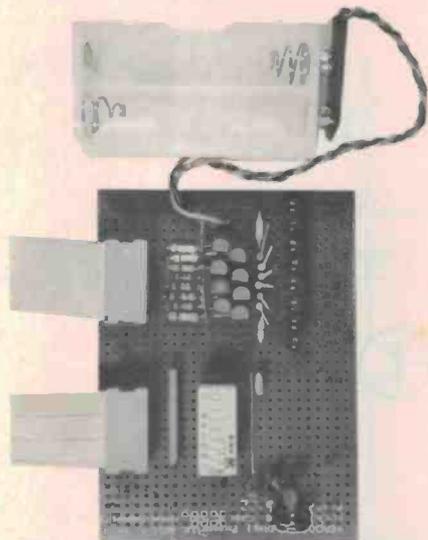
- Two 8-bit ports (A&B) and two 4-bit ports (from C).
- Any port can be configured as an input or an output.
- All outputs are latched.
- All inputs are not-latched.

There are sixteen different I/O configurations for the two 8-bit and two 4-bit ports for Mode 0 and these are summarized in Table 1. The PPI is programmed for one of these configurations by writing the appropriate hexadecimal 'control word' into the PPI's control register at the start of each program.



Control Word (Hex.)	Group A		Group B	
	Port A	Port C _u (U)	Port B	Port C(L)
80	Out	Out	Out	Out
81	Out	Out	Out	In
82	Out	Out	In	Out
83	Out	Out	In	In
88	Out	In	Out	Out
89	Out	In	Out	In
8A	Out	In	In	Out
8B	Out	In	In	In
90	In	Out	Out	Out
91	In	Out	Out	In
92	In	Out	In	Out
93	In	Out	In	In
98	In	In	Out	Out
99	In	In	Out	In
9A	In	In	In	Out
9B	In	In	In	In

Table 1. Mode 0 Control Word Summary.



A simple construction on matrix board allows you to try out experiments 1 and 2.

The following simple experiments have been developed to illustrate the programming and use of the PPI in Mode 0, and to assist in understanding each program full source listings of each program have been provided. All programs have been written using a similar 'structure'. An 'initialisation' section at the beginning of each program loads the appropriate hex control word into the PPI's control register and pre-conditions the required CPU registers. The second section contains the main program, and a third section (if required) contains any subroutines required by the main program. All programs have been written in standard Signetics 2650 Assembly Language mnemonics using the Microbyte 2650 ASSEMBLER.

Requirements

To evaluate the operation of the PPI with these programs you will first have to construct the following two interface circuits. The first, a *data monitor*, consists of eight transistor buffers and eight LEDs. The second is a *data input switch* consisting of an octal DIL switchpack and eight pull-up resistors.

Each circuit is connected to the appropriate PPI port by a 16-way flat ribbon cable. The original circuits were assembled on a 'solderless breadboard' and then permanently constructed on a section of 'stripboard'. Permanent construction is advisable as these test circuits will be very useful for debugging your own programs later. ▶

KEYBOARD DISPLAY PROGRAM

```

;*
;*      Execute with G500<
;*
;*Monitor Subroutines used:
!MBUG  EQU   H'0022'      Monitor return
!CHIN  EQU   H'0286'      Read keyboard into R0
;*Defined Constants
!ESC   EQU   H'1B'
!PORTA EQU   H'00'        Port A Register address
!CNTRL EQU   H'03'        Control Register address
;*
:      ORG    H'500'
;*
;*Initialise the PPI Control Register
0500 0480 :!INIT  LODI,R0 H'80'      A,B and C Out Mode
0502 D403 :      WRTE,R0 CNTRL      Write to Control Res.
;*
;*Read Keyboard and Write to Port A
0504 3F0286 :!STRT  !BSTA,UN CHIN      Fetch K'bd character
0507 D400 :      !WRTE,R0 PORTA      Display on LEDs
0509 E41B :      !COMI,R0 ESC      Check if 'ESC' Key
050B 1C0022 !      !BCTA,EQ MBUG      Exit if true
050E 1B74 :      !BCTR,UN !STRT      else loop to start
;*
;*END
;*
00 ERRORS DETECTED

0500 04 80 D4 03 3F 02 86 D4 00 E4 1B 1C 00 22 1B 74

```

RUNNING LEDS PROGRAM

```

;*
;*      Execute with G500<
;*
;* Monitor Subroutines used!
!MBUG  EQU   H'0022'      Monitor return
!DLAY  EQU   H'039B'      BINBUG and MULTIBUG
;*Defined Constants
!PORTA EQU   H'00'        Port A Register address
!PORTB EQU   H'01'        Port B Register address
!CNTRL EQU   H'03'        Control Register address
;*
:      ORG    H'0500'
;*
;*Initialise the PPI Control Register
0500 0482 :!INIT  LODI,R0 H'82'      A and C Out, B In Mode
0502 D403 :      !WRTE,R0 CNTRL      Write Control
0504 7700 :      !PPSL  H'00'          Clear carry
;*
0506 0708 :!STRT  LODI,R3 H'08'      Count
0508 0580 :      LODI,R1 H'80'      Set bit A7
050A D500 :!LOOP  !WRTE,R1 PORTA      Output to Port A
050C 5601 :      !REDE,R2 PORTB      DLY loop number
050E 3F039B :!WAIT  !BSTA,UN !DLAY      Delay
0511 FA7B :      !BDRR,R2 WAIT      till R2 is zero
0513 12 :!TEST  SPSU          Test for the BREAK key
0514 9E0022 :      !BCFA,N MBUG      Exit if operated
0517 51 :      !RRR,R1          Shift Right bit set
0518 FB70 :      !BDRR,R3 !LOOP      to end of byte
051A 1B6A :      !BCTR,UN !STRT      Loop back to start
;*
;*END
;*
00 ERRORS DETECTED

0500 04 82 D4 03 77 00 07 08 05 80 D5 00 56 01 3F 03
0510 9B FA 7B 12 9E 00 22 51 FB 70 1B 6A

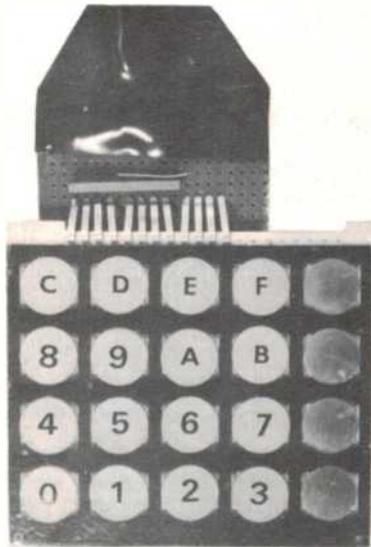
```

The power for these, and the following interface circuits, is *not* derived from the CPU board. This is to prevent any accidental short-circuits from damaging the CPU or the programs stored on-board. A separate dc power supply or suitable plugpack is recommended.

Experiment No. 1: Keyboard display.

This program displays the binary code of each character entered from the keyboard on the LED data monitor connected to Port A. The program is started by keying G500<return> and terminated by the entry of the 'Escape' key.

When you have the programs going, try experimenting by altering the program to output the data to Port B and Port C. The byte to change is located at address 0508. Observe the output from Port C if you change the mode control word at address 0501 from 80 to 81 and 88.

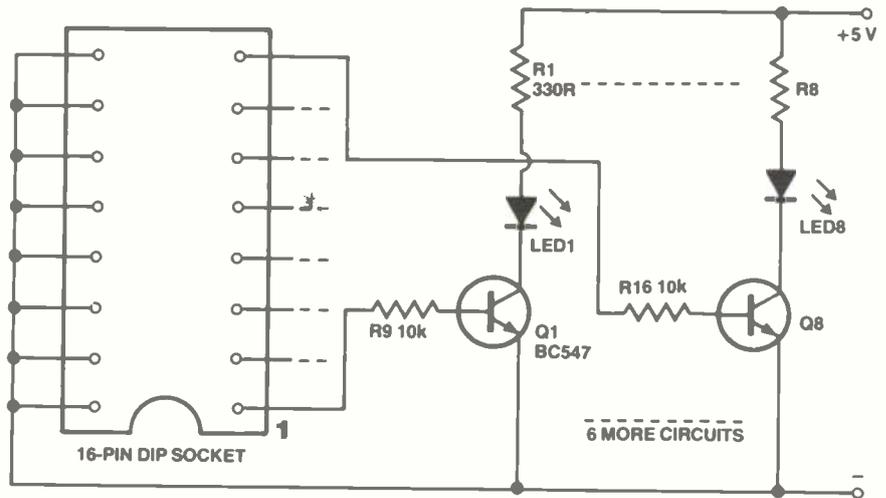


I made this hex keypad from an old calculator board — it's cheap, simple and effective!

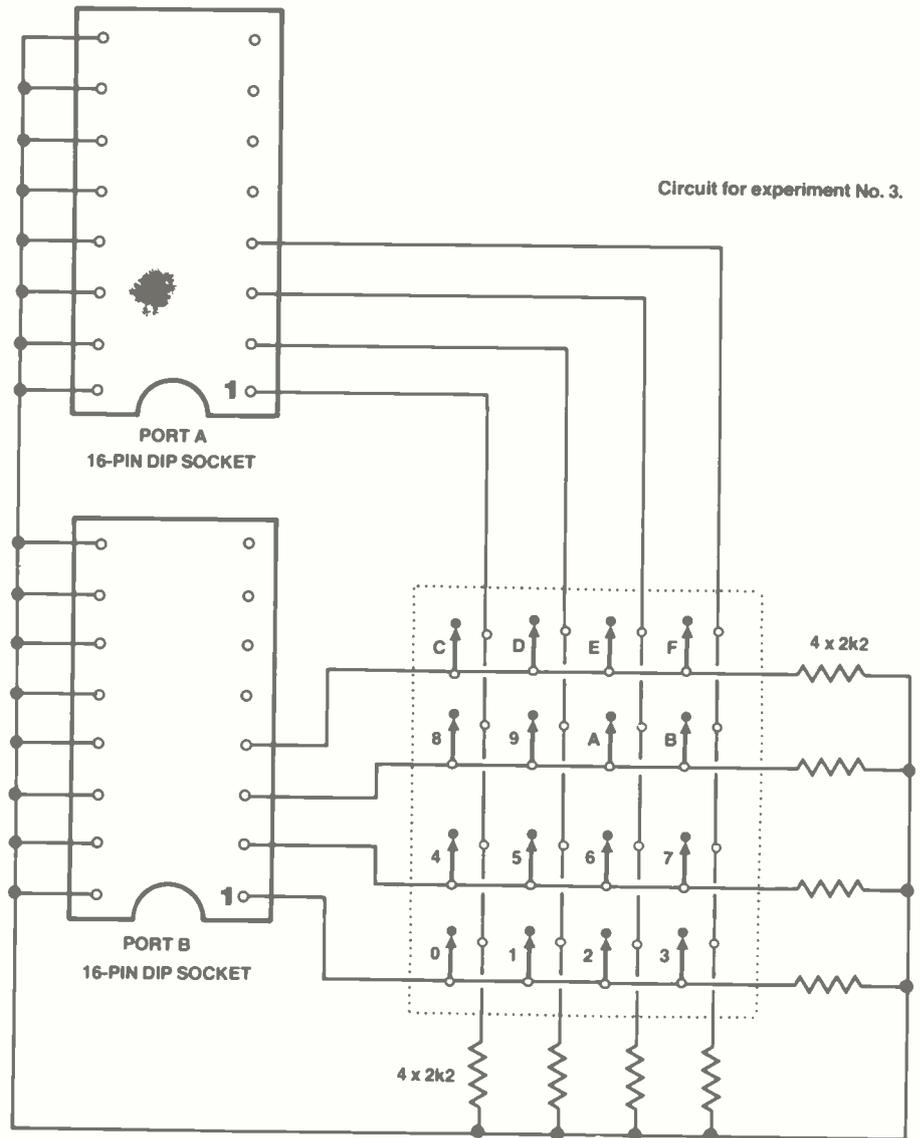
Experiment No. 2: Running LEDs.

For this experiment, Port A and Port B are used concurrently, with the PPI programmed for Port A as an output and Port B as an input. The program produces a moving point of light on the data monitor at Port A, moving at a speed determined by the binary value read in from the data switch at Port B. The program is started by keying G500<return>, and terminated by the operation of the 'Break' key.

This program can be used as the basis of the game 'Shoot'. The object of the game is to shoot down a flying target (in this case the LED) as it passes the



Circuit for experiment No. 2.



Circuit for experiment No. 3.

centre of the display. Modify the program to test for the operation of the Break key after each movement of the LED. If the Break key is found to be operated when the LED is at position 5 (PA3) then turn off the LED and terminate the game. If the LED is not at position 5 then turn that LED on also (i.e. use the Inclusive-OR instruction) so that there are now two LEDs as targets. The data switch connected to Port B can be used as a 'skill switch' to increase the speed of the target. There is no prize for writing this program but you may like to submit it to ETI for publication (*we pay! — Ed.*).

Experiment No. 3: Hex keypad.

The hex keypad program has been developed as a practical application of the basic 'scanning' program used in Experiment No. 2. In this application the moving pulse (which we saw as the running LED) is used to strobe the columns of a 4-by-4 (16-key) matrix. The hex keypad's rows are read into Port B each time the strobe position is changed and tested to determine if a key is operated. When a key is found operated its position is calculated from the current column and row position, which are known to the program, and the hex value determined is printed on the VDU.

The program is started by keying G500<return> and is terminated by the operation of the 'Break' key. The program can be modified to scan a full 64-key keyboard and to act as a self-contained subroutine. The hex keypad



You can substitute a standard hex keypad, like this one, for the Jerry-built one I used. You'll still need pull-up resistors. Eight pins on the back will be marked '1' to '8'. Pins 1 to 4 connect to pins 1 to 4 of Port A. Pins 5 to 8 on the keypad connect to pins 1 to 4 of Port B.

HEX KEYBOARD PROGRAM

```

:*
:*      Execute with G500<
:*
:* Scans a Hex Keyboard connected to Port A and Port B
:* of the PPI and returns with a Hex. value in R0.
:*
:*Monitor Subroutines used:
:MBUG   EQU   H'0022'
:FOUT   EQU   H'0279'   BINBUG and MULTIBUG
:DLAY   EQU   H'039B'   "   "   "
:*
:PORTA  EQU   H'00'
:PORTB  EQU   H'01'
:CNTRL  EQU   H'03'
:*
:      ORG   H'0500'
:*
0500 7702 :INIT   PPSL   2           Logical compare
0502 7640 :      PPSU   FLAG        Set flag
0504 0482 :      LODI,R0 H'82'
0506 D403 :      WRTE,R0 CNTRL        Set Port A output, B input
0508 12   :START  SFSU                Test for Break key
0509 9A2B :      BCFR,N EXIT          Exit if operated
050B 20   :      EORZ,R0          Clear registers R0
050C C1   :      STRZ,R1          and R1
050D 5601 :WAIT   REDE,R2 PORTB        Check keyboard status
050F 460F :      ANDI,R2 H'0F'        Mask out top byte
0511 987A :      BCFR,Z WAIT        Wait for key released
0513 0701 :      LODI,R3 H'01'        Select first column
0515 D700 :SCAN  WRTE,R3 PORTA        Strobe column
0517 5601 :      REDE,R2 PORTB        Read rows for key down
0519 460F :      ANDI,R2 H'0F'        Mask out top byte
051B 9809 :      BCFR,Z CODE         Key down if not zero
051D 8401 :      ADDI,R1 H'01'        Inct. Col Weight (00,04,08,0C)
051F D3   :      RRL,R3          Select next column
0520 E708 :      COMI,R3 H'08'        Last column?
0522 1964 :      BCTR,GT START      Yes, start again
0524 1B6F :      BCTR,UN SCAN      No, continue scan
:* Calculate key code value
0526 52   :CODE   RRR,R2          Shift row bit to determine
0527 E610 :      COMI,R2 H'10'        which key in the row is actuated
0529 1904 :      BCTR,GT VALUE        Row weightings in R1, else
052B 8504 :      ADDI,R1 H'04'        Inct. Row weight (00,04,08,0C)
052D 1B77 :      BCTR,UN CODE        Loop till B0 to B3 zero
052F 81   :VALUE  ADDZ,R1          Form key code
0530 C1   :      STRZ,R1
:* The above line would be replaced with RETC,UN
:* Hex '17', and the following lines deleted if
:* this programme is to be used as a subroutine.
0531 3F0279 :      BSTA,UN FOUT        Print key value and TAB
0534 1B52 :      BCTR,UN START      Loop around forever
:*
0536 9B22 :EXIT   ZRRR   MBUG        Return to monitor

```

Hexadecimal Keyboard Listing.

```

0500 77 02 76 40 04 82 D4 03 12 9A 2B 20 C1 56 01 46
0510 0F 98 7A 07 01 D7 00 56 01 46 0F 98 09 84 01 D3
0520 E7 08 19 64 1B 6F 52 E6 10 19 04 85 04 1B 77 81
0530 C1 3F 02 79 1B 52 9B 22

```

used for this experiment may be purchased, built from individual keys and hand-wired or constructed from a discarded calculator.

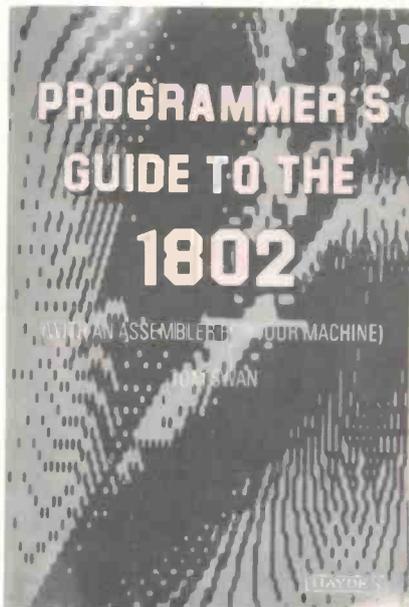
the software provides all the timing signals (only a multimeter is required to set up the circuit).

Next to come

A 2716 EPROM programmer will be described, which connects to the three ports of the PPI. The circuit for the programmer consists of only one TTL IC and two voltage regulators. A full source listing of the program to read, program-and-verify 2716 EPROMs will be supplied and, for this programmer,

Coming soon

Soon we'll be publishing a real-time clock/calendar circuit which is connected to the PPI. This circuit contains a crystal-timed clock/calendar LSI device (with battery back-up) which can supply the seconds, minutes, hours, day-of-week, date, month and year without the need to initialise each time the power is turned on!



USEFUL BOOK FOR COSMAC VIP/ETI-660 OWNERS

For those wishing to delve into the 'bits and bytes' of the 1802 microprocessor — employed in the ETI-660 Learner's Microcomputer and the Cosmac VIP — this book is a must.

Written by Tom Swan, 'Programmer's Guide to the 1802' is published by Hayden and available in Australia through Butterworths, P.O. Box 345, North Ryde NSW 2113. (02)887-3444.

The book has four chapters — (1) A System of Numbers — A Number of Systems, (2) Fundamentals of Assembly Language, (3) 1802 Instruction Set and (4) The Assembler. From this you can see the author has included an 'Assembler' for 1802 microcomputer systems — a very handy programming tool.

The chapter covering the 1802 instruction set is thorough, well organised and clearly written. In fact, those comments go for the rest of the book. In general, it is written in **straightforward English** — jargon is eschewed. Every abbreviation, mnemonic or special word is carefully introduced and explained to the reader as he or she progresses.

Chapter 1 should be required reading for all students of the microprocessor — any microprocessor. Exercises are given in Chapters 1 and 2, with answers in the back of the book. An appendix gives a mini-library of useful subroutines written in assembler. A comprehensive Index finishes off the book.

Thoroughly recommended. The book is 156 pages long, comes with a 'limp' cover, measures 153 mm x 230 mm and costs \$10.75. (R.H.)

