SCANNERS' WORLD - NEW BEARCAT REVIEWED

"BONUS" 32 PAGE OP-AMP COOKBOOK

eti ELECTRONICS TODAY INTERNATIONAL

JULY 1983 $2.35* NZ$2.75

LOUDHAILER

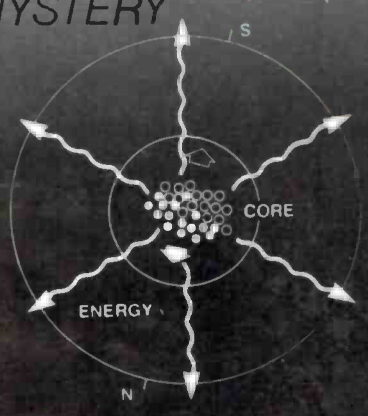
TO BUILD

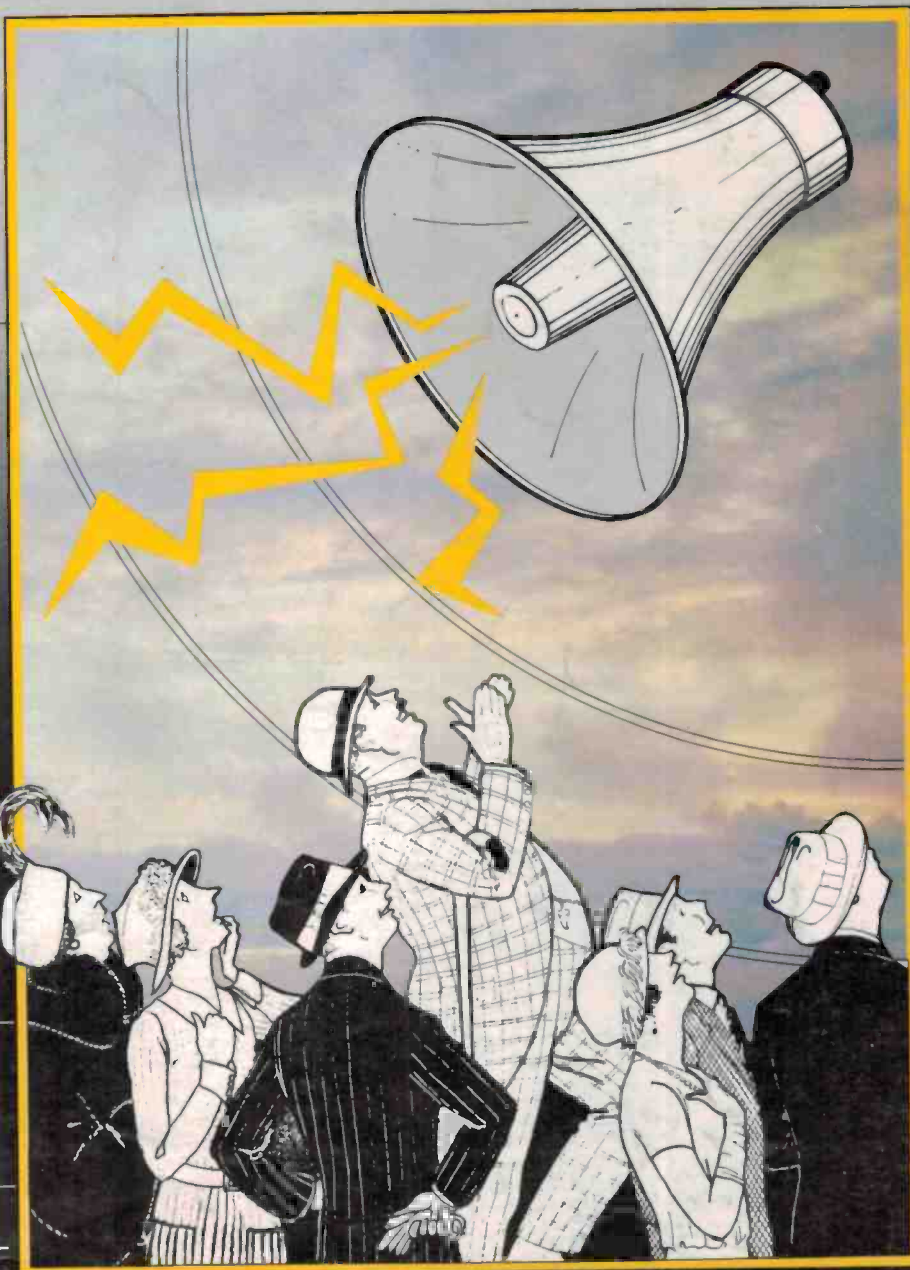
DICK SMITH'S VZ200

PUSHING DOWN THE PRICE OF PERSONAL COMPUTING

MAGNETIC MONOPOLES

SCIENTIFIC MYSTERY





TO BUILD:

'POWER DOWN' MAINS APPLIANCE TIMER

GENERAL PURPOSE AUDIO AMP. PROJECT

features

projects and technical

computing today

sight & sound

news

contests and special offers

general

Stand out among the crowd — with the ETI-465 Loudhailer!

Cover design by Ali White

Registered by Australia Post — Publication No. NBP0407
ISSN No. 0013-5216

ALL KITS LESS 10%. OFFER ENDS JULY 31, 1983

ROD IRVING ELECTRONICS

425 High Street, Northcote 3070, Melbourne, Victoria. Ph (03) 489 8131. Telex No. 38897
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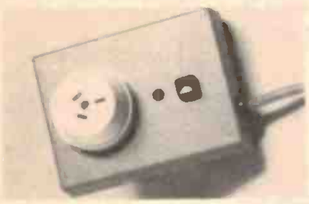
kits this month

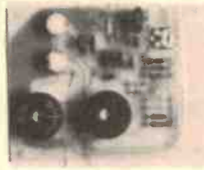


ETI-265 Power Down Mains Appliance Timer

Push the button to turn your appliance on, this turns it off automatically some convenient time later. Simple to build, low in cost.

ETI-464 Audio Amp Module

Every hobbyist should build at least one! This simple project can be built in quick-smart time and has a host of uses — in an intercom, as a baby minder, to power a loudspeaker from your crystal set. Will deliver up to four watts output.



ETI-1520 Wideband Amp Module

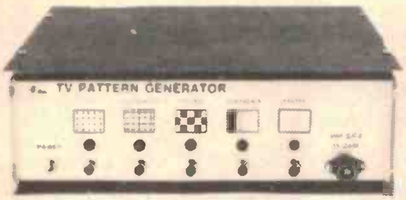
Never mind the low cost, just look at the specs! Bandwidth of 5 MHz (−3 dB), delivers 10 V peak-to-peak into 50 ohms from +/−15 V supply, 20 dB gain, 0.03% distortion, etc. Ideal for improving CRO sensitivity, as a video amp, etc.

ETI-465 Loudhailer

Now you can make yourself heard at the local football match of the next anti-nuclear rally. Simple, yet effective, it uses the ETI-464 amp module.

TV PATTERN GENERATOR

$64.50



Adjust your TV for a first-class picture with EAs crystal controlled TV Pattern Generator. **EA June 80**

WIND SPEED INDICATOR

October 81

$52.50

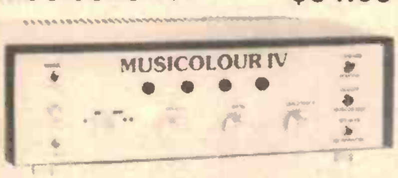
TRANSISTOR ASSISTED IGNITION

EA November 79

$34.50

MUSICOLOR IV

$84.00



Add excitement to parties, card nights and discos with EAs new Musicolor IV light show. This is the latest in the famous line of Musicolors and it offers features such as four channel "Color Organ", plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety. **EA August 81**

BIPOLAR TRAIN CONTROLLER

EA December 80

$34.50

AUDIO TEST UNIT FOR CASS DECKS

$47.50

EA October 81

ETI 477 MOSFET MODULE

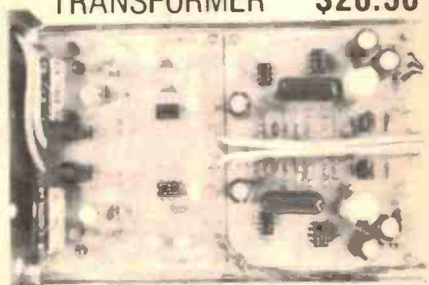
$63.50

Remember the great **ETI** 5000 power amp. With this module as the hub of the **ETI** 5000 and a transformer you get an amazing power output of 150W RMS.

Plus Power Supply (No Trans)	$49.00
Plus Transformer	$39.50

MIXER PREAMP TRANSFORMER

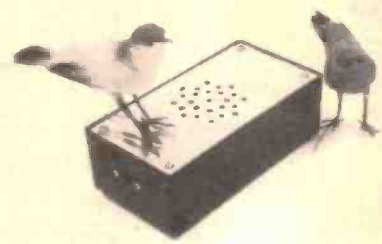
$26.50



Easy construction and versatile operation, this Preamp was for coupling with the 300W "Brute" Power Amp. **ETI 467 July 80**

PC BIRDIES

$14.50



Granny's Birthday – PC Birdies.
Grannys got a birthday coming up and you don't know what to give her! Her cat ran away, her dog starved and the fish turned upside down. Well here's the perfect gift. A no nonsense, no maintenance companion. The PC Birdies — She'll whistle, sing and dance for hours to this amazing electronic canary. **EA May 81**

CRYSTAL MARKER (INC 1MHZ X)

$34.50

ETI 157 October 81

eti

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* Recommended retail price only

comment

OVER THE PAST few months, following a change of ownership and a traumatic move of the complete office and laboratory to a new location, publication of the magazine has got a little 'off the rails'. If you like your regular 'hit' of electronics/computing/communications/audio every month and haven't been able to enjoy it when you've come to expect it, then we apologise. However, from next month we'll be back on the rails again with maybe just the odd 'loose wheel' to fix.

A serious hiccup in the distribution in New Zealand earlier this year has alarmed a great many loyal New Zealand readers. That problem was outside our control but has now been fixed. For good, we hope.

In this column last January, I said we'd be introducing new features during the coming year. The VIC-20 computer column, introduced in April, is well under way, the new Scanners' World column, introduced last month, is off to a good start and this month, we have a 32-page Op-amp Cookbook for you. We intend to include more cookbooks in future issues and, if the response is what we expect it to be, they'll become a regular feature.

Stick with us, we've got yet more goodies in store!

Roger Harrison
Editor

services

Technical enquiries: We can only answer readers' technical enquiries by **telephone after 4.30 pm Mondays to Thursdays.** The technical enquiry number is (02)662-4267. Technical enquiries by mail must be accompanied by a stamped, self-addressed envelope. There is no charge. We can only answer queries relating to projects and articles as published. We cannot advise on modifications, other than errata or addenda. We try to answer letters as soon as possible. Difficult questions may take some time to answer.

General enquiries: For enquiries about back issues, photostats of articles, artwork or submitting articles, call (02)663-9999 or write to the address on this page.

The publisher accepts no responsibility for unsolicited manuscripts, illustrations or photographic material.

next month

THE KUIPER AIRBORNE OBSERVATORY IN AUSTRALIA

A Lockheed L-300 jet transport aircraft, fitted with a 36" aperture telescope is operated by NASA to provide scientists with a very special infrared observatory. The telescope is carried to heights of 12 km (40 000 ft) to get it above 90% of the earth's water vapour, which absorbs infrared rays. This craft carried out a series of observing flights for Australian scientists in May and June. Jennifer Whyte tells the story.

SEVEN PERSONAL STEREO CASSETTE PLAYERS REVIEWED

A sort of 'across the market' review of seven 'famous name' personal stereo cassette players — we give the facts on how they measure up. Are they hi-fi or low-fi? Find out next month!

DEVELOPING THE MPF-1B MICROPROFESSOR

Here's one for the hackers! Ever wanted an alphanumeric character set for your MPF-1B? No problem — in fact, you have a choice of a limited 32-character set or a 64-character set. Sorry, no preprints, you'll just have to wait till August!

'SCREEN SPOTTER' LIGHT PEN FOR THE MICROBEE

Just what all you 'bee bugs have been waiting for! This simple, low-cost device plugs into the 8-bit port and operates in the lo-res mode (that's because a hi-res light pen is 100 times as difficult, and a lot more expensive). Software listing is included.

ETI-166 FUNCTION AND PULSE GENERATOR

Now you can get into the guts of the project. Any electronics workshop worthy of the name needs a good function and pulse generator — this means you. All the functions and features you could wish to want. Another project in the David Tilbrook 'lab-standard' series.

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.

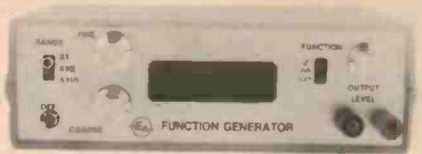
500MHz Digital Frequency Period Meter

Ref: EA Dec '81 – Feb '82
Jaycar has by far the best kit version of this project in Australia. We now supply 2 x GOLD plated BNC input connectors at no extra cost!
Cat. KA1390 $119 (50MHz Version)
Cat. KA1392 $26 (500MHz option)
(Beware of kits that don't conform to the original design).

ONLY $119

Function Generator

Ref: EA April 1982



$99
Cat. KA1428
FREE! TILTING BAIL WORTH $4.95 included

"Pigeon Pair" companion to the new 500MHz DFM. Low distortion generator of sine, square and triangular waveforms. From below 20Hz to over 160kHz. Inbuilt 4 digit frequency counter in de-luxe case.

JAYCAR EXCLUSIVE – 1% 50ppm metal film resistors used for stability

TRANSISTOR ASSISTED IGNITION

Ref: EA Jan '83. Latest version of this popular kit. The Jaycar kit has a genuine die cast box - as used in the EA prototype. Beware of others that use flimsy sheet metal.
Cat. KA1506 $35

magnificent!

BBD EFFECTS BOX

Fantastic low-cost instrument using the versatile MN3001 Bucket-Brigade Delay line to achieve brilliant sonic effects.
Now you can emulate the commercial rock groups with Phasing, Flanging, Reverb and Echo. The Jaycar kit includes all components INCLUDING IC sockets and the TU-04 box. (Not cut down but this is easily done).
Jaycar has a specially built cabinet for this kit with all holes pre-punched etc., at only $10 extra but only if you buy the original kit from us. Available as a separate item for $29.50.

COMPLETE KIT
Cat. KE1522
$79.00

Special cabinet to suit $10.00
Cat. HB6445

ROBOTICS

JAYCAR – FIRST IN AUSTRALIA WITH THE VERY LATEST IN THE FIELD OF ROBOTICS

Jaycar is the first major electronics company in Australia to stock useful robots in kit and built-up form.

MICRO GRASP

ONLY
$499

The Micro Grasp is the first low cost true robot. Basically the unit has an articulated arm jointed at the shoulder, elbow and wrist positions. The entire arm rotates on its base and has a motor driven gripper on the end of the arm. Each of the arm movements is SERVO CONTROLLED i.e. there are position sensors feeding back information to the interface board where it is compared with the programmed in intended position. Any positional error is automatically and continuously corrected. This servo action is independent of the computer, simplifying greatly the software to drive the robot. All programming is carried out with a small number of common BASIC commands. The interface board is memory mapped using only 64 Bytes at any of the 1024 switch selectable locations.
Control of the Micro Grasp as a computer peripheral is accomplished thru the parallel expansion port of most small computers. To keep the cost to an absolute minimum and to increase the learning factor the Micro Grasp is supplied as a self assembled kit. All components down to the last nut and bolt are included, as is the power supply.

MICRO GRASP KIT INCLUDING POWER SUPPLY Cat. XR1000 – SPECIAL INTRODUCTORY PRICE $499.00
UNIVERSAL COMPUTER INTERFACE BOARD (in kit form) Cat. XR1010 ONLY $179.00 (not required for Sinclair ZX81 computer)
23 + 23 way edge connector at $9.95 ZX-81 peripheral/RAM pack splitter board $10.95
CALL IN TO OUR YORK STREET SHOWROOM AND SEE WORKING!!

AS DESCRIBED ETI MAG. APRIL/MAY 1983

LOW COST DIGITAL MULTIMETER KIT

BY POPULAR DEMAND

Ref: EA March 1983 (This month)
Almost everyday we are asked for a multimeter kit. Up until now we thought that it was just not worth it considering the fine low cost built-up units available. The DP2010 changed all that.
This kit, fully imported from the UK uses the famous DPM-05 custom LCD/Voltmeter to achieve phenomenal accuracy at very modest cost!
All parts are included to complete the meter including an attractive and colourful front panel.
(a 9V battery is required)

Set of test probes to suit $2.95
Probe to suit Cat. WT5312 ONLY $2.50
Eveready 216 (red) 9V Battery Cat. SB2370 ONLY $1.40

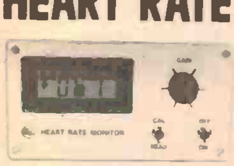
DP2010 kit Cat. KJ7010
ONLY $45

SPECIFICATIONS

AC VOLTAGE AND CURRENT RANGES
When S3a selects a.c. functions the output from either the voltage attenuator or current shunts is fed through C1 to remove any d.c. component

Function	f.s.d.	Resolution	Accuracy	Protection
Volts (d.c.)	2V	1mV	1%±1 digit	500V for
	20V	10mV	1%±1 digit	one minute
	200V	100mV	1%±1 digit	
	500V	1V	1%±1 digit	
Current (d.c.)	2mA	1uA	1%±1 digit	1A/250V
	20mA	10uA	1%±1 digit	
	200mA	100uA	3%±1 digit	
	2000mA	1mA	6%±1 digit	
Volts (a.c.)	2V	1mV	2%±5 digit	500V for
	20V	10mV	2%±5 digit	one minute
	200V	100mV	2%±5 digit	
	500V	1V	2%±5 digit	
Current (a.c.)	2mA	1uA	2%±5 digit	1A/250V
	20mA	10uA	2%±5 digit	
	200mA	100uA	4%±5 digit	
	2000mA	1mA	7%±5 digit	
Resistance	2K	1	1%±1 digit	260V
	20K	10	1%±1 digit	r.m.s.
	200K	100	1%±1 digit	
	2000K	1K	1%±1 digit	
Diode Test	2V	1mV	1%±1 digit	260V r.m.s.

HEART RATE MONITOR



$79

Ref: EA July '82
Brilliant kit which enables you to measure your heartbeat instantly. One of our most popular kits ever. The Jaycar kit comes in a beautiful ABS splashproof case with professional silkscreened panel.
Cat. KA1466 $79

DIGITAL CAPACITANCE METER

$74.50

Ref: EA March '82
Accurately measure capacitance from 1pF – 19.99uF. A must for the serious enthusiast.
Cat. KA1420 $74.50

Digital Thermometer

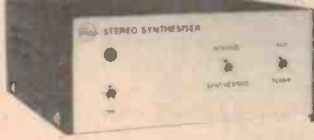
$74.50

Ref: EA Feb '82
0 – 100 degrees C with 0.1 degree resolution. Bright, easy to read display. Kit includes two temperature sensors.
Cat. KA1404 $74.50

STEREO STEREO STEREO STEREO Synthesiser

Cat. KA1476
Short Form Version Only $39.50

Creates a very realistic stereo sound from mono sources i.e. AM tuners, TV or video units. Very easy to build and comes complete.
Cat. KA1478 ONLY $49.50



Ref: EA September 1982

JAYCAR

SEE THE OTHER JAYCAR ADS IN THIS MAGAZINE FOR OUR STORE ADDRESSES AND PHONE NUMBERS....

Channel 9 busted over unlicensed microwave equipment

Two television stations, Consolidated Press Holdings Ltd's Channel 9 in Sydney and Brisbane station QTQ-9, owned by AWA, have had summons issued against them for the alleged use of unlicensed microwave links between Sydney and Brisbane.

The Federal Department of Communications, which issued the summons, seized microwave equipment on June 3, following investigations by officers from the radio frequency management division.

The seized equipment consisted of two microwave stations; one had been set up at Somersby on the NSW central coast and the other was at Coolangatta, just over the Queensland border.

The Government acted on this matter because it doesn't want telecommunications links to sidestep Telecom, unless the Minister for Communications authorises otherwise.

The department claims the two stations were links in a chain, comprising both authorised and unauthorised stations, which provides an alternative unofficial route for some television transmissions between Sydney and Brisbane. It was alleged that these stations had no purpose other than transmitting television programmes between north and south.

The Government's action is taken under Section 6 of the Wireless Telegraphy Act which bans the unauthorised establishment, erection, maintenance or use of "any station or appliance for the purpose of transmitting or receiving messages by means of wireless telegrapy".

The Act prescribes a penalty of five years' imprisonment or $1000 fine.

Section 7 says such unauthorised equipment shall be forfeited to the Commonwealth.

Neither the Federal Department of Communications nor the Station Manager of Channel 9 in Sydney would comment on the matter.

The department launched its seizures after talks with the Deputy Crown Solicitor's offices in Sydney and Brisbane. The Queensland action was taken with the support of State police, but the NSW police refused to take part in the NSW action on the basis that it was a Federal matter.

Channel 9 has been summonsed to appear in the Federal Court on July 11 for a hearing.

In a separate inquiry, department officers are understood to be investigating unauthorised microwave links between Sydney and Melbourne.

Investigations claim to show evidence of a temporary system which could be set up at short notice with towers and microwave dishes in place but with no transmitters or receivers installed.

So far there is no evidence that these links have been in unauthorised operation.

Twelve years, 147 ETI issues, six overseas editions, six new magazines, and it's time to move on . . .

Founder-editor of Electronics Today International (ETI), Collyn Rivers, and his technical-editor wife Jan Vernon have left the publication and its now world-wide associated editions.

Jan and Collyn have started a technical writing and publishing company, **Vernon, Rivers & Associates Pty Ltd, 18 Clifton Lane, East Balmain NSW 2041.**

Among other activities Vernon, Rivers & Associates will be preparing business computing and general technology features for the Bulletin, Australian Business, and the monthly general, software and equipment news sections of the recently redesigned Australian Computer Society Bulletin, and other publications worldwide.

The organisation will also be undertaking specialised writing assignments for a number of trade and professional organisations in the computing and general technical industries.

Planning is also apparently well in hand for a new technical publication due to be launched within the next three months.

Electronics Today International, Collyn's original publication, was owned by Murray Publishers before its acquisition by the Federal Publishing Company division of Eastern Suburbs Newspapers earlier this year. Further info: **Collyn Rivers (02)818-3559.**

For hot fingered solderers

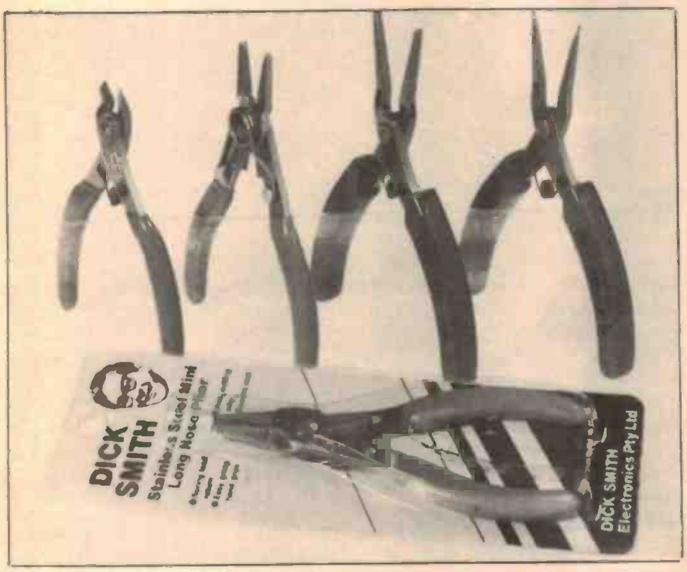
Scope Laboratories now offers a mains voltage 20 W non temperature controlled iron.

It features an air insulated grip, which helps keep the fingers cool during continuous soldering, and long life anti-corrosive iron plated tips.

The interchangeable tips come in four sizes and the tip and barrel are fully earthed for component protection.

Trade price is expected to be around $15 in most states (tax extra).

For further information contact **Scope Laboratories, 3 Walton St, Airport West Vic. 3042. (03)338-1566.**



The pick of pliers

Dick Smith has a brand new range of four directly imported stainless steel high quality pliers.

The s/s transistor nipper, super sharp with a long life cutting edge, is ideal for pc board work. Cat T-3205.

The s/s mini flat nose plier is also for working on pc boards and can be used as a heatsink while soldering. Cat T-3325.

The s/s mini needle nose plier is for getting into small spaces and working with small components like DS549s. Cat T-3570.

The s/s mini long nose plier can be used in 'rat's nests' of wires, great for pulling components out of tight spots. Cat T-3565.

The pliers are priced at $7.75 each and are available from all **Dick Smith Electronics stores Australia-wide.**

Electronic night fishing

The Matsushita Battery Company (National Panasonic) of Japan has been producing very small, light-weight batteries since 1978 with thicknesses down to 0.7 mm.

Recently they have employed lithium to obtain a higher energy density and this has resulted in a new application.

A fisherman's float using one of these batteries connected to a light emitting diode can be used as an imitation glow-worm. It is claimed that fish will bite at the glowing diode which (when fitted with a suitable hook) results in a much greater catch than would otherwise be obtained at night!

A reasonably high capacity is required to maintain the glow for an adequate time, yet the batteries must not be large enough to alarm the fish. Lithium paper cells, nominally 3 V, with a diameter of 4.2 mm and a length of 26 mm weighing only 0.5 g offer a 20 mA-hr capacity. A cell of the same diameter and 10 mm in length has a 40 mA-hr capacity and is said to be able to attract fish for a period of at least 4 hours.

B. Dance

Innovative lead-acid battery design

Under the Federal Government's Assistance to Inventors Scheme, James Mackaness, an engineer of Cheltenham (New South Wales) has received $10 000 to manufacture prototypes of a new lightweight lead-acid battery.

Mr Mackaness designed the battery after discovering that almost half the lead used in conventional batteries was wasted. By using much finer lead for the conducting function, and substituting polypropylene for the structure, he was able to reduce the wasted lead by 70%.

Known as a lead-acid automotive (LAAUTO) battery, Mr Mackaness' design also eliminates the need for the heavy — and expensive — lead grids used in conventional lead-acid batteries. This not only reduces the weight, but improves the charging and discharging rates.

While the battery's main market is presently in the vehicle industry, it offers a number of new applications, particularly for portable tools, machines, lighting and electronics.

Further details are available from **Eric Hunter, Director of Public Relations, Department of Science and Technology, Canberra ACT 2600. (062) 64-4145.**

Self-help for handicapped people

Prototypes of FRED (Friendly Education Device), a new training aid for handicapped people, are currently being manufactured by Thorn-EMI Electronics Australia.

The tested product is expected to be commercially available within the next 18 months.

A portable, microprocessor-based training unit, FRED is designed to be connected to a television set in the same way as computer-based television games. It uses computer-generated programs to provide displays on the television screen, which a handicapped person can control with a lever or joystick.

FRED allows handicapped people to move through training or rehabilitation programs at their own speed and can be used by people with mental or physical handicaps, as no technical knowledge of the equipment is required.

The unit is expected to cost between $1 200 and $1 500 and further information is available from **Eric Hunter, Director of Public Relations, Department of Science and Technology, Canberra ACT 2600. (062) 64-4145.**

Magnetic monopoles — a scientific mystery

Single north and south magnetic poles are predicted to exist but haven't yet been found. Could this be because of their unexpected properties: massive, slow-moving and rare?

Jennie Whyte

FOR MORE THAN 50 years physicists have been looking for magnetic monopoles, elementary particles which carry a single magnetic pole.

They are predicted to exist but so far no one has produced enough conclusive evidence of an observation. A new theory explains that this may be because the monopoles are too massive, slow-moving and rare.

Blas Cabrera, a researcher at Stanford University, thought that he might have found one early in 1982. But he has yet to verify an effect he has observed only once in six months. Theory suggests that there are not enough monopoles around today to explain why one should have been found in such a relatively short space of time.

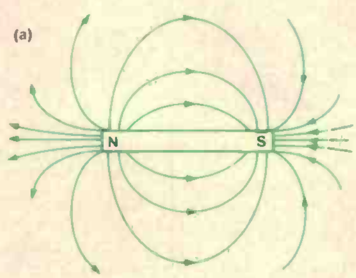
As early as 1269 Petrus Peregrinus, a French investigator of the magnetic properties of materials, noted that magnetic objects have paired regions of opposite polarity; that is, all magnets are dipoles. It seems that magnetic 'charges' or poles always occur in pairs, unlike electric charges which can occur as isolated positive or negative charges.

If you cut a bar magnet in half you end up with two smaller magnets, each with a north and south pole, rather than two pieces with opposite poles. This is because every atom in a magnetic material behaves as a tiny magnet, each atomic field being generated by electrons orbiting the atomic nucleus (just as an electromagnet is created by an electric current looping round a coil).

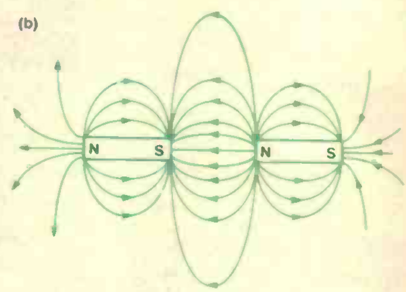
Speculation about the possible existence of magnetic monopoles has been going on for a long time. However, in the theory of electromagnetic phenomena, formulated by James Clerk Maxwell in 1864, the possibility of isolated magnetic charges was ignored since none had ever been observed. Over the past century Maxwell's theory has been put to many experimental tests and has never been found wanting. That fact alone severely limits the contexts in which magnetic monopoles might be found.

Interest in the idea intensified in 1931 when the British physicist Paul A.M. Dirac showed that an important observed property of electrically charged particles could be explained by assuming the existence of single magnetic poles.

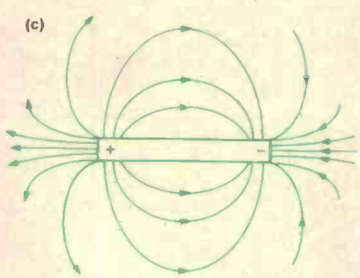
Dirac was trying to explain the quantisation of electric charge; the fact that electric charge appears only in multiples of the charge of the electron and the proton. Dirac showed that if an isolated magnetic pole exists anywhere in the universe, electric charge must be quantised everywhere. Until recently, Dirac's magnetic monopole hypothesis was the only explanation of the observed quantisation of the electric charge.



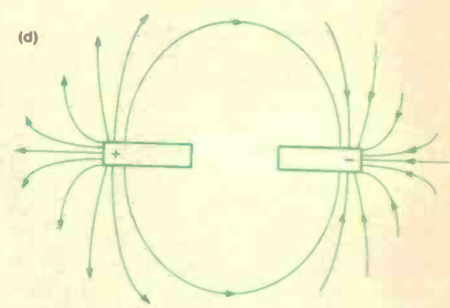
Dipole fields. Set up by a bar magnet.



Magnet cut in half. Two smaller dipoles are created.



An electric structure analogous to the above. Opposite electric charges are deposited at the ends.



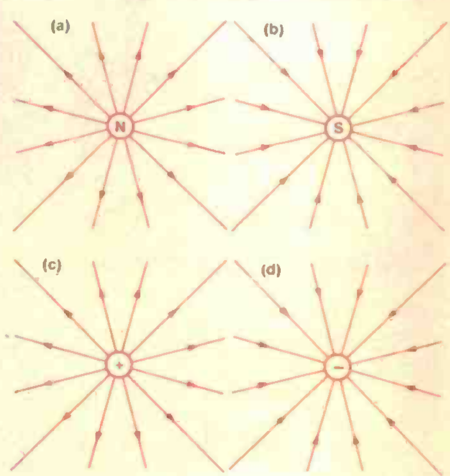
Electric analogue cut in half. The field remains dipolar because the electric charges that generate the field remain in place.

Dirac's monopole has a minimum unit of magnetic charge about 70 times as large as the corresponding unit of electric charge. He also predicted that the magnetic monopole would be matched by a magnetic antimonopole. However, his theory made no prediction about the mass or size of the magnetic monopoles, or about their abundance in the universe.

Dirac's predictions stimulated a rush of theoretical papers on the expected properties of the hypothetical monopoles, and several experiments were undertaken to detect them. Physicists searched for them in particle accelerators, cosmic rays and even moon rocks, but with no luck. However, they may not have been looking for the right effects.

Some interesting properties of magnetic monopoles arise when Maxwell's equations of electromagnetism are augmented to include magnetic charges and magnetic currents.

For example, as the velocity of a moving electric charge approaches the speed of light, its properties should increasingly resemble those of a magnetic charge. Similarly, a mov-



Symmetry exists. A north monopole (a) would have as its antiparticle a south monopole (b), just as the proton (c) has as its antiparticle the antiproton (d).

ing magnetic monopole would begin to take on the properties of an electric charge at a speed approaching the speed of light.

These transformations, which follow from Einstein's special theory of relativity, have been confirmed experimentally for moving electric charges but not of course for moving magnetic charges.

A moving electric charge can lose energy by ionising matter; that is, it detaches electrons from their atoms. Because of the much stronger charge of the magnetic monopole, it would ionise atoms some 10 000 times more effectively. Thus a magnetic monopole passing through a photographic emulsion of the type employed by physicists to detect electrically charged particles would leave a track thousands of times darker than the track left by an electric charge moving at the same speed.

Because the monopole would lose energy to the ionisation process so quickly, it would slow down much sooner on entering a substance than does an electrically charged particle with the same kinetic energy.

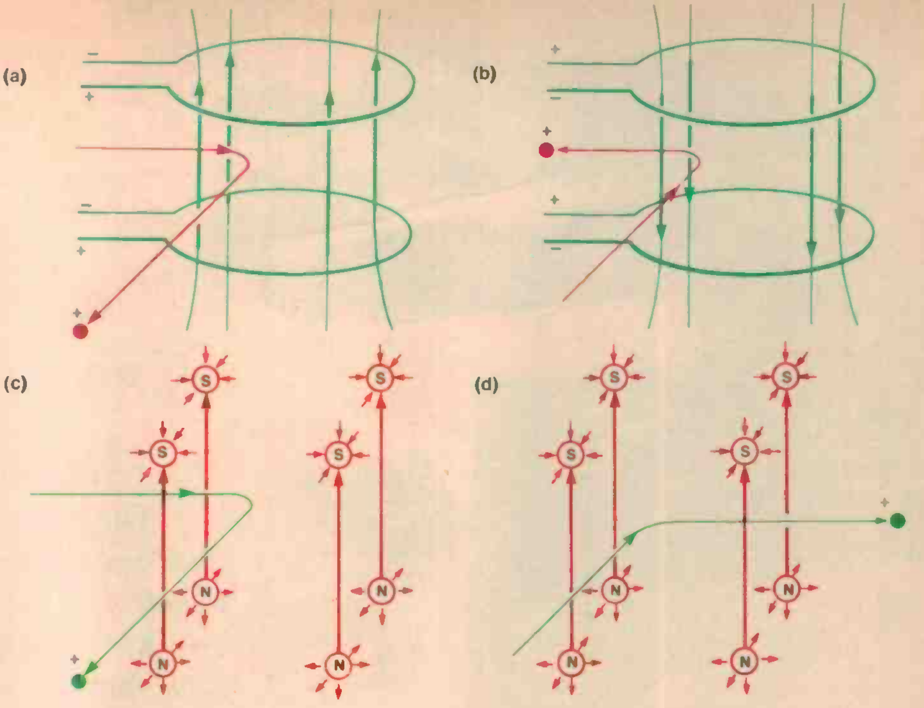
A magnetic monopole traversing a superconducting coil one metre long would gain more energy than a proton acquires in the largest particle accelerator yet built.

The physics of magnetic monopoles has another curious feature which can only be made apparent by imagining that the flow of time can be reversed. This is a thought experiment suggested by Robert K. Adair of Yale University.

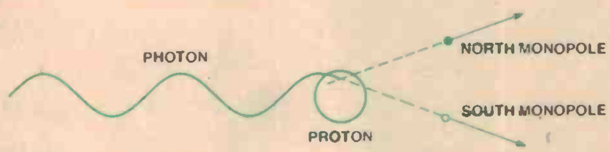
A proton is in a magnetic field which arises not from an electric current but from the presence of a magnetic monopole. Reversing time does not alter the polarity of the monopole and therefore leaves the direction of the magnetic field unchanged. The proton's path in the field of a monopole depends on the direction of time, an effect that violates the principle of time-reversal invariance.

The predicted effects of a magnetic monopole when time is reversed were for many years viewed as a serious argument against its existence.

In 1964, however, an experiment was done at Princeton University which discovered an effect much like a violation of time-reversal invariance in the decay of the particles called neutral kaons. As this finding has become better understood some of the opposition to the idea of magnetic monopoles has abated.



Time reversal. In (a) a proton is moving through a perpendicular magnetic field generated by electric currents. If the direction of time is reversed (b) everything is reversed, the particle retracing its path in the opposite direction. In (c) the magnetic field is produced by an idealised array of north and south monopoles. Reversing time would leave the magnetic field unchanged (d). Although the proton would reverse direction, it would not retrace its path; a violation of the principle of time-reversal invariance.



Particle-antiparticle pair. A north monopole and a south monopole could be created when a high-energy photon interacts with an electrically charged particle such as a proton. The mutual attraction between the monopoles, however, would cause them to collide, converting their mass back into photons.

Searching north and south

Knowing something of the properties of magnetic monopoles means that the experimental search for their existence can take a more positive direction. Soon after every new particle accelerator is commissioned magnetic monopoles are looked for in the debris of the initial high-energy particle collisions.

Monopoles have also been sought among the by-products of collisions between cosmic rays and atoms in the atmosphere. Other experiments have tried to detect them among the atoms of terrestrial and extraterrestrial substances. Samples of iron ore collected from the rocky outcroppings of old mountains are another potential source of material.

One detection method, first discussed in the 1960s, was implemented in the 1970s by Luis W. Alvarez and his colleagues at the Lawrence Berkeley Laboratory of the University of California. In their device a sample of material suspected of harbouring magnetic monopoles is passed repeatedly through a superconducting coil. On each pass of a magnetic monopole the electric current in the coil would presumably increase by a small amount. Because the coil is superconducting the incremental induced current would persist indefinitely. It's then a matter of measuring the extremely small signal induced by the multiple passes of a single monopole.

By means of this technique Alvarez and his colleagues were able to show that the density of magnetic monopoles in rock samples recovered from the surface of the moon is less than one for every 10^{28} protons. Even at this limiting abundance, however, there could still be an average of one monopole in every 20 kilograms or so of matter.

A less direct way of hunting for magnetic monopoles is to look for signs of the creation and destruction of a monopole-antimonopole pair. In theory a pair of this type could be created when a high-energy photon passes near a proton, just as an electron-positron pair is known to be produced. The oppositely charged monopoles would exist for only a moment, however, as they would soon come together and annihilate each other, converting their mass into additional photons.

In 1975 investigators at the University of California at Berkely and the University of Houston announced that they had discovered a magnetic monopole. Their evidence was an anomalously thick, dark track, presumably of cosmic ray origin, recorded on a stack of photographic emulsions and plastic sheets.

The detector had been exposed to cosmic rays while it was suspended from a balloon flown at high altitude for two and a half days. The area-time factor of the detector was roughly a million times smaller than that attained in previous searches in which no monopole had been seen.

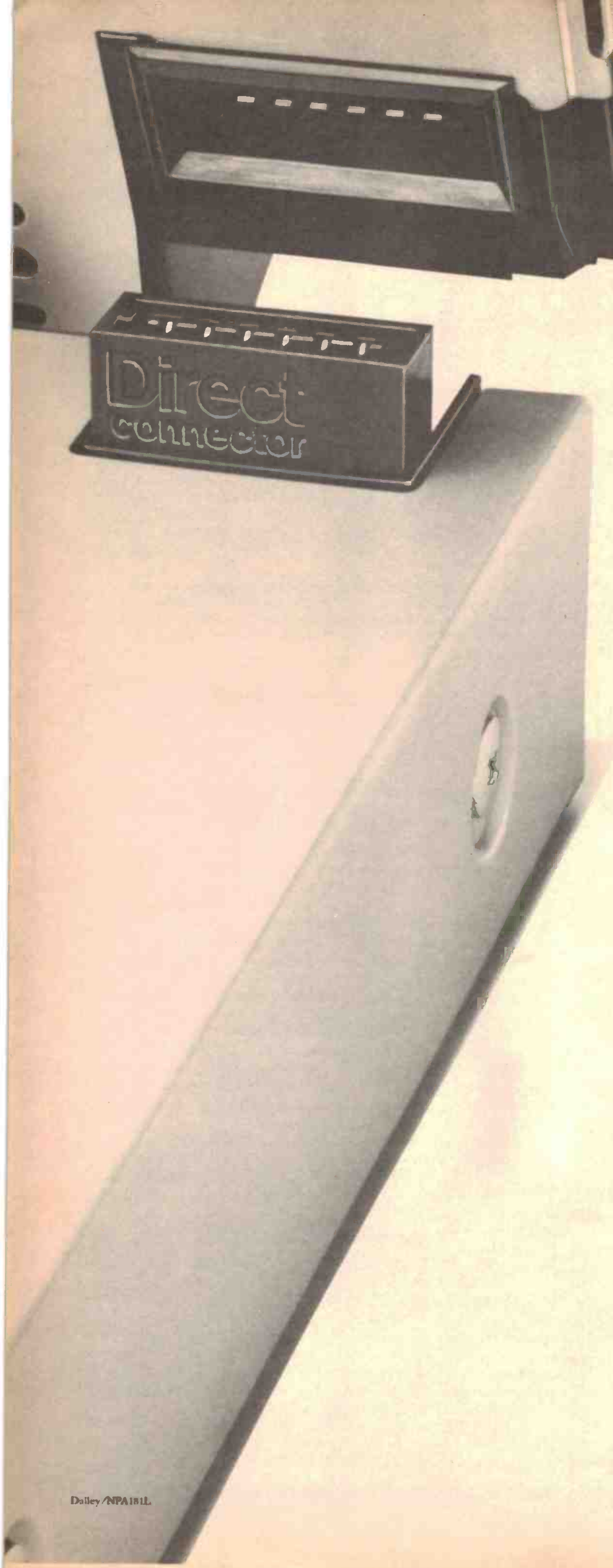
Other problems with the monopole interpretation of the event subsequently led the experimenters to suggest instead that the track might have been caused by the passage of a superheavy atomic nucleus or a massive antiparticle.