Addition problems

This program constructs simple addition problems using two randomly chosen numbers between 0 and 127. On entry to the program a problem is presented, e.g: 076 + 093 = ? Answers are entered through the keyboard one digit at a time (i.e: 1, 6, 9), and when the last digit is entered 169 is displayed. A 'C' is displayed after the entered number if it is correct and an 'E' if it is incorrect. The correct answer is shown if your answer was incorrect.

```

0600 00 E0 ERASE DISPLAY      0654 16 62 GQ TO 0662
0602 CD 7F VD=RND           0656 85 25 V5=V5-V2
0604 CE 7F VE=RND           0658 35 00 SKF V5=00
0606 8C D0 VC=VD           065A 16 62 GO TO 0662
0608 8C E4 VC=VD+VE        065C 66 0C V6=0C
060A A6 A2 I=06A2          065E F6 18 TONE=V6
060C 6A 00 VA=00           0660 16 6A GO TO 066A
060E 6B 00 VB=00           0662 6A 15 VA=15
0610 FD 33 MI=DEQ,VD       0664 6B 10 VB=10
0612 F2 65 VO:V2=MI        0666 26 76 D0 0676
0614 26 76 D0 0676         0668 66 0E V6=0E
0616 A6 88 I=0688          066A 6A 26 VA=26
0618 7A 07 VA=VA+07        066C 6B 08 VB=08
061A DA B5 SHOW 5MI@VAVB   066E F6 29 I=DSP,V6
061C A6 A2 I=06A2          0670 DA B5 SHOW 5MI@VAVB
061E 7A 08 VA=VA+08        0672 FO 0A VO=KEY
0620 FE 33 MI=DEQ,VE       0674 16 00 GO TO 0600
0622 F2 65 VO:V2=MI        0676 FO 29 I=DSP,VO
0624 26 76 D0 0676         0678 DA B5 SHOW 5MI@VAVB
0626 A6 8E I=068E          067A 7A 05 VA=VA+05
0628 7A 07 VA=VA+07        067C F1 29 I=DSP,V1
062A DA B4 SHOW 4MI@VAVB   067E DA B5 SHOW 5MI@VAVB
062C A6 92 I=0692          0680 7A 05 VA=VA+05
062E 6A 18 VA=18           0682 F2 29 I=DSP,V2
0630 6B 08 VB=08           0684 DA B5 SHOW 5MI@VAVB
0632 DA BF SHOW FMI@VAVB   0686 00 EE RETURN
0634 FO 0A VO=KEY           0688 20 20 pattern for +sign
0636 F1 0A V1=KEY           068A F8 20
0638 F2 0A V2=KEY           068C 20 00
063A DA BF SHOW FMI@VAVB   068E 00 FO pattern for = sign
063C 6A 15 VA=15           0690 00 FO
063E 26 76 D0 0676         0692 FF FF pattern for ? sign
0640 A6 A5 I=06A5          0694 03 03
0642 F2 55 MI=VO:V2        0696 03 FF
0644 A6 A2 I=06A2          0698 FF C0
0646 FC 33 MI=DEQ,VC       069A C0 C0
0648 F5 65 VO:V5=MI        069C C0 C0
064A 83 05 V3=V3-V0        069E 00 C0
064C 33 00 SKF V3=00       06A0 C0 00
064E 16 62 GO TO 0662      06A2
0650 84 15 V4=V4-V1        06A4
0652 34 00 SKF V4=00       06A6
                                work space

```

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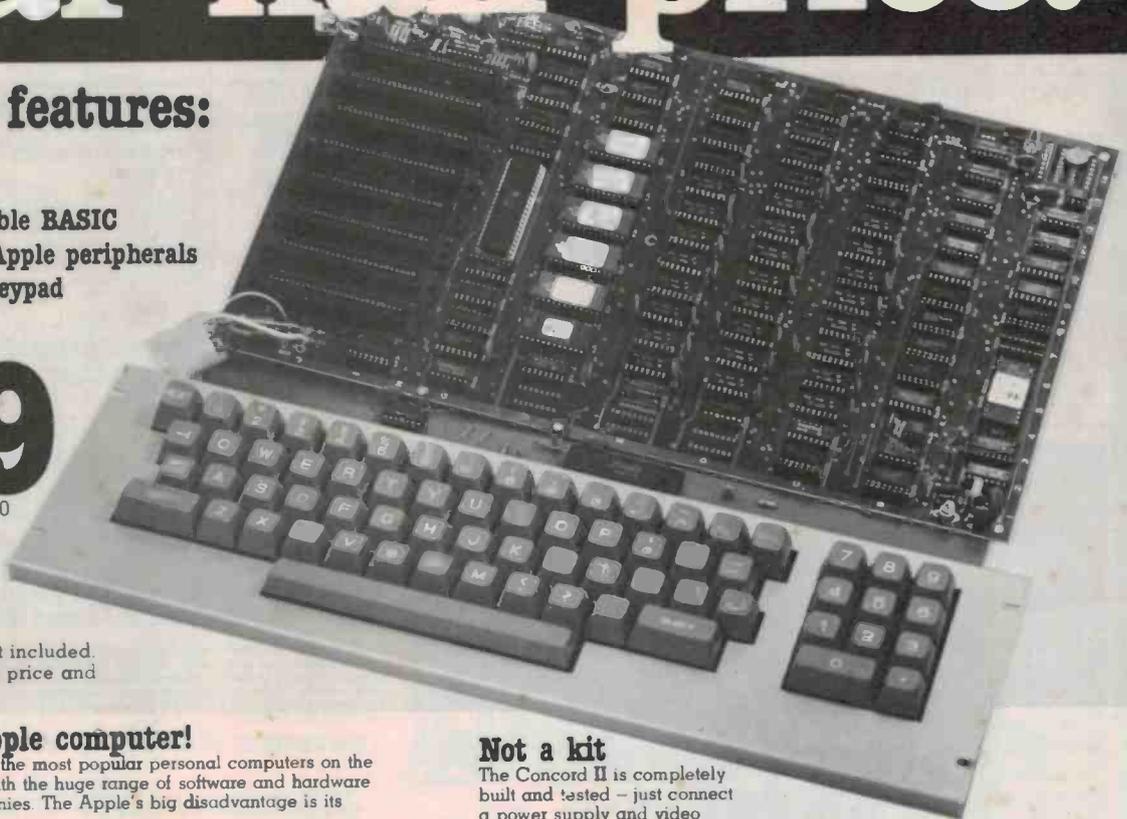
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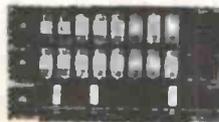
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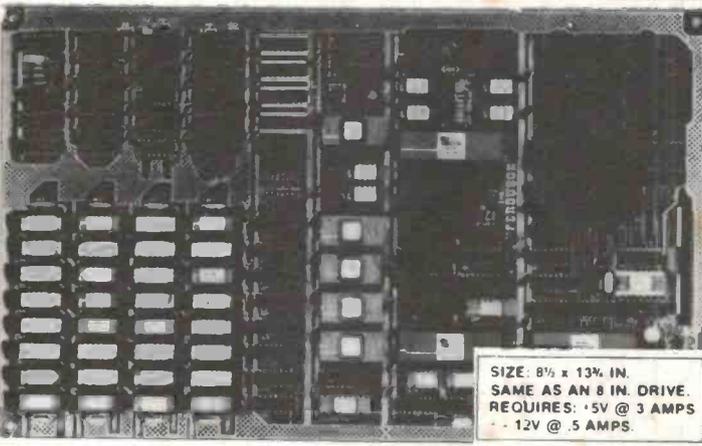
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A look at software for the TRS80 Colour Computer

Getting/got a TRS80 Colour Computer? Then you'll need software. Here's a rundown on the what, where, who, hassles and how about it.



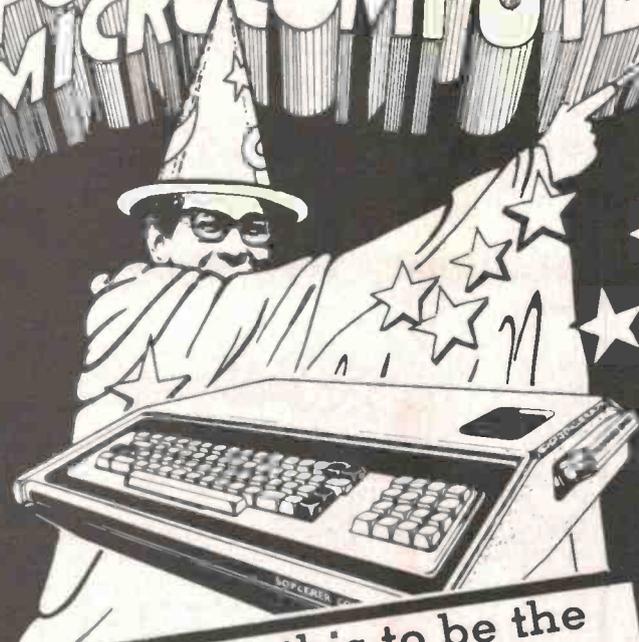
Greg Wilson

THE TRS-80 Colour Computer was introduced just over a year ago. *Too much* software has been released! Can there be too much? *You bet*, if you try to keep track of it. *Too right*, if you order from everyone who puts it out. I have been doing so since last June.

Tandy has a tiger by the tail. They marketed the 80C as a machine for games; at most, a home terminal for data access, ordering and banking. It is not marketed, or intended, to compete with their Models II and III. About half of the programs you can buy are games, mostly of the arcade-type. That still leaves more than 180 that are not! Applications predominate, followed by utilities and education.

A number of programmers and technical writers have shifted off Tandy's other models, saying that the TRS80 Colour Computer is quicker and more ▶

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powerful. Rumour has it that Tandy did not like that one bit, so they are planning a Model II type built around a 68000 chip.

At first, the TRS80 CC (... that's neater! —Ed.) was taken at its face value. A large slice of its 16K Extended BASIC is used for colour and sound manipulation. The early programs showed off these features. After about eight months the message got through. There really was no need to go Tandy's way and wait for each ROMPAC they released, or for their disk controller. It was easy to extend this cheap machine to 32K, and so on.

It had a fast, reliable cassette system. Was there really a need for disks? Some thought not. They went ahead to develop eight monitors, seven editor/assemblers,

A selection of locally available Tandy ROMPACs.



seven disassemblers, four Forths, two Pascals, four databases, three word processors and sundry terminal, RTTY, and SSTV programs. How about a speech synthesiser that needs no extra hardware? Others thought disks were essential. You won't guess the first to market a controller — Exatron of Stringy Floppy fame, that's who!

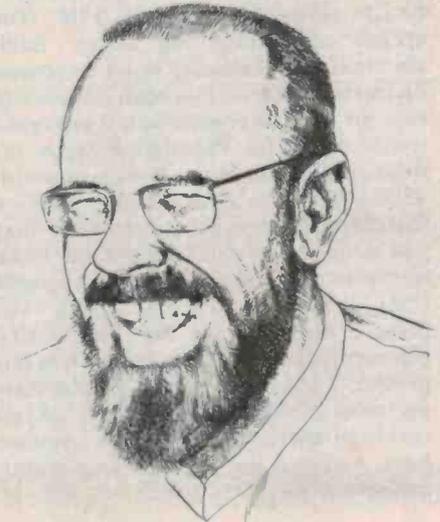
Now are you beginning to catch my complaint? Things are moving too fast. The TRS80 CC software is like fireworks! No sooner has one burst in the sky, when another appears, to be greeted by ever more gasps of amazement. Luckily, the number of duds has been surprisingly few. As usual, though, there have been plenty of firms promising but not delivering.

If you are a software collector, you'll want Magic Box to download Level 2 cassettes. The different CPU will bar you from Model I machine language. The limited screen display, and the slightly different (Microsoft) Extended BASIC, will demand some minor editing. If that won't satisfy you, go for Exatron's Disk Operating System (DOS) to tap into Model I disks and the really hefty ones available on the FLEX system. (FLEX is the most popular DOS for 6800/9 machines).

If you are happy with BASIC, you'll have to get Master Control for single key writing of commands and statements, and auto line-numbering. It may be hard to keep you away from the BASIC Tool Kit to link subroutines. It has the features to turn out a professional product with little effort. If you want more languages, you have the problem of choosing a version. If you prefer assembly language and shun PEEKs, POKEs and string knotting, it will be a long time before you write a line. You'll be too busy choosing your tools. A FLEX cross-assembler will help you convert your library of 6502 or Z80 routines.

The Ferrari enthusiast will go for the 64K expansion with double-everything disk system, available from Tallgrass Technologies. Cer-Comp have brought out a more powerful DOS and a pack of utilities for it. I think that the well established FLEX programs will prevent even an independently hepped-up TRSDOS becoming the standard. That doesn't mean we won't see Model I releases for the TRS80 CC. The classical lightweights will always be worthwhile. It would be better to start from scratch on the heavyweights.

If teachers weren't in love with tradition they would leap on the timer and



Greg Wilson

PUBLICATIONS devoted to the TRS80 Colour Computer are:

68 Micro Journal, P.O. Box 849, Hickson, TN 37421

CINTUG, 44 Dow Court, Fairfield, OH 45014

Chromasette, P.O. Box 1087, Santa Barbara, CA 93012

Color Computer News, P.O. Box 92, Muskegon, MI 49443

TRC, P.O. Box 3191, Chapel Hill, NC 27514

Rainbow, 5803 Timber Ridge Dr, Prospect, KY 40059

audio cassette controls of the TRS80 CC. Don Inman, in last July's Computing Teacher (p.33), pointed to the exciting abilities and possibilities. Tandy have contracted with Dorset for their Talk-Tutor system add-on for VCR control. I think that's going too far too soon. I have found the most effective learning by computer is with programs that have modest aims and are easy to use. The TRS80 CC can easily make learning more colourful and exciting. The teacher can record words of encouragement or correction in his or her own voice, and it's easy to write a program that decides which to play back.

Tandy games on ROMPAC are hard to beat, but they have been overtaken by cassette products. It takes Tandy nine months to make and distribute a PAC, after they've developed and debugged the code, and a lot can happen in nine months. Berserk and the Space Trilogy have shown their heels to Tandy. Space (39) and other arcade (21) games dominate, followed by Adventure (23). About half of the remainder improve on popular favourites. Because of the variety, selection is the big problem.

Tandy targeted Personal Finance and ▶

File PACs to home use. This is reflected in the seven file types in 'File'. The option of setting up seven field-personalised databases won't be missed by business users. I've been an accountant for too many years to tell you and I would settle for Personal Finance for most small businesses. It will cope with 1800 cheques or cash disbursements a month into 26 expense accounts that you define. You can juggle three bank accounts and budget. To leave an audit trail, you'll have to spend \$499 for the printer designed for the TRS80 CC. Since reliability of tape storage has improved, I am going backwards by storing most of my data on cassette. If you insist on speed, all three disk systems have random, as well as sequential, access.

Most of the software available right now for business applications is geared to decision making and charting. Tandy's Spectaculator (Visicalc equivalent) and Scripsit PACs are overdue. In fairness to them, returns to the drawing board haven't been due to bugs so much as enhancements when latent power is discovered. It's hard for a programmer to stop refining a program, but he must.

The hunt for programs may cause headaches. Only eight of the 39 software sellers advertising in the US have experience distributing programs that weren't for the 6809. Some major distributors, such as Instant Software, have announced TRS80 CC development but they haven't yet produced. I don't expect many Australian shops will be flooded with programs, but some will,

for sure!

I'm enthusiastic, but there are a few warnings. Start off with a 4K machine. Tandy's memory expansion seems rather over-priced. Check before you buy. The sign-on should read 'Version 1.1', or higher. 'POKE 65494,0' should not send it haywire. If it does, it's got older chips that won't work at 1.8 MHz. Hold off from Extended BASIC until you have decided that you really need the high resolution programming ability in BASIC. Look at what's really needed for the software that you want. Don't take the plunge on printers, disks, modems, EPROM burners and the like until you know what you really want. If you phone me at (02)358-6491 I'll try to help you.

SOURCES FOR SOFTWARE

At this early stage, the only known Independent Australian stockists of software for the TRS80 Colour Computer are:

GSI Electronics, 1190 Canterbury Rd, Punchbowl 2196
Greg Wilson, P.O. Box 504, Potts Point 2011

Known independent suppliers from the USA are:

Aardvark-80, 2352 S. Commerce, Walled Lake, MI 48088
Abrams Clayton, 1758 Comstock Ave, San Jose, CA 95124
Adventure International, P.O. Box 3435, Longwood, FL 32707
Alford & Associates, P.O. Box 6743, Richmond, VA 23230
Allen Gelder Software, Box 11721 Main P.O., San Francisco, CA 94101
American Business Computers, 118 S. Mill St, Pryor, OK 74361
Bank Software, 37 Balmoral Dr, Spring Valley, NY 10977
Cer-Comp, 5566 Ricochet Ave, Las Vegas, NV 89110
Color Software Services, P.O. Box 1723, Greenville, TX 75041
Computer Information Exchange, Box 159, San Luis Rey, CA 92068
Computer Simulations Co, 305 Hammes Ave, Joliet, IL 60436
Computer Store Inc, 114 West Taft, Sapulpa, OK 74066
Computerware, Dept C, P.O. Box 668, Encinitas, CA 92024
Datasoft Inc, 19519 Business Center Drive, Northridge, CA 91324
Digibyte Systems Corp, 31 East 31st St, New York, NY 10016
Dorset Educational Systems, P.O. Box 1226, Norman, OK 73070

Frank Hogg Laboratory Inc, 130 Middletown Plaza, Syracuse, NY 13210
HW Electronics, 19511 Business Center Dr, Dept V8, Northridge, CA 91324
Hoyt Stearns Electronics, 4131 E. Cannon Dr, Phoenix, AZ 85028
Huntington Computing, P.O. Box 787, Concoran, CA 93212
Illustrated Memory Banks, P.O. Box 289, Williamstown, MA 01267
Lyman Frank, 12 Reservoir St, Cambridge, MA 20138
Mark Data Products, 23802 Barquilla Mission, Viejo, CA 92691
Micro Learningware, P.O. Box 2134, N. Mankato, MN 56001
Micro Processor Systems Inc, 37060 Garfield, Mt Clemens, MI 48043
Micro Works, P.O. Box 1110, Del Mar, CA 92014
Micro-Labs Inc, 902 Pinecrest, Richardson, TX 75080
Mint Software, 6422 Peggy St, Baton Rouge, LA 70808
Mucci Andrew, 73 Martland Place, Garfield, NJ 07026
Nelson Software Systems Inc, P.O. Box 19096, MPLS, MN 55419
Program Store, Dept E09, Box 9609, 4200 Wisconsin Ave, Washington, DC 20016
Programmer's Institute, P.O. Box 3191, Chapel Hill, NC 27514
Rainbow Connection Software, 3614 6th Place NW, Rochester, MN 55901
Seebree's Computing, 456 Granite Ave, Monrovia, CA 91016
Soft Sector Marketing Inc, 6250 Middlebell, Garden City, MI 48135
Spectral Associates, 141 Harvard Ave, Tacoma, WA 98466
Strawberry Software Inc, Box 743, Vashon Island, WA 98070
Talbot Microsystems, 5030 Kensington Way, Riverside, CA 92507
Tallgrass Technologies Corp, 9009 W. 95th St, Overland Park, KS 66212.

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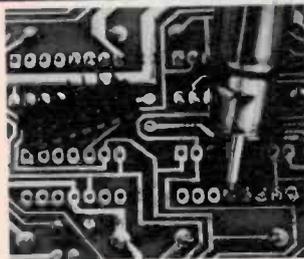
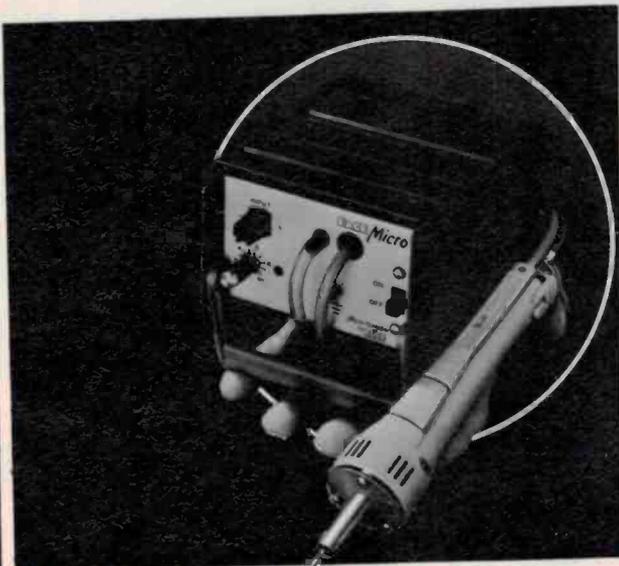
- Vol 0: Summary of all group volumes
- Vol 28: Algol compiler, documentation & programs
- Vol 40: Disk cataloging system
- Vol 50: Pascal compiler & C programs
- Vol 23: Basic - a "FOURTH" like compiler (2 volumes)

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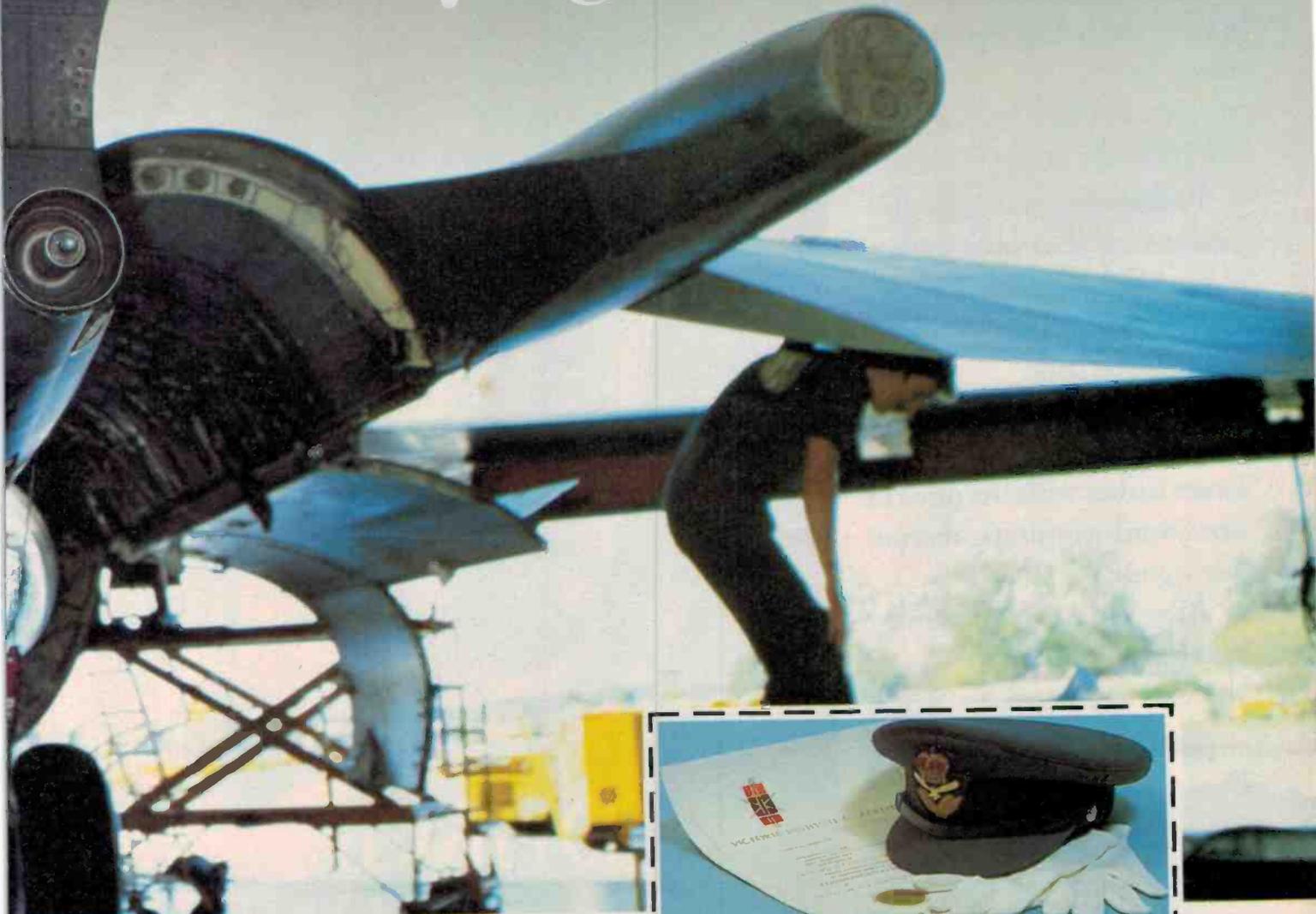
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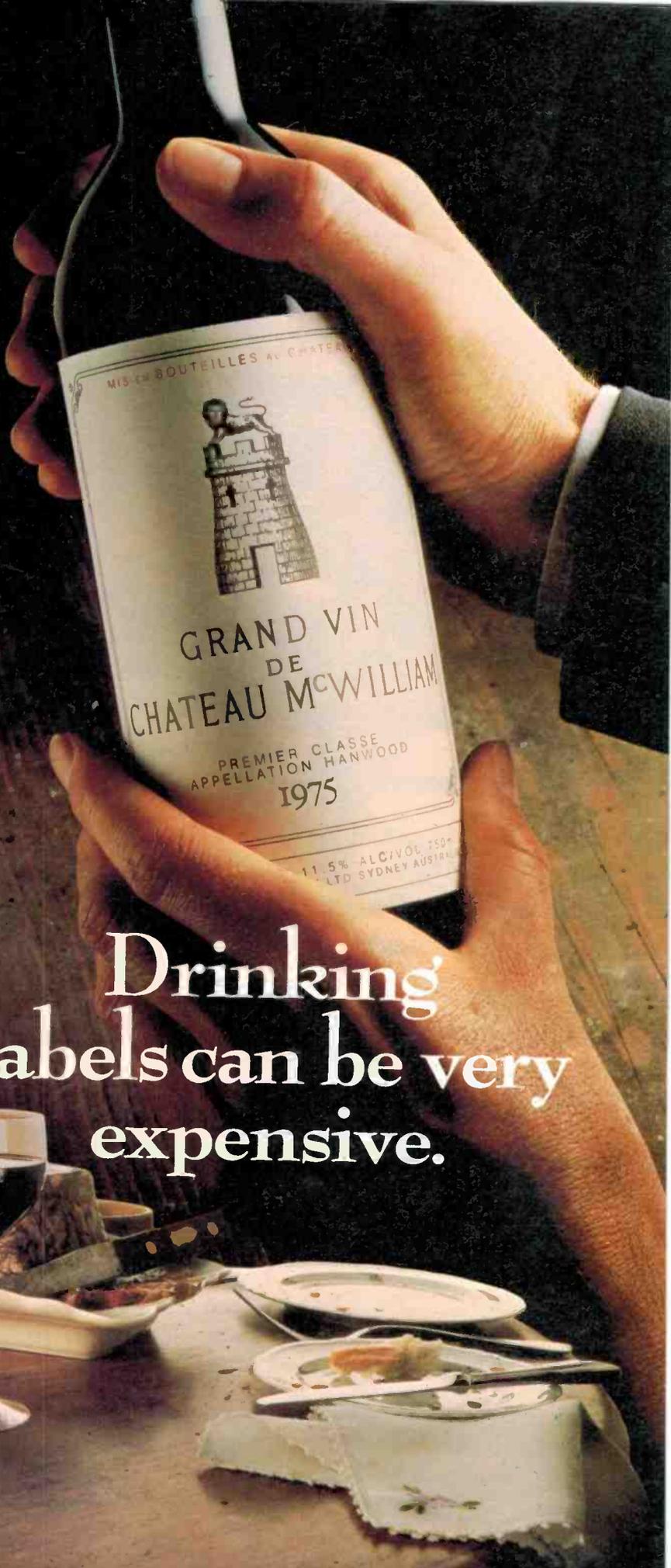
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A real-time game for the Sinclair ZX80 (1K) – go to it!

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A STREAM of ten missiles leaves an enemy base ten kilometres from your city. Each missile has an approach speed of one kilometre per second, and weaves left and right as it comes. You are defending the city with a gun which

fires explosive shells at a rate which depends on your skill. A shell exploding within a one kilometre radius of a missile will destroy it, and the enemy immediately fires another.

Once the display appears on the

screen, you have to judge its range and bearing, and every second counts. The game ends with all ten missiles destroyed and the acclaim of the population, or with the sound of one hand clapping.

Program listing:

<pre> 1 CLS 2 LET L = 1 3 LET M = 16414 4 LET B = RND(10) - 1 5 LET R = 10 10 FOR K = 1 TO B 11 PRINT "ΔΔΔ"; 12 NEXT K 15 PRINT " ";CHR\$(156+L);"" 16 PRINT "ΔΔ"; 17 FOR I = 1 TO B 18 PRINT "ΔΔ";I; 19 NEXT I 20 PRINT 21 FOR P = 1 TO R 22 PRINT ,R - P 23 NEXT P 24 PRINT 25 PRINT "Δ ΔΔΔΔ=" 26 PRINT "Δ ΔΔΔΔ ";CHR\$(130) 27 PRINT ,CHR\$(139);CHR\$(128); CHR\$(139);"";CHR\$(128); CHR\$(132);"=" 30 POKE M,0 31 POKE M+1,0 </pre>	<pre> The number of the approaching missile Address for timer Set initial bearing of missile Set initial range of missile } Positions missile on screen Missile graphics } Print bearing numbers } Print range numbers } City graphics } Set timer to zero </pre>	<pre> 32 PRINT 33 PRINT "SET BEARING THEN RANGE 0 TO 9" 36 INPUT X 37 INPUT Y 38 CLS 40 LET T = (PEEK(M)+PEEK(M+1)*256) /50 41 LET B = B + T*(2 - RND(3)) 42 LET R = R - T 45 IF B<0 THEN LET B = RND(3)-1 46 IF B>9 THEN LET B = 6 + RND(3) 47 IF R<1 THEN GOTO 55 50 IF ABS(X-B)<2 AND ABS(Y-R)<2 THEN GOTO 60 51 GOTO 10 55 PRINT "CITY OBLITERATED" 56 GOTO 55 60 PRINT "MISSILEΔ";L;"ΔDESTROYED" 61 IF L = 10 THEN GOTO 68 62 LET L = L + 1 64 GOTO 4 68 CLS 69 PRINT "WE ARE SAFE, THANKS TO YOU" 70 GOTO 69 </pre>	<pre> Time elapsed since last defensive shot Update bearing Update range } Conforming to screen restriction Doomsday Your warhead within destructive range of incoming missile </pre>
---	---	--	---

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This is what Reg Hesper, Technical Officer of Gladesville had to say about 'Super 80' "I enjoyed building the Super 80 project and felt it worthwhile, of immense educational value and quite easy to construct. It worked as soon as I turned it on and has provided many hours of enjoyment".



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Easy to build

Even though we would not recommend this kit to the raw beginner, it is very easy to build. Any person who can use a small soldering iron and can solder neatly should have no difficulty in construction. This is because of the unique double side board design which means there is virtually no other wiring. The board is covered with professional 'solder mask'; this makes soldering much easier without the problems of bridges, etc. Once the components are soldered onto the board in their marked positions over 98% of the construction is completed. Even if you cannot get the completed kit to work, we have a special "Sorry Dick it doesn't work" repair service to assist you.

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Most computers sold in Australia are manufactured in the U.S.A. where extremely high labour rates prevail - and you pay dearly for this on built up units. With this computer kit, you provide the labour and therefore save a fortune. And remember, this computer does not have a small toy-like calculator keyboard but a full size professional typewriter keyboard.

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One of the most popular computers in the world (the Tandy TRS-80 Level 1) only has 4K of BASIC. The BASIC we have with this unit is a large 9K. When you consider that our popular Sorcerer computer (over 2,000 sold) only has 8K BASIC and sells for over \$1,000, it is obvious that by building yourself, you are saving real money.

Electronics Australia/Dick Smith design

This is not a half baked design with no back up. The resources of Electronics Australia, Australia's most popular electronics magazine, and Dick Smith Electronics have combined to design and bring you this kit in the interests of computer enthusiasts actually building and not just buying. The design is fully Australian.

Imagine how much you will learn!

Most computer enthusiasts can program a computer but would have absolutely no idea of how to build one. By building this kit you will learn both the technical side of construction, how it works and then how to program. What a fantastic background for a future.

Sectional construction

We have designed this kit not only for the serious computer user but also for first time users like the student or hobbyist. This is why we have a short form kit which may be added to as you build (and as you have the money!). For example, you may build the computer originally and operate it with 'BASIC on tape' and then add 'BASIC in ROM', add the S-100 and provide other parts at a later stage.

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Technical specifications: 4 MHz Z-80 CPU • Dbl-sided, dbl-den. 5 1/4" or 8" floppy disk controller (handles both drives simultaneously) • CP/M 2.2 included • 64K RAM, expandable per your requirements • Comes complete in single mainframe • RS232C serial port • Parallel port • Hard disk compatible • Monitor program & disk routines included on EPROM • Power-on/reset jump to monitor program • Documentation included. • Extensive software available

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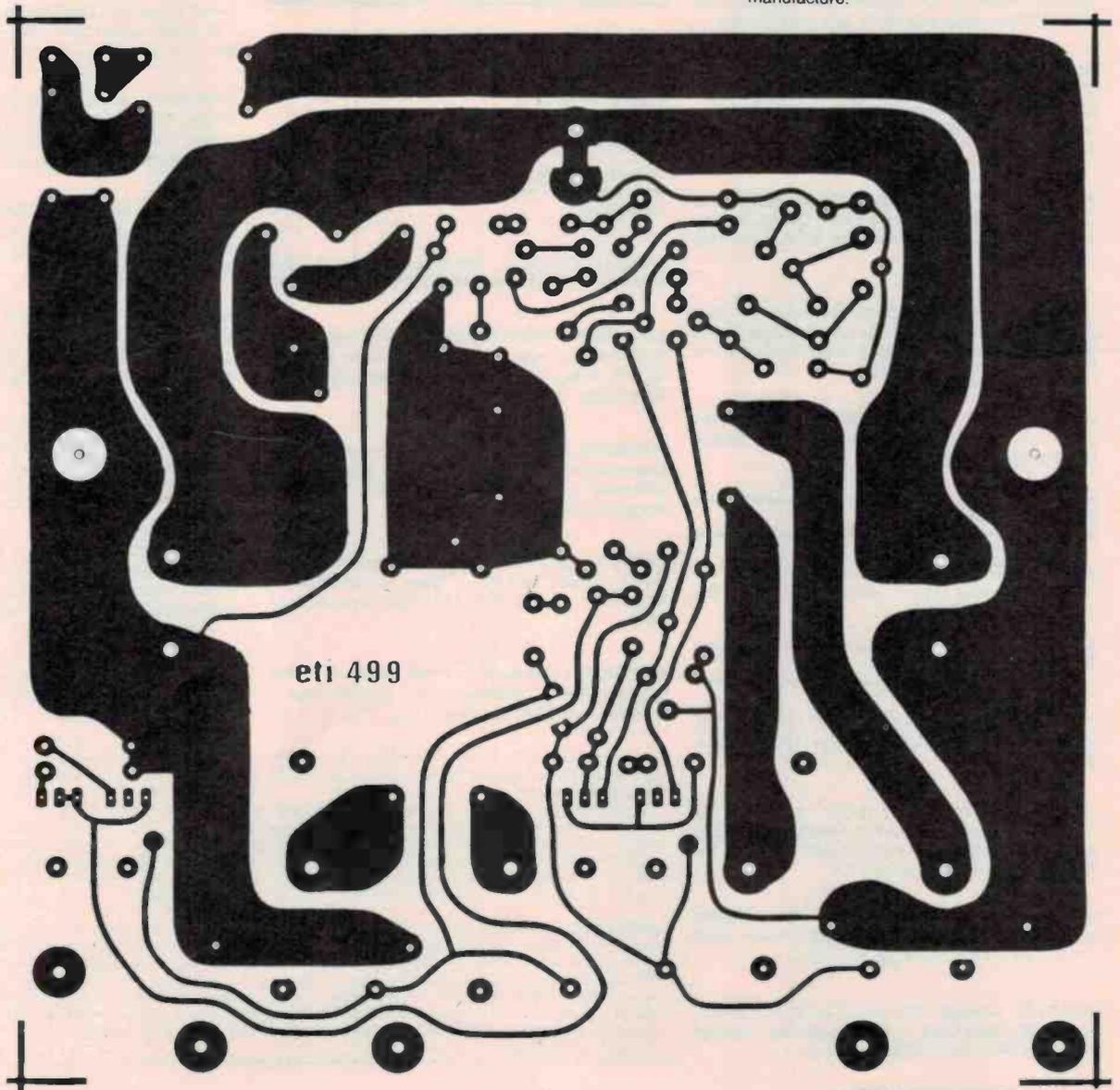
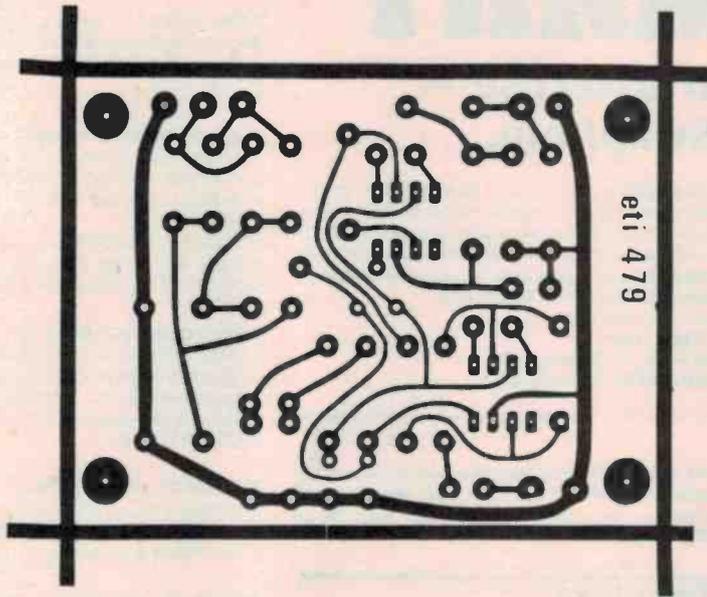
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007, which is UV sensitive and can be used under normal subdued light.

Cut a piece of film a little larger than the pc board and expose it to UV light through the magazine page. The non-emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner — it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and pcb manufacture can be found in the September and December 1977 issues of ETI.

Please note that occasionally lack of space may prohibit the printing of blue type behind all pcbs. In this case the reader must resort to more conventional photographic techniques for pcb manufacture.



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FOR SALE: Model 15 teleprinter & transformer, Model 14 tape reprocessor, Model 14 tape transmitter, with documentation, \$125. Dave McKeough, 34 Moore St, Campsie NSW (02)78-1494.

SELL: ZX80 8K ROM, 4K RAM, power supply, 4K, 8K manuals, 4K ROM. Cost \$475, sell \$380. C. Bloomer, 367 Lesmurdie Rd, Lesmurdie WA 6076. (09)291-6749.

WANTED: Game program listings for the System 80 and Sorcerer computers. Will pay reasonable price. Contact J. Burns, 6 Banksia St, Townsville Qld. 4814. (077)73-1896 after 6pm.

SARGON II PATCH PROGRAM for TRS/System 80. Modifies and improves Sargon. Save and load unfinished games, plus 50 chess problems on cassette data file. Send SAE to B. Fripp, 30 Castlecree St, Ferny Grove Qld 4055, for details.

MICROPOLIS 1042 143K per disk disk-drive system, ready for any \$100. Includes manual, disk BASIC, assembler, editor. Switch-selectable bootstrap addresses. \$650. Phone (08)268-8021.

SORCERER 32K (devpac, manuals, cabling, lots software), \$1200; expansion unit, \$400; DG640 VDU, \$80; Godbout XX 32K S100 static RAM, \$350. Terry, (02)682-4649 ah.

AUDIO

AUDIO FREQUENCY TRACER/spectrum analyser, Meguromat—142. Recently calibrated, ideal for amplifiers, speakers, tape recorders and video tape recorders. 20 Hz — 20 kHz, two channel, new price \$3600 sacrifice at \$2150 ono. (02)46-5451.

AUSTRALIAN TAPE RECORDING CLUB: Make friends all over Australia through the hobby of tape recording. For information about our club, write to Bill Skillman, P.O. Box 147, Kogarah NSW 2217.

WANTED: Instruction booklet (or copy) for Optonica RT 3838 cassette deck. Stuart Robertson, 2/28 Burton St, Randwick NSW 2031. (02) 398-1378 (ah).

FOR SALE: ETI 4600 music synthesiser, 90% completed, works perfectly, immaculate cabinet, worth \$700-\$800, must sell \$395. (03)052-9360. 4 Buna Ct, H-Hill, Geelong Vic. 3218.

DISCO-STROBE for sale (ETI Sept '79). Works well, has two strobe tubes. \$40 ono. Phone (02)436-3005 after 6pm.

COMMUNICATIONS

WANTED: SSB/AM CB radio, preferably with antenna and power supply. Matthew Cook, Box 66, Minlaton SA 5575.

MISCELLANEOUS

SELL: Back issues ETI from Nov. '77 to May '79, dirt cheap, \$20. Phone Simon (08)332-3928, Adelaide.

SELL: EA 'Prospector' metal detector. Assembled, works well, host of extras, fully collapsible for portability. Only \$35. Rowan Loh, Trio Rd, Kyneton, Vic. 3444. (054)22-1336.

SELL OR SWAP: Elect. mags — EA, ETI plus others. Swap for 23-ch CB. Gary McQueen, RMB 5022, Cobram Vic. 3644. (058)73-5231.

WANTED: January 1975 issue of ETI or photocopies of project 231 — flip-flop flasher. Contact Richard Falkland on (08)271-0706 ah.

FOR SALE: ETI 549 metal detector. Complete, but requires alignment. \$50 ono. Also one twin 12 V supply — suit train set etc. \$60 ono. David Wilkinson, (03)469-3171.

COMPUTERS

FOR SALE: SYM-1 plus KTM-2, BASIC and 8K RAM. Also Dick Smith video monitor. \$400 ono. Brian Williamson, 19 Phillip St, Port Augusta SA 5700. (086)42-5769.

MICROACE with 4K ROM, 2K RAM, leads, adaptor, manual and 30 programs book. Good condition. Sell for \$150. Phone (02)639-3115 after 5 pm weekdays.

WANTED: Model III TRS80 computer. Dr. E.H. Plunkett, Hill St, Eugowra NSW 2806. (068)59-2472.

MINI WORD-PROCESSOR for 2650 micro with DG640 VDU, listing and full instructions included, \$15. B. Healy, 44 McAndrew Crescent, Mangerton NSW 2500.

WORKING READY TO GO: 8085 microcomputer board loaded with ICs and sockets, power supply included — offers to J.D., 106 The Esplanade Brighton SA 5048.

ZX80/81 OWNERS! Join the National Sinclair Users' Group. Send 24c stamp for introductory newsletter to: P.O. Box 148, Glen Waverley Vic. 3150.

FOR SALE: Synertek SYM-1 with cables, \$100 ono. Contact Simon Wardrop (a.h.) (03)878-0469, 3 Gwenda Ave, Blackburn Vic. 3130.

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SIGHT & SOUND

Sony to appeal US ruling on VCR usage

Sony Corp. of America announced mid-January that it would appeal to the US Supreme Court to reverse its earlier decision that makes it illegal to use VCRs for off-air recording of copyrighted material.

Sony's planned move follows its unsuccessful attempt to receive a rehearing by the Ninth Circuit Court of Appeals in San Francisco in that case.

The appeals court ruled last year that Sony Corp. of America and its parent firm, Sony Corp., Tokyo, as well as certain Sony retailers and an individual VCR owner, are infringing US copyright laws.

Following the Ninth Circuit's ruling, Sony requested a re-hearing of the case by an eleven-judge panel. A three-judge panel had made the initial ruling for the Ninth Circuit. That request was denied by the court, without an explanation.

Sony was joined in its Ninth Circuit appeal request by Matsushita and the Electronic Industries Association, both of which filed friend-of-the-court briefs. It could not be learned by presstime if they will also join Sony in its appeal to the Supreme Court. It is expected they will do so.

Sony and Matsushita make virtually all VCRs built for the US con-

sumer market. Matsushita supplies its VHS-type recorder to its JVC affiliate and its Panasonic and Quasar subsidiaries, as well as to RCA General Electric, and N.A. Philips Consumer Electronics Corp., which markets them under the Magnavox, Philco and Sylvania labels.

Sony supplies its Beta format to Zenith, Sanyo, Toshiba and Sears.

The copyright issue was first ruled in Sony's favour in a suit filed by Universal Studios and Walt Disney Productions in Los Angeles federal court in 1976. The decision was reached in that court in 1979.

Disney and Universal then appealed to the Ninth Circuit in San Francisco.

Sony had argued in its petition for an appeal that "Video recording reception at home, followed only by non-public performance, does not constitute copyright infringement", noting that the decision against it "has impugned the legality of the daily conduct" of US VCR owners.



Remote control VCR

National Panasonic recently introduced the NV-7200 home video recorder with infrared remote control and Dolby noise reduction.

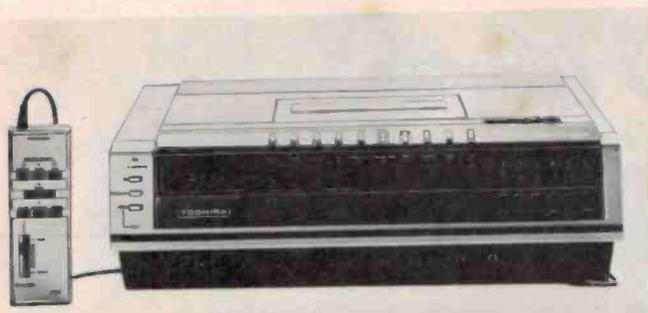
There are no cumbersome wires to the infrared remote control unit, and the NV-7200 can be controlled from anywhere in the room. 24-mode gives complete control: record, play, fast forward, rewind, stop, pause/still, still advance, half-speed, double speed, cue, review and channel selection. You'll never have to leave your armchair!

Simultaneous viewing/recording means you can watch your favourite television programme and record at the same time. The unit is also equipped with a timer that is prog-

rammable for as many as four programmes during a 14-day period. A single time slot may also be automatically recorded every day. The built-in battery back-up system will keep the clock, timer and memory functioning with perfect accuracy for up to a full hour in the event of an interruption to the power supply.

Other features include six different playback speed variations for convenience, and the world renowned Dolby noise reduction system to provide the highest quality audio recording.

New Toshiba VCR with four-head system



A new video cassette recorder incorporating a four-head system has been released by Toshiba Australia. Called the V-8600A, the new Toshiba model is claimed to eradicate video interference and bar noise common on some players during the 'slow motion' and 'still picture' phases.

Toshiba's four-head design also allows a wider choice of tape speeds. These include a 'vari-speed' (from one thirtieth to one third of normal); double speed; and 'Cue' and 'Review' functions, which allow speeds seven and 25 times faster than normal. The optional fast speeds greatly accelerate scene location, whilst the extremely slow speeds afford a revealing study of action situations.

Recording time extends to 3¾ hours. The machine will record whilst the viewer watches, will record one programme whilst transmitting another for viewing, or will record up to three separate programmes over a one-week pre-set period even when received from three different channels.

Other Toshiba V-8600 features include an Audio Dub control for the adding of soundtrack to previously recorded material, plus an Auto Rewind facility and a Counter-Memory function to return the tape to any preselected position.

The unit will edit out unwanted sections of a programme and automatically dovetail the unedited content together without 'jittering' the picture, using the remote control pause function.

A Toshiba microcomputer control system is the key to the V-8600's sensitivity, reliability, versatility and ease of operation.

For enquiries or additional information contact Roger Porter, (02) 922-6877.

ROLLS ROYCE ?
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JANSZEN
ELECTROSTATIC HI-FI SPEAKERS



JANSZEN HI-FI SPEAKERS

Dear Customer,

A myriad of companies manufacturing high fidelity speakers seems to be limitless, and each company, including JANSZEN, vehemently claim that their product is the only accurate reproducer of music.