One benefit of this episode is that it inspired a careful evaluation of how a magnetic monopole would lose energy through ionisation. Even so, the question still remains unsettled.

Superheavy particles

The prospects for magnetic monopole hunters suddenly brightened in the mid-1970s as a result of the independent work of Gerard 't Hooft in Utrecht in the Netherlands and Alexander M. Polyakov in Moscow. They both found that a certain class of theories of elementary particle interactions not only allows magnetic monopoles but also demands them.

These grand unification theories attempt to unify the four basic forces in nature — gravity, electromagnetism, and the strong



Why Direct

Don't tangle with Technics.

The majority of audio systems – even the most beautifully designed – have something ugly to hide.

It's that mass of jumbled-up connecting leads that you find, all too easily, at the rear of the equipment. Not only are they ugly, they're inconvenient, too.

And as audio components become smaller, the problem becomes bigger and more unsightly.

To solve this problem, Technics developed their Direct Connector systems, which eliminate all audio connecting leads between the tuner, amplifier, graphic equalizer and cassette deck.

Each of these components features a special flip-up connector to allow them to be literally plugged in to each other!

It's an elegant piece of Technics technology that results in a stylish, neat installation that can be put together or taken down for re-location in a matter of seconds.

The 315 Series.

But Direct Connector capability is not the only innovative feature in this new and compact series from Technics.

The SL-5 direct-drive, linear-tracking turntable employs its own plug-in connector system for the pickup cartridge.

This unique Technics development has been adopted as a World Standard.

It means you can compare and evaluate cartridges from leading manufacturers like Audio Technica, Ortofon, Shure, Stanton, Empire, Pickering, ADC and, of course, Technics without conventional setting up procedures.

and weak nuclear forces — into one graspable mathematical structure. According to this theory monopoles are 'superheavy', 10^{16} times the mass of the proton or ten nanograms, which is about as heavy as an amoeba.

Such a particle is so much heavier than any other elementary particle yet discovered that it could well explain why previous searches for monopoles have been unsuccessful.

Such heavy particles cannot be created at even the highest energies particle accelerators can reach, but they could have been produced copiously in the aftermath of the big bang with which, cosmologists generally believe, the universe began.

Up to times as little as 10^{-35} seconds after the big bang, the universe would have been hot enough (almost 10^{30} degrees Kelvin) to generate such particles. Both north and south magnetic monopoles would have been formed, and a small fraction of them would have recombined, annihilating each other. Most of the superheavy monopoles would have escaped an early death, however, and there is no reason to think they would not have survived to the present.

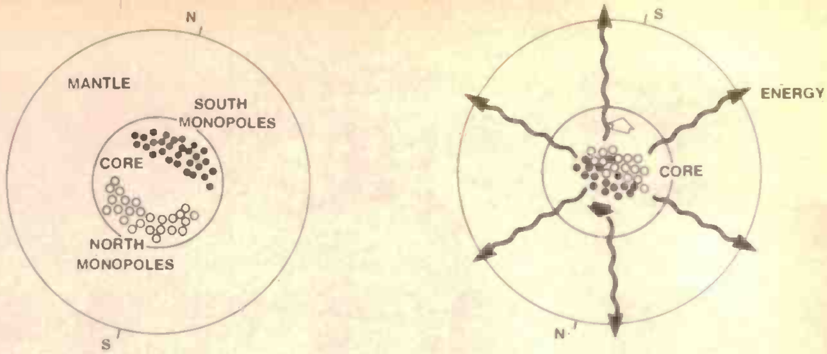
Researchers at the European Organisation for Nuclear Research (CERN) in Geneva decided that the interaction of monopoles with the galactic magnetic field sets a limit on the ratio of magnetic monopoles to protons of about one to 10^{20}. Given that abundance, some 200 monopoles per year would be expected to pass through an area of one square kilometre. A more conservative estimate, based on a more uniform distribution of monopoles in the universe, would result in a flux of a few monopoles per year per square kilometre.

So for the first time the theory of magnetic monopoles provides estimates of the expected mass and flux of magnetic monopoles. At least these estimates, even if they are rough, provide a fresh field for experimenters to explore.

One place to look for superheavy monopoles is in large-scale natural effects. So what was the fate of monopoles in the material which collected together to form the solar system? One could speculate that as the earth condensed the monopoles would have sunk toward the centre under the influence of the planet's gravitational and magnetic fields. North monopoles would have collected near the south geomagnetic pole and vice versa.

From the geologic record it is known that the earth's magnetic field has reversed many times. Such a field reversal would cause the two separated populations of monopoles to migrate toward and then through each other. During their journey some monopoles and antimonopoles would be annihilated, liberating the enormous energy embodied in their mass.

From the measured heat flow at the surface of the earth one can set a rough limit on the number of monopoles trapped in the core; the number calculated in this way is consistent with other experimental limits on the abundance of superheavy monopoles.



Monopoles trapped in the earth. They tend to collect at two places in the earth's core near their opposite geomagnetic poles. Following a reversal of the earth's magnetic field (an event observed repeatedly in the geological record) the two segregated populations of monopoles would migrate through each other. Some would meet and annihilate each other, converting their mass into energy, which could be observed in the outflow of heat at the earth's surface.

But how do you find them?

The design of a detector to search for these heavy, rare particles is, however, not obvious. But there are a lot of ideas around, many of them quite bizarre.

The massive monopoles are expected to travel slowly, at speeds far below the velocity of light. The collision of a superheavy monopole and a stationary atomic nucleus would be like a steamroller hitting an ant. A cosmic ray monopole could lose a huge amount of energy to such encounters as it ploughed its way ponderously through the earth, and it might still emerge virtually unscathed from the other side.

So under these circumstances it is difficult to predict what degree of ionisation would be observed in a detector. Whatever happens, it's obvious that an extremely large detector is required if the experimenter is to observe a monopole event in his lifetime.

One detector which records the light generated by ionisation and covers many square kilometres has been developed at the University of Utah. The device, called the fly's-eye detector, is an array of photomultiplier tubes directed at the night sky; it registers the light given off by secondary particles produced by rare ultra-high-energy cosmic ray interactions in the upper atmosphere. As the secondary particles shower down toward the earth they collide with nitrogen atoms in the atmosphere, causing them to scintillate. However, the passage of a magnetic monopole, even with the most optimistic estimate of its ionisation rate, would give rise to less than a ten-thousandth of the light needed to set off the detector.

The ability of such a detector to respond to particle-induced scintillations is limited by background illumination from stars, overflying aircraft and other sources such as beacon lights on distant radio towers. Perhaps a fly's-eye detector could be installed in a large cave or salt mine such as those now being used to look for proton decay.

Another large-volume detector is the Deep Underwater Muon and Neutrino Detector which will be sensitive to events within a cube of ocean about a kilometre on a side. This detector will respond to the Cerenkov radiation emitted when a particle moves through the seawater faster than the speed of light in water. Unfortunately superheavy magnetic monopoles would probably move too slowly to give off Cerenkov radiation.

Some of the largest existing scintillation detectors are too small by a factor of about 100 to have a good chance of observing magnetic monopoles if the flux is limited by the galactic magnetic field.

The contrary view holds that all searches with ionisation detectors are doomed to failure because the slow-moving, superheavy monopoles will cause no ionisation.

Another possible means of detection is based on the fact that the passage of any charged particle through metal is accompanied by eddy currents. These eddy currents are independent of the particle's speed and whether its charge is electrical or magnetic. A spherical metal detector has been designed but the signal can only be detected above the background noise if the detector is cooled to a few millidegrees above absolute zero, a difficult technical requirement with a large detector.

One comparatively simple strategy for detecting superheavy monopoles, which does not rely on assumptions about mass, calls for a superconducting coil similar to the one used by Alvarez and his colleagues.

Blas Cabrera claimed to have detected a monopole with a superconducting niobium coil five centimetres in diameter, kept in liquid helium at a temperature only 4.2 degrees above absolute zero.

Another plan is to mount a superconducting detector under an iron-ore processing plant which heats more than a million tons of ore per year to a temperature of 1700°C. At this temperature any magnetic monopoles trapped in the iron would be released, allowing them to fall through the detector.

The discovery of a magnetic monopole would rank as one of the finds of the century, comparable to the discovery of the positron, Dirac's other great prediction. If the monopole was found to be very massive, the case for some form of grand unified theory of elementary particle interactions would be strengthened.

Even if no magnetic monopoles are found, physicists, being what they are, will not view the negative evidence as conclusive.

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3. C. Sutton, *Magnetic monopoles fail to oblige the physicists*, New Scientist, vol 97; no 1349, p 721, March 1983.

Betamovie here in November

Sony's revolutionary compact colour video camera — it packs the standard Beta-format cassette into its own body, resulting in easy handling and increased portability — will go on sale in Australia in November.

Called the Betamovie, the Australian package will include the camera, an ac adaptor and a battery pack, and is expected to sell for under $1500.

The currently available Sony SL-F1E portable video recorder, which comprises separate camera and cassette pack, will be promoted as the 'pro' model of the Sony portable range, offering editing facilities and instant playback. The Betamovie will be aimed at the 'home movie' market.

Weighing just 2.48 kg, the Betamovie takes full advantage of the Beta cassette — it is more compact that the rival VHS cassette — and is only slightly larger than a deluxe 8 mm camera.

It records on any standard Beta cassette, which can be played back immediately on any Beta-format video cassette recorder. An adaptor is not necessary.

The Betamovie, which measures 125 x 220 x 357 mm, features a single-head drum three-fifths the size of a conventional head, a 13 mm SMF Trinicon pick-up tube for higher resolution and sensitivity, an F1.2 lens with macrofocus and a 6x power zoom, and a through-the-lens viewfinder.

A single button on the handgrip starts and stops the recorder. The rechargeable battery pack fits into the handgrip.

For further information contact **Sony Australia, 453-463 Kent St, Sydney NSW 2000. (02)266-0655.**

Yamaha's commercial power amps and recording mixer

The four heavy duty two-channel power amplifiers have a nominal power output (per channel, both channels driven into eight ohms) as follows: PC1002-120 W; PC2002 and PC2002M-240 W; PC5002M-500 W.

The 'M' suffix denotes a pair of large peak-reading meters that display power output in watts or dB.

All models have a typical separation of better than 80 dB wideband (95 dB at 1 kHz) so the two channels may be used for different programs (or two bands of bi-, tri- or quad-amped system). By sliding a rear panel mono switch, the amplifier outputs can be bridged to deliver significantly more power into eight or 16 ohm loads.

Harmonic distortion is typically 0.005% (20 Hz to 20 kHz, both channels driven) and intermodulation distortion is below 0.01%.

Their noise floor is from 110 dB to 120 dB below maximum rated output. Massive side-mounted heatsinks cool by convection.

The RM804 is a new 8x4 bus mixer designed for four and eight track recording. Each channel has an electronically balanced mic/line input and an unbalanced tape input.

The XLR mic/line inputs have continuously variable gain trim controls which enable the sensitivity to be optimised for levels from −60 to −20 dB, covering most microphones and electric instruments as well as many line level sources.

Following the mic/line-tape switch, the signal goes through a 3-band equaliser.

For more information on Yamaha products contact **Rose Music Pty Ltd, 17-33 Market St, Sth Melbourne Vic. 3205. (03)699-2388.**

Howdey, Partner...

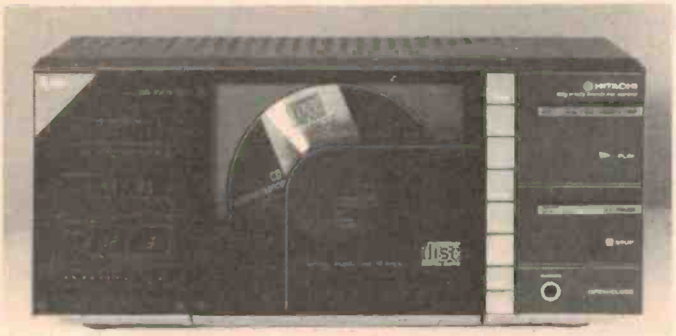
TEAC Australia has released what it calls 'the ultimate personal stereo' — the TEAC Partner, Model PC-7RX.

The Partner incorporates continuous automatic reverse and a noise reduction system to eliminate tape hiss. This has previously been a problem with personal stereos, due to the very nature of headphone listening.

Available options include the LS-X3, an internally amplified mini-speaker system and the TP-7 AM/FM stereo tuner.

Meanwhile, TEAC Australia has been appointed Australian distributor for the Japanese range of Denon cassette and open-reel tapes. Denon is recognised as one of Japan's leading manufacturers of magnetic tapes and produces one of the largest ranges available.

For further information contact **TEAC Australia, 115 Whiteman St, South Melbourne Vic 3205. (03) 699-6000.**



Hitachi digital audio disc player

The Hitachi DA-1000 plays those compact digital audio discs which have been so much in the news lately.

Each compact disc has a diameter of 120 mm and has a playing time (on one side) of 60 minutes.

Since the disc is read optically through a transparent protective layer, dust and scratches have no effect on the sound. Of course, deep, concentric scratches can obscure the data to a point where any brand of CD player will not be able to conceal the errors.

To store information on a compact disc the sound is sampled at a rate of 44.1 kHz and then each sample is given a 16-bit code. The code is printed on the disc as a series of reflective pits which are read optically by a laser beam and then converted back into music.

The DA-1000 claims to have a frequency response of 20 Hz to 20 kHz, a dynamic range of more than 90 dB and total harmonic distortion of less than 0.03%. The wow and flutter is to crystal oscillator precision and the channel separation is more than 60 dB..

The Hitachi CD player features pickup forward and reverse, cue, repeat and auto search which is a function that lets you quickly hear any selection no matter where it appears on the disc. Program playback allows you to program up to 15 selections for playback in any sequence automatically.

For more information on the DA-1000 contact **Hitachi, 153 Keys Rd, Moorabbin Vic. 3189. (03)555-8722.**

Philip's super VCR

Philips has launched a new top-of-the-line model for its range of VHS-format, front-loading video cassette recorders.

Designated the VR901, it has a cordless remote-control unit which duplicates the full 14 functions of the VCR's main control panel: adjustable picture quality; two picture search speeds in both forward and reverse; a clear freeze-frame picture; and a tape-elapsed indicator which is adjustable for cassettes from E30 to E240.

In addition to the usual recording facilities, the VR901 has a socket at the front of the unit that allows the direct connection of a video camera.

The VR901, which retails at $1299, allows full stereo sound to be played through existing stereo systems and is equipped with a Dolby noise-reduction system.

For further information, contact **Philips Industries, 15 Blue St, North Sydney NSW 2060.**

Visionhire defends Videotex

Despite the critics' dire predictions for Videotex in Australia, Visionhire is confident that the computer-based two-way information system, which involved telephone-line access to data-storage bases, has a bright future.

Visionhire is a member of the newly formed Australian Videotex Industry Association which has set, as one of its goals, the dissemination of accurate information on Videotex, to counteract the confusion arising from misleading reports.

According to David Peers, Visionhire's technical director, "Most of the negative viewpoints have been almost word-for-word recitations of the British experience." (In Britain, the equivalent Prestel system has had a difficult beginning.)

"On the other hand, Videotex found an immensely receptive market in the business community. From day one it has been aimed not as a system for public use but as a system of providing information retrieval by the business community.

"That's not to say, however, that Videotex will always remain within the narrow confines of the business market. There is absolutely no doubt that it will one day beome commonplace in our homes."

Stereo video from the General

General Electric's new Model GE-V-8900 stereo video-cassette recorder incorporates two audio channels which allow playback of pre-recorded stereo video cassettes and taping of simulcast televion programmes.

The front-loading recorder has a multi-programmable timer for pre-setting the recording of up to eight programmes from any channel within a 14-day programme.

It also has a search function which moves the picture at nine times normal speed, both forward and reverse. A variable-speed playback gives double speed, slow motion, freeze-frame and frame-advance modes.

To prevent the loss of part of a progamme during a power failure, the system has a clock/timer memory-hold system with a back-up time of about 10 minutes.

This is the second General Electric VCR to go on the Australian market — the first was the economy unit, Model GE-V-6900.

For additional information contact **Rank Major Appliances, 19 Forge St, Blacktown NSW 2148. (02) 671-1322.**

Pocket television sets

Sanyo has started production of pocket-size LCD-based television sets with 75 mm and 100 mm screens.

Sanyo says it has overcome major problems with the driving systems, while the development of a 'stacked liquid-crystal matrix panel' has produced clear pictures. The panel combines a newly developed liquid crystal display with amorphous silicon thin-film transistors.

Reliability has also been improved, along with contrast, wider viewing angle and response speed.

The 100 mm screen model has a display size of 60 x 80 mm, and an overall size of 253 x 30 x 113 mm. The reception bands include both UHF and VHF and the batteries provide four hours of viewing.

No other details have been released.

The Ultimate Performance.

The new Special Performance Series Components from Pioneer.

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A-70 Amplifier. 120 watts per channel. Dynamic Power Non-Switching Amplifier, featuring DC – Servo high-gain phono equalizer, Line Straight switch and L.E.D. peak power indicators.

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CT-90R Cassette Deck. Three head auto reverse record and play cassette deck, featuring Pioneer's own Ribbon Sendust heads and the computer aided convenience of Music Search, Blank Search, Index Scan, Blank Skip and Reverse, Music Repeat and Real Time Counter; auto B.L.E.

PL-S70 Turntable. A fully automatic Direct-Drive Turntable, featuring Quartz-PLL coreless DC – Servo Hall Motor with Stable Hanging Rotor, low mass straight P.G. tone arm with Dynamic Resonance Absorber, and automatic operations of record detection/selection and repeat.

SG-540 Graphic Equalizer. Seven band graphic equalizer, featuring L.E.D. – lit slide controls, equalizer recording and tape monitor switch.

If there's anything more you'd like to know about Pioneer's amazing Performance Series Components, please mail this coupon to 'Performance Components Brochure', Pioneer Electronics Australia Pty. Ltd., P.O. Box 295, Mordialloc. 3195.

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Sight and Sound NEWS

Digital age speaker systems

Pioneer's three new speaker systems feature two technologies developed by Pioneer to take maximum advantage of digital recordings.

The cone material is polymer graphite which is as stiff as metal and has the excellent damping qualities of paper, yet generates significantly less distortion than either.

Pioneer has also developed a range of ribbon tweeters which have eliminated voice coils completely because the entire direct-driven diaphragm surface acts as the voice coil. It is claimed that this results in a wider frequency range, better transient characteristics, lower distortion and far wider dynamic range than any competing tweeter designs currently available.

The S-910 is Pioneer's top bookshelf style speaker system and contains a large 30 cm woofer and a 10 cm midrange speaker. The beryllium ribbon has an extremely low mass diaphragm for better transient response together with individual controls for adjustment of middle and high frequencies.

The S-710 bookshelf system has a large 30 cm woofer and 10 cm midrange with an aluminium ribbon tweeter which gives a wide dynamic range.

The S-510 bookshelf system has a 25 cm woofer and 4.5 cm midrange with an aluminium tweeter to handle frequencies up to 50 kHz.

Retail pricing of the systems will range from approximately $650 per pair for the S-910 down to approx. $350 for the S-510 type.

For further information contact **Pioneer Electronics Aust. Pty Ltd, 178 Boundary Rd, Braeside Vic. 3195. (03)580-9911.**

New Dynavector tonearm and cartridge

Concept Audio now has the Dynavector DV.501 tonearm which is a refined version of the DV.505 tonearm.

It features a dual pivot system and electromagnetic damping. It also incorporates a cueing device.

The complete package has a recommended retail price of $498 and will fit onto most standard sized turntables.

To complement the DV.501, Dynavector has introduced the DV.10X.3 cartridge which is lower in mass than its predecessor, the DV.10X.2. It weighs three grams and the output voltage has been increased to 2.6 mV. The new DV.10X.3 does not require a step up device and is designed specifically for use in moderate priced hi-fi systems.

The recommended retail price of the DV.10X.3 is $148 and it is also available pre-packaged and mounted on a high quality magnesium alloy headshell at a price of $175 complete.

Dynavector products can be obtained from **Concept Audio Pty Ltd, 17/98 Old Pittwater Rd, Brookvale NSW 2100. (02)938-3700.**

SONY
THE ONE AND ONLY

The Sony CDP101 The magic of digital audio becomes a magnificent reality.

Digital Audio is a revolution. The greatest advance in home music reproduction since the

gramophone record. As you'd expect, Sony is the leader of this revolution with its magnificent CDP-101 player that offers you original studio master quality at home.

For the technically minded, the specifications read more convincingly than any superlatives • flat frequency response over the entire audible range • dynamic range and signal to noise ratio over 90dB • perfect channel separation • immeasurable wow and flutter • negligible distortion.

Sony's CDP-101 uses an optical laser pick-up (incorporating three micro processors), it is easier to use than a conventional turntable and connects easily to your existing system.

Other features include • fully automatic linear skate front disc loading • automatic music sensor • dual function digital readout of playtime • audible fast forward and reverse • 10 function wireless remote control.

<u>Compact Discs Last Forever</u>

Just 12 cms in diameter, the Compact Disc plays up to 60 minutes of music. It's protected from scratches, dust and finger prints by a plastic coating; and because the pick-up is a laser beam, deterioration is non-existent. Reproduction remains perfect virtually forever.

Hundreds of titles will be available with many more to follow from major companies such as CBS.

<u>CDP-101 Specifications</u>

Frequency Range	5Hz-20kHz ± 0.5dB
Dynamic Range	more than 90dB
S/N	more than 90dB
Channel Separation	more than 90dB (at 1kHz)
Harmonic Distortion	less than 0.004% (at 1kHz)
Wow and Flutter	immeasurable

Contact Sony for the name of your nearest dealer.
Sydney (02) 266 0655, Adelaide and N.T. (08) 212 2877, Brisbane (07) 44 6554, Perth (09) 323 8686, Melbourne (03) 419 3133, Launceston (003) 44 3078, Wollongong (042) 71 5777.

AUD0378

Jamo CBR 1703 loudspeakers

Louis Challis

. . . "offer a performance bordering on the superlative." New on the local scene, these four-way Danish speakers are well matched to the compact disc players. Well designed, they are able to handle peak power levels of 600 W with low distortion.

MOST OF OUR READERS will probably remember 1983 as the year of the compact disc, affectionately known as 'CD' by the trade.

However, I suspect the trade, overwhelmed with problems, some of which are technical but generally financial, will not remember 1983 with so much affection.

One of the most interesting technical problems facing the high fidelity industry is the obviously wide gap between the technical performance of the new CD players and that offered by the 'average' loudspeaker of the type that you might buy in your local hi-fi shop.

CD players, with dynamic ranges of 90 dB and frequency responses that are flat from 10 Hz to 20 kHz, really need loudspeakers to be better than they have ever been before if they are to do credit to the new medium. So it is not surprising that most of the major speaker manufacturers or their importers are concerned that their cheaper speaker enclosures might not be suitable for the new demanding task.

Until these Jamo speakers turned up for review I must admit I had never heard of the firm. The speaker system that came out of the box was sufficiently unusual in its appearance to provoke a lot of comment in our office.

The 'CBR' concept, which stands for Centre Bass Reflex, but which I would describe as the Circumferential Bass Reflex, obviously has its merits. If this concept is half as good as it seems to be, it could well make this speaker stand out in the marketplace.

A four-way speaker system is not usually my 'cup of tea' because it makes the testing more complicated; however, I realise that this system does have obvious attributes.

It was purely coincidental that at the time of reviewing the Jamo speaker system I had the good fortune to have three different CD players in my house. It seemed that these two separate sets of circumstances were auspicious, for many people at this moment are considering whether or not their existing speaker systems are suitable for use with CD players.

It seems appropriate for me to look briefly at the specific attributes that a speaker system should possess if it is to be suitable for listening to a CD player system. Obviously, one of the first requirements is that its frequency response should ideally extend from 25 Hz or at worst 40 Hz through to 16 kHz and be as smooth as possible.

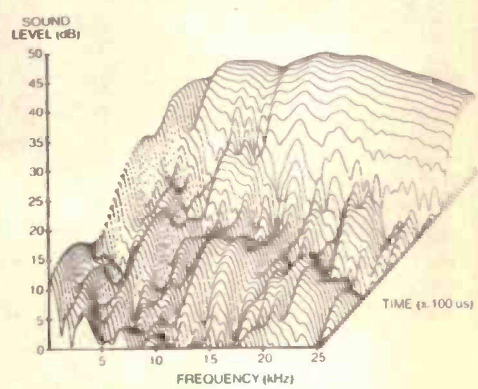
This frequency response should be supplemented by low distortion at high signal levels, low colouration from the drivers and the cabinet, low intermodulation distortion, a good transient decay response with minimal resonance, broad non-directional output in the horizontal plane and the ability to handle transient signals with peak powers of hundreds of watts.

So it was with these salient criteria in mind that I proceeded to evaluate the Jamo CBR 1703 loudspeaker system.

An overall view

After you remove the speaker grill the most unusual feature of the speaker system that catches your eye is the method of loading the low frequency driver. This makes use of a 'centre bass reflex' (abbreviated to CBR) system in which the woofer is inserted in the middle of its own circular, annular loading port.

The woofer is supported on four rectangular rubber isolating mounts which are apparently intended to vibrationally decouple the driver from the cabinet and from the loading port structure. The lack of resilience of these



Every picture tells a story. The decay response spectra for the Jamo CBR 1703 loudspeakers.

JAMO CBR 1703 LOUDSPEAKERS

Dimensions:	*425 mm wide x 365 mm deep x 810 mm high*
Weight:	*31 kg*
Price:	*Rrp $1695 per pair, including pedestals*
Manufactured:	*In Denmark by Jamo Hi-Fi*
Distributor:	*Scan Audio, P.O. Box 741, Dandenong Vic. 3175. (03)793-5670.*

four rubber mounts leaves one with the immediate impression that they can only be really effective at high frequencies and therefore they must be relatively ineffectual at low frequencies.

The woofer speaker is a 325 mm diameter unit with a large rolled plastic edge. Behind the main driver is a reasonably large ceramic magnet assembly. The woofer edge frame is designed to create the inner element of the CBR system, while the outer table element on which it is supported by the rubber blocks forms the other element of the CBR system.

The low mid-range unit is a 173 mm driver with plastic roll edge support, the mid-range unit is a 50 mm domed tweeter and the tweeter is a 25 mm domed unit.

The distribution of these individual low mid-range, mid-range and tweeter units on the top of the cabinet is asymmetrical with an L-shaped configuration. This must affect the uniformity of the sound field in the mid-range region and detract from the directional attributes, rather than optimise the sound field generated by the speaker.

Thin foam plastic has been inserted around the mid-range and tweeter units to minimise the diffraction effects at the front of the loudspeaker. However, the foam that has been chosen has apparently been selected on the basis of its durability rather than its acoustical absorption.

The concept of forming the front of the speaker enclosure from a plastic moulding is delightfully simple as it saves all the expense of machining wood and all the other milling operations that are required in the construction of conventional wooden enclosures. ▶

MEASURED PERFORMANCE OF :
JAMO Model 1703

FREQUENCY RESPONSE:
35Hz - 18kHz

CROSSOVER FREQUENCIES:
280Hz/1400Hz/3500Hz

SENSITIVITY:
(for 90dB average at 2m)

5.6 VRMS - 3.9 Watts (nominal into 8Ω)

HARMONIC DISTORTION:
(for 96dB at 1m)

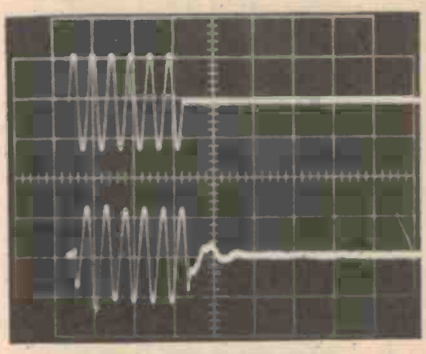
	100Hz	1kHz	6.3kHz	
2nd	-43.3	-47.4	-55.2	db
3rd	-45.6	-44.9	-	dB
4th	-62.2	-72.6	-	dB
5th	-66.0	-67.6	-	dB
THD	0.76%	0.71%	0.17%	

INPUT IMPEDANCE:

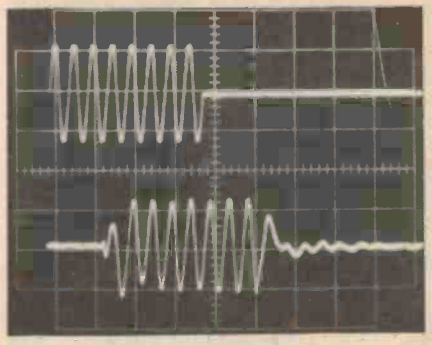
100Hz	5.6 ohms
1kHz	9.5 ohms
6.3kHz	8.2 ohms
Minimum at 90Hz	5.4 ohms

Tone burst response of the Jamo CBR 1703 loudspeaker system. For 90 dB steady state sound pressure level at two metres on axis.

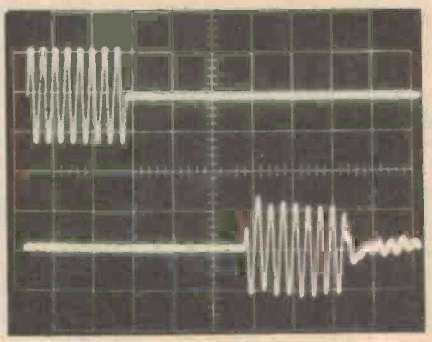
Upper trace is electrical input. Lower trace is the loudspeaker output.



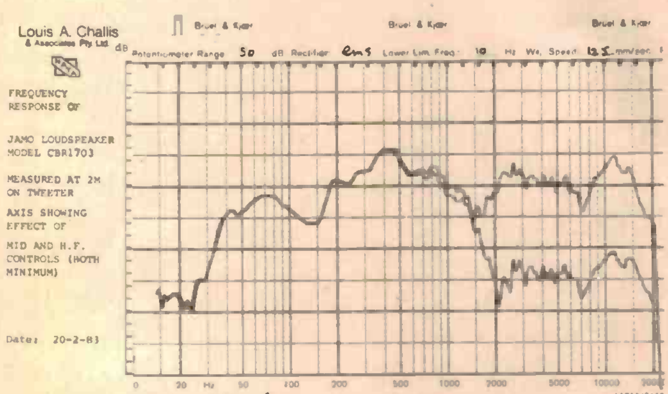
Output at 100 Hz (20 ms/div).

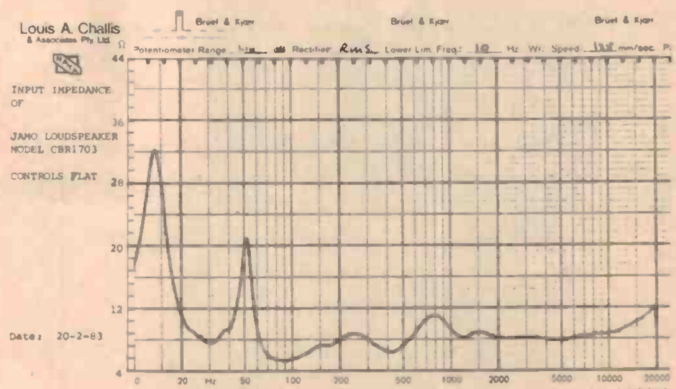


Output at 1 kHz (2 ms/div).



Output at 6.3 kHz (0.5 ms/div).





It also means that the complications in providing mounting holes, mounting systems, dimensions of those systems and the fabrication of the other complex parts of the system are minimised. It is all economically fabricated in one simple operation. Even the mounting holes for the fancy cloth-covered front of the cabinet are moulded into the face structure and may then be forgotten.

What may have been overlooked is the resonance and damping characteristics that a plastic system provides when compared to a well-braced timber system.

The whole front of the speaker cabinet is moulded as a complete unit. This provides for all the mounting requirements of the individual speakers as well as incorporating the treble and mid-range attenuators on the top lip of the cabinet and overload indicator lights on the front edge of the cabinet.

The front clip-on panel which supports the black speaker cloth is also a plastic moulding and it seems that one of Jamo's strongest points is their moulding technology and the extent to which they are prepared to utilise their plastic mouldings and automated processes to reduce the manufacturing costs.

The cabinet structure is unusual as it features a contoured front panel. The full significance of this does not become apparent until you see the supporting steel pedestals on which each speaker is to be floor-mounted, or until you examine the installation instructions that show how the unit may optionally be mounted upon the wall.

The pedestals unquestionably enhance the appearance of the speakers as well as being functional. Each pedestal is a very strong, two-piece, 4 mm thick steel unit with interlocking elements. These provide a back-rest which restrains the back of the speaker.

On the top of the pedestal are four self-adhesive pads which reduce the likelihood of the speaker system slipping off the top of the stand.

With typical Danish ingenuity the pedestal is very simply manufactured to provide strong and resilient support for the speaker as well as providing a small degree of vibration decoupling for low frequency energy being fed through to the floor. This is evident as the low frequency performance is substantially improved in the critical 25 Hz to 40 Hz region.

The rear of the cabinet contains a terminal connection box with two colour-coded, large, spring-loaded terminals to accept bare speaker wires which may be up to 2.5 mm in diameter.

Objective testing

We placed one of the Jamo speakers in our anechoic room and proceeded to evaluate its objective performance. The first data we produced was the impedance curve which provides an assessment of the CBR system. This displayed two significant resonances; the first one is due to the main venting port of the CBR resonance which peaks at 12 Hz. The second resonance is the main speaker resonance which occurs at 51 Hz with a peak impedance of 21 ohms.

The minimum impedance measured is approximately six ohms at 90 Hz. The rest of the impedance curve from 100 Hz to 20 kHz is relatively smooth and consequently safe for virtually all amplifiers with which it is likely to be used.

The frequency response of the Jamo 1703, when measured on axis and without a reflective plane underneath the speaker, is not particularly smooth and lies within a range of ±6 dB from 38 Hz to 20 kHz. Obviously with the speaker mounted on its pedestal above a reflective plane, the bottom end response would receive a significant lift as a result of the floor reflection. This does compensate for the drooping low frequency response that is visible in the level recording.

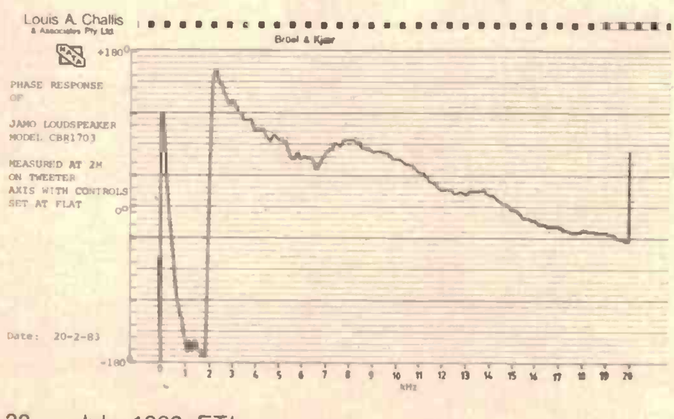
The frequency response exhibits a far greater number of peaks and bumps than I would have expected, particularly in the 350-500 Hz region and again between 2000 Hz and 7000 Hz. There is also a sharp rise in the response between 8 kHz and 16 kHz. These peak responses are measurable and, as we discovered later, audible and give the speaker a degree of frequency colouration which affects the audible response on both classical and pop music programme content. I pondered the non-linearity and suspect that the individual components are not closely monitored for uniformity of performance.

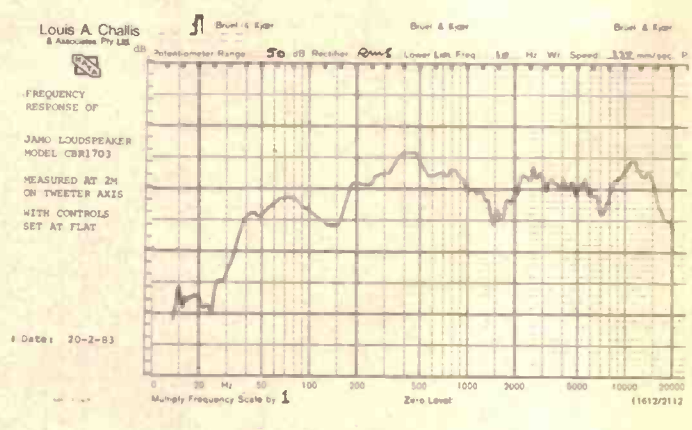
The speaker crossovers occur at 250 Hz, 1400 Hz and 3500 Hz, which are substantially different from the manufacturer's claims. The lowest crossover between the bass driver and the low mid-range is not easy to pick, even with a microphone close to the speaker, and I gained the impression that the woofer was not delivering its fair share of the total output.

The mid-range attenuator, which is one of the 'push to activate' type, provides useful adjustment between 1500 Hz and 6 kHz, which is a maximum of −7 dB between 1800 Hz and 3 kHz. The treble attenuator, which is located next to the mid-range unit, provides effective attenuation from 2 kHz to 20 kHz with a maximum of −14 dB between 7 kHz and 14 kHz. The values and graduation of attenuation are sensible and it is clear that the designers have put a lot of thought into both the ergonomic and electronic design of the attenuators.

The overload indicator lights did not register at all during our testing and I suspect that I just did not push out enough power to activate them.

The speakers are quite efficient, requiring less than four watts to produce 90 dB at two metres. This means that with a 100 W stereo amplifier peak levels of greater than 110 dB





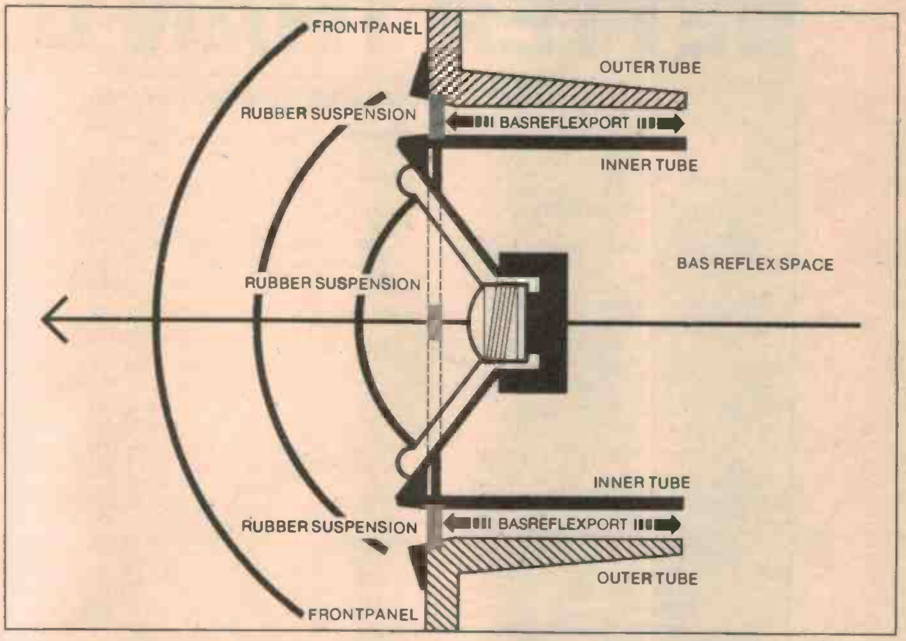
are possible in a normal moderately reverberant living room.

The phase response of the Jamo 1703 is extremely smooth and it is clear that, even though the unit contains four separate drivers and their associated crossovers, the designers have achieved a commendable result in precisely positioning the drivers and in designing matching crossover networks that appear to work well.

The distortion levels are particularly low, being well under 1% at 100 Hz and 1 kHz and less than 0.2% at 6.3 kHz. The low distortion levels are a primary feature of these speakers and the distortion levels do not really become significant until the power level approaches 100 W (i.e: 107 dB at two metres on axis).

I was not surprised to find that both the tone burst testing and the decay response spectra produced excellent results. Only moderate levels of decay resonance were apparent at about 5 kHz and even this was well down compared with the peak signal level.

This part of the testing was particularly pleasing as it augured well for the subjective testing that followed.



Fundamental construction of the Centre Bass Reflex system.

Subjective testing

With a choice of three CD players, more than a dozen compact discs and many excellent conventional records, I had what I can only call an exciting time.

The music on the compact discs was exhilarating and the performance of the speakers was generally extremely good. The first thing that was apparent was the ability of the Jamos to handle an instantaneous peak power up to 600 watts per speaker without complaint and with remarkably low distortion. At these power levels the sound pressure level in my living room was over 114 dB and my family was starting to complain.

The sound was remarkably clean but by comparing the outputs of selected tracks against my reference speakers it was clear that the mid-range balance was not really perfect and that speech and singing had quite discernible colouration. This was readily observable on Classical Guitar (Albeniz Granada — track nine on the Sony CD disc YEDS4; Demonstration disc, Volume 1). The sound was not at all poor but was unquestionably different from what it should be. By contrast, on organ music the speakers were absolutely outstanding.

I played Virgil Fox's 'The Digital Fox' (Ultragroove UG9001) and was amazed how well these speakers coped with the record. The low frequencies were full-bodied with no signs of frequency doubling and remarkably free of distortion, while the mids and highs were rich and vibrant. The speakers reproduced the organ almost as well as any speakers I have heard, and they handled peak levels of over 400 W without complaint. The overload lights didn't come on and I was quite impressed.