It must be confusing trying to decide which speaker system will give the highest degree of accuracy in relation to price. We would not be so pretentious as to say the JANSZEN ELECTROSTATIC is the only "Ultimate" reproducer. There are other companies utilizing electrostatics who deserve consideration, but, we believe it is generally accepted among knowledgeable people and technical experts, that by the laws of physics it is not possible for any speaker other than the electrostatic to achieve the ultimate goal: accurate reproduction. JANSZEN was the "original" electrostatic manufacturer in the United States, and holds the major base patents on electrostatics. JANSZEN has developed and manufactured electrostatic loudspeakers for over 30 years, considerably longer than anyone else in the industry.

We feel that JANSZEN electrostatics offer to the serious listener, a level of sophistication, manufacturing technology, and performance that is associated with the theoretical excellence of a speaker system that many strive for, but few accomplish.

Sincerely

Nigel V. Cowan
Managing Director
N.V. DALE ELECTRONICS
JANSZEN DISTRIBUTORS
FOR AUSTRALIA

Mail this for the name and address of your nearest stockist and/or literature on the range of Janszen Electrostatic Speakers

Contact:

n.v.dale electronics

274 VICTORIA STREET, BRUNSWICK
VICTORIA 3056 387 6170
(03) 387 7076

Lasers record loudspeaker movement

The British firm of Celestion, one of the few remaining British firms specialising in the design and manufacture of loudspeakers and their components, has developed a technique for recording the movement of loudspeakers with holograms. They can thus obtain video recordings of the cone movement in response to electronic signals, which helps engineers to spot faults.

Still pictures of the cones had previously been made with laser holography — a laser beam is split into two parts, with one half scanning backwards and forwards across the speaker cone while it is reproducing sound. The reflection of this beam is mixed with the other beam and directed at a sensor to produce an electrical output. The output signal provides a measure of the cone's movements because of the Doppler effect produced by the cone movement in the reflected beam. A still picture is drawn on an oscilloscope screen from the data provided by the signals.

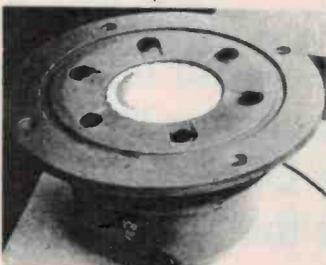
By recording a series of these pictures in a computer memory,

Celestion has gone one step further and can reproduce the sequence like an animated film, creating a moving replica of the cone's movement.

The laser beam scans backwards and forwards across the loudspeaker cone in a raster of 64 lines, with 64 samples of the sensor output taken in each line. When this 'frame' of information is displayed on an oscilloscope screen it produces a frozen still picture of the cone's movement made up of 4096 picture points.

The loudspeaker is scanned twelve times in sequence, each frame being stored in a computer memory. The sequence of twelve

frames is then displayed on an oscilloscope screen so that it is repeated over and over again like twelve frames from an animated film. The result on the screen is a smooth, slow-motion replica of the original rapid motion of the cone. Irregularity of cone movement is shown up on the display, for example distortion of the cone surface caused by spurious sound patterns.



Heavy stuff!

That's the Naim Audio NAC A4 speaker cable (nicknamed Tyrannosaurus cable . . . if you get our drift).

Consisting of two conductors made up of 56 strands of '0.030' coppers separated 10 mm centre-to-centre, the cable features special low capacitance construction.

The makers claim this cable is suitable for high-quality amps that don't like 'funny' loads. (To us, this

indicates marginal stability . . . but, to others . . .) OK — if you're after a heavy, low loss speaker cable, you might look over the Naim NAC A4 — at your local Naim dealer.

Enquiries to Stolmack, P.O. Box 139, St Ives NSW 2075.



Arms for the Linn lover!

At long last — a low-cost arm for the Linn Sondek turntable, made by Linn. Yes folks, it's the Linn Basik LV-V tonearm!

Featuring 'high-quality' bearings, cosmetic compatibility and the usual Linn workmanship, the Linn Basik LV-V tonearm can be obtained with an 'induced magnet' cartridge, or you can fit your own moving coil type, or what have you.

The Linn arm-and-cartridge combination costs just \$123 — making the Linn turntable-plus-arm \$1398.

It's available from all Linn dealers now. Further information from Stolmack, P.O. Box 139, St Ives NSW 2075.



Improved cylindrical speaker

JR Loudspeakers Ltd have completely redesigned their JR149 cylindrical loudspeaker (ETI, March 1981), although it remains a unit with a 60 W power handling capacity.

Improvements in the JR149 Mk. 2 include:

- A new treble unit with hexagonal wire in the voice coil, a new 20 mm ultra-light diaphragm and a new magnet system which will provide improved power handling and a superb polar response.
- A new bass unit with a high-temperature 'Neoflex' diaphragm of low mass yet increased rigidity, a very compliant outer suspension system, an oversized magnet and a heavy-gauge steel chassis.
- A new crossover network with inductors in the bass section which provide less distortion, new air-

cored inductors in the treble section and a preset control which permits +/- 2 dB adjustment of the treble response. The crossover frequency has been reduced to 2.2 kHz.

- A new acoustic chamber of eight-litre capacity with a front baffle of 16 mm resin-bonded board, a hexagonal steel centre shaft of doubled strength and a lower systems resonance.

Enquiries about availability in Australia should be made to International Dynamics, P.O. Box 205, Cheltenham Vic. 3192.

Brian Dance

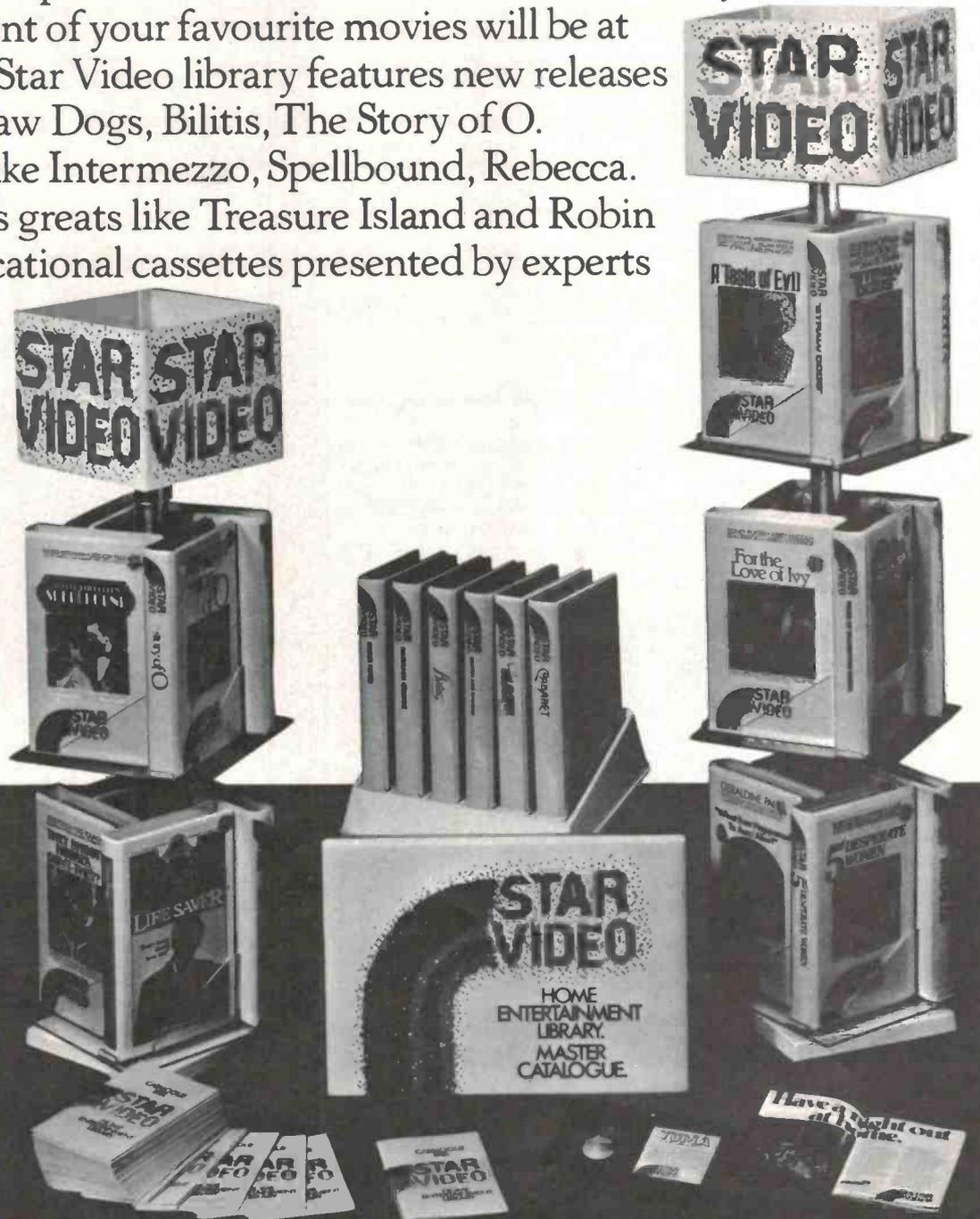
Name our E-I. And win a S--r

If you can fill in the gaps you're on your way to winning the prize.
And what a prize it is. The Star Video cassette library.

All the excitement of your favourite movies will be at your fingertips. Star Video library features new releases like Cabaret, Straw Dogs, Bilitis, The Story of O.

Classics like Intermezzo, Spellbound, Rebecca.

Children's greats like Treasure Island and Robin Hood. And educational cassettes presented by experts



r names.

Video cassette library.

like Alan Seale, Dr. Wright, Charmaine Solomon. To win the Star Video cassette library you have to fill in the gaps in the name of this magazine.

There's a total of \$25,000 worth of prizes in the Name our Names contest. In Wheels and Two Wheels you could win a MiGi sports car valued at \$7,200.

In Revs and Modern Motor you could win a Kawasaki K175 trail-bike, Eurovox car stereo, Bob Jane mag wheels and tyres, Astraview sunroof and a Perfect Tune car cylinder head conversion valued at over \$2,000. In Modern Boating and Modern Fishing you could win a Haines Hunter runabout V133 outboard, 55 h.p. Tohatsu outboard motor and D.A.M. fishing tackle valued at \$5,290. In Outdoors and Overlander you could win a Jayco Jayfinch camper trailer valued at \$4,600.

In Australian Golf and Rugby League Week you could win Dunlop golf gear, a Sony video recorder and Star Video sports library valued at \$3,400.

The name of this magazine is:

E - I.

Read the conditions, fill in your entry form and mail it to Name our Names, Murray Publishers Pty. Ltd., 154 Clarence Street, Sydney. The first correct entry opened wins the Star Video cassette library.

Name _____

Address _____

Postcode _____ Telephone No: _____

Conditions of Entry: 1. Only entries received by the closing date will be accepted and proof of posting will not be considered as proof of entry. 2. The Judges' and company's decision is final and no correspondence will be entered into. 3. All entries remain the property of the Editor. 4. The winner will be notified by registered mail and the name published in the June issue of this magazine. 5. The prize is not redeemable in cash, nor transferable to a third party, except where the winner is under 16 years of age, when the prize in total shall be delivered to the care of a parent or guardian. 6. Each entry must be handwritten on an original coupon printed in this magazine except in those States where local laws prohibit this limitation in which case an original handwritten entry in the same format as the coupon on plain paper will be acceptable. 7. Employees, and their relatives of Murray Publishers Pty. Ltd., or their related companies or agencies are ineligible to enter. 8. Submission of an entry to this competition indicates acceptance of the above conditions, and no claim of a legal nature will be entertained as a result of such participation by any contestant. Closing date, April 30th, 1982. Permit No: TC81/1735.

Not Just Speaker Wire



Conventional speaker wire limits the performance of your sound system by decreasing power output, restricting dynamic range, and reducing clarity and definition. You can significantly improve the performance of your audio system by switching from your present speaker wire to Monster Cable.

Constructed of over 500 strands of high purity copper in a unique configuration, Monster Cable is specifically engineered for low resistance, low capacitance, and low inductance. The Results?

Deeper, tighter bass.
Maximum power transfer.
Increased clarity and definition.
Wider dynamic range.

Even low-powered systems show a remarkable improvement. Recommended by leading audio manufacturers, Monster Cable is safe to use with all amplifiers and receivers, regardless of design.

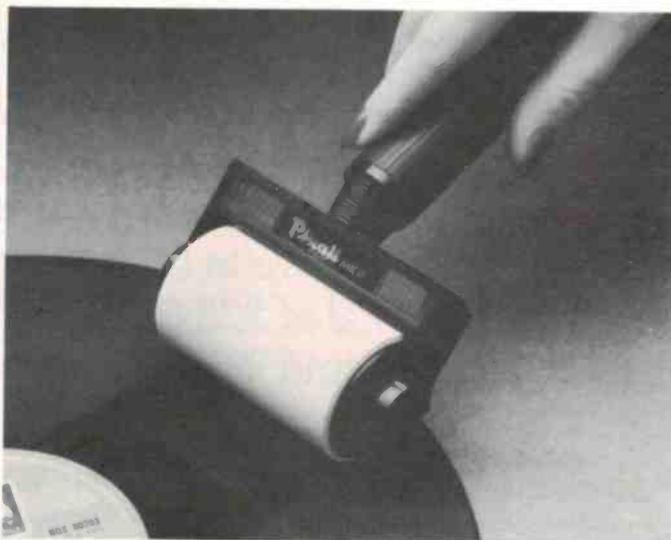
Don't be deceived by imitations. If it doesn't say Monster Cable you're not getting all the performance you paid for.

MONSTER CABLE

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DURATONE HI FI Phillip • KINGSTON HI FI Kingston • VICTORIA—NATSOUND Melbourne •
BOON SOUND Wodonga • EAST COAST AUDIO Albert Park • SOUNDCRAFTSMAN Nth. Caulfield •
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Townsville • GOLD COAST HI FI Southport • HANDO HI FI Toowoong • HI FI SALES Redcliffe
HIGHWAY SOUND Mt. Isa • REG MILLS STEREO Buranda • STEREO SUPPLIES Brisbane • STEREO
WORLD Cairns • STN. AUST.—ASLIN HI FI Mt. Gambier • BLACKWOOD SOUND Blackwood •
GRENELL PLAZA HI FI Adelaide • SOUNDCRAFTSMAN Hawthorne • TRACK HI FI Adelaide • W.A.—
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SIGHT & SOUND



Filth off!

Filth on your records — lying in or on the grooves — not that contained in the groove modulations, silly! — causes crackles and pops that decrease your enjoyment of the recorded material.

Milty Products of the UK have been making record care devices and products for some years, well known among them being the Permostat process and the Pixall Record Cleaner.

The new Pixall Mk II features the roller-and-sticky-tape system that proved so effective previously, and now incorporates a few new features. The sticky tape on the roller is specially formulated so that when rolled over the record surface it picks up not only surface dust but also 'reaches down' into the grooves and

picks up dust and grime.

The Pixall Mk II has a unique cutting blade mounted in the handle that allows quick and easy cutting of the sticky tape on the roller so that the contaminated tape may be removed, exposing fresh sticky tape.

We've had the opportunity to try one out over the past few months and can report that it seems to be quite effective. The Pixall Mk II sells for around \$20. Further details are obtainable from the distributors, Concept Audio, 22 Wattle Rd, Brookvale NSW 2100. (02) 938-3700.

Dynavector cartridges improved

Concept Audio, the Importers and distributors of Dynavector moving coil cartridges, recently announced the availability of two new cartridges from the Dynavector stable: the DV Karat 17 Diamond and the DV Karat 23 Ruby.

The DV Karat Ruby and the DV Karat Diamond are models that have been on the market in Australia for two years now and the Ruby in particular has met with great enthusiasm.

Dynavector's minimum wave dispersion theory was demonstrated in these first two Karat models, and is taken a step further with the new Karat series.

The DV Karat 17 Diamond has a cantilever measuring only 1.7 mm in length (made of pure diamond), whilst the DV Karat 23 Ruby has a cantilever measuring 2.3 mm (made of synthetic ruby). Along with the great benefits associated with the short cantilever theory, Dynavector have now made it possible to place a diamond tip on their diamond cantilevered units at a much more economical price than before. In

fact, the new diamond will sell for \$498 — just half the price of the existing unit. The new ruby will sell for the same price as the existing ruby, namely \$225.

Some changes have taken place, particularly in the cantilever assembly area. Special silver-coated stainless steel wire is now used to anchor the cantilever, offering greater flexibility and resulting in better trackability and longer life. The use of this technique also means no rubber damping material is used, therefore the cartridges cannot be affected by moisture or temperature as many other moving coil cartridges are.

For further information contact Concept Audio Pty Ltd, 22 Wattle Rd, Brookvale NSW 2100 (P.O. Box 422, Dee Why NSW 2099). (02) 938-3700; telex: 24369.

Richard Allan

RA8

AS SUPPLIED TO THE B.B.C.

The RA8 has been designed to achieve the maximum performance possible from a speaker system of average price and therefore some sensitivity has been sacrificed in favour of a smooth response.

The RA8 Loudspeaker system has a linear frequency response, a feature associated with all the RA range of enclosures. In consequence it only delivers the correct amount of bass output energy demanded by the input signal. Initially, it may sound slightly lacking in bass output, therefore it is advisable to play some material with a genuine bass content in order to be convinced of its true ability to reproduce the lower bass frequencies. This is achieved without excess energy and overhang associated with many so called hi-fi systems.

Typical Performance Specification

Power handling capacity	50 watts peak programme. 30 watts r.m.s.
Sensitivity	10 watts pink noise for 90 dB at 1 metre.
Frequency Response	90 Hz to 20 kHz = 3 dB.
Distortion	T.H.D. < 1% 100 Hz - 20 kHz.
Size	395 x 266 x 247 mm.

\$479⁰⁰

PER PAIR

"For detail and clarity the RA8's score high marks and it is not difficult to appreciate why the BBC have chosen them!"

Geoff Giles, "Practical Hi-Fi"



The ACOUSTIC FOUNDRY HiFi

56 King William Road, Goodwood 5034
(08) 2710276.

(Trade enquiries also welcome).

REACH FOR RALMAR...

MICROPHONES GALORE!



DMS200

STEREO SET

Twin metal mesh ball dynamic microphones from your own stereo recordings. Low (300 ohm) impedance with omnidirectional pattern. Frequency response 50-10000 Hz. Suitable for most hi-fi systems and other general voice applications.



DM301L
Low Impedance
Dynamic.

BUDGET OMNI

This is our most popular seller. Metal mesh ball, on/off switch and stand. Low impedance 500 ohms to suit most cassette decks and music centres up to 1000 ohms. Frequency response; 50-14000Hz. Complete with 1 metre cord.



DM25D

DUAL IMPEDANCE DYNAMIC

Ideal for PA and band work. Also suitable for home recording. Cardioid pattern. Heavy mesh ball. On/off switch. Low 300 ohms/high 30k ohms. Frequency response 50-14000Hz. Supplied with 3 metres cord and stand adaptor.

RALMAR FOR MICROPHONES

Condenser-Dynamic-Electret.
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RAL 2/82

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RALMAR®





Hitachi innovative technology:
uncompromising quality, made to work
better, longer.

For first time buyers of video systems, the quality of both sound and picture is the most important factor. But Hitachi portable and home systems offer far more than outstanding reproduction clarity— they deliver unequalled reliability and ease of operation.

Our portable system's colour camera has an optically precise 6X zoom lens that glides from wide angle to close up, automatic sound recording is built in as well as instant replay through the viewfinder, yet its low weight and simplicity make home movies child's play.

The portable recorder has a smooth-edit facility and the convenience of remote control, while its companion tuner/timer allows direct off-air recording (where copyright is not infringed) and acts as power source and battery charger for the portable recorder.

As an alternative to our compact and lightweight portable system, the Hitachi home video recorder is unmatched in technical innovation and smooth, trouble-free operation. Remote control, with visual search to get you to the action quicker— all with the ease of feather touch logic controls. Reliable operation and tape transport are taken care of with twin, quartz controlled direct drive motors.

Even our 34cm. portable colour television has such excellent picture quality and low interference in areas of poor reception that we guarantee it with a three year warranty:

Backed with fast, efficient after sales service, Hitachi video systems achieve a standard of precision and simplicity that others can only hope to equal.

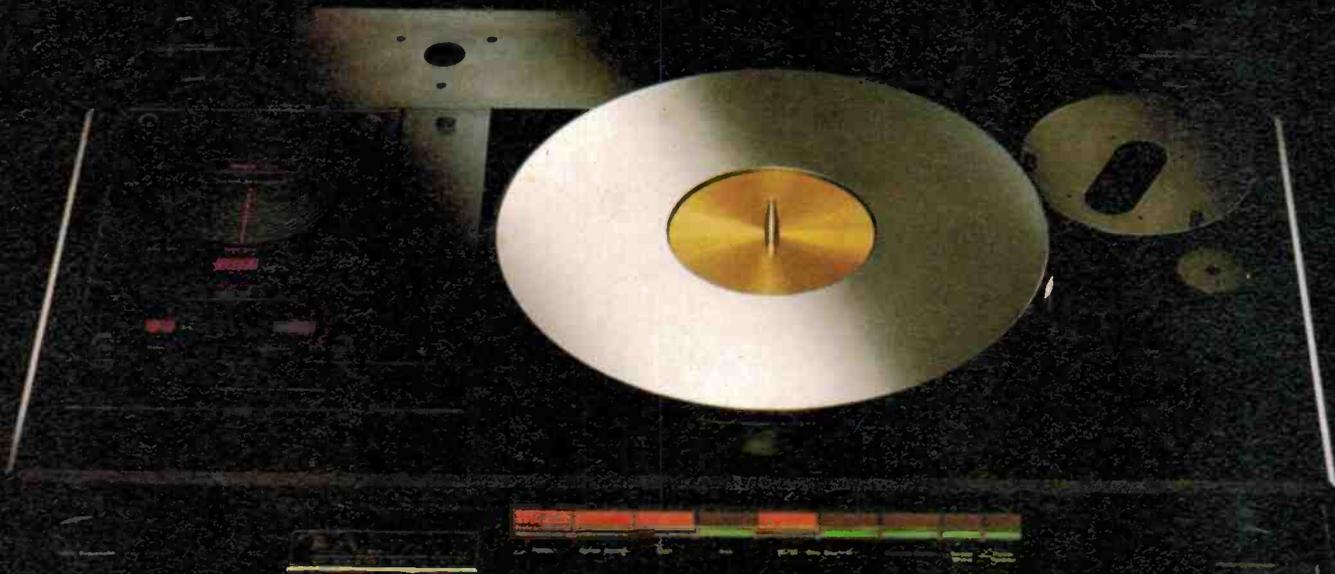
Make sure you see an Hitachi before you buy anything else— it's not merely a matter of good judgement and sound common sense, it is the realisation that anything less is most certainly a compromise.

But because our standards also apply to our dealer network, you won't find our products on any street corner. However, you can discover your nearest franchised Hitachi dealer by ringing:

Melbourne 555 8722; Sydney 669 2200;
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 **HITACHI**
Where quality comes first.