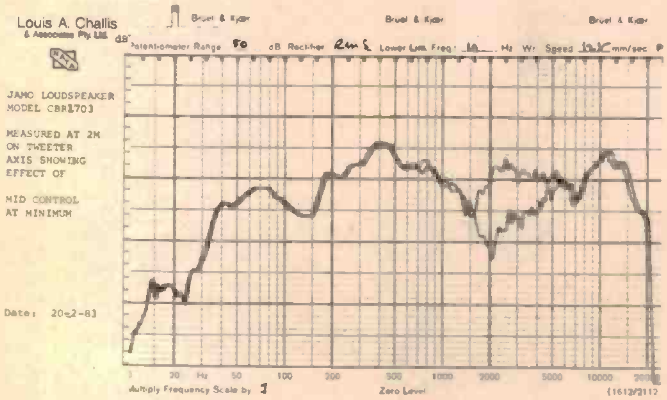
I played an excellent Mobile Fidelity record, Earl Klugh's 'Finger Painting' (MFSL 1-025), and was rewarded with rich transients and exciting percussion. However, the response was coloured and the 'sound of the speakers' was superimposed on the sound of the music. The staccatos of the Earl Klugh were not quite as clean as they are on the monitors and I was a trifle less impressed.

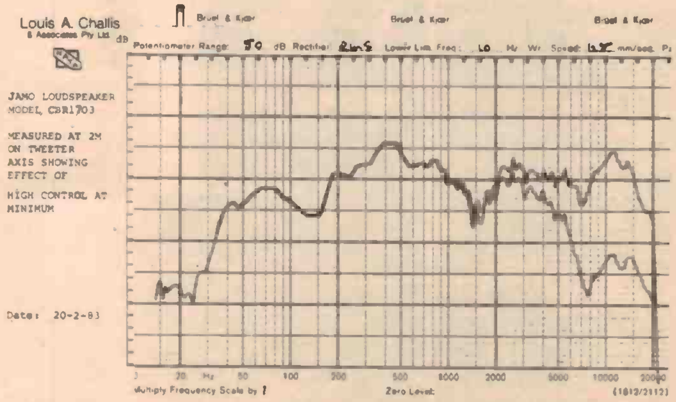
I returned to the CD players and was once again rewarded with the magic of crystal clear digital recordings free of clicks, pops or background noise. The Jamos were really in their element and I was suitably impressed that these speakers are the first of a new generation of speakers that are well suited to the CD generation.

The Jamo CBR 1703s are an exciting speaker system which is generally well designed, well executed and which offers a performance bordering on the superlative. They are well suited for listening to both classical and rock music and are not afraid to handle power levels which would quickly destroy lesser speakers.

The only factor which detracts from an almost perfect testing and subjective assessment is the variability of the mid-band frequency response and the consequent frequency colouration.

Jamo would do well to spend a little more time and effort in matching their individual drivers if they would like a five-star rating instead of the excellent four stars that they won for this review. ●





SOME COMPUTERS ARE BETTER THAN OTHERS

COMPUTER COMPARISON CHART

	SPECTRAVIDEO SV-318	APPLE II PLUS	ATARI 800	COMMODORE 64	COMMODORE VIC 20	TANDY TRS-80
BASE PRICE	$499	$2100	$1100	$699	$299	$549
COMPUTING POWER FEATURES						
BUILT-IN ROM	32K	12K	10K	20K	20K	8K
EXPANDABLE TO	96K	N/A	42K	N/A	N/A	14K
BUILT-IN EXTENDED MICROSOFT BASIC	YES	YES	ADDITIONAL COST	NO	NO	NO
BUILT-IN RAM	32K*	48K	16K	64K	5K	4K
EXPANDABLE TO	144K**	64K	48K	N/A	32K	32K
KEYBOARD FEATURES						
NUMBER OF KEYS	71	51	61	66	66	53
USER DEFINE FUNCTIONS	10	N/A	4	8	8	N/A
SPECIAL WORD PROCESSING	YES	NO	NO	NO	NO	NO
GENERATED GRAPHICS (FROM KEYBOARD)	YES	NO	YES	YES	YES	YES
UPPER/LOWER CASE	YES	UPPER ONLY	YES	YES	YES	UPPER ONLY
GAME/AUDIO FEATURES						
SEPARATE CARTRIDGE SLOTS	YES	NO	YES	NO	NO	NO
BUILT-IN JOYSTICK	YES	NO	NO	NO	YES	NO
COLORS	16	15	128	16	16	8
RESOLUTION (PIXELS)	256 x 192	280 x 160	320 x 192	320 x 200	196 x 184	192 x 256
SPRITES	32	N/A	4	8	8	N/A
SOUND CHANNELS	3	1	4	3	3	1
OCTAVES PER CHANNEL	8	4	4	9	9	3
A.D.S.R. ENVELOPE	YES	NO	NO	YES	YES	NO
PERIPHERAL SPECIFICATIONS						
CASSETTE	2 CHANNEL	1 CHANNEL	2 CHANNEL	1 CHANNEL	1 CHANNEL	1 CHANNEL
AUDIO IO	YES	NO	YES	NO	NO	NO
BUILT-IN MIC	YES	NO	NO	NO	NO	NO
DISK DRIVE CAPACITY	256K	143K	96K	170K	190K	156K
(LOW PROFILE)	YES	NO	NO	NO	NO	NO
CP/M COMPATIBILITY (80 column programs)						
CP/M* 2.2	YES	NO***	NO	NO****	NO	NO
CP/M* 3.0	YES	NO	NO	NO	NO	NO

* 16K user addressable plus 16K graphic support
** 128K user addressable plus 16K graphic support
*** Apple II can accept modified 40 or 80 column CP/M
**** Commodore 64 accepts 40 column CP/M

Microsoft is a registered trademark of Microsoft Corporation
CP/M is a trademark of Digital Research, Inc.

OURS IS MUCH BETTER

When you start comparing Spectravideo's SV-318 to other personal computers, you'll find there really is no comparison. The SV-318 is the only logical choice, because it does more than some computers costing 4 times as much. And its abilities simply embarrass other computers in this price range.

The SV-318 isn't just more capable. It's much more capable. No other computer at even twice the price comes near its 32K ROM expandable to 96K. Or to its 32K RAM expandable to 144K. And no other computer has a built-in joystick/cursor control—an immeasurably useful feature when it comes to playing your favorite video game. Further, the SV-318 has, as its resident "language" Extended Microsoft Basic, the industry standard. It even has built-in CP/M (standard 80-column program), so you can immediately utilize over 10,000 existing software programs.

The SV-318 isn't just more expandable. It's much more expandable. Unlike many other so-called computer systems, all our important peripherals are available at once. That means you can get almost full usage out of your SV-318 from the day you buy it. With the Super Expander, Data Cassette, Floppy Disk Drive, Dot Matrix Printer, Graphic Tablet and SV-800 Series Expansion Cartridges, there's almost no end to the work you can do. Or to the fun you can have. The SV-318 is well designed to interface with new options as they become available, too. All this adds up to a computer you'll grow into, not out of.

The SV-318 is not only eminently affordable, it's the first real bargain of the computer age! Besides business application, home budgeting, word processing, programming and self-teaching, the SV-318 is the best entertainment value in town. Not only can you use it with your TV or color monitor to play hundreds of different video games,

FOR UNDER $500

with the optional SV-105 Graphic Tablet you can draw pictures, graphs, charts and other visual images on your TV screen. Considering what you get for what little you pay, the SV-318 is once again the only logical choice.

Whether you're investing in your first computer, or are already well versed in today's most important machine, you'll find that the SV-318 is the only logical choice for you.

SPECTRAVIDEO

SV-318

PERSONAL COMPUTER

VIDEOACTIV ELECTRONICS
70 St Kilda Road, St Kilda. VIC 3182. Phone: (03) 537 2000

Spectravideo SV 318 personal computer

The Melbourne-based firm, Videoactive, the Australian agent for Spectravideo video games (including Planet Patrol, Master Builder and Quickshot) has just released the Spectravideo SV 318 personal computer in Australia.

Spectravideo is an American-based electronics company with an affiliation with Bondwell, a large firm located in Hong Kong.

Combining the research and development facilities of the two companies has provided the technological and manufacturing capabilities to produce the SV 318 personal computer.

The SV 318 computer features, as standard, 32K RAM; 16K is for graphics and 16K is user addressable memory. Memory expansion can be accommodated up to a total of 144K RAM. The 32K ROM is expandable to 96K with a custom extended Microsoft BASIC interpreter built in.

The computer is compactly and stylishly constructed in a console unit with keyboard and TV modulator. The keyboard unit can be linked up with the full range of peripheral options or user devices through the SV 601 Super Expander or adaptor to suit all requirements.

Other features include a Z80A microprocessor with 36 MHz clock, CP/M compatibility, combined cursor/joystick control, easy loading cartridge slot, arcade quality graphics and sound, a seventy-one-key, multi-function keyboard and built-in word processor keys.

With these features and priced at $499 Videoactive claim that the SV 318 offers exceptional value.

The SV 328 personal computer will follow later this year.

More details on the SV 318 are available from **Videoactive Electronics, 70 St Kilda Rd, St Kilda Vic. 3182. (03)537-2000.**

Buggy brings computers to life

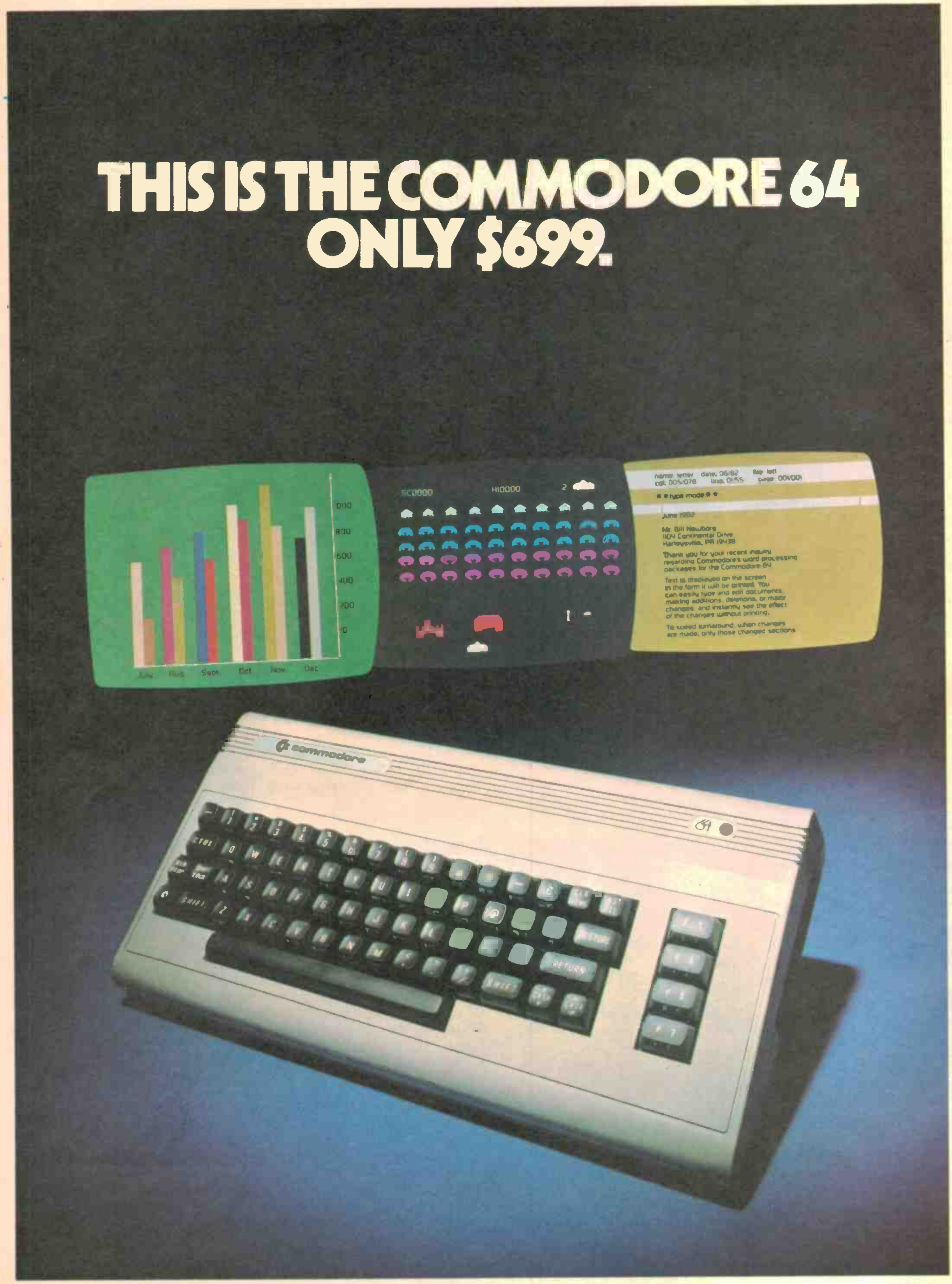
A robotic vehicle, the BBC Buggy, has been designed to provide children and adults with a stimulating and versatile introduction to the world of computer-control technology.

Developed for use with the BBC microcomputer, the 127 mm square vehicle has three wheels driven by two precision stepped motors and is equipped with detectors to feel objects and seek out light sources, together with an infra-red transceiver to read bar codes.

A series of 13 programs are supplied which explore important aspects of microcomputer technology. These include a memory function, line follower, route planner (in which the buggy follows a picture of the route on the computer screen), programs for exploring objects or a given territory, working out the dimensions and transferring them to the screen and a sun-seeker program (which enables it to seek out light sources among a maze of objects). It can also compose music, reading the information from a series of bar-codes.

Though primarily developed for the BBC microcomputer, the manufacturer, Economatics, plans to include an interface with the vehicle so that it can be used with other microcomputers.

For more details contact **Economatics, 4 Orgreave Crescent, Dore House Industrial Estate, Handsworth, Sheffield, United Kingdom.**


THIS IS THE COMMODORE 64
ONLY $699.
commodore

"THE COMMODORE 64 COULD BE THE MICROCOMPUTER INDUSTRY'S OUTSTANDING NEW PRODUCT INTRODUCTION SINCE THE BIRTH OF THIS INDUSTRY."

–SHEARSON/AMERICAN EXPRESS

They're speaking to a group as interested as anyone else in the future of computers: the people who buy stock in the companies that make computers.

If, on the other hand, you're a person whose livelihood depends on a personal computer – or whose leisure time revolves around one – what follows should impress you even more than it impresses investors.

MIGHT MAKES RIGHT.

The value of a computer is determined by what it can do. What it can do is largely determined by its memory.

The Commodore 64's basic RAM is 64K. This amount of power is unusual enough in a micro at any price.

At $699, it is astonishing.

Compared, with the Apple II+,® for instance, the Commodore, 64™ offers 33% more power at considerably less than 50% of the cost.

Compared with anything less, it's even more impressive.

And it can effectively double your computer-equipped work force.

PILE ON THE PERIPHERALS

Because the basic cost of the 64 is so low, you can afford more peripherals for it. Like disk drives, printers or even printer-plotters.

This means you can own the 64, disk drive and printer for a little more than an Apple II+ computer alone.

HARD FACTS ABOUT SOFTWARE

The Commodore 64 will have a broad range of custom software packages including an electronic spreadsheet; business graphics (including printout); a user-definable diary/calendar; word processor; mailing lists, and more.

With BASIC as its primary language, it is also PET BASIC compatible.

The Commodore 64 will also be programmable in USCD PASCAL, PILOT and LOGO.

And, with the added CP/M® option, you will have access to hundreds of exciting software packages.

THE FUN SIDE OF POWER

The Commodore 64 can become very playful at a moment's notice.

You can use Commodore's plug-in game cartridges or invent your own diversions. All will be enhanced by brilliant video quality and high resolution graphics (320 × 200 pixels, 16 available colors, 3D Sprite graphics), plus outstanding sound.

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commodore COMPUTER

Dictionary program

Software Source has signed an agreement with Oasis Systems, California, for exclusive distribution of the powerful new dictionary program, 'The Word Plus'.

Software Source will be providing full technical support for the package which is something new to those who have used a conventional 'spelling checker' package.

The Word Plus is a series of integrated spelling check tools which perform a wide range of spelling check and word analysis functions, including the ability to find incorrectly spelt words in context and to suggest similar words and to actually carry out the spelling correction.

The Word Plus is compatible with nearly all CP/M word-processors and text editors.

For further information contact **Software Source, 344-348 Oxford St, Bondi Junction NSW 2022. (02)389-6388.**

AED Melbourne

Elston Micro has been appointed as Melbourne dealer for the Australian-designed and manufactured AED Universe range of computers.

AED Universe's Super-computer II features a choice of eight- or 16-bit single- or multi-user operating systems, and has full S100 buss compatibility.

For further details, contact **Elston Micro, 53 Waverley Rd, East Malvern Vic 3145. (03) 211-5542.**

Information Technology Week

Information Technology Week, an annual national event aimed at heightening community awareness and understanding of information technologies, is being held in New South Wales from August 7-13.

As part of the activities Sydney's Power House Museum (Mary Ann Street, Ultimo) will stage an exhibition of computers, as well as providing visitors with 'hands-on' computer experience in its new 'computer lab'.

A variety of displays and workshops will be held in shopping centres throughout Sydney, as well as at the Institute of Chartered Accountants, the OTC showrooms in Martin Place and local council chambers and libraries.

Other participating organisations include the Metropolitan Water Board, the Sydney Stock Exchange, the State Government Information Office and various business houses.

For further information contact **Hartley North, Executive Secretary, Information Technology Week, P.O. Box K701, Haymarket NSW 2000. (02) 218-8080.**

Computer games spectacular

Australia's first major computer games exhibition, Electronic and Computer Games and Toys '83, will be staged at the Sydney Entertainment Centre from August 18-21.

Organised by the Industrial Presentations Group of Companies, the exhibition will be open to both the trade and the public; on the mornings of August 18-19 entry will be restricted to the trade.

For more details, contact **Industrial Presentations Australia, 4/389 Victoria Avenue, Chatswood NSW 2067. (02) 412-4124.**

MicroBee games software

M.B. Software is a recently established software house specialising in high quality software for the MicroBee.

Mine Drop is an exciting chase game for the standard 16K MicroBee. The program is written in machine code and is fully interactive. The operator controls the movement of Supertank as it moves around the screen picking up urgently needed supplies.

Supertank is pursued by a homing rocket, Bingle. However, Supertank has a defence. Mine Drop, a mine, can be placed and exploded on command. Bingle is destroyed if it is passing over the mine at the time of detonation.

Mine Drop is available on cassette for $12.95 from **M.B. Software, 248 Brunswick Rd, Brunswick Vic. (03)380-9805** and from MicroBee outlets.

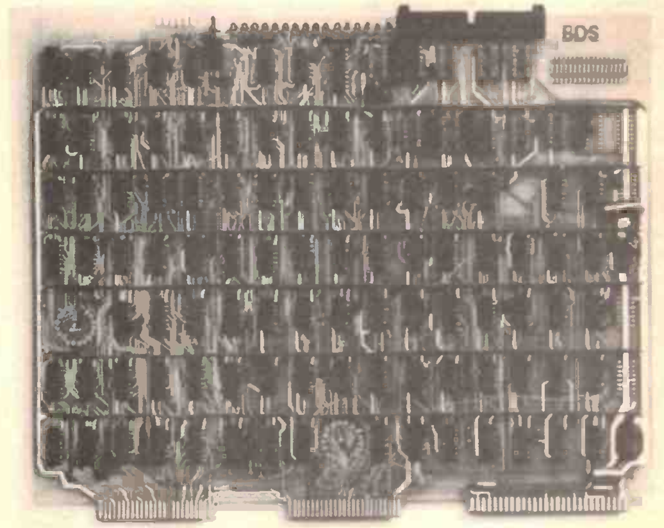
Pineapples are not Apples

Apple Computer has been awarded a preliminary injunction against a Los Angeles distributor of one of the copies of the Apple II personal computer being sold in the US.

Formula International, distributor of the 'Pineapple' computer, has been enjoined from copying or selling any of Apple's copyrighted software programs in the computer's memory circuits or diskettes.

This includes the Autostart ROM, Applesoft, DOS 3.3 and Integer BASIC programs.

In Australia steps are being taken to ensure that further sales of bogus Apple computers are prevented.



High speed printers for HP 3000 series

BDS has introduced a new microprocessor controlled printer system which gives users of HP 3000 series 30/33/40/44/64 computers printing speeds up to 1500 lpm.

The HPC-33L controller includes a Z80 microprocessor and an Intel 8291 talker-listener for interfacing with the HP general purpose interface lines. The printer is daisychained with other peripherals in the standard series 33 fashion.

The unit has three modes of operation, the control, transfer and print modes. It also responds to self test commands which result in remote initiation of internal diagnostics.

Long line drivers, which are standard, allow the printer to be located up to 200 metres from the system.

The range of Dataproducts' band printers, which are supplied in conjunction with the controller, have speeds of 300, 600, 1000 and 1500 lpm.

For further details contact **BDS Computer Australia Pty Ltd, 8th Floor, 445 Toorak Rd, Toorak Vic. 3142. (03)241-8901.**

Plato and the home computer

Plato educational courseware, originally developed by the Control Data Corporation for use in schools through terminals connected to a mainframe computer, will be available later this year on diskette for the Texas Instruments 99/4A home computer.

There are 64 packages, offering mathematics, reading and grammar programs for students in Years Three to Eight, and 44 packages covering mathematics, writing, science, social studies and reading for Years Nine to 12.

The initial Plato package includes an interpreter solid-state cartridge and diskettes containing a survey to help parents or teachers select courseware for individual needs. For those not familiar with the operation of the computer, there is a program designed to teach beginners how to use the TI-99/4A keyboard.

These Plato packages will cost $49.95 each.

To take advantage of the Plato software, TI-99/4A owners will need a Texas Instruments peripheral expansion system, a memory expansion card, a disk memory drive, and a disk controller card.

Also soon to be available for the TI-99/4A home computer are 15 educational software cartridges, featuring mathematics learning exercises for children in the kindergarten to Year Nine age group.

For further information contact **Texas Instruments Australia, 6-10 Talavera Rd, North Ryde NSW 2113. (02) 887-1122.**

Colour video display processor

Texas Instruments has a new video display processor, designed to interface between a microprocessor and a PAL video colour monitor.

The new TMS9929A has four display modes, graphics 1, graphics 2, multicolour and text mode, displaying information in 15 colours. As well, using an advanced planar representation, one can simulate objects in three dimensions.

Low cost 16K-type dynamic memories are used for storage of the display parameters and the TMS9929A does an automatic and transparent refresh of the dynamic RAMs.

A unique graphics feature of the TMS9929A is the special animation patterns called sprites which provide smooth motion and multilevel pattern overlaying. Up to 32 sprites can be displayed on the screen at any one time.

Interfacing to most 8-bit or 16-bit microcomputers is easy, using a minimum number of external components.

The chip is available now for $35 from **Texas Instruments Australia Ltd, 6-10 Talavera Rd, North Ryde NSW 2113. (02)887-1122.**

Supa edit

Supa Edit, by eei is a powerful enhancement to level II BASIC's 'edit' and 'list' commands and is designed to suit the needs of the serious programmer/hobbyist.

It is claimed that Supa Edit will improve programming speed and is suitable for both Tandy TRS-80 and DSE System 80, Model I and Model III, 16K, 32K and 48K tape based systems. A lower case driver is also included for Model I systems.

This machine language program occupies less than 0.5K of user memory, especially important to users of 16K systems, and is simple to operate.

The introductory price, including sales tax, package and posting is $14. Send payment to **Elite Electronic Industries Pty Ltd, 36 Luxmoore St, Cheltenham Vic. 3192. (03) 583-1201.**

Games cartridges for Intellivision and VIC-20

Imagic has released three new games cartridges for the Intellivision system and two for the popular VIC-20.

Dracula, Ice Trek and Tropical Trouble are for the Intellivision. Dracula features the legendary count who prowls the night in search of sustenance, pursued by ravens, wolves and the law. If daylight dawns, he's finished!

Ice Trek makes you the hero fighting your way across icy wastes dodging caribou and snowdrifts. With an ice hook and fire torch you must build and defend an ice bridge.

In Tropical Trouble you are marooned on a swamp-and-volcano-infested island and must rescue the heroine. Plagued by snakes, man-eating clams, hostile gorillas and spitting lava, this game requires co-ordination, quick reflexes and stamina.

Demon Attack and Atlantis are for the VIC-20 — and it doesn't take much imagination to guess what they're like.

Further information can be obtained from Don Dennis, Imagic, P.O. Box 300, Forestville NSW 2087. (02)981-2744.

Apple gains injunction against the Wombat!

Apple Computer has been granted a court order by the Supreme Court of New South Wales, prohibiting a microcomputer dealer from selling microcomputer copies of the Apple computer.

The dealer, Microeducational, of Newcastle (New South Wales), also agreed to pay the court costs involved.

The microcomputers in question, the Golden II and the Wombat, contained substantial parts of the Autostart and Applesoft ROMs, which are Apple Computer's intellectual property.

Commenting on the order, David Strong, general manager of Apple Computer, said, "We are gratified by the Supreme Court order. As a precaution, we recommend that prospective purchasers of personal computers or accessories which might violate copyright laws check first with Apple Computer, or any of our authorised dealers. In some cases, purchasers are often misled by statements such as 'compatability with programs for the Apple'."

High-speed joystick

Discwasher, an American company previously associated with record cleaning accessories, has expanded its product range to cater for the video game and computer accessory market.

Heading the new range is the Pointmaster, a joystick that plugs into Atari and Commodore VIC-20 game centres. It features a high-speed thumb trigger, comfortable handgrip, self-centring mechanism and a 1.5 m cord. It costs about $29.99.

The manufacturer claims the Pointsmaster has a very fast reaction time, enabling the operator to achieve much higher game scores than with a normal joystick.

Also available is a rapid-fire adaptor ($14.99) which allows the joystick to be fired continuously, like a machine gun.

The Discwasher range is handled in Australia by Arena Distributors, 642 Albany Highway, Victoria Park WA 6100. (09) 361-5422.

Sinclair ZX Spectrum software

Gloster Software has new software packages for the Sinclair ZX Spectrum.

Gloster Software has been devoted exclusively to the ZX series, providing original software which is both serious and entertaining.

'Display' handles over 300 user-defined characters on screen at the same time. Display and printing can now employ 64 alphas or numerics per line. Fast and smooth animation in BASIC are also possible. ($14.90)

'Protext' is the text processor that sets up the text for 48K only. Up to six A4 pages per text file can be saved and loaded during program operation. ($24.50)

Gloster Software also provides the means of loading ZX81 saved programs straight into the ZX Spectrum ($14.90).

'Matcalc', the first of the ZX81 series to be upgraded for the ZX Spectrum, is a spreadsheet calculator. ($14.90)

All software is on cassette and can be obtained from **Gloster Software, GPO Box 5460CC, Melbourne Vic. 3001. (03) 232-2398 after business hours.**

The Gospel according to James

James Martin, the computer industry's most widely read author and co-founder of the DMW Group and of Database Design, will host a five-day data-processing seminar in Melbourne from August 1-5.

The program will open with a self-contained one-day senior management seminar on August 1. The fee for the one-day seminar is $340; the full five days cost $1195.

Guest speakers include Dr Vance Gledhill, managing director of Wicat Computer of Australia, and Dr J. C. Mudge of the CSIRO Division of Computing Research.

For further details, contact **Doll Martin Associates, 131 Walker St, North Sydney NSW 2060. (02) 923-2233.**

The Aussie Byte

The Aussie Byte is a new single board computer, totally designed and manufactured in Australia.

It has been designed specifically for the high performance, single and multi-user operating systems such as CP/M 3, MP/M II, CPNET 1.1, TURBODOS etc.

The board incorporates 256K of RAM, four RS-232C serial ports, Z80A CPU at four MHz, DMA, two Winchester hard disk interface ports to suit WD 1001 and Konan controllers, D/D, D/S floppy disk controller (max eight drives), voice synthesiser, video with 24 lines x 80 characters display and high resolution graphics and light pen input etc.

More information about Aussie Byte (The Great Australian Byte) can be obtained from **RDM Computers Pty Ltd, 225 High St, Northcote Vic. 3070. (03)481-0136.**

Club Call

If any DGZ-80 computer owners in Queensland are interested in forming a users' club could you please contact Peter Grimes, 6 Iandra St, Strathpine, Brisbane Qld. 4500. For more information phone (07)205-4597.

The Newcastle Microcomputer Club meets on the second and fourth Monday of each month at 7.30 pm in room G12 of the Physics Building at the University of Newcastle.

The club publishes a monthly newsletter. Members own a variety of microcomputers; the club is not devoted to any particular brand or type of microcomputer.

Anyone interested in further information should contact Angus Bliss on (049)67-2433 bh or Tony Nicholson on (049)52-6017 ah.

Dick Smith's VZ200 personal colour computer

Jamye & Roger Harrison

Since Clive Sinclair dropped his ZX80 and 81 'toy' computers on an unsuspecting and unprepared market, there's been a rush, no — a stampede, to expand the features of personal computers and contract the price. The VZ200 currently sits right at the forefront. What does it offer?

THE VZ200 packs an amazing number of features in such a tiny package: 8K bytes of memory (RAM), 16K Microsoft BASIC in ROM, colour graphics — eight colours in medium resolution and four in higher resolution, programmable sound generator with 2½-octave range and nine different note durations, 45-key moving-key keyboard (with auto-repeating keys), both RF output (to TV antenna input) and direct video (for a monitor), inverse video and on-screen cursor-controlled editing.

The VZ200 measures just 290 mm wide by 163 mm deep by 50 mm high overall. The keyboard is on the sloping front apron and all the attachments plug into the rear. It is powered from a 9 Vdc plugpack. Along the rear apron are the following connectors: dc input socket, cassette recorder jack, monitor output, expansion connector, peripheral connector and TV (RF modulator) output on channel 36 UHF.

The video display only uses about three-quarters of the screen (unlike the picture in the Dick Smith catalogue shows), like many of the colour home computers available. The text format is 32 columns across the screen by 16 lines down. In what they call medium resolution graphics mode you get 64 pixels (blocks) across the screen by 32 down, 128 x 64 (i.e: double) in the 'high resolution' mode.

In the medium resolution mode, you can program a block to be any of eight colours — green, yellow, blue, red, buff, cyan (a blue), magenta or orange. They're what's called the 'foreground' colours. The background (i.e: the rest of the screen area) can be either green or orange in this mode.

In the higher resolution mode, you can program any block (foreground) to be any of only four colours — green, yellow, blue or red — with the background colour green, or with the background buff you can program the blocks to be buff, cyan, magenta or orange.

The programmable sound generator has a range of 31 notes over 2½ octaves from A_2 to $D\#_5$, plus a 'rest'. There are nine programmable note durations of 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1½, 2 and 3.

The text character set comprises 62 of the standard 64-character ASCII table, 5 x 7 dot matrix format. The two you don't get are hardly important in this application. Thirty of the keys on the keyboard have four 'shift' levels — as can be seen from the accompanying pictures. With the exception of the RETURN, SPACE, CTRL and SHIFT keys, the rest have three levels of shift. That is, apart from obtaining the normal character when you press a key, you can get more functions, such as a graphics character, a BASIC command, an operating command or a program statement.

Four keys act as cursor control keys in the CTRL mode, these being the four on the right of the lower rank. The L and ';' keys provide the INSERT and RUBOUT editing functions in the CTRL mode. The colour programming command keys, 1 to 8, are labelled and colour-coded.

The expansion connector will accommodate such things as a memory expansion module. A 16K module is available for just $79, allowing expansion of the user memory to 24K.

The peripheral connector is for plugging in such things as a printer interface, and one is available for $49.50, permitting the attachment of a standard Centronics printer, many models being widely available — and the prices are continually coming down.

The VZ200 is supplied with all cables in generous lengths, a plugpack, a User Manual, a demonstration program on cassette, a BASIC Reference Manual and a booklet of BASIC Applications Programs.

From the user's view

For all the functions packed into the keyboard, the key operation is a big let-down. The keys are rubber-buttoned microswitches and while they do have movement, the feedback via your finger can only be described as uncertain.

We've criticised this type of keyboard in the past and can't help but think that, where a cost compromise is necessary, an elastomeric keyboard (like that on the ZX81) is preferable. The computer gives a 'beep' when you press a key (except for the CTRL, SHIFT and RETURN keys), which helps, but the key action is so light that double-keying is common. The auto-repeat feature, however, is a good idea. The key will repeat the character or command if you hold it down for longer than one second.

The on-screen editing functions are very good — a real boon to the beginner programmer. The usual BASIC editing feature of simply retyping a crook line works, but that can be time-consuming, especially with long lines. The VZ200 allows you to move the cursor around and re-type incorrectly entered characters, commands or statements. With the latter two, the single-key entry feature is a real time-saver. We would rate the editing facilities as one of the VZ200's major features.

The keyboard has an enlarged SPACE key at the right of the lower rank. This is a problem if you're used to a normal typewriter-style keyboard as you keep cracking your finger on the case below the keyboard! It takes a little getting used to. We also took a little time to learn not to confuse the SHIFT and CTRL keys. There are other problems with the keyboard that relate to its partly non-standard layout, but if you're a beginner in the personal computer stakes it's unlikely to be a worry.

The single-key entering of statements and commands was an idea introduced by Clive Sinclair with his ZX80, forerunner to the ZX81 and Spectrum computers. It's a good idea, taken to its logical limit with the VZ200. Strictly, you need to use more than one key to enter a command, statement or graphics character, but only three at the most; e.g: to get the PRINT command you push CTRL and P together. To get the command or statement under a key, you hold down CTRL and press RETURN, then the key you want.

The direct video output into a Philips 20" colour monitor is good, but plagued by patterning that ripples seemingly diagonally across the display. The display is noticeably inferior when using the RF output into the TV set's antenna. However, it is better than some other popular colour computers around. For the price, it's acceptable.

The VZ200 uses a Z80 microprocessor, probably the most widely used microprocessor in all the personal computers produced to date. The specifications say it runs at 3.58 MHz. However, it's not all that fast, but is probably quite fast enough to manipulate simple graphics effectively.

If you really want to know, a FOR-NEXT loop takes four milliseconds, which in today's computer world is pretty slow. As it really is a beginners' machine, that's no real disadvantage. If you're thinking of ploughing through your maths homework with it, a pocket scientific calculator is faster. ▶

Continued on page 37

The military coup

# of Lieutenant Wilson. Aged 20.

When you talk to Geoff Wilson about his 18 months in the Army you can't help but feel he's a young man who's come a long way in a short time.

Already he's graduated from Officer Cadet School, Portsea, with a commission as a Lieutenant. And already he commands an Infantry Platoon of thirty men.

It's a tremendous responsibility. Especially for a 20 year old. But as Geoff says, "You get enormous satisfaction from using what you've learnt in your training to help bring out the best in your team. And in achieving results together."

"Obviously situations which I haven't had experience in crop up all the time. And that's when I have a real responsibility to myself and my men to make decisions based on sound knowledge rather than guesswork. As a result you constantly find yourself learning and mastering new skills. And that's a challenge I always enjoy accepting. You really begin to realise your full potential and believe in your ability."

"I suppose you might say my decision to take on a career as an Army Officer is my personal 'military coup'."

"It's hard to visualise another career as exhilarating, varied and satisfying. Or which provides as many opportunities to be recognised and rewarded for a job well done."

"Think about it carefully. I know I did before joining!"

Armour, Artillery, Engineering, Survey, Signals, Transport, Infantry, Intelligence and Aviation are just some of the fields open for you to enter.

If you're aged between 18½ and 23 on entry (or up to 25 with a degree or diploma), have your HSC or equivalent, (at a level acceptable to the Army), and think you have what it takes to pull-off your own military coup, contact your nearest Army Careers Recruiting Centre or fill in the supplied coupon.

There are two courses per year. Applications close mid-March for a July entry and early August for a January entry.

For more information post coupon to GPO Box XYZ, Sydney 212 1011, Newcastle 2 5476, Wollongong 28 6492, Albury 55 2248, Lismore 21 6111, Canberra 82 2333, Melbourne 61 3731, Geelong 21 1588, Bendigo 43 8008, Ballarat 31 1240, Brisbane 226 2626, Townsville 72 4566, Adelaide 212 1455, Perth 325 6222, Hobart 34 7077, Launceston 31 1005.

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Medfly is a thinking machine to expand young minds; a working machine for home or business accounting; a games machine for family fun. And above all, Medfly is a value machine, with quality electronics by Siemens and with more features, capabilities and add-on potential than many costlier microcomputers.

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2/190 George Street, PARRAMATTA. PH: (02) 689 2599

SUMMARY OF BASIC COMMANDS

Functions:

1) Arithmetic operators

+, −, *, /, ↑

2) Relational operators

>, <, =, > =, < =, <>

3) Arithmetic functions:

SQR – Square root
INT – Integer part
RND – Random number
ABS – Absolute magnitude
SGN – Sign
COS – Cosine
SIN – Sine
EXP – e^x
TAN – Tangent
LOG – Natural logarithm
ATN – Arc tangent

4) String functions:

LEN – Length
STRS – String of numeric argument
VAL – Numeric value of string
ASC – ASCII value
CHRS – Character
LEFTS – Left characters
MIOS – Middle characters
RIGHTS – Right characters
INKEYS – Check keyboard

5) Logical operators

AND
OR
NOT

Relation and logical expressions have value 1 if true, 0 if false.

6) Graphics and sound functions:

CLS – Clear screen
SET – Plot a point
RESET – Clear a point
POINT – Return the color code
COLOR – Set color
SOUND – Produce tone of different frequency and duration
MOOE – Select graphic or text

7) Program statements

OIM – Olmensions
STOP
END
GOTO
GOSUB
RETURN
FOR . . . TO . . . STEP
NEXT
REM
IF . . . THEN . . . ELSE
INPUT
PRINT
PRINT TAB
PRINT USING
PRINT @
LET
DATA
READ
RESTORE

8) Commands:

LIST
RUN
NEW
CONT
VERIFY – Check whether program on tape and memory are equal
CLOAD – Load program on tape
CSAVE – Save program on tape
CRUN – Load program on tape and run
CTRL RESET – To halt program

9) Other Statements

PEEK – Return the value stored at the location specified
POKE – Load a value into a specified location
LPRINT – Print on line printer
LLIST – List on line printer
INP – Return the contents read from ports
OUT – Send values to ports
COPY – Copy the content on screen to printer
USR – Call the user's assembly language subroutine

Documentation

The BASIC Reference Manual and the two booklets supplied with the VZ200 are generally well produced, clear and understandable — which is just what the raw beginner wants.

The BASIC Reference Manual is spiral bound, which facilitates laying it open so the pages sit flat. However, the spiral binding is just slightly too small for the number of pages and it's a bit of a bind trying to turn them.

This manual covers all the functions and operations of the VZ200 in a fundamental way, with some programming examples. You are encouraged to learn by trying things for yourself. We found a number of small errors, but nothing disastrous.

For example, the method of using the INSERT command when editing does not work the way it's described in the book. Say you typed PRIT instead of PRINT. The book says you do an INSERT by moving the cursor up to the character *before* the place you want to insert a character (that is, 'I' here), type CTRL INSERT, then type the required character (that is, 'N' here). However, that gives you PRNIT!

What you really have to do is cursor up to the character *after* the place where you need to insert a character, then do the insert routine.

The reference manual lists all the available text characters and BASIC statements, operators and commands, with some brief explanations. An error message list is given, but incredibly, no explanation of what they all mean or what to do when you get one! Grrr.

For all its good points, the manual contains no *detailed* index, which would be very useful for a beginner. The contents list is at least comprehensive, so that's a plus in its favour.

What happens when you've worked your way through the reference manual? Well, you won't be a hot-shot programmer, but you will have gained an understanding of programming and be able to tackle some programs of your own invention, plus modifications to published software.

As Microsoft BASIC is used — the erstwhile 'industry standard' — there are huge amounts of published programs and many, many books on the subject that will keep you occupied for ages.

A booklet of applications programs is included with several dozen short programs that are not only interesting and amusing, but instructive and perhaps useful to boot. Many would be good 'starting points' for developing programs of your own devising or useful as subroutines within your own programs.

Absolutely no technical details, not even a memory map, are given, but we guess that such things might appear in some 'support' publications.

The BASIC

The 16K Microsoft BASIC included can only be described as excellent — outshining the mechanical and electronic constraints of the VZ200. But, we have to keep reminding ourselves that this is really a low cost beginners' machine. The range of commands, etc, available, and the flexibility of the language, stand out. Learning to use the facilities is a breeze. The buzzword is 'user friendly'!

All the BASIC commands, operators and statements are shown in the accompanying panel. Those of you who know will see that it's all pretty standard fare. However, it's good to see the inclusion of such things as IF . . . THEN . . . ELSE statements and the COPY statement (otherwise known as a 'screen dump'). Seeing that USR is included for the benefit of using machine code in BASIC programs, we can only hope that some suitable books or manuals on the subject, specifically for the VZ200, will appear at some later date.

Programming using graphics or sound is relatively simple. The graphics commands are simple, largely because of the 'chunky' graphics employed. You'll find no DRAW, PAINT, LINE or CIRCLE commands here, but what you do get is effective for the sort of graphics included in the machine. It's best to crawl before you walk, and it's a beginners' machine, remember. Similar sentiments apply to the sound programming.

Cassette comments

A pre-recorded cassette with cute demonstration software comes with the VZ200. For one thing, it shows that the cassette interface is quite good, as reliable loading was no problem.

As the VZ200 is not a games/computer machine, the pre-recorded software base is only going to be available on cassette, as there's no ROM socket. At present, there's no pre-recorded software available, but, from past experience, that's probably a situation that will rectify itself.