Nakamichi's 'computing turntable'



No matter what shape your record's in — to paraphrase an old advertising line — Nakamichi's new TX-1000 turntable computes the error and compensates!

IN THE APRIL 1980 issue of ETI we published a reader's letter discussing some of the problems that occur with discs and turntables. The reader, Robert Clark, presented calculations to show that any eccentricity in a disc's centre, or an oversized centre hole, would introduce a 'virtual wow' component of at least 0.05% RMS — quite clearly audible, irrespective of whether the turntable had a considerably lower wow figure or not. Recognising that record manufacture is not a 'perfect art', the problem remains as one of the last nagging imperfections to be tackled in an audio reproduction system. From research results produced by Nakamichi's engineers, it seems Mr Clark underestimated the magnitude of the problem.

Generally, the technology involved in producing records has improved dramatically since the first stereophonic recordings were released in 1958. We saw the remarkable four-channel recordings of the early 1970s, and today there are a multitude of non-limited (no compression) direct cut and digital master recordings that are all aimed at improving the final quality of reproduction.

The phono reproduction equipment it-

self has undergone drastic changes as well. There are many turntable systems available that provide some very fine engineering in terms of rotational accuracy, speed stability, functional control and tracking accuracy. As with tape reproduction equipment, however, in which the final quality of reproduction depends largely on how accurately the tape's characteristics are matched to those of the tape deck (bias, level, equalisation and azimuth, for example), the ultimate reproduction quality of any record/turntable combination depends on whether these two essential elements function together as a precision reproduction unit.

Nakamichi engineers, basing their approach on the above concept, began to search for a way to optimally integrate the turntable and record into one 'ideal' reproduction mechanism. The result is the Nakamichi TX-1000 Computing Turntable with a unique 'Absolute Centre Search' system that they claim completely eliminates sound quality degradation due to off-centre rotation of the record in relation to the turntable platter — perhaps the one remaining barrier to achieving optimum reproduction based on today's record technology.

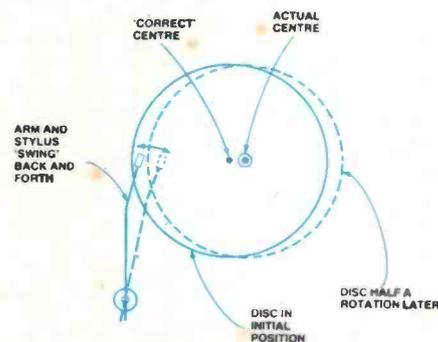
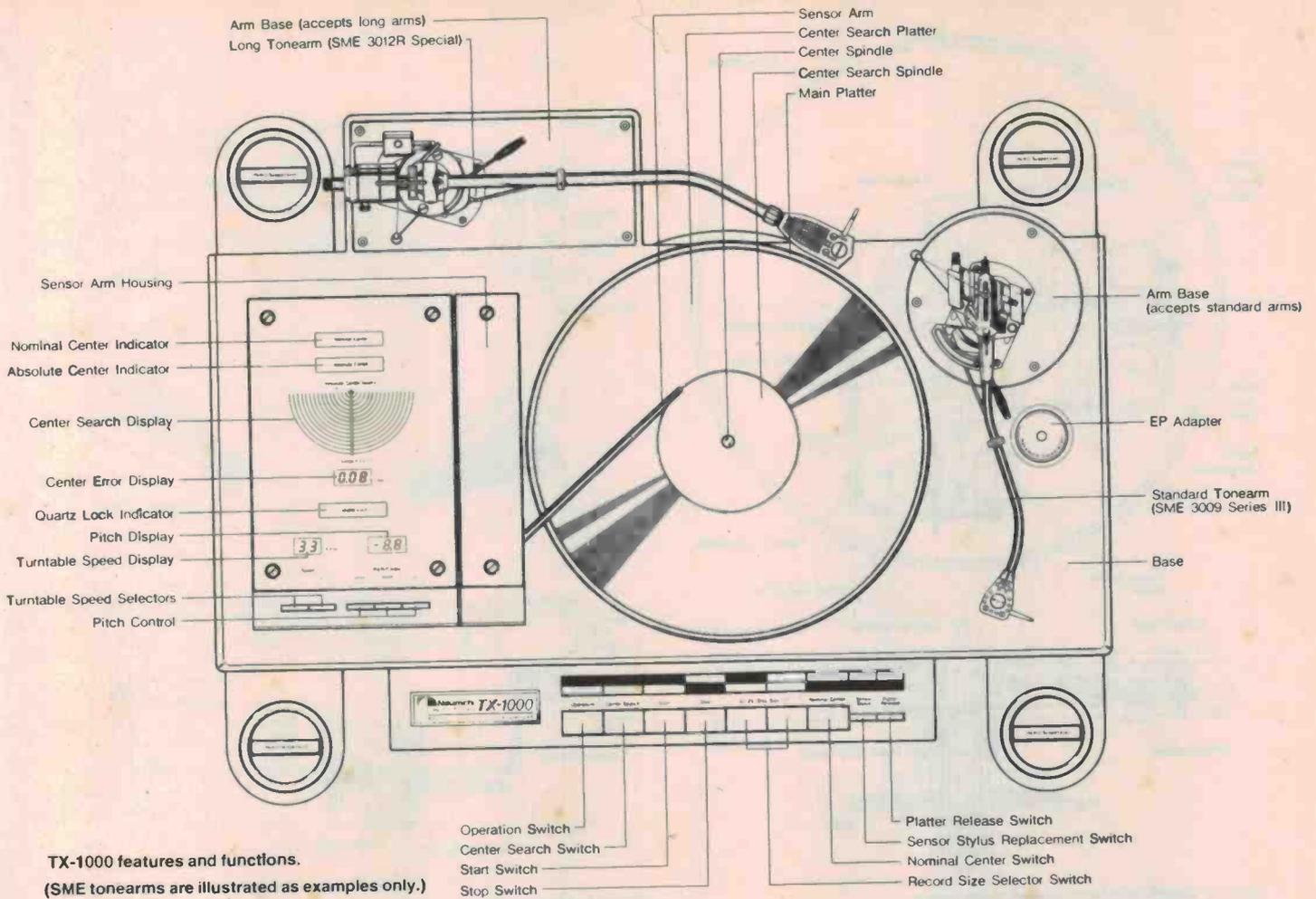


Figure 1. A record with an off-centre hole introduces a wow component as it swings the arm and stylus back and forth.

The problem, the solution

Wow and flutter can be reduced to negligible levels in the turntable by increasing the mass of the platter (that is, by making it larger and/or heavier). This technique does, in fact, achieve remarkably low wow and flutter levels in the turntable itself, but the real test of wow and flutter performance begins when a record is placed on the platter and the cartridge stylus lowered into its groove.

The standard diameter of record centre spindle holes is:



TX-1000 features and functions.
(SME tonearms are illustrated as examples only.)

$7.24^{+0.09}_{-0}$ mm (IEC standard 98A),

while the average diameter of turntable spindles varies from 7.05 to 7.15 mm. This means that, combining the smallest spindle diameter and largest allowable centre hole diameter, a spindle-to-record gap of as much as 0.28 mm is possible. This means a concentricity error of 0.14 mm. Add to this the maxi-

mum allowable record hole concentricity error of 0.2 mm (IEC 98A), and we end up with a total centre error of 0.34 mm. Even with a turntable that has no wow and flutter itself, the amount of wow and flutter created by this type of centre error is considerable, as shown in Figure 2.

The Nakamichi method of eliminating this effect is, with the record placed on the turntable, to relocate the platter

spindle ('Centre Search Platter') so that the record's grooves are perfectly concentric in relation to the platter's axis of rotation. The true centre thus located is referred to as 'Absolute Centre'.

Referring to Figure 3, we can see that the TX-1000 drive motor and main platter form an integral unit, while a laterally moveable secondary platter ('Centre Search Platter') is located on top of the main platter. ▶

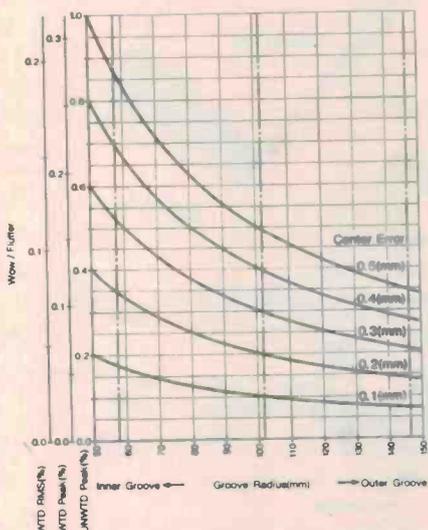


Figure 2. Wow and flutter increase due to record centre error at various groove radii.

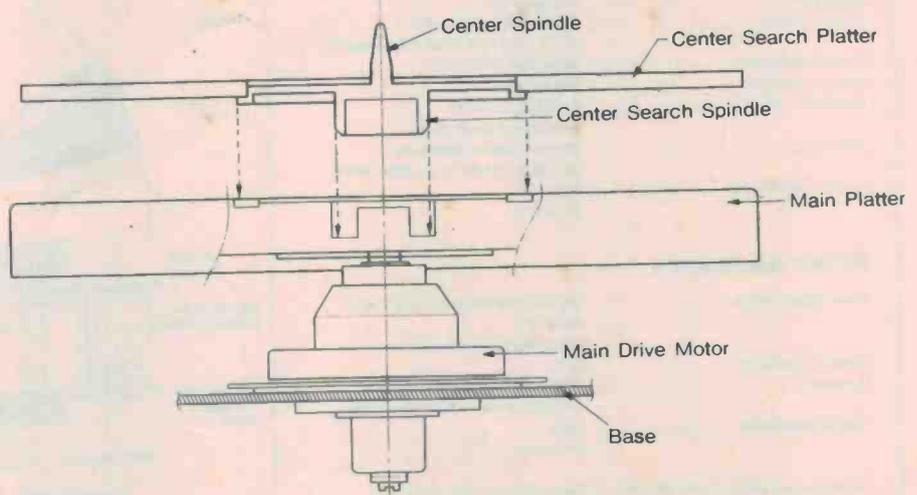


Figure 3. Turntable construction.

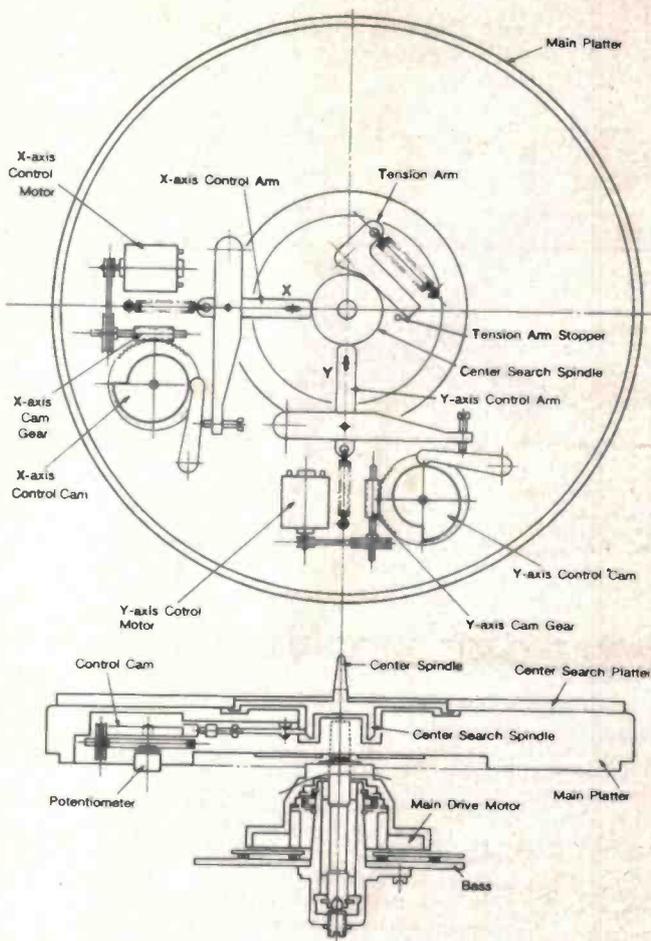


Figure 4. Absolute Centre Search mechanism.

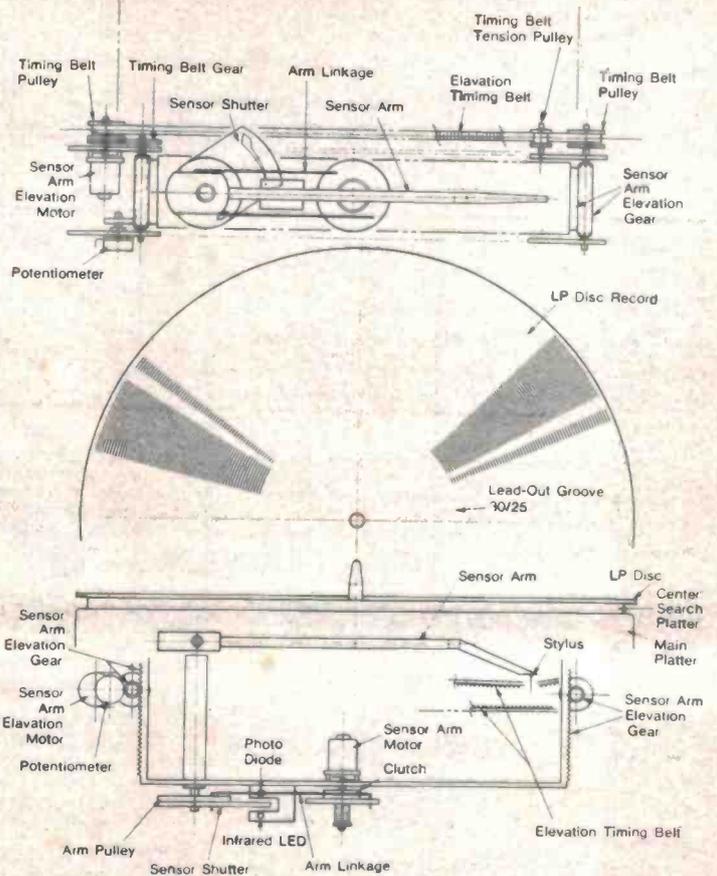


Figure 5. Sensor arm retracted.

TX-1000 Specifications

Drive System.....	Direct drive
Drive Motor.....	Quartz PLL DC, brushless, slotless, coreless, zero-cogging motor
Speeds.....	33-1/3 and 45 rpm
Pitch Control.....	PLL synthesizer, $\pm 9.9\%$ in 0.1% increments
Center Search Platter.....	Metallized glass (6 mm thick, 29 cm dia., 600 g)
Main Platter.....	Aluminum (31.5 mm thick, 30 cm dia., 4.5 kg)
Start-Up Time.....	Within 3/4 revolution
Speed Deviation.....	Unmeasurable
Speed Drift.....	Unmeasurable
Wow and Flutter.....	0.003% (Wrms/FG-direct) 0.02% (Wrms/JIS, after Center Search)
Signal-to-Noise Ratio.....	Better than 70 dB (JIS)
Moment of Inertia.....	585 kg cm ²
Power Requirements.....	5 V/0.5 A, ± 12 V/3A Independent power supply
Dimensions.....	670(W) x 165(H) x 520(D) mm 26-3/8(W) x 6-1/2(H) x 20-1/2(D) inches
Approximate Weight.....	37 kg 81 lb. 6 oz.

PS-1000 Specifications

Power Requirements.....	100, 120, 120/220-240 or 240 V AC, 50/60 Hz (According to country of sale)
Power Consumption.....	90 W
Dimensions.....	124(W) x 82(H) x 312(D) mm 4-7/8(W) x 3-1/4(H) x 12-5/16(D) inches
Approximate Weight.....	4.5 kg 9 lb. 14 oz.

* Specifications and appearance design are subject to change for further improvement without notice.

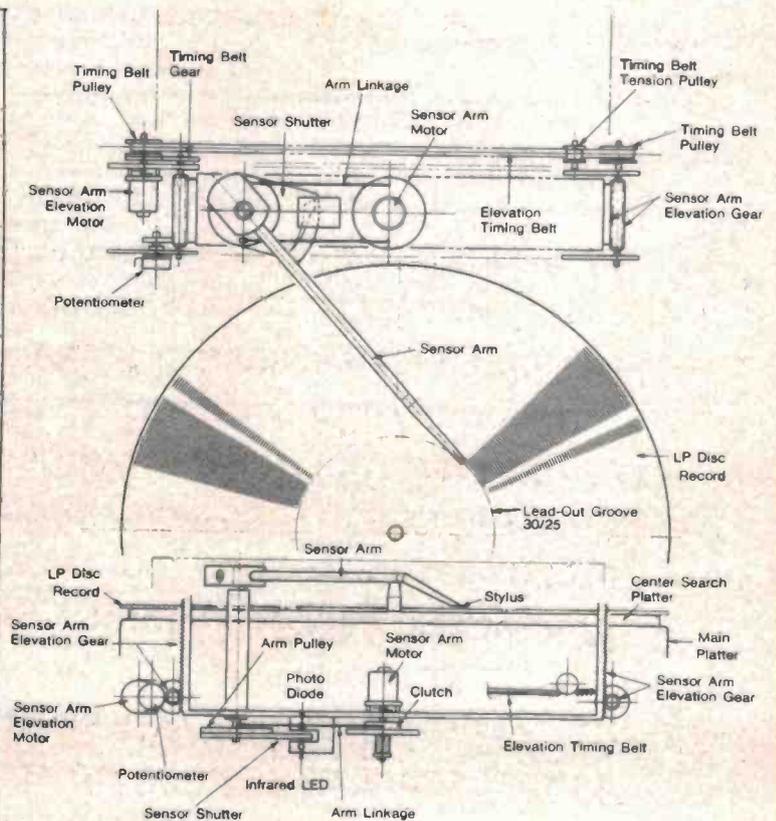


Figure 6. Sensor arm in operation.

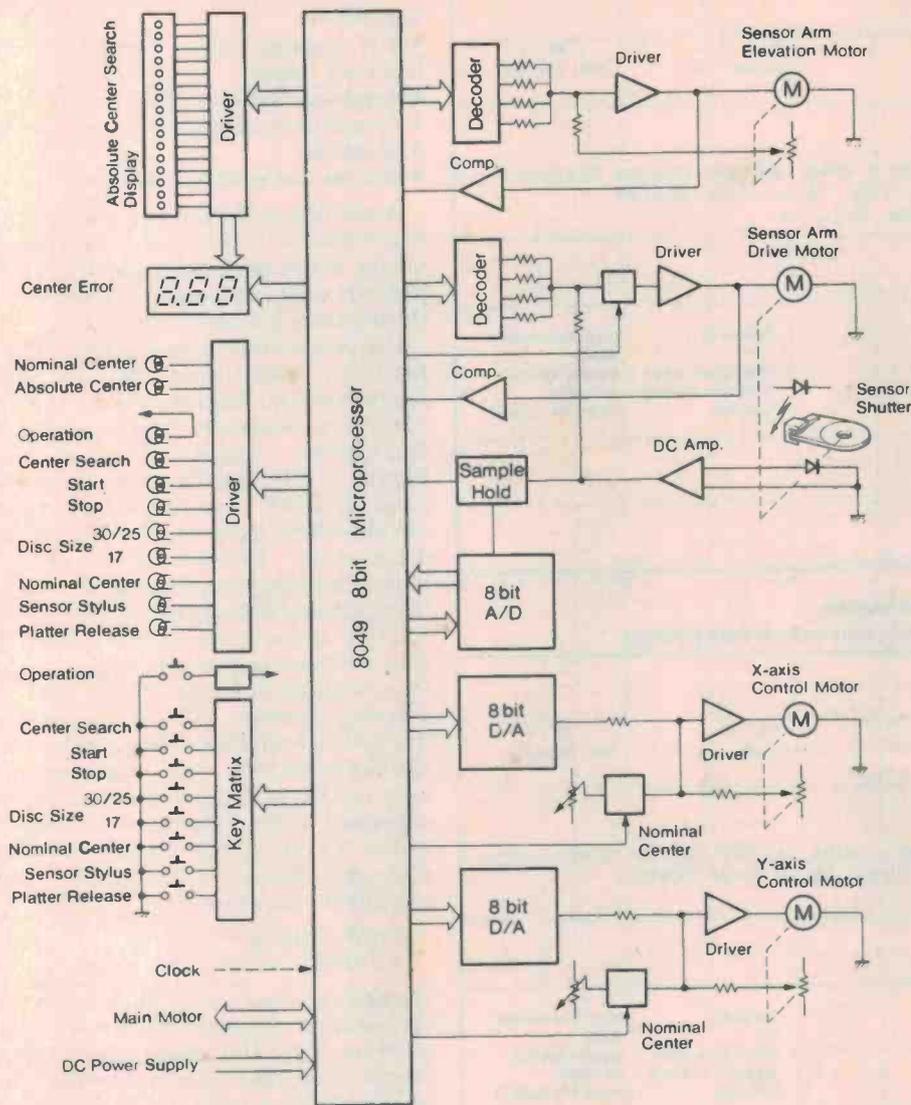


Figure 7. Absolute Centre Search block diagram.

As shown in Figure 4, the main platter houses motors and the control mechanism for accurately positioning the Centre Search Platter along two axes (X and Y), permitting relocation of the Centre Search Platter's spindle in relation to the main platter's axis of rotation.

Absolute Centre Search system operation

When the TX-1000 is initially turned on, the drive motor spindle and Centre Search Platter spindle are aligned along precisely the same axis ('Nominal Centre'). The record to be played is then placed on the platter, and the appropriate record size selected (300, 250 or 170 mm). Then, to initiate the Absolute

Centre Search operation, the Centre Search button is pressed. This activates the sensor arm elevation motor, raising the sensor arm housing 50 mm. The sensor arm then swings out of the housing and across the record until its stylus is located above the record's final lead-out groove. The elevation mechanism lowers the sensor arm 16 mm, permitting the sensor arm stylus to trace the lead-out groove (refer to Figures 5 and 6).

Any movement of the sensor arm corresponding to record concentricity error is detected by a special infrared LED/shutter/photodiode system coupled to the sensor arm. The amount of concentricity error is thus converted to a dc voltage, which then undergoes analogue-to-digital conversion so it can be processed by the TX-1000's eight-bit

microprocessor system. The microprocessor outputs the appropriate 'Centre Error' signal to the digital Centre Error display and to the X and Y axis centre correction motors. The X and Y axis motors, pulleys, belts, worm gears and control arms are thus activated so that the Centre Search Platter is moved into a relationship with the main platter axis such that the centre error is eliminated. This process of moving the Centre Search Platter to correspond with absolute centre is graphically displayed on the Absolute Centre Search LED display, and when absolute centre has been accurately located the Absolute Centre indicator lights. At the same time the sensor arm rises, returns to its housing, and finally recedes to its original position in the turntable base. Refer to the Absolute Centre Search system block diagram (Figure 7) and flowchart (Figure 8).