There are lots of 'freelance' software producers in the market supplying software for existing machines who will doubtless get behind the VZ200.

Conclusion

The VZ200 is very reminiscent of the Sinclair ZX81/Spectrum or National JR100 (which is sort of rare here, as yet). It has a very great deal to offer in price, functions and features. The major disappointment is the keyboard, but all low cost home computers compromise here and it's a matter of preference whether you favour one type of cheap keyboard over another.

The big question is, would you do any better at $299. You'd almost certainly get a better keyboard, but we haven't yet seen anything in that price range to compete with the features and memory capacity of the VZ200.

Judging from the phenomenal success and popularity of other 'bottom end of the market' computers, such as the ZX81, Spectrum and VIC-20, there are huge numbers of people who want a low cost computer just to 'get started', or get their children started, in computing.

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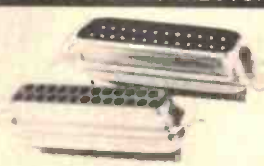

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Machine language graphic driver for the ETI-640/ETI-685

Part 2

In the first part we whetted your appetite telling you what was in the graphic driver package. Now you've read (almost) all about it, here's the real thing! . . . from two of the 'slacker hackers'.

G.H. Secomb J.F. Adamthwaite

Rectangle function

This routine draws a rectangle, using the two pairs of user-supplied coordinates as opposite corners. Conceptually quite straightforward, it constructs the coordinates for the other two corners from combinations of the supplied coordinates, and plots a line from corner to corner until the full rectangle is drawn, using the appropriate pixel plotting mode of SET, CLEAR or INVERT.

The requirements for the rectangle functions were:

1. Double plotting of the corner pixels must not occur. Each corner is the end point of one line and the start point of the next. Double plotting during the INVERT RECTANGLE function would leave the corners as they were, effectively remaining unplotted. To get around this, each line must be shortened by one point (see diagram below).
2. The user must be able to specify any of the diagonally opposing coordinates, as for the window function, and achieve the same rectangle on the screen.

X1,Y2 X2,Y2
X1,Y1 X2,Y1

(X1,Y1)(X2,Y2)
(X1,Y2)(X2,Y1)
(X2,Y1)(X1,Y2)
(X2,Y2)(X1,Y2)

These combinations should all give the same results. Don't call us if they don't.

The line shortening and flexible coordinate specification capability are shown in the algorithm below.

Ellipse function

The brain-strain required to come up with a useful ellipse plotting routine caused nearly as many hairs to desert their post as did the LINE routine. Several techniques were tried before the final one was selected. They were:

1. Calculating sine and cosine for progressively increasing angles from 0 through to 359 degrees. This approach proved to be slow and took too much code. (Machine language trig. is a pain.)
2. Using look-up tables for sines and cosines. This was fast, but required a large look-up table, even when using a single 90 degree quadrant table backwards and forwards to create the sines and cosines for each of the four quadrants.
3. Using coarse angle increment look-up tables with interconnecting lines to fill the gaps.

This seems to be the method employed in the TRS-80 colour computer, although we are not sure of that. It was fast, but the code required to avoid double plotting at the line junctions proved to be too cumbersome. This method requires greater resolution than is possible on the ETI-640, in order to look convincing.

4. Using a version of the Variable Duty-Cycle Algorithm.

This method held promise of being the fastest of all, but it suffered from a precision problem due to the use of integer arithmetic, resulting in a noticeable distortion of the circle. It also didn't seem to know when to stop. We only wanted one lap.

Finally, a chance encounter with two bright young lads (these kids make us oldies feel so stupid) at an establishment known as 'Comp-Soft' in Swan Street in Richmond, brought to light a workable solution. I will be forever grateful to the proprietor for allowing me to waste his time and that of his workers. It saved us from needing to weave baskets.

The method has its roots in calculus. Don't cringe, we've already done it for you. It is quite novel in the method it uses to create the sine and cosine values. An explanation follows:

Looking at a sine curve or trig. table book, you will notice that at 0 degrees, sine = 0, rising rapidly with increasing angles at first, then progressively slowing in its ascent till 90 degrees is reached where the sine value is momentarily stationary, with a maximum value of +1.

The 'secret' is in deriving a progressively decreasing value from somewhere to be added to the old sine to create the new one. Where can we get such a decreasing value from?

The answer is . . . trumpet fan-fare . . . *the cosine!* ▶

```
* RECTANGLE FUNCTION
* Input parameters are- (X1,Y1) coords of any corner
*                       (X2,Y2) coords of opposite corner

  IF X2 ) X1 THEN XINCREMENT = +1.
  IF X2 = X1 THEN XINCREMENT =  0.
  IF X2 ( X1 THEN XINCREMENT = -1.

  IF Y2 ) Y1 THEN YINCREMENT = +1.
  IF Y2 = Y1 THEN YINCREMENT =  0.
  IF Y2 ( Y1 THEN YINCREMENT = -1.

  SET Y = Y1
  FOR X = X1 TO (X2-XINCREMENT) STEP XINCREMENT
    PLOT(X,Y)
  NEXT X

  SET X = X2
  FOR Y = Y1 TO (Y2-YINCREMENT) STEP YINCREMENT
    PLOT(X,Y)
  NEXT Y

  SET Y = Y2
  FOR X = X2 TO (X1+XINCREMENT) STEP (-XINCREMENT)
    PLOT(X,Y)
  NEXT X

  SET X = X2
  FOR Y = Y2 TO (Y1+YINCREMENT) STEP (-YINCREMENT)
    PLOT(X,Y)
  NEXT Y
  END.
```

Going back to our trig. table again it will be found that the cosine has a maximum value of +1.0 at 0 degrees, progressively decreasing towards a value of zero as 90 degrees is approached. If a small portion of the current cosine value is added to the current sine value, it will yield the *new* sine value.

Fine. So where do we get the new cosine value from?

Notice that the *amount* by which the cosine decreases is progressively increasing as 90 degrees is approached. (Yes, it is a mouthful.) In other words, an increasing value is being subtracted from the cosine at each step. Where can we find a number which just happens to be increasing?

The source of a suitable increasing value is found to be the sine (surprise, surprise).

We therefore take a small portion of the sine value and subtract it from the old cosine to give the new cosine value.

The pleasant feature of this approach is that the method follows through into the second, third and fourth quadrants without the need for any further trickery.

Further subtractions from the cosine value after 90 degrees is reached make it swing negative, and further additions of a portion of this negative cosine to the sine value make the sine start dropping from +1 towards zero, and so on. In this way, the values of the sine and cosine leap-frog right around the circle, eliminating the need for traditional calculations based on a known angle. The information required for the next point is extracted from the previous point values. Wake up!

Before tackling the final algorithm chosen for circle and ellipse plotting, a simplified version will be examined. This version is a 'stripped' example of the 'bells and whistles' model. It has the advantage of significantly greater speed due to the lack of multiplication operations, sacrificing the ability to draw ellipses. If only circles were needed, and speed was vital for a particular application, it could be used in place of, or better still, in addition to the ellipse function.

It is slightly different to the previous description in that the variables SINE and COSINE, instead of containing values varying between +1 and −1, contain values varying between +RADIUS and −RADIUS. The concept is the same, just the magnitude of the variables has been changed to gain speed.

You will notice spontaneously, if nudged, that the divisions can be done in machine language as simple right shifts, as long as the divisor, in this case PORTION, is a simple power of 2. e.g: 32, 64, 128 etc.

Increasing values for PORTION give more plotted points along the perimeter of the circle, allowing circles of larger radius to be plotted without gaps. This also causes the values of SINE and COSINE to be altered in smaller increments, more closely approximating a true differentiation function, resulting in a rounder circle at the same time. Very helpful if circles are round, it is. Saves overworking your imagination. Sadly, you must sacrifice speed if you want large circles or high precision. Try experimenting.

The final value of PORTION chosen for the machine language version is 128 (2 to the power of 7). This allows circles with a radius of up to approximately 140 to be plotted without gaps. (That's huge.) If your application doesn't require such large arcs, a doubling of speed can be obtained by selecting a value for PORTION of 64. A value of 32 would further double the speed but the maximum radius of 35 (now) is starting to become restrictive, and the circle gets a little slanted to one side.

There is no correct value, merely values of greater or lesser convenience.

We chose a value of 128 to keep the precision high. It gives the maximum usable precision for the ETI-640 and could be regarded as the practical upper limit here. At a radius of 140, the circle has a diameter of 280 and wraps around the screen due to byte overflow. It is a simple matter to alter the precision if desired.

The final algorithm presented now is identical to the machine code version. The penalty for ellipse plotting capability is the need for two multiply operations per loop, which slows it considerably. Unfortunately we must do true multiplies, not just left shifts.

In this version 'correct' values for sine and cosine are kept in the variables SINE and COSINE with values between +1 and −1. These values are multiplied by the vertical and horizontal radius and added to the ellipse centre coordinates to give the final plot point coordinates. Remember, this happens some 804 times per circle if PORTION is set at 128.

A comparison to the previously plotted point is performed to ensure freedom from double plotting. Some twiddling to the loop counter eased testing for the exit condition.

```
* ELLIPSE FUNCTION
* Input variables are - XCENTRE      X coord of ellipse centre
*                     - YCENTRE      Y coord of ellipse centre
*                     - HRADIUS      Horizontal radius
*                     - VRADIUS      Vertical radius

LET SINE = 0.
LET COSINE = 1.0
LET PORTION = 128

LET XPLOT = XCENTRE + HRADIUS              (Plot first point)
LET YPLOT = YCENTRE
PLOT(XPLOT, YPLOT)

FOR COUNTER = 0 TO 3.14159 STEP 1/256

  SINE = SINE + COSINE/PORTION
  COSINE = COSINE - SINE/PORTION

  NEWXPLOT = INTEGER (COSINE * HRADIUS + XCENTRE + 0.5)
  NEWYPLOT = INTEGER ( SINE  * VRADIUS + YCENTRE + 0.5)

  IF NEWXPLOT = XPLOT
     AND IF NEWYPLOT = YPLOT
        THEN GOTO NEXT-COUNTER     (Same as last, skip plot)

  XPLOT = NEWXPLOT
  YPLOT = NEWYPLOT
  PLOT(XPLOT, YPLOT)
NEXT COUNTER
END.
```

```
* CIRCLE GENERATOR ALGORITHM
* Input variables are - XCENTRE   X coord of circle centre
*                     - YCENTRE   Y coord of circle centre
*                     - RADIUS    Desired circle radius

  LET SINE = 0.
  LET COSINE = RADIUS
  LET PORTION = 128              (Speed/accuracy trade-off value)

  LET XPLOT = XCENTRE + RADIUS
  LET YPLOT = YCENTRE
  PLOT(XPLOT, YPLOT)                  (Plot first point on circle)

  FOR COUNTER = 1 TO 804.2477         ( = 2 * PI * PORTION )

    SINE = SINE + COSINE/PORTION                  (Calc new sine)
    COSINE = COSINE - SINE/PORTION              (Calc new cosine)

    XPLOT = INTEGER (XCENTRE + COSINE + 0.5)      (Round result)
    YPLOT = INTEGER (YCENTRE +   SINE + 0.5)

    PLOT(XPLOT, YPLOT)
                                                  (and plot it)
  NEXT COUNTER
  END.                                          (Back for more?)
```

Software interfacing

The program was designed to make interfacing as easy as possible (we hate phone calls) while allowing for future expansion in the number of supported functions, or changes in the number of parameters passed to it.

The only absolute address you need to remember is the subroutine entry point 'ENTRY' at hex 6400. All the parameters which need to be communicated to or from the program are stored in a 6-byte table starting at 'ENTRY+3', hex 6403 through to 6408, inclusive. The number of parameters required to be passed depends on the desired function. See tables opposite.

Speculation

This package is by no means complete, and it can never be so, due to the diversity of requirements in different applications. It is

ADDRESS HEX	DECIMAL	LABEL	USE
6400	25600	ENTRY	Enter here after storing parameters.
6403	25603	FUNCTION	Graphic op-code store.
6404	25604	PARAM1	Parameter list.
6405	25605	PARAM2	" "
6406	25606	PARAM3	" "
6407	25607	PARAM4	" "
6408	25608	BITVALUE	Result of "BIT TEST" funtion call.

FUNCTION	PARAMS REQ'D	PARAMETER DESCRIPTION
0 SET WINDOW	1,2,3,4	- Parameters 1 & 2 define one corner of the desired area.
1 CLR WINDOW	1,2,3,4	- Params 3 & 4 define the diagonally opposite corner.
2 INV WINDOW	1,2,3,4	- As above.
3 PROT SCRN	1	- Parameter 1 is the number of text lines to be protected from scrolling.
4 SET PIXEL	1,2	- Parameter 1 is the X coordinate.
5 CLR PIXEL	1,2	- Parameter 2 is the Y coordinate.
6 INV PIXEL	1,2	- As above.
7 TST PIXEL	1,2	- Pixel status returned in location "BITVAL".
8 SET LINE	1,2,3,4	- Parameters 1 & 2 define the start point of the line.
9 CLR LINE	1,2,3,4	- Parameters 3 & 4 define the end.
10 INV LINE	1,2,3,4	- As above.
11 N.U.		
12 SET RECTNGL	1,2,3,4	- Same parameter definitions as the WINDOW functions.
13 CLR RECTNGL	1,2,3,4	- As above.
14 INV RECTNGL	1,2,3,4	
15 N.U.		
16 SET ELLIPSE	1,2,3,4	- Params 1 & 2 define the X & Y coords of the centre of the ellipse.
17 CLR ELLIPSE	1,2,3,4	- Param 3 is the horizontal radius.
18 INV ELLIPSE	1,2,3,4	- Param 4 is the vertical radius.
19 N.U.		

designed to be easily extendable and as fast as possible. Computer graphics can never be too fast.

If you have a different memory-mapped VDU, don't despair, as only the subroutine 'CONVRT' need be changed to perform the required coordinate translation. If your VDU has a greater coordinate addressing range, the use of 16-bit arithmetic will be necessary. Those of you with Z80/ETI-640 combinations are invited to try your hand at rewriting this program.

Hardware tricks to consider are pre-programmed ROMs on I/O ports to speed up coordinate-to-address conversion or for use as look-up tables for trig. or multiply/divide functions.

We chose not to do this here, as it was judged to be out of the range of the average part-time hobbyist.

The user should try to adapt and use the program according to the application needs. It works quite well as a Napoleon hat or a fleet of paper darts.

Reader application examples are invited, as we are burnt out. We are currently threatening upgrades to the program such as macro function capability, relative coordinate addressing and string processing functions. These will most likely be added as a 'front-end' program, which preprocesses the extended functions and feeds the derived parameters to this one.

A 6809 (wot's dat) version is currently in the pipeline, and if this article makes us rich and famous, it may get some airplay as well. ▶

EXERCISE PROGRAM — 640/685 graphic driver

```
1000 REM       ****** GRFXTEST.BAS ******
1010 GOSUB 9980 : GOTO 1200
1020 REM Sample POINT operation driver.
1030 POKE(F7,F)                REM Set function 4,5,6,7
1040 POKE(X6,X) : POKE(Y6,Y) REM Set POINT coords
1050 CALL(G7)                  REM Plot it
1060 RETURN
1070 REM Sample LINE & RECTANGLE driver
1080 POKE(F7,F)                REM Function 0,1,2 8,9,10 12,13,14
1090 POKE(X6,X1):POKE(Y6,Y1) REM Set start coords
1100 POKE(X7,X2):POKE(Y7,Y2) REM Set end coords
1110 CALL(G7)                  REM Draw it
1120 RETURN
1130 REM Sample ELLIPSE driver
1140 POKE(F7,F)                REM Set function 16,17,18
1150 POKE(X6,X) : POKE(Y6,Y) REM Ellipse position
1160 POKE(X7,W) : POKE(Y7,H) REM Ellipse dimensions
1170 CALL(G7)                  REM Draw it
1180 RETURN
1200 PRINT "           ******* GRFXTEST.BAS *******" : PRINT
1210 PRINT "                 SAMPLE GRFXPAK DRIVER" : PRINT
1220 PRINT "    Lines 1020-1180 give examples of how to pass"
1230 PRINT "    parameters to the graphic driver package."
1240 PRINT "    Normally, the function calls would be placed"
1250 PRINT "    'in-line' in a program to increase speed."
1260 FOR I=1 TO 4 : PRINT : NEXT I
1300 REM Rotating screen clear using 'CLEAR LINE' function.
1310 F=9 : X1=0 : Y1=0 : X2=127 : FOR Y2=0 TO 63
1320 GOSUB 1080
1330 NEXT Y2
1340 F=9 : X1=0 : Y1=0 : Y2=63 : FOR X2=126 TO 0 STEP -1
1350 GOSUB 1080
1360 NEXT X2
1380 REM Set alternate Horiz. lines from top to bottom.
1390 F=8 : X1=0 : X2=127 : FOR Y1=63 TO 0 STEP -2
1400 Y2=Y1 : GOSUB 1080
1410 NEXT Y1
1420 REM INVERT alternate vert. lines from right to left.
1430 F=10 : Y1=0 : Y2=63 : FOR X1=127 TO 0 STEP -2
1440 X2=X1 : GOSUB 1080
1450 NEXT X1
1460 FOR D=1 TO 500 : NEXT D
1480 REM Clear screen
1490 POKE(F7,3) : POKE(X6,0) : CALL(G7)
1510 REM Random horizontal & vertical lines.
1520 REM Do 1 horiz. & 1 vert. line per loop.
1530 F=10
1540 FOR I=1 TO 40
1550 X1=INT(RND(0)*128)
1560 Y1=INT(RND(0)*64)
1570 X2=INT(RND(0)*128)
1580 Y2=Y1
1590 GOSUB 1080
1600 X1=INT(RND(0)*128)
1610 Y1=INT(RND(0)*64)
1620 X2=X1
1630 Y2=INT(RND(0)*64)
1640 GOSUB 1080
1650 NEXT I
1660 FOR D=1 TO 500 : NEXT D
1680 REM Invert state of entire screen twice
1690 F=2
1700 X1=0 : Y1=0 : X2=127 : Y2=63
1710 GOSUB 1080
1720 FOR D=1 TO 500 : NEXT D
1740 X1=127 : Y1=63 : X2=0 : Y2=0
1750 GOSUB 1080
1790 REM Sceen clear, rotating from top corner.
1800 F=9 : X1=127 : Y1=63 : Y2=0 : FOR X2=127 TO 0 STEP -1
1810 GOSUB 1080
1820 NEXT X2
1830 F=9 : X1=127 : Y1=63 : X2=0 : FOR Y2=1 TO 63
1840 GOSUB 1080
1850 NEXT Y2
1880 REM Random angled lines, joined end-to-end.
1890 F=8
1900 FOR I=1 TO 4
1910  FOR L=1 TO 3
1920   X1=X2 : Y1=Y2
1930   X2=INT(RND(0)*128)
1940   Y2=INT(RND(0)*64)
1950   GOSUB 1080
1960  NEXT L
1970  FOR D=1 TO 500 : NEXT D
1980 NEXT I
2000 FOR D=1 TO 500 : NEXT D
2020 REM Clear screen, 0 lines protected
2030 POKE(F7,3) : POKE(X6,0) : CALL(G7)
2050 PRINT "      This may be a good opportunity to adjust"
2060 PRINT "      the vertical height and linearity of your"
2070 PRINT "      monitor screen to give a ROUND circle."
2080 FOR I=1 TO 6 : PRINT : NEXT I
2110 REM Draw concentric circles about centre of screen
2120 F=16 : X=64 : Y=32
2140 FOR C=0 TO 11
2150  W=C*5 : H=W
2160  GOSUB 1140
2170  NEXT C
2200 REM Draw another circle to produce Moire fringe
2210 X=46
2220 FOR C=0 TO 15
2230  W=C*5 : H=W
2240  GOSUB 1140
2250 NEXT C
2280 REM Clear screen
2290 POKE(F7,3) : POKE(X6,0) : CALL(G7)
2310 REM Draw random Ellipses.
2320 F=16
2330 FOR I=1 TO 3
2340  FOR C=1 TO 10
2350   X=INT(RND(0)*128)
2360   Y=INT(RND(0)*64)
2370   W=INT(RND(0)*100)
2380   H=INT(RND(0)*85)
2390   GOSUB 1140
2400  NEXT C
2410  FOR D=1 TO 500 : NEXT D
2420  POKE(F7,3) : POKE(X6,0) : CALL(G7)
2430 NEXT I
2450 REM Use 'INVERT LINE' function to create Moire Fringe.
2460 F=10
2470 FOR I=1 TO 2
2480  X1=0 : Y1=0 : X2=127
2490  FOR Y2=0 TO 63
2500   GOSUB 1080
2510  NEXT Y2
2520  X1=0 : Y1=0 : Y2=63
2530  FOR X2=126 TO 0 STEP -1
2540   GOSUB 1080
2550  NEXT X2
2560  X1=0 : Y1=63 : Y2=0
2570  FOR X2=0 TO 127
2580   GOSUB 1080
2590  NEXT X2
2600  X1=0 : Y1=63 : X2=127
2610  FOR Y2=1 TO 63
2620   GOSUB 1080
2630  NEXT Y2
2640 NEXT I
2660 REM Draw random rectangles using 'INVERT RECTANGLE'
2670 F=14
2680 FOR I=1 TO 3
2690  FOR R=1 TO 10
2700   X1=INT(RND(0)*128)
2710   Y1=INT(RND(0)*64)
2720   X2=INT(RND(0)*128)
2730   Y2=INT(RND(0)*64)
2740   GOSUB 1080
2750  NEXT R
2760  FOR D=1 TO 500 : NEXT D
2770  POKE(F7,3) : POKE(X6,0) : CALL(G7)
2780 NEXT I
2800 REM Use 'INVERT WINDOW' function to draw random blocks.
2810 F=2
2820 FOR I=1 TO 4
2830  POKE(F7,3) : POKE(X6,0) : CALL(G7)
2840  FOR R=1 TO 8
2850   X1=INT(RND(0)*128)
2860   Y1=INT(RND(0)*64)
2870   X2=INT(RND(0)*128)
2880   Y2=INT(RND(0)*64)
2890   GOSUB 1080
2900  NEXT R
2910  FOR D=1 TO 500 : NEXT D
2920 NEXT I
2940 REM Invert whole screen with 'INV WINDOW' function.
2950 F=2
2960 X1=0 : Y1=0 : X2=127 : Y2=63
2970 GOSUB 1080
2980 FOR D=1 TO 500 : NEXT D
2990 X1=127 : Y1=63 : X2=0 : Y2=0
3000 GOSUB 1080
3010 FOR D=1 TO 500 : NEXT D
3020 REM
3030 FOR I=1 TO 6 : PRINT : NEXT I
3040 PRINT "               RANDOM POINT TEST"
3050 PRINT " This would be a good time to make a cup of tea."
3060 PRINT
3070 PRINT " The display will show any pattern sensitivity in"
3080 PRINT " your BASIC random number generator function, if"
3090 PRINT " left running for several minutes."
3100 PRINT
3110 PRINT " This is the last example. It is a 'near-infinite'"
3120 PRINT " loop.  Press 'BREAK' when you wish to stop."
3130 PRINT : PRINT
3140 FOR D=1 TO 1000 : NEXT D
3160 REM Avoid subroutines here to gain speed.
3170 POKE(F7,4)
3180 FOR I=1 TO 1E4
3190  POKE(X6,INT(RND(0)*128))
3200  POKE(Y6,INT(RND(0)*64))
3210  CALL(G7)
3220 NEXT I
3240 PRINT : PRINT "      My, we are patient, aren't we."
3250 END
3260 REM
9980 REM Standard GRFXPAK Parameter Definition Module
9981 G7=25600    REM grfxpak s/r entry address
9982 F7=G7 + 3   REM grfx function code store
9983 X6=F7 + 1   REM X1 co-ordinate store
9984 Y6=X6 + 1   REM Y1    "       "
9985 X7=Y6 + 1   REM X2    "       "
9986 Y7=X7 + 1   REM Y2    "       "
9987 T7=Y7 + 1   REM pixel test result store
9988 REM Clear screen (text mode), protect 0 lines
9989 POKE(F7,3) : POKE(X6,0) : CALL(G7) : RETURN
9990 REM  0. SET WINDOW (4) PARAMS   10. INVERT LINE    (4)
9991 REM  1. CLEAR "    (4)          11. -
9992 REM  2. INVERT "   (4)          12. SET RECTANGLE  (4)
9993 REM  3. PROT/CLEAR (1)          13. CLEAR "        (4)
9994 REM  4. SET POINT  (2)          14. INVERT "       (4)
9995 REM  5. CLEAR "    (2)          15. -
9996 REM  6. INVERT "   (2)          16. SET ELLIPSE    (4)
9997 REM  7. TEST "     (2)          17. CLEAR "        (4)
9998 REM  8. SET LINE   (4)          18. INVERT "       (4)
9999 REM  9. CLEAR "    (4)          19. -
```