The above process precisely aligns the record's groove centre with the turntable's drive motor spindle axis (Absolute Centre), thereby achieving precise phono reproduction with an absolute minimum of wow and flutter. Wow and flutter spectral analyses made before and after Centre Search are shown in Figures 9 and 10 (overleaf).

Drive motor

The TX-1000 employs a brushless, coreless, slotless, Hall element direct-drive motor that is claimed to excel in the following critical sound reproduction parameters: ▶

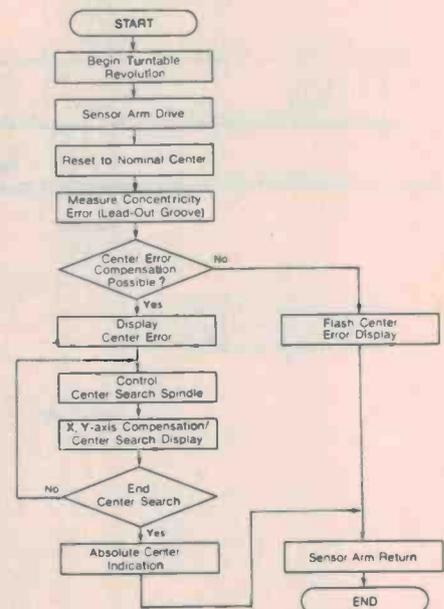


Figure 8. Absolute Centre Search flowchart.

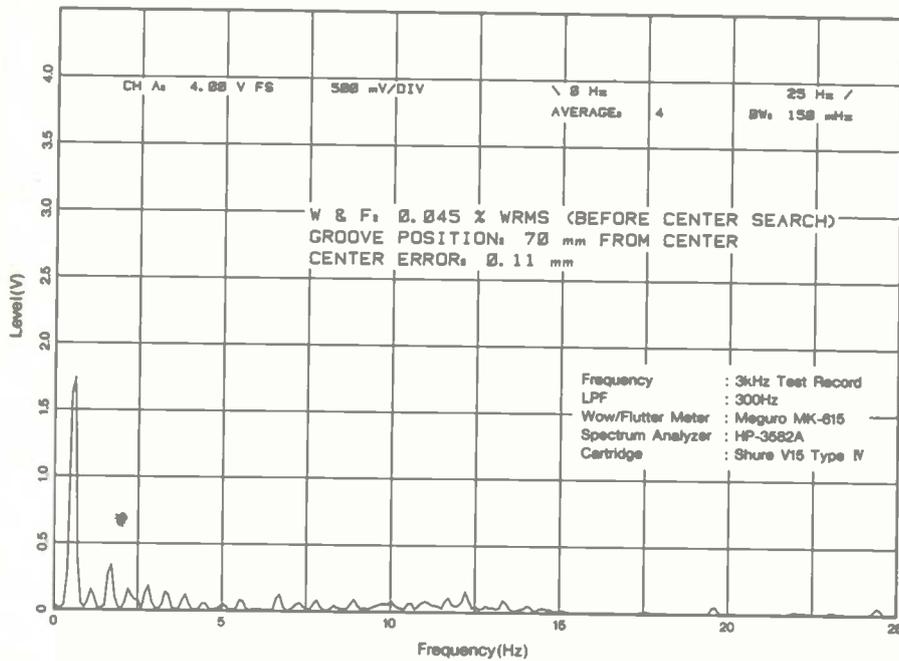


Figure 9. Wow and flutter spectral analysis at nominal centre (prior to Centre Search).

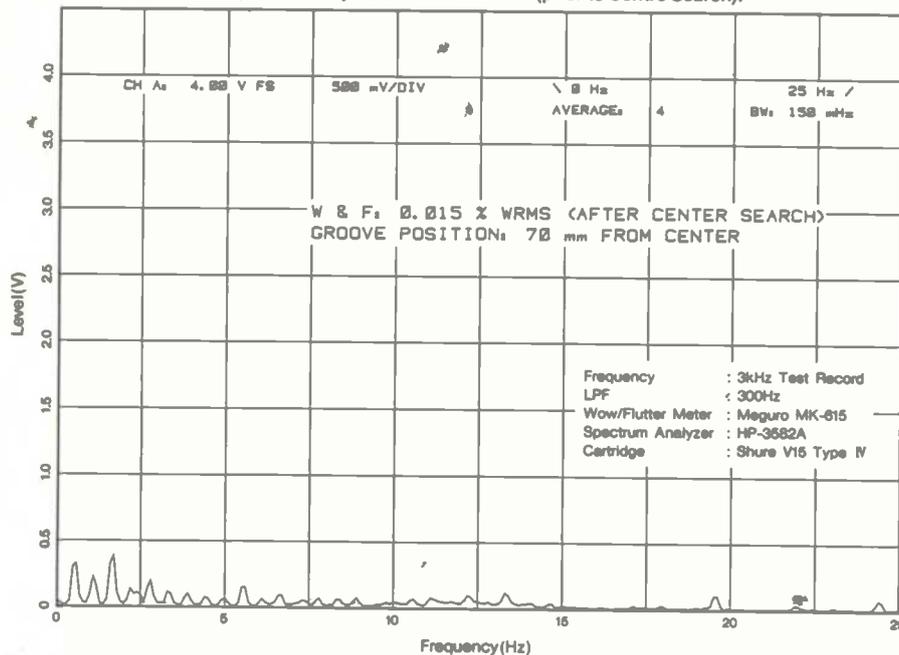


Figure 10. Wow and flutter spectral analysis at absolute centre (after Centre Search).

- Wow and flutter (cogging, torque variation)
- S/N (cogging, torque variation, servo feedback ripple)
- Rotational speed stability
- Torque characteristics
- Response
- Mechanical and electrical noise.

According to Nakamichi's claims, the motor used in the TX-1000 is superior in all the above parameters, and particularly in terms of cogging-related wow/flutter and signal-to-noise ratio.

Conventional brushless motors suffer rotational disturbances due to rotor magnetisation, magnetic field strength variation, magnetic saturation and non-uniform magnet/coil gaps (see Figure 11). Figure 12 shows the rotor magnetisation pattern and coil arrangement used in the TX-1000's drive motor. Because of the special magnetisation pattern used, the varying magnetic flux density generated by rotation of the rotor magnet causes a Hall element located in an appropriate fixed position in relation to the rotor to output a sinewave. This sinewave signal is then amplified and applied to the motor's drive coils to produce even, unvarying torque. This relationship can be expressed by the following equation, in which θ is an angle travelled by the rotor and $\Delta\theta$ is any instantaneous rotor position during travel:

$$\begin{aligned} \text{Sin}^2\theta + \text{Sin}^2(\theta + 2/3\pi) \\ + \text{Sin}^2(\theta + 4/3\pi) = 3/2 \end{aligned}$$

We can see from this equation that no matter what the value of θ , the result is constant. If the Hall element detector is placed an appropriate distance from the rotor magnet a virtually perfect sine-wave output can be obtained. The result is that the cogging (stepped motor rotation) has been eliminated, while wow and flutter have been reduced to an absolute minimum. Figure 13 shows the construction of the main drive motor.

To page 131 ►

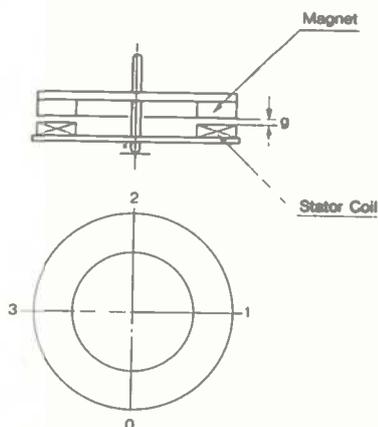


Figure 11. Cross-section of conventional brushless motor.

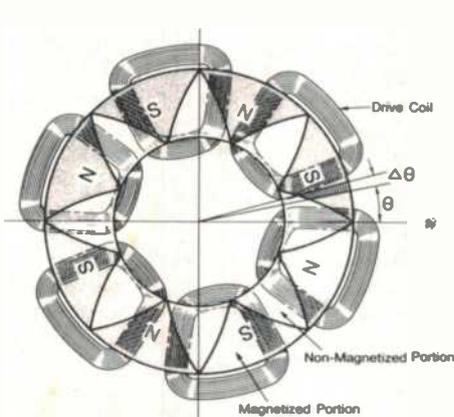


Figure 12. Coil/rotor magnetisation pattern relationship.

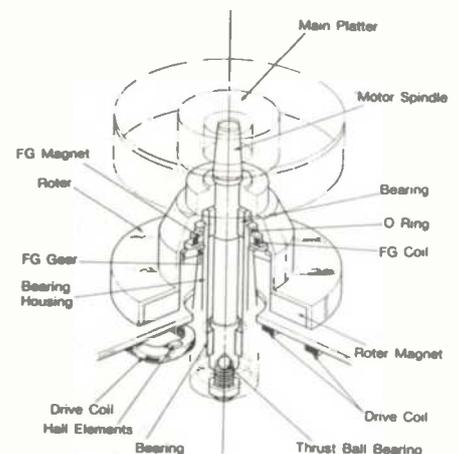


Figure 13. Main drive motor construction.

Marantz Gold. Your New Recording Standard.



For over twentyfive years the name Marantz has stood for the ultimate in audio engineering brilliance and fidelity.

In keeping with this standard of technical excellence, the new Marantz Gold range of Cassette Decks with stunning designer element of brushed-gold finish now includes a recorder incorporating the latest in noise reduction processing.

The Marantz SD3030 Cassette Deck features the new Dolby C system to provide recordings with far less tape hiss than those made using standard Dolby B.

Unlike some other noise reduction systems, Dolby C recordings can be played back on a deck equipped with standard Dolby only without audible distortion or pumping effects.

Recording enthusiasts will be delighted by the other models in the new range.

Marantz Gold decks offer a variety of advanced features such as LED peak level meters on the SD1030, fine bias adjustment on the SD2030, and a motorized linear skating loading system on the SD5010.



All feature Dolby B noise reduction, compatibility with metal tapes, soft touch controls and DC Servo motors to ensure constant tape speed and silent operation.

So, set your standards high. And your recording standards higher.

See your local stockist and listen to the future. Listen to Marantz.

marantz.
Now you're listening.



Decks shown in stack (from top): SD1030, SD3510, SD2030, SD3030 and SD5010.
All decks shown with TDK Metal tapes.

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Marantz Gold.
The New Audio Standard.

IT NOT ONLY SOUNDS FAMILIAR, IT SOUNDS FANTASTIC.

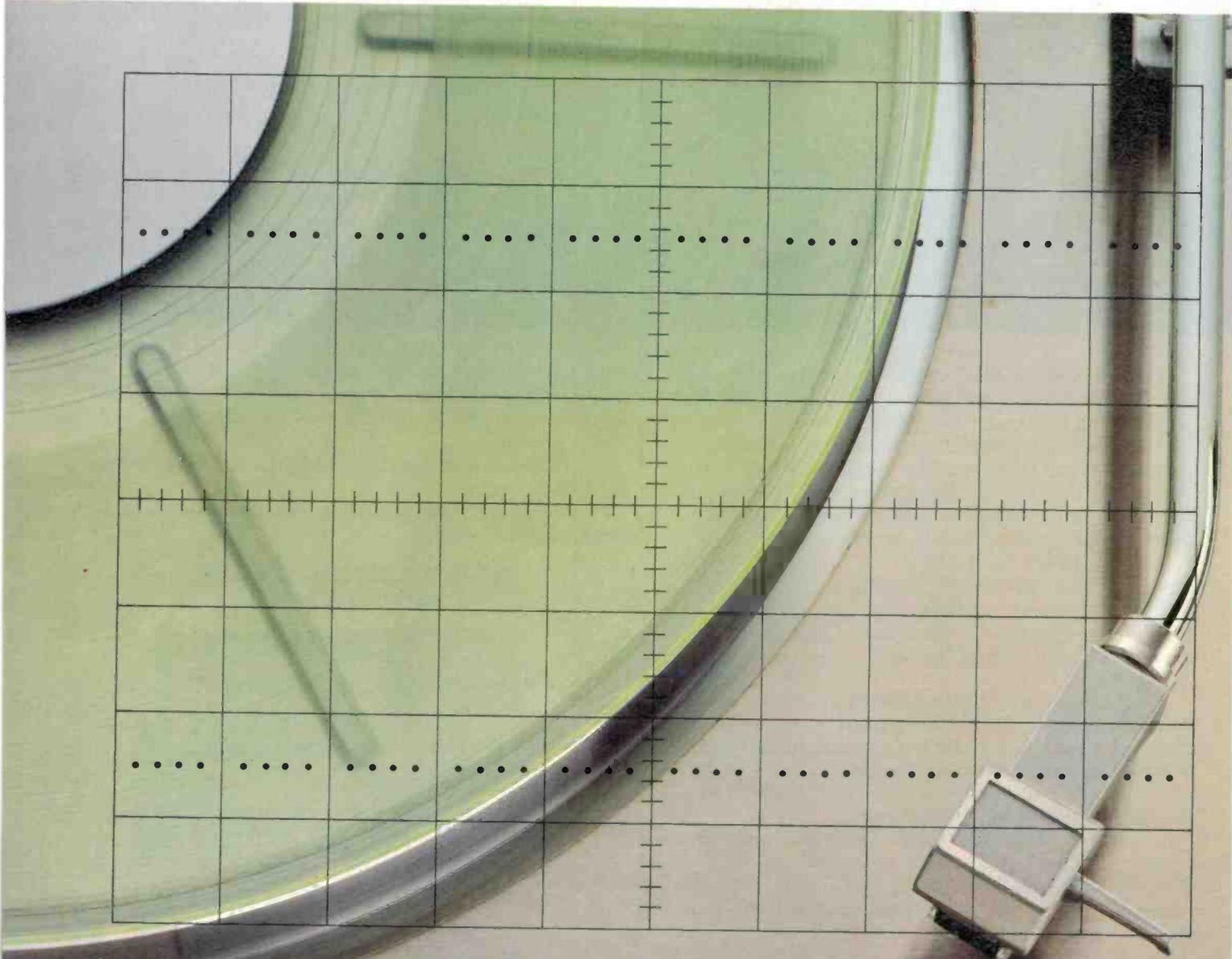
If you were interested in hi-fi a few years ago, you'll remember the name Fisher.

Fisher made the first dynamic range expander back in 1939.

The first transistorised preamplifier/ equalizer in 1956. Fisher also introduced the

first stereophonic AM/FM receiver in 1959.

But if you have not heard what we've been up to lately, we suggest you get along to a Fisher retailer. At your retailer you'll find some products that not only sound familiar. They sound fantastic. **The first name in hi-fidelity**



FISHER

Servo

The TX-1000 drive motor is controlled by a PLL synthesiser servo system. Employing a quartz crystal oscillator, VCO (voltage controlled oscillator) and phase comparator, this system maintains rotational speed accuracy as well as providing full 'quartz lock' (i.e. motor drive still crystal controlled) even when the pitch control (0.1% increments) is activated (refer to Figures 14 and 15).

Nominal Centre switch

Pressing this switch causes the Centre Search Platter spindle to be aligned with the motor spindle for operation as a conventional turntable system. The position feedback potentiometers connected to the X and Y axis control arms are factory set to permit virtually perfect 'nominal centring'. Once nominal centre has been located, the Nominal Centre indicator will light.

Sensor stylus replacement

Although replacement of the sensor arm stylus (diamond, two gram tracking pressure) should rarely be necessary, this function is provided in case replacement or cleaning do become necessary. Pressing the Sensor Stylus switch activates the sensor arm elevation motor, which raises the sensor arm housing and swings the sensor arm half-way out across the platter. In this position the stylus can easily be cleaned or replaced as necessary. Pressing the Sensor Stylus switch a second time causes the stylus arm and housing to return to its original position.

Platter Release

Pressing the Platter Release switch causes the X and Y axis control motors to rotate, decoupling the X and Y axis control arms from the Centre Search Platter spindle. In this condition, the Centre Search Platter can be removed from the main platter. If, after replacing the Centre Search Platter on the the main platter, the Platter Release button is pressed a second time, the control arms are recoupled to the Centre Search Platter and nominal centre is located ready for normal operation.

Tonearm mounting

The TX-1000 can be fitted with two tonearms — one long and one normal or two of normal effective length — to provide maximum versatility for the advanced audiophile.

A number of optional tonearm bases that accept many of the most popular high-performance tonearms will be made available.

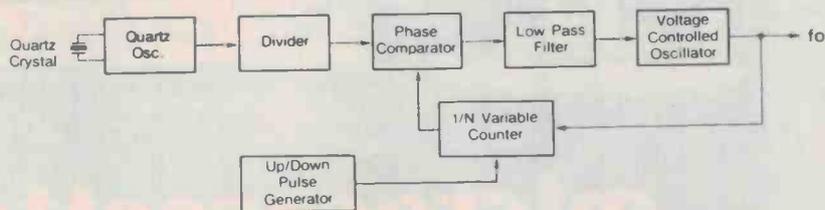


Figure 14. PLL synthesiser circuit block diagram.

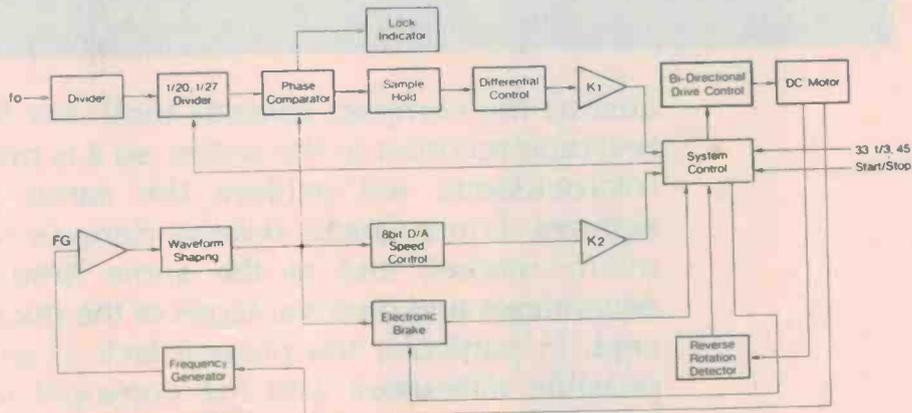


Figure 15. Main drive motor servo system block diagram.

Power supply

The TX-1000 power supply has been separated from the main turntable unit to maintain as high a signal-to-noise ratio as possible. All control operations including drive motor activation are carried out from the TX-1000 front panel, while the PS-1000 (power supply) panel features a power on/off switch, power-on LED and operation condition LEDs.

The power supply unit has been carefully shielded to minimise electromagnetic radiation. Nakamichi recommend that it be located as far as possible from the turntable unit for maximum performance.

Centre Search Platter

The TX-1000 Computing Turntable Centre Search Platter is formed of a special glass featuring high surface flatness and hardness that has been coated on both surfaces with a layer of metal. In addition to providing a completely flat surface, this metallised glass provides an effective ground path to drain off record static charges, according to Nakamichi.

The ultimate turntable? Only time and the acceptance of PCM digital disc systems will tell.

For the present, though, it certainly seems way ahead of whatever is in second place!

Sanyo RD-XM1



microcassette deck

Just as the compact cassette took over from the reel to reel tape recorder in the sixties, so it is predicted that the microcassette will achieve the same growth in the eighties. Louis Challis reviews Sanyo's first shot at the micro market, and at the same time discusses the advantages and disadvantages of the microcassette concept, in particular the present lack of software and the possible difficulties with the copyright laws of various countries.

Louis Challis

HISTORY seems to repeat itself in the hi-fi world as elsewhere; the names change but the situation is the same. It is approximately 20 years since the first compact cassettes were released for dictation. Nobody thought that they would ever challenge reel to reel recorders in the high fidelity field, but in those 20 years they have all but replaced reel to reel tape recorders as the preferred recording format for the consumer field.

Approximately ten years ago when the Japanese developed the microcassette, even fewer people thought that this new sub-miniature format would

pose any threat to the compact cassette in the field of home entertainment. And yet history has repeated itself as the advantages of the miniature size of the micro in terms of its suitability for portable, car and personal tape recorders become apparent.

Obviously the very slow 2.4 cm/sec tape transport speed creates even larger hurdles than the compact cassette faced, but the compact cassette is now readily capable of achieving frequency responses of 20 Hz to 20 kHz and beyond. In the review of the two-speed Nakamichi 680 in 1979 we found that it

was possible to use such a slow speed tape format (2.4 cm/sec) to achieve a very acceptable frequency response, although that concept, like the double speed alternative, was not commercially exploited for long on compact cassette recorders.

Sanyo Japan are probably only one of many manufacturers who drew the correct conclusion from the development of the 680 machine and were not slow to put the system development team into action. They have just released (at least for viewing or reviewing purposes) their model RD-XM1 Micro Miniature

Cassette Deck. Apart from its small size this unit contains all the normal operational features found in a conventional cassette deck, supplemented by a couple which are not.

The first of these obvious differences relates to the use of electronic logic-controlled touch recording buttons as well as LED VU meters, which work exceptionally well in such a small unit. The unit incorporates an optional remote control socket for which an extension unit is also available, but is not displayed.

In order to extend the high frequency dynamic range and simultaneously to reduce the low frequency distortion from which this unit would otherwise suffer at low frequencies, Sanyo have chosen to use the Dolby HX noise reduction system.

The deck drive incorporates two coreless motors to provide a more regular and nearly constant tape speed. The blurb claims that this results in the elimination of the 'cogging modulation' that less effective motors would produce, as a result of the interaction of the pole pieces with the torque speed characteristic.

The unit

The front panel of the RD-XM1 cassette player is relatively neat, of brushed satin aluminium trim with black stencilled lettering.

On the left hand side of the deck is a power switch, a very small three-digit counter and its tiny reset button, a timer standby switch (which allows an external timer to either operate in the play mode or to record) and a stereo headphone jack immediately below. On the left centre of the deck is a microcassette well which pops open and tips forward to ease the entry or removal of

the microcassette. Below this are seven miniature pushbuttons. The record button needs the simultaneous operation of the play button to activate recording, whilst the mute button facilitates the the provision of blank sections of tape should this be required for special functions.

At the top right hand side of the deck is a peak level VU meter. This neatly utilises LEDs for the display, with green diodes for -30 VU to -1 VU and red diodes covering the range from 0 VU to +6 VU. On the left hand side of this escutcheon are four illuminated bezels to indicate the activation of record, play, pause and mute modes. The pause and mute lights flash on and off cyclically, to draw your attention to them so you won't forget to deactivate them. In the panel immediately below a series of switches is provided. These are for ejecting the cassette, for selecting the Dolby HX noise reduction (supplemented by a green LED), a tape selection button for normal or metal tape, each with its own individual LED, an input selector for mike or line, and a dual concentric input level control for each channel. (The manufacturer's selection of Dolby HX instead of Dolby B or Dolby C is intriguing, in that this automatically means that unless the software produced by the recording companies is compatible there is likely to be a small problem in terms of the quality of signal.)

Because of lack of space on the front panel the microphone sockets have been relegated to the rear panel together with the input/output coaxial sockets.

The unit is provided with a voltage selector for 120-220 volts and the chassis is fabricated from unusually strong steel for such a small unit. The inside of the cabinet is jam-packed with elec-

tronics, using two large printed circuit boards, one stacked on the top of the other on the right hand side of the unit. The left hand side of the unit contains the very small but solidly built cassette drive mechanism, together with its own separate electronic governor printed circuit board.

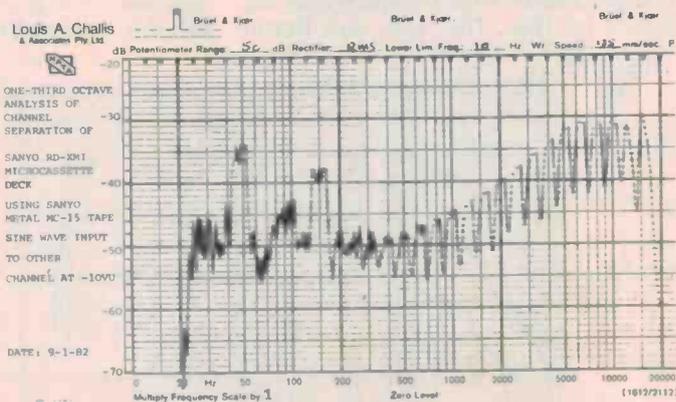
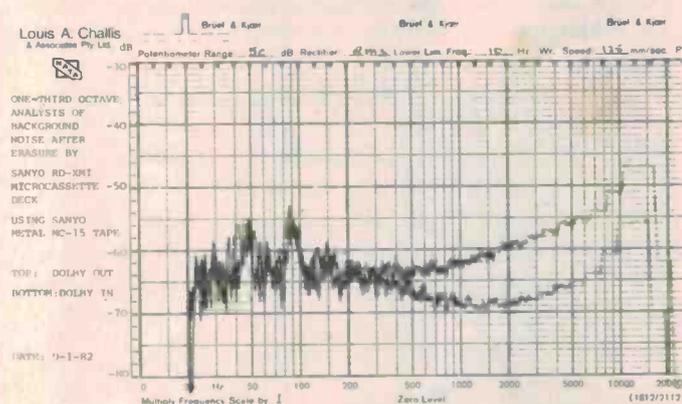
Near the rear of the unit is a large and fully screened mains transformer, and there is little or no space for very much else even if they had wanted to incorporate it. The unit is well made but would present a number of interesting problems for a serviceman because of the lack of space and the large amount of wiring between the circuit boards.

The cassette deck drive mechanism features a number of unusual features, including a micro miniature servo speed control motor. The motor speed regulator board contains approximately 14 transistors and one large integrated circuit.

The belt drives between the capstan drive and servo motor are unquestionably the tiniest I have yet seen, and because of the small size of the drive it has features reminiscent of a watchmaker's art as much as that of an electronic design.

On the bench

The performance of the unit was better than I would have expected with the single 'metal' microcassette provided. The frequency response extends from 40 Hz to 8.5 kHz without Dolby and 42 Hz to 7.5 kHz with Dolby at zero VU. At -20 VU the frequency response extends from 40 Hz to 11.5 kHz without Dolby and 52 Hz to 10 kHz with Dolby. Overall this is a fairly commendable frequency response, but only approaches that achieved by the Nakamichi 680 cassette deck I reviewed two years ago. ▶





The channel separation is only modest, achieving less than 48 dB separation at mid-band frequencies and 30 dB separation in the 6 to 12 kHz region. The signal to noise performance is, however, substantially better than I would have expected in such a small unit, being 59.5 dB(A) relative to the +6 dB signal and 53.5 dB(A) relative to the zero dB level.

The third octave spectra noise levels in the mid frequency region are 70 dB down and the Dolby HX system provides a performance roughly comparable with Dolby B, but in no way comparable with that of Dolby C.

The measured distortion performance is fair, being only 1.6% at 100 Hz at zero VU and typically less than 1% at higher frequencies. At -6 VU this performance is substantially improved, being 0.66% at 100 Hz, 0.3% at 1 kHz and 0.53% at 6.3 kHz. The erasure ratio was particularly good, with the residual signal being better than 80 dB on metal tape.

After hearing the manufacturer's claims for special coreless motors I was intrigued to see what the speed stability would be like. The wow and flutter

figures were not outstanding at 0.5% peak to peak and a 0.3% unweighted RMS at the standard test frequency. Because the performance of this unit was not as good as the typical compact cassette decks with which we are familiar, I carried out an additional test in the form of a graphical measurement of the frequency deviation on a 1250 Hz signal. This shows that the cyclical reductions in speed are as much as 9 Hz and upward variations typically as much as 3 Hz; on one occasion there was a 6 Hz variation. For reference purposes we carried out a similar test on an Aiwa AD6900 deck that we use for laboratory test and found that the speed variation under similar measuring conditions is less than 0.5 Hz.

To the listener

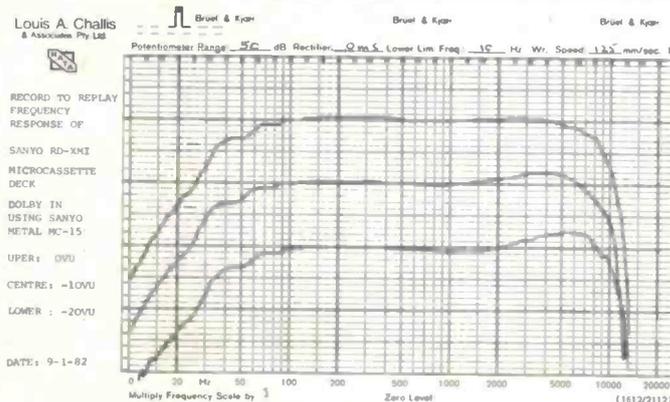
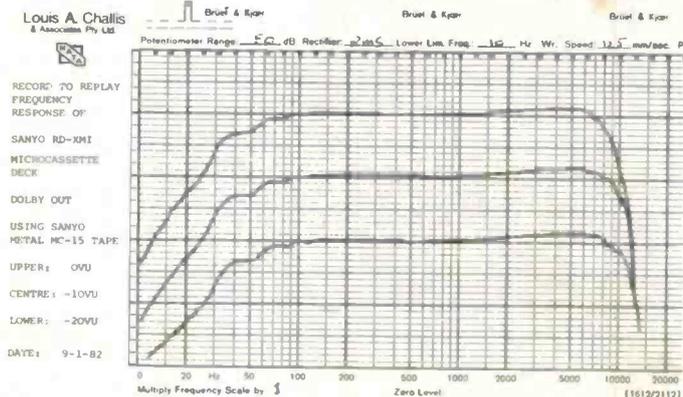
The subjective evaluation of the unit was much briefer than normal, because the Sanyo people only had one small demonstration cassette to supply with the unit. This had only two numbers recorded on it, both of which were inexplicably recorded at the maximum +6

VU recording level. This was obviously not a good recording and the content was all modern rock music rather than some more varied programme material that I would have preferred. However, I recorded some music on the other side of this cassette prior to erasing it for the objective testing. These recordings revealed that the quality of sound produced is reasonably good when over-modulation is avoided. The recording quality is not in the same class as the best compact cassette decks currently available and falls short of the medium performance of the main bulk of machines produced since 1978.

In summary

For people looking for the convenience of a microcassette recorder, this machine may prove to be an acceptable compromise, if only to halve the size of a portable player. The microcassette tape recording medium has two major disadvantages. The first and currently more important one is the total lack of suitable software at present. This is the obvious reason for Sanyo not releasing the unit on the Australian market right now. The second disadvantage relates to the lack of suitable portable stereo playback units to justify the expense of a microcassette recorder. For those of you who regard the first limitation as no limitation, you should remember that Sanyo, like all other reputable manufacturers, are not out to push a product which must automatically necessitate an infringement of the copyright laws in Australia (or anywhere else). It is my belief that because of the pending court actions in America (and possibly some in Australia), no sensible and responsible manufacturer or importer would dare put himself in such a position.

Sanyo have created an interesting and novel machine with the RDXMI Micro Cassette Recorder. When the software is available, I have no doubt that



this unit will be marketed to meet the demand. Until that time you must simply wait patiently for what will initially prove to be an expensive toy for the person who has a separate micro-cassette player in his or her car, pocket or handbag.

SANYO MODEL RD-XM1 MICRO CASSETTE TAPE DECK

Dimensions: 220 mm wide x 17 mm high x 240 mm deep
Weight: 4 kg
Price: Not announced
Manufactured: In Osaka, Japan, by Sanyo

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MEASURED PERFORMANCE OF SANYO MICROCASSETTE DECK RDXM1 S.N.11100972

RECORD TO REPLAY FREQUENCY RESPONSE AT -20V_L

Tape	Dolby	Lower - 3dB Point	Max. Point and Frequency	Upper - 3dB Point
Sanyo Metal MC-15	Out	40Hz	+1dB 5kHz	11.5Hz
Sanyo Metal MC-15	In	50Hz	+3dB 5.5kHz	10 kHz

HARMONIC DISTORTION: Tape: Sanyo Metal MC-15

OV _L		Tape: Sanyo Metal MC-15		
		100Hz	1kHz	6.3kHz
-6V _L	2nd	-40.4	-44.9	-42.6 dB
	3rd	-38.2	-45.8	-62.1 dB
	4th	-59.6	-60.6	-63.8 dB
	5th	-62.6	-	-
	T.H.D.	1.6	0.8	0.75%
-6V _L	2nd	-45.1	-54.9	-45.9 dB
	3rd	-49.0	-54.6	-58.1 dB
	4th	-61.5	-59.1	-61.5 dB
	5th	-	-	-
	T.H.D.	0.66	0.3	0.53%

SPEED ACCURACY:

WOW AND FLUTTER:

WOW:	Average	0.05% PP
FLUTTER:	Unweighted	0.3% RMS
	Weighted	0.12% RMS

MAXIMUM INPUT LEVEL:

(for 3% third harmonic distortion at 1kHz)

Tape: Sanyo Metal MC-15 +6 VU

DYNAMIC RANGE:

Tape: Sanyo Metal MC-15

Dolby Out	47 dB(Lin)	51 dB(A)
Dolby In	53 dB(Lin)	59.5 dB(A)

ERASURE RATIO:

(for 1kHz signal recorded at OVU)

Tape: Sanyo Metal MC-15 > 80 dB

AVAILABLE IN AUSTRALIA FOR THE FIRST TIME.

One of the worlds most advanced Video Games systems (Signetics UVI. (MODEL MPT03. The main console houses 2 games controllers that feature 14 Button Key pads and Joystick controls, for the first time this allows competition to program or "customize" games offering nearly infinite possibilities. Instant TV connection via standard coaxial cable to TV aerial input socket.

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The MPT03 Cartridge library offers a wide range of exciting games. The high resolution graphics offer stunning visual on screen effects.

Games Cartridges: MG301 Soccer, 302 Capture, 303 Basketball, 304 Space Mission, 305 Baseball, 306 Allen Invader, 307 Math Logic, 308 Football, 309 Chess, 310 Bowling, 311 Breakaway, 312 Sea Battle, 313 Missile War.

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 1103 Dandenong Rd., E. Malvern
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Also send me the following games cartridges:

MG301	MG302	MG303	MG304	MG305
MG306	MG307	MG308	MG309	MG310
MG311	MG312	MG313		

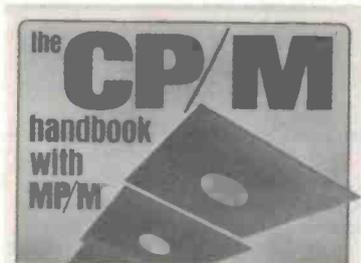
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Signature _____

Address _____

Postcode _____ (ETI March)



CP/M finally explained!

Rodney Zaks



Anyone interested in computers will have heard the expression **CP/M**, but many may still be unclear as to what it is and what it does. Rodney Zaks' book **The CP/M Handbook with MP/M** will answer any questions you may have about using a computer equipped with CP/M.

CP/M stands for Control Program for Microprocessors, and is the industry standard in operating systems for small computers. It is available on nearly all computers using the 8080, 8085 or Z80 microprocessors, as well as some using the 6502 microprocessor.

The **CP/M Handbook** is a simple, clear and practical introduction to the use of CP/M-equipped computers, and a reference text. For beginners this book offers step-by-step instructions for using CP/M without fear — turning the system on, inserting a diskette, correct user discipline, remedial action for a problem situation — and everything is explained in a clear, concise and easy-to-read format.

For experienced programmers the book includes a comprehensive description of all CP/M facilities and resources, plus a complete discussion of all versions of CP/M, up to and including 2.2, MP/M and CDOS. Fifteen appendices feature complete summaries of all commands and facilities.

Contents include:

- An introduction to CP/M
- CP/M and MP/M facilities
- Handling files with PIP
- Using the editor
- Inside CP/M and MP/M
- Reference guide to CP/M and MP/M commands and programs
- Practical hints
- The future

The **CP/M Handbook with MP/M** is available from **ETI Book Sales, 4th Floor, 15 Boundary St, Rushcutters Bay NSW 2011** for \$16.95 plus \$2 postage and packing.

Please send me . . . copies of The CP/M Handbook with MP/M at \$16.95 + \$2 p&p per copy

Total

Name

Address

Postcode

Signature

the beginning!

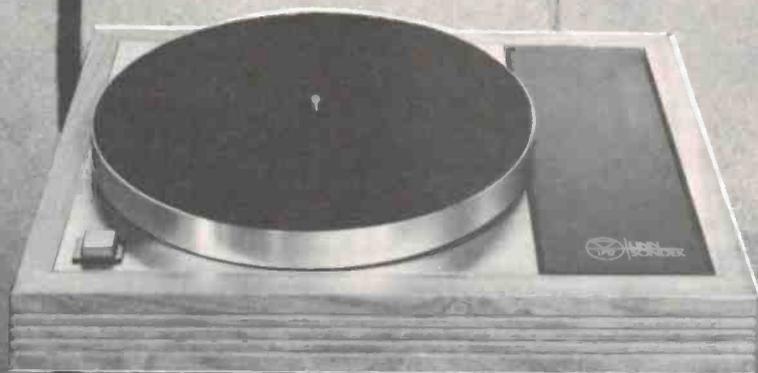


The beginning of a record playing chain is the record. If the turntable does not extract the musical information from the record, it is lost for ever. No amount of money spent further along the chain, on speakers for example, will recreate a signal which is lost at the beginning. In fact, you may only amplify original deficiencies by reproducing them more faithfully.

The Linn Sondek LP12 transcription turntable is designed and manufactured to extract as much information as possible from the modern long playing record. It is, quite simply, the link missing in so many play-back systems between your ear and the recorded performance.

If you can appreciate the differences between listening to a record on a good system and hearing something that approaches live music, then the logical place to start is with the Linn Sondek LP12

A product of integrity which offers proven value and performance



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acclamation

“Loud or eager approval or shouting . . . 1585”

‘The Oxford English Dictionary’

Eager approval — yes. How loud at the time is an element difficult to assess. But what counts is that which appeared in print.

READ EXTRACTS FROM REVIEWS ACROSS THE WORLD ON THE AUDIO TECHNICA AT32 MOVING COIL CARTRIDGE.

LABORATORY TEST



AUDIO TECHNICA AT32 Cartridge

The Audio Technica range of moving magnet cartridges has a good reputation in the audio industry and this is the first moving coil unit from the company to be sure to establish the same high standards in the MC area of the cartridge.

Performance

Firstly, take a look at the noise level and extended frequency response. The AT32 is designed to give you a wide range of sound reproduction.

“ON AN ABSOLUTE SCALE IT WOULD RANK AMONG THE BEST.” — BUYERS GUIDE (AUSTRALIA)

RECORDS 5




“I AM UNASHAMEDLY ENTHUSIASTIC ABOUT THIS CARTRIDGE . . . VOICE AND STRINGS REPRODUCED MORE CLEANLY THAN ANY OTHER CARTRIDGE I HAVE TESTED.” — JOHN BORWICK ‘GRAMAPHONE’ (UK)

ON TEST: CARTRIDGE

Audio Technica AT32

James Michael Hughes, fan of the AT30, gets to grips with its more expensive alternative.



“ . . . THE AT32 PROVED AN EXCELLENT TRACKER INDEED! EVEN THE NOTORIOUS TELARC RECORDING OF TCHAIKOVSKY'S 1812 WAS HANDLED WITH EASE.” — JAMES MICHAEL HUGHES HI FI ANSWERS

2

AUDIO-TECHNICA AT-32 CARTRIDGE and ESO TRAY

“ . . . WITHOUT A DOUBT THE AT32 IS A SUPERIOR PHONO CARTRIDGE WITH A DEFINED AND TIGHT BASS . . . AMONG THE VERY TOP MOVING COIL CARTRIDGES . . . ” — B. V. PISHA AUDIO MAGAZINE



“ . . . AUDIO TECHNICA'S AT32 MOVING COIL CARTRIDGE . . . SUPERB ON THE TEST BENCH . . . BUT TO THE EARS . . . TRULY AN EXPERIENCE OF TOTAL ENJOYMENT . . . ” — M. A. PERERA ALTO FIDELIDAD



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KEF 105 speakers — close to perfection

After testing the KEF 105 Series II loudspeakers Louis Challis rated them as "almost indistinguishable... from our reference monitors" and as displaying characteristics "bordering on the superlative". Read on for more...

Louis Challis

THE MAGIC of the digital computer has laid its hands on so many different areas of technology that we tend to be a little blasé about the results and potential of its power. We see the results but often forget that the computer is like the character Lenny in the Steinbeck play 'Of Mice and Men' — powerful, but simple. It is really the innovators and scientists who are the clever ones, for they have seen the power and potential and have harnessed them to solve the previously insoluble problems of technology.

Laurie Fincham is one such innovator who, as the technical director of KEF in the early 70s, set up a laboratory in Maidstone UK to unravel the mysteries of the loudspeaker. What makes him special is that he saw his thoughts pass from a twinkle in his eye to be transformed into a powerful tool that others quickly acknowledged as the first true breakthrough in speaker design. He

presented numerous papers on his developments and even saw an IEC Committee propose the technique as the basis of a new international standard. He resisted this with the simple advice that it was still 'too early' in the sequence of development.

Since that time KEF has carried on with the basic research, so that by the time the present KEF series of loudspeakers had arrived we knew that they were clearly a second generation of advanced loudspeakers.

The speakers

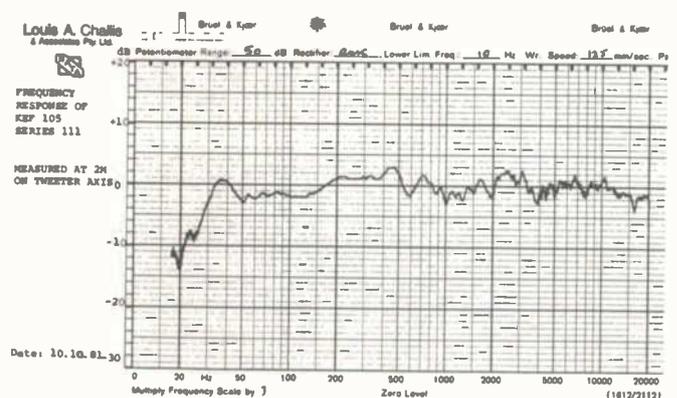
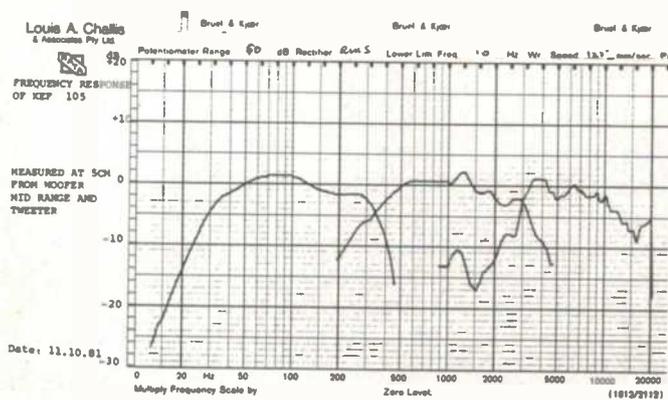
The KEF 105s are, by current standards, almost conventional in appearance, as they feature truncated pyramidal enclosures for mid-range and tweeter, stepped back over the top of the bass driver enclosure.

For those who like this appearance the unit can become the talking point of the living room. If you are otherwise

inclined, they have designed an optional cover with black transparent cloth to hide the drive units and create an appearance more in keeping with that expected of a speaker. Each speaker has four castors to ease the problem of positioning the units, and this is one feature that all manufacturers should consider emulating.

The drive units in this system are unusual, as all the diaphragms are moulded from plastics selected for their high damping, stiffness and transmission loss. KEF claim that the aging, temperature, humidity resistance and stability of these diaphragms are superior to paper diaphragms and that they have exhaustive measurements to prove the point.

The bass driver is a 300 mm diameter unit with the ability to handle the output of 200 watt amplifiers. The edge is flexibly supported and the enclosure uses air damping to produce a 28 Hz

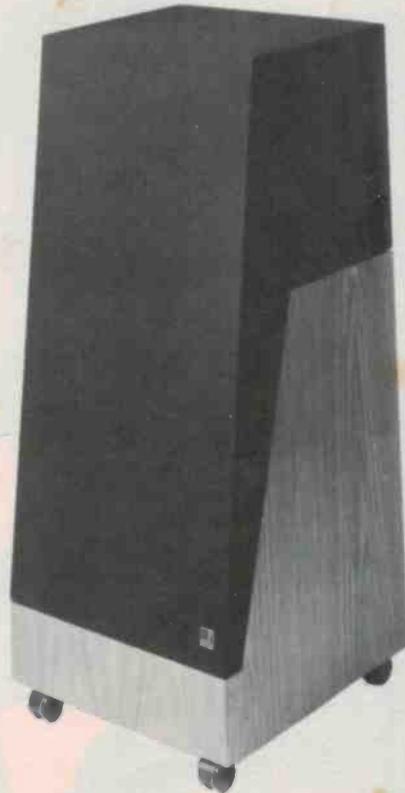


lower cutoff frequency. The mid-range sits on top of the bass enclosure in its own little moulded enclosure within the tweeter enclosure, forming part of the moulding. These small enclosures are designed to pivot on top of the main enclosure to facilitate optimum azimuth and axis adjustment. To assist this aim, each unit incorporates a recessed LED, each of which should be visible when the midrange and tweeter units are correctly aligned for the specified 40° horizontal angle and 10° vertical angle of the best listening area.

At the rear of each speaker behind the tweeter is a knob calibrated in terms of the peak power rating of the amplifier being used. When the voltage corresponding to that power rating is produced the LED lights up to indicate the onset of amplifier clipping. Very handy.

The protection for the mid-range driver and tweeter takes the form of thermally matched fuses, which should only blow under fault conditions and not as a result of nominal program transients. Unlike other manufacturers KEF clearly state the maximum continuous sinewave rating for each of the three drivers, as well as the maximum peak output on normal program content. This is stated as being 107 dB sound pressure level (presumably at one metre) under typical listening conditions. Obviously, when the switch is set at the 200 watt position the LED doubles as a peak level overload warning light; my measurements confirmed this during the reviewing.

The other major features of the system are cabinets designed with very effective damping and decay resonance control, supplemented by crossover networks using a fourth order Linkwitz-Riley dividing network. This network design achieves a breakthrough by providing terminal voltages to each driver



unit which are in phase in the crossover regions. This ensures that the radiation pattern in the vertical plane does not change abruptly at the crossover frequencies and thus achieves a very smooth phase response.

KEF's development of the cumulative decay response analysis technique (see January 1981 issue of ETI for a more complete description) has led the world in the development of a three-dimensional presentation of response spectra re-

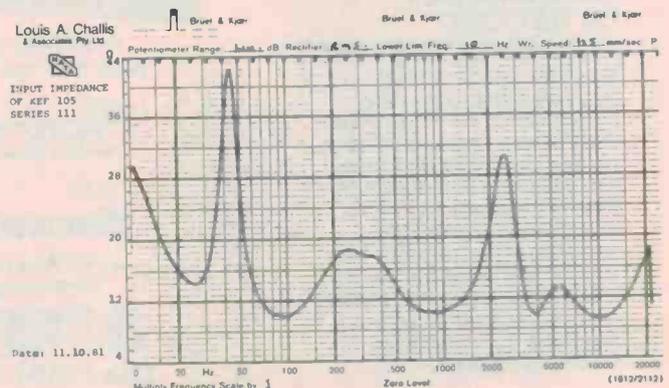
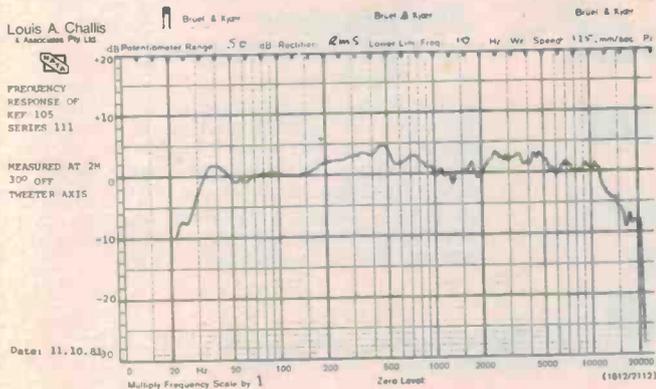
lating amplitude, frequency and time for the loudspeaker. It is clear that the KEF Series 105s are a direct outcome of approximately ten years of development based on this procedure. It should consequently be as interesting for you as it has been for us to compare one of the most advanced loudspeakers available with our measured and subjective evaluations.

Trials

The first test I performed was to measure the frequency response of the speaker in the anechoic room at 2 m on axis. I was not surprised to find one of the flattest frequency responses I have seen to date, with a ripple of less than ± 3 dB from 30 Hz through to beyond 20 kHz, and with an overall smoothness that must delight the manufacturer and the intending purchaser.

The response even at 30° off-axis (which is, it should be noted, beyond the specified listening window recommended by the manufacturer) still extends from 30 Hz to 12 kHz. The droop at 15 kHz is a modest 5 dB and the overall response is still within 8 dB to beyond 20 kHz.

The impedance curve is one of the strangest we have seen from any speaker to date, and this comes in part as a result of the utilisation of the Linkwitz-Riley filter configuration chosen for the crossover network. The impedance is maximum at 40 Hz, with a value of approximately 42 ohms; it then peaks again at 2.5 kHz, where it is approximately 31 ohms. The impedance does not drop below 9 ohms and generally lies between 9 and 16 ohms. The impedance-matching characteristics obviously are more than adequate for an amplifier rated to handle a nominal 8 ohm or even 4 ohm loading, and apart from the unusually large number of



'The quality remains after the price is forgotten.'

Henry Royce, founder of Rolls-Royce, 1906.



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New formula D-4 fluid removes dust, dirt, even fingermarks, whilst protecting the vinyl record surface. Walnut mounted D-4 fabric pad has extra soft directional fibres to absorb fluid and contamination, leaving record surface entirely free of contamination or residue of any kind. DC-1 pad cleaner keeps the fabric in good condition for maximum efficiency. \$24.95.

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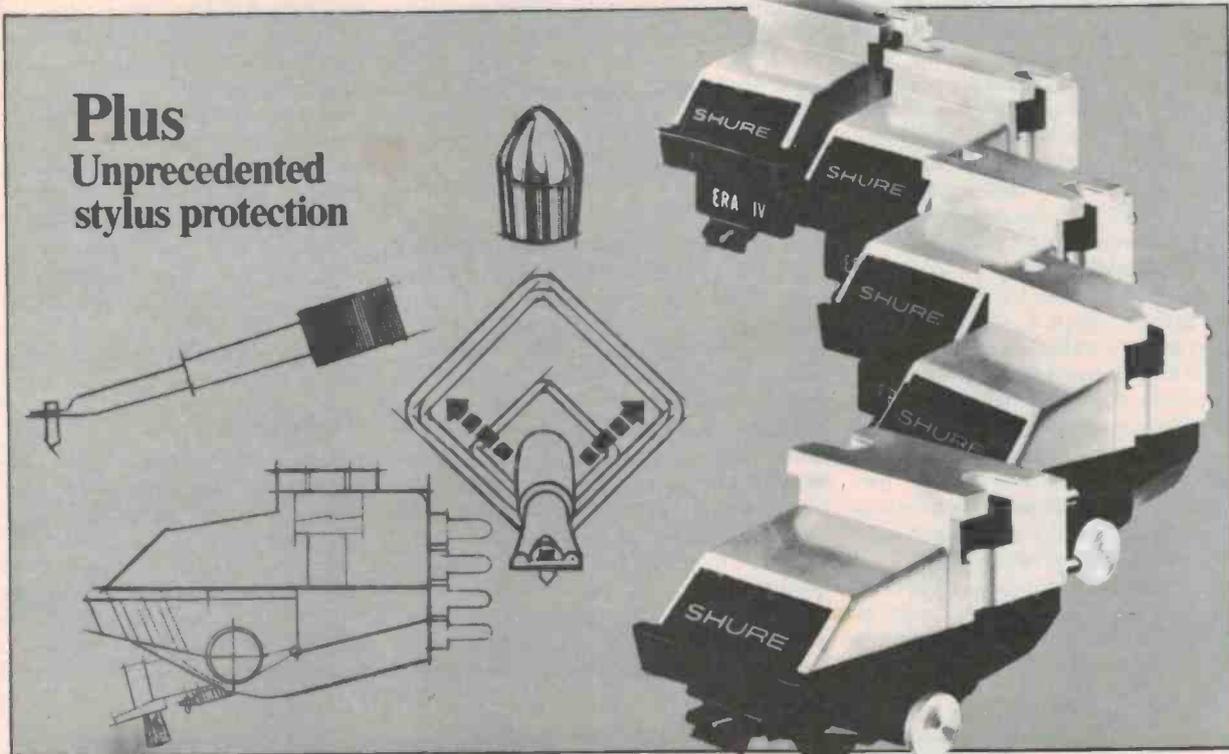
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fact: five new Shure Cartridges feature the technological breakthroughs of the V15 Type IV



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the M97 Era IV Series phono cartridges

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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 improves trackability.

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AE 161

SOUND review

ripples and peaks the impedance curve would present even a wayward amplifier with few problems.

When one compares the responses measured at 5 cm from the woofer, mid-range and tweeter with the impedance curve, one starts to understand more clearly the nature of the peaks and ripples within the impedance curve. These are obviously created as a combination of factors related to the woofer main enclosure resonance, the crossover of the woofer and mid-range at approximately 350 Hz and the crossover between the mid-range and tweeter in the 2.5 to 3 kHz region.

The phase response is particularly smooth, and although it is lagging up to approximately 3 kHz, over the range 5 kHz to 20 kHz it is an almost constant or linear phase response, which augurs well for the overall characteristics of the system.

At the region of the crossover frequencies the phase response is particularly smooth, and the crossover network obviously performs extremely well.

The sensitivity of the speaker is only moderate, in that it requires 1 watt of energy to produce 86 dB sound pressure level at 1 m on axis in the anechoic

room. The distortion characteristics are excellent at 100 Hz, moderately high at 1 kHz (nominally 2%) and particularly low at the high frequency region. The decay response spectra recorded at 1 m on axis exhibit an extremely smooth response. The ripples that were evident are only apparent at very low levels, with significant ripples at 40 Hz and a ripple in the frequency region just below the crossover frequency of the mid-range and tweeter unit.

To listen to

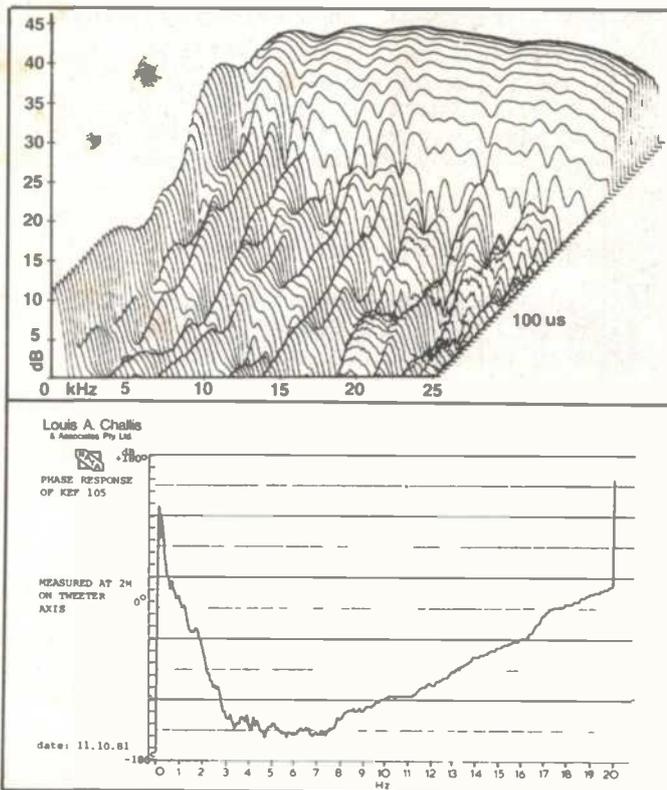
The objective testing of the KEF 105 Series II exhibited first-class performance in all the major areas, and apart from a slightly higher distortion than we would expect in the mid-range region, it displayed characteristics that could be described as bordering on the superlative. The subjective testing of these speakers involved some three months of evaluation, with comparison tests being performed against a wide range of other speakers, and in tests powered by a large number of differing amplifiers.

The direct comparison tests were also carried out against our normal reference speakers with a wide range of pro-

gram content which included classical, rock, percussion, choral works, organ music and speech. In each area the 105s performed exceptionally well and the results were almost indistinguishable in performance from our reference monitors. The manufacturer's claims in terms of power handling capacity, lack of resonance or distinct audible colouration were confirmed in our testing. The low frequency response and lack of frequency doubling under high drive conditions were equally evident. I soon found that I was able to use them in parallel with our existing monitor speakers for direct monitoring of the most sensitive and important colouration produced by amplifiers, cassette players, record players and even microphones.

Summary

KEF's development of the cumulative decay response spectra and their utilisation of their computer analysis to assist in the design, construction and matching of the components used in their speakers has unquestionably been one of the most significant electro-acoustic developments of the 70s. The proven performance of the 105 Series II



MEASURED PERFORMANCE OF KEF 105 SERIES II
TYPE SP1118 SERIAL NO. 2775B

FREQUENCY RESPONSE: 30Hz - >20kHz

CROSSOVER FREQUENCIES: 350Hz - 3kHz

SENSITIVITY:

(for 90dB average at 2m)

14.5 VRMS = 26 Watts
(nominal into 8 Ω)

HARMONIC DISTORTION:

(for 90dB at 2m)

	100Hz	1kHz	6.3kHz
2nd	-41.6	-37.2	-55.6dB
3rd	-57.6	-37.1	-46.3dB
4th	-62.8	-55.8	-
5th	-60.9	-56.6	-
T.H.D.	0.85%	1.99%	0.5%

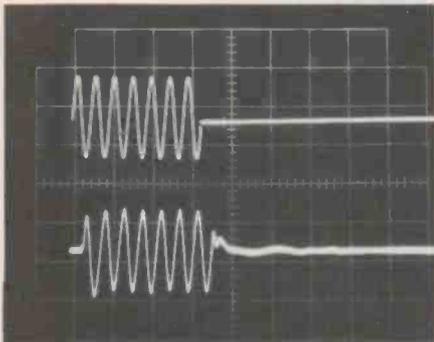
INPUT IMPEDANCE:

100Hz	10.0 Ω
1kHz	10.4 Ω
6.3kHz	12.0 Ω

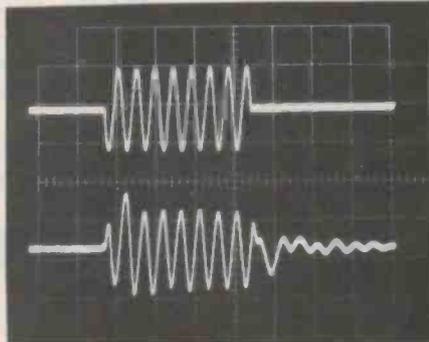
Minimum at 100kHz

9.3 Ω

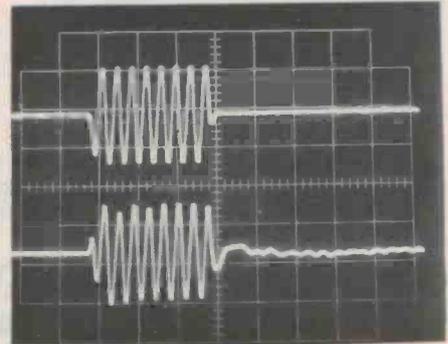
Tone-burst response of KEF 105 Series II type SP118, serial no. 2775B (for 90 dB steady state SPL at 2 m on axis). Upper trace is electrical input; lower trace is loudspeaker output.



100 Hz (20 ms/div.)



1 kHz (2 ms/div.)



6.3 kHz (0.5 ms/div.)

speakers has justified that development. The KEF 105 Series II are particularly fine speakers. They may not be cheap but they provide an exceptionally good 'state of the art' performance which I feel sure will not be readily improved upon in the immediate future. ●

KEF 105 LOUDSPEAKER SERIES II

<i>Dimensions:</i>	965 x 415 x 455 mm
<i>Weight:</i>	36 kg
<i>Price:</i>	\$3850 rrp.
<i>Manufactured:</i>	In UK by KEF Electronics
<i>Distributor:</i>	Audioson, P.O. Box 361, Brookvale NSW 2100.

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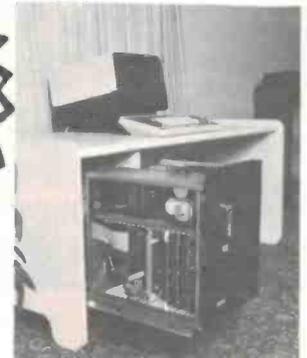
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DREGS

STRANGE how 'digital' electronics has begun to pervade every field of human endeavour, activity, etc. A reader, Tony Southwell of Ringwood in Victoria, passed on this 'press release' so that other Dregs readers might enjoy it.

"Many different devices employing digital circuitry have been developed in recent years, but not in the field of personal grooming and hygiene. To fill this gap, Wonga International Inc. has commenced R & D work on the Digital Earwax Remover.

"The circuitry for this device is of course secret at this stage. For the moment it can be said that the device, code-named 'The Finger', couples digital technology with simple, well-established hygiene practice!"

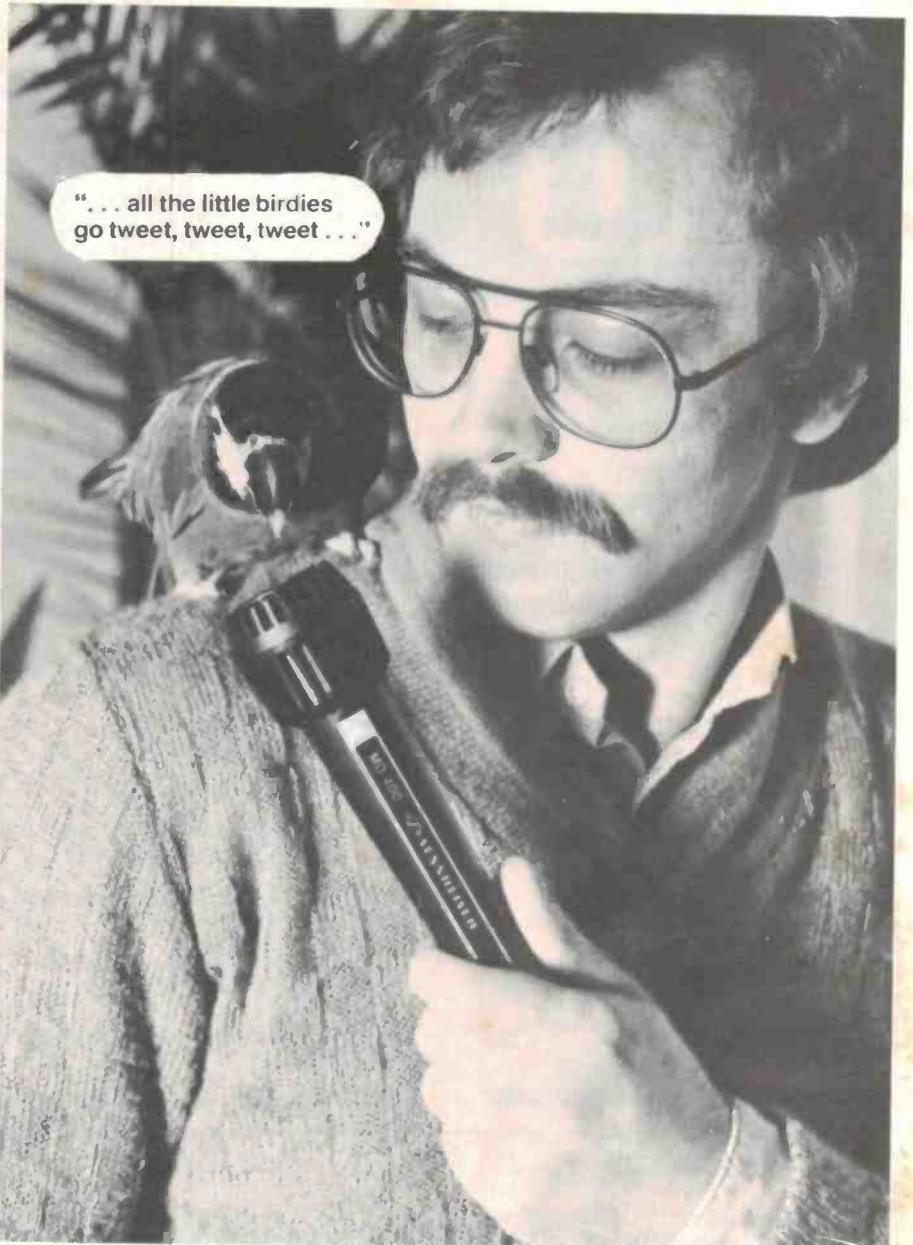
At this stage, the Dregs hacks will leave it to readers to **imagine** how it works.

Post Festive Comp.

Either readers were suffering from 'post festive clouded brain syndrome' or our January Dregs competition was too esoteric. Not a single entrant guessed the answer!

We asked what Teledyne Acoustic Research boss Bob Berkovitz was saying in a voice print — a picture of which was given on page 130 of the January issue. Hmm. Perhaps our clue wasn't plain enough. As the contest was post festive, Bob Berkovitz must have made his utterance pre-festive. Thus it was likely to be a festive greeting or something. In fact, he said "Noel". We caught everyone on that.

By far the greatest number of entrants thought he said 'Teledyne'. Next came 'clue' followed closely by 'hello'. Then there were a whole mixed bag of guesses ranging from 'try' to 'antedeliteratureouslywised'! In lieu of anyone guessing what Bob Berkovitz really said, we just have to award a copy of Circuits 3 to J. Berry of Bardonia QLD for that last ingenious effort!



One-shot weaponry

We learned only recently that the Lawrence Livermore Laboratory in California in the USA secretly tested an X-ray laser device early last year. In the field of weapons supremacy, this one would be the 'ace in the hole'. Naturally, neither the Livermore Laboratory nor the US Defence Department is saying much about it, but professional journals have carried reports from scientists supposedly in a position to know suggesting that the report (or rumour) about this development is likely to be true.

Scary stuff. Laser weapons seem frightening enough — to those in the know, they probably represent more of a threat than nuclear weapons (cur-

rently receiving all the limelight). Fortunately, Murphy (bless his Irish heart) seems to have become entangled along the line somewhere for it seems an X-ray laser could not really provide the basis of a practical weapon. Now, as you know (if not, see ETI July 1980, pages 18-23) a laser requires an external energy source to 'pump' electrons from one level to another, to bring about a 'population inversion' and the laser effect. In helium-neon lasers a current passed through the gas provides the pump energy, in ruby lasers it comes from a xenon flash tube. Reportedly, the Livermore Lab's X-ray laser is powered by an atomic explosion! The pacifist's perfect weapon — it destroys itself upon first use!



TC-FX6C

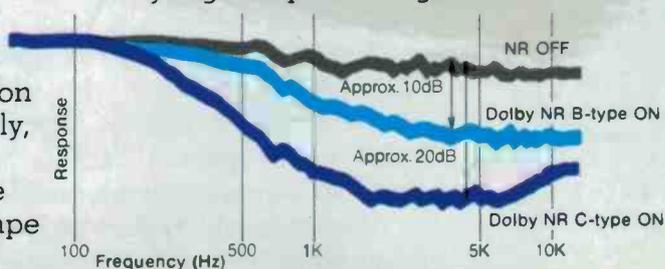
Deep C.

Sony presents a dramatic new standard in noise reduction: Dolby C.*

Silence has an indispensable part to play in the reproduction of recorded sound. So naturally, the newest advances in the science of noise reduction are featured on the latest Sony tape decks: TC-FX6C and FX5C.

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tape when confronted with especially high amplitude signals. For



example, at 10kHz the saturation threshold is expanded by 4dB.

In conjunction with conventional Dolby (B type), Sony's new "C" decks do not simply cover up unwanted sound debris. They take it all the way down to clean silence.

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