SOURCE LISTING — 640/685 graphic driver

GRFXPAK

```
             :* PERFORMS ONE OF SEVERAL GRFX OPERATIONS.
             :*
             :* THE ACTUAL OP. PERFORMED IS SELECTED BY A CODE BYTE
             :* POKED INTO LOCATION "FUNCTN" BY THE CALLING PROGRAM.
             :*
             :* FUNCTIONS--
             :*
             :* GENERAL SCREEN OPERATIONS--
             :* 00.  SET WINDOW WITH OPP. CORNERS (X1,Y1) & (X2,Y2)
             :* 01.  CLEAR WINDOW
             :* 02.  INVERT WINDOW
             :* 03.  SCROLL PROT. (X1) LINES, CLR SCREEN TO TEXT MODE
             :*
             :* SINGLE POINT OPS--
             :* 04.  SET (TURN ON) SCREEN POINT @ X1,Y1
             :* 05.  CLEAR (TURN OFF) "     "
             :* 06.  INVERT (REVERSE) "     "
             :* 07.  TEST STATE OF SCRN POINT (X1,Y1) AND LEAVE A 00
             :*      (IF BIT OFF) OR "FF" VALUE AT LOC. "BITVAL".
             :*
             :* LINE OPS--
             :* 08.  DRAW (SET) A LINE FROM (X1,Y1) TO (X2,Y2)
             :* 09.  ERASE (CLEAR) "
             :* 10.  INVERT (REVERSE) LINE
             :* 11.  RESERVED
             :*
             :* RECTANGLE OPS--
             :* 12.  SET RECTANGLE WITH OPP. CORNERS (X1,Y1) & (X2,Y2)
             :* 13.  CLEAR  "
             :* 14.  INVERT "
             :* 15.  RESERVED
             :*
             :* CIRCLE OPS--
             :* 16.  SET AN ELLIPSE AT CENTRE (X1,Y1), 1/2 WIDTH OF (X2)
             :*      AND 1/2 HEIGHT OF (Y2)
             :* 17.  CLEAR  ELLIPSE
             :* 18.  INVERT ELLIPSE
             :* 19.  RESERVED
             :VDU     EQU     7800       BASE OF VDU
             :VSTAT   EQU     VDU+400    VDU ATTRIBUTE RAM
             :XMAX    EQU     7F         MAXIMUM HORIZ. COORD.
             :YMAX    EQU     3F         MAXIMUM VERT.  COORD.
             :*
             :*
             :        ORG     H'6400'
6400 1B08    :ENTRY   BCTR,UN ENT2       NORMAL ENTRY POINT.
             :*                        ASSUMES ALL NECESSARY VALUES HAVE
             :*                        BEEN POKED INTO STORAOE LOCATIONS.
             :*
6402 0B      :VERSN   DATA    0B         VERSION NUMBER
             :*
             :* STORAGE AREA FOR EXTERNAL ACCESS
             :*
6403 00      :FUNCTN  DATA    0          FUNCTION NUMBER
6404 00      :X1      DATA    0          START CO-ORDINATE STORE
6405 00      :Y1      DATA    0
6406 00      :X2      DATA    0          END CO-ORDINATE STORE
6407 00      :Y2      DATA    0
6408 00      :BITVAL  DATA    0          TESTED BIT VALUE
             :*
             :* INTERNAL USE FUNCTION INDEX
             :*
6409 00      :INDEX   DATA    0          FUNCTN NO. * 3
640A 0402    :ENT2    LODI,R0 LCOM       LOG.COMP, CLEAR C, WC
640C 93      :        LPSL
640D 0975    :        LODR,R1 X1         PICK UP CO-ORDS
640F 0A74    :        LODR,R2 Y1
             :*
6411 0B70    :        LODR,R3 FUNCTN     GET FUNCTION NUMBER
6413 E713    :        COMI,R3 D'19'      SILLY?
6415 15      :        RETC,GT             YES!
             :*
6416 03      :        LODZ,R3             MULTIPLY FUNCTION BY 3
6417 D0      :        RRL,R0              FOR USE AS INDEX
6418 83      :        ADDZ,R3
6419 C3      :        STRZ,R3
641A CB6D    :        STRR,R3 INDEX
641C 9F641F  :        BXA     FNTBL,R3   JUMP TO FUNCTION
             :*
             :* FUNCTION JUMP TABLE
             :*
641F 1F645D  :FNTBL   BCTA,UN WINDOW     00, FLOOD AREA WITH 1'S
6422 1F645D  :        BCTA,UN WINDOW     01, CLEAR AREA TO ZEROES
6425 1F645D  :        BCTA,UN WINDOW     02, INVERT AREA
6428 1F6485  :        BCTA,UN PROTCT     03, CLR SCREEN, PROT (X1) LINES
642B 1F64B6  :        BCTA,UN SETBIT     04, SET BIT @ (X1,Y1)
642E 1F64BE  :        BCTA,UN CLRBIT     05, CLEAR BIT
6431 1F64C8  :        BCTA,UN INVBIT     06, INVERT BIT
6434 1F64D0  :        BCTA,UN TSTBIT     07, TEST BIT
6437 1F656D  :        BCTA,UN LINE       08, DRAW LINE (X1,Y1)-(X2,Y2)
643A 1F656D  :        BCTA,UN LINE       09, CLEAR LINE
643D 1F656D  :        BCTA,UN LINE       0A, INVERT LINE
6440 1F645B  :        BCTA,UN RESRVD     0B, RESERVED
6443 1F65F1  :        BCTA,UN RCTNGL     0C, SET A RECTANGLE
6446 1F65F1  :        BCTA,UN RCTNGL     0D, ERASE      "
6449 1F65F1  :        BCTA,UN RCTNGL     0E, INVERT     "
644C 1F645B  :        BCTA,UN RESRVD     0F, RESERVED
644F 1F662A  :        BCTA,UN ELIPSE     10, SET AN ELLIPSE
6452 1F662A  :        BCTA,UN ELIPSE     11, CLEAR      "
6455 1F662A  :        BCTA,UN ELIPSE     12, INVERT     "
6458 1F645B  :        BCTA,UN RESRVD     13, RESERVED
             :*
```

Reserved function handler

```
             :*
645B C0      :RESRVD  NOP                NO OPERATION
645C 17      :        RETC,UN
```

Function handler routines

```
             :*
             :* SCREEN WINDOW FUNCTION
             :* USES (X1,Y1) & (X2,Y2) TO DEFINE OPPOSITE
             :* CORNERS OF A SCREEN AREA TO BE SET, CLEARED,
             :* OR INVERTED.
             :*
645D 3F6534  :WINDOW  BSTA,UN DIRTST     WORK OUT STEPPING DIRECTIONS

6460 0F0409  :WLOOP   LODA,R3 INDEX      FETCH INDEX TO POINT HANDLER
6463 BF642B  :        BSXA    FNTBL+0C,R3 PLOT POINT

6466 0D04DC  :        LODA,R1 XPLOT      RECOVER COORDS
6469 0E04DD  :        LODA,R2 YPLOT
646C 0402    :        LODI,R0 LCOM       LOG. COMP, NO CAR
646E 93      :        LPSL

646F EE0407  :        COMA,R2 Y2         FINISHED VERT LINE YET?
6472 1805    :        BCTR,EQ WXTST
6474 8E05B1  :        ADDA,R2 YINCR      NO, STEP VERTICALLY & CONT.
6477 1B67    :        BCTR,UN WLOOP

6479 ED0406  :WXTST   COMA,R1 X2         FINISHED WHOLE WINDOW?
647C 14      :        RETC,EQ             YES, RETURN TO CALLING PROGRAM.
647D 8D05B0  :        ADDA,R1 XINCR      NO, MORE TO DO
6480 0E0405  :        LODA,R2 Y1         RESET Y TO Y1
6483 1B5B    :        BCTR,UN WLOOP
```

Screen clear and protect

```
             :*
6485 0C0404  :PROTCT  LODA,R0 X1         FETCH SCRL PROTECT VALUE
6488 440F    :        ANDI,R0 0F         TRUNCATE ANY SILLY VALUES
648A C8AB    :        STRR,R0 *PROT
             :*
648C 0420    :        LODI,R0 H'20       SPACE CODE
648E 0700    :        LODI,R3 0          INDEX
6490 CF7800  :INT2    STRA,R0 VDU,R3     CLEAR SCREEN
6493 CF7900  :        STRA,R0 VDU+100,R3
6496 CF7A00  :        STRA,R0 VDU+200,R3
6499 CF7B00  :        STRA,R0 VDU+300,R3
             :*
649C CF7C00  :        STRA,R0 VSTAT,R3   CLEAR ATTRIBUTES
649F CF7D00  :        STRA,R0 VSTAT+100,R3
64A2 CF7E00  :        STRA,R0 VSTAT+200,R3
64A5 CF7F00  :        STRA,R0 VSTAT+300,R3
64A8 DB66    :        BIRR,R3 INT2
             :*
64AA 0478    :        LODI,R0 <VDU       SET UP POINTERS
64AC C830    :        STRR,R0 POINT
64AE CB2F    :        STRR,R3 POINT+1
64B0 CF0408  :        STRA,R3 BITVAL
64B3 17      :        RETC,UN

64B4 0437    :PROT    ACON    H'0437     BINBUG SCROLL PROTECT STORE
```

Single pixel functions

```
             :*
             :* SET A POINT ON SCREEN @ R1,R2
             :*
64B6 3B2B    :SETBIT  BSTR,UN CONVRT     CONVERT POINTERS TO AN ADDRESS
64B8 14      :        RETC,EQ             IF CC=EQ, COORDS OUT OF RANGE.
64B9 68A3    :        IORR,R0 *POINT     BIT-MASK IN R0
64BB C8A1    :        STRR,R0 *POINT
64BD 17      :        RETC,UN
             :*
             :* CLEAR POINT ON SCREEN
             :*
64BE 3B23    :CLRBIT  BSTR,UN CONVRT     CONVERT POINTERS
64C0 14      :        RETC,EQ             TEST FOR CLIPPING (CC=EQ)
64C1 24FF    :        EORI,R0 0FF        INVERT MASK
64C3 4899    :        ANDR,R0 *POINT
64C5 C897    :        STRR,R0 *POINT
64C7 17      :        RETC,UN
             :*
             :* INVERT A POINT ON SCREEN (REVERSE IT)
             :*
64C8 3B19    :INVBIT  BSTR,UN CONVRT     CONVERT POINTERS
64CA 14      :        RETC,EQ             TEST FOR CLIPPING
64CB 2891    :        EORR,R0 *POINT
64CD C88F    :        STRR,R0 *POINT
64CF 17      :        RETC,UN
             :*
             :* TEST STATE OF POINT ON SCREEN
             :* IF POINT "ON" RETURNS R0=FF CC=LT
             :* "     "  "OFF"    "      " 00  " EQ
             :* IF POINT OUT OF RANGE, RETURNS "OFF" STATE CONDITIONS.
             :*
64D0 3B11    :TSTBIT  BSTR,UN CONVRT     CONVERT POINTERS
64D2 488A    :        ANDR,R0 *POINT
64D4 1802    :        BCTR,EQ TSTB2
64D6 04FF    :        LODI,R0 0FF        POINT WAS "ON"
64D8 CC0408  :TSTB2   STRA,R0 BITVAL
64DB 17      :        RETC,UN
             :*
             :* LOCAL STORAGE FOR SINGLE POINT OPERATIONS
             :*
64DC 00      :XPLOT   DATA    0          COORDS OF POINT
64DD 00      :YPLOT   DATA    0
64DE 7800    :POINT   ACON    VDU        POINTER TO VDU
64E0 7C00    :ATTPNT  ACON    VSTAT      POINTER TO VDU ATTRIBUTES
64E2 00      :BITMAP  DATA    0          MASK FOR "BIT WITHIN BYTE"
```

Coordinate to address conversion

```
             :*
             :* Converts X,Y coords in R1,R2 to VDU memory address & bitmask
             :* Coordinates 0,0 are at bottom-left of VDU. Coords greater
             :* than XMAX & YMAX return a bitmask of 00 & CC=EQ.
             :*
64E3 7702    :CONVRT  PPSL    LCOM
64E5 C975    :        STRR,R1 XPLOT      SAVE A COPY OF CO-ORDS
64E7 CA74    :        STRR,R2 YPLOT
64E9 E57F    :        COMI,R1 XMAX       XCOORD > MAX?
64EB 193D    :        BCTR,GT CONV3
64ED E63F    :        COMI,R2 YMAX       YCOORD > MAX?
64EF 1939    :        BCTR,GT CONV3
64F1 26FF    :        EORI,R2 0FF        INV YCOORD TO SUIT SCRN ADDRESSING
             :*
64F3 040A    :        LODI,R0 WC+LCOM    CLR C,SET WC & LCOM
64F5 93      :        LPSL
64F6 51      :        RRR,R1              GET L/R BIT OF X VALUE
64F7 D2      :        RRL,R2              PUT ON BACK OF Y VALUE
64F8 7508    :        CPSL    WC
64FA 453F    :        ANDI,R1 3F         R1 HAS BYTE-ON-LINE COUNT
64FC 0407    :        LODI,R0 07         EXTRACT BIT NO. FROM R2
64FE 42      :        ANDZ,R2
64FF 0C652C  :        LODA,R0 BTABL,R0   GET BIT-MASK
6502 CB5E    :        STRR,R0 BITMAP     SAVE
6504 C3      :        STRZ,R3
6505 D2      :        RRL,R2              CONTINUE ROTATION OF R2
6506 D2      :        RRL,R2
6507 D2      :        RRL,R2
6508 04C0    :        LODI,R0 0C0        FINISH LOW BYTE OF POINTER
```

▶

```
650A 42        :          ANDZ,R2
650B 61        :          IORZ,R1
650C C851      :          STRR,R0 POINT+1      SAVE IT
650E C851      :          STRR,R0 ATTPNT+1     SET ATTR. POINTER
6510 4603      :          ANDI,R2 03           BUILD HIGH BYTE OF POINTER
6512 6678      :          IORI,R2 <VDU         ADD VDU ADDRESS
6514 CA48      :          STRR,R2 POINT
6516 8604      :          ADDI,R2 04           SET ATTR. POINTER HI BYTE
6518 CA46      :          STRR,R2 ATTPNT
651A 0402      :          LODI,R0 02           CHUNKY GRFX BIT
651C C2        :          STRZ,R2
651D 4AC1      :          ANDR,R2 *ATTPNT      TEST IF GRFX ALREADY SET
651F 1907      :          BCTR,GT CONV2
6521 CCB4E0    :          STRA,R0 *ATTPNT      NO, SO SET IT NOW
6524 20        :          EORZ,R0               AND ERASE ASCII CHAR
6525 CCB4DE    :          STRA,R0 *POINT
6528 03        :CONV2     LODZ,R3               FETCH BITMAP & SET CC NON-ZERO
6529 17        :          RETC,UN
652A 20        :CONV3     EORZ,R0               BAD COORDS. SET R0 & CC=00
652B 17        :          RETC,UN
               :*
652C 01020408  :BTABL     DATA    1,2,4,8      BIT-MASK TABLE
6530 10204080  :          DATA    10,20,40,80
```

Direction test subroutine

```
               :*
               :* Used by WINDOW, LINE & RECTANGLE functions
               :* Tests X1 against X2 to give DELTAX & XINCR
               :* Tests Y1    "    Y2 "     DELTAY & YINCR
               :* Returns with (X1,Y1) in R1,R2
               :*
6534 7509      :DIRTST    CPSL    WC+CAR
6536 0D0404    :          LODA,R1 X1           Compare X1 against X2
6539 0C0406    :          LODA,R0 X2
653C 0700      :          LODI,R3 0            Prepare XINCR

653E A1        :          SUBZ,R1               Determine DELTAX
653F 180A      :          BCTR,EQ CALDX2       X2=X1, XINCR=0
6541 1906      :          BCTR,GT CALDX1       X2>X1, XINCR=+1
6543 07FE      :          LODI,R3 -2           X2<X1, XINCR=-1
6545 24FF      :          EORI,R0 0FF          DELTAX negative, make it positive
6547 8401      :          ADDI,R0 1
6549 8701      :CALDX1    ADDI,R3 1
654B CC05AE    :CALDX2    STRA,R0 DELTAX       Save ABS(DELTAX)
654E CF05B0    :          STRA,R3 XINCR        Save X stepping increment

6551 0E0405    :          LODA,R2 Y1           Compare Y1 against Y2
6554 0C0407    :          LODA,R0 Y2
6557 0700      :          LODI,R3 0            Prepare YINCR

6559 A2        :          SUBZ,R2               Determine DELTAY
655A 180A      :          BCTR,EQ CALDY2       Y2=Y1, YINCR=0
655C 1906      :          BCTR,GT CALDY1       Y2>Y1, YINCR=+1
655E 07FE      :          LODI,R3 -2           Y2<Y1, YINCR=-1
6560 24FF      :          EORI,R0 0FF          DELTAY negative, make it positive
6562 8401      :          ADDI,R0 1
6564 8701      :CALDY1    ADDI,R3 1
6566 CC05AF    :CALDY2    STRA,R0 DELTAY       Save ABS(DELTAY)
6569 CF05B1    :          STRA,R3 YINCR        Save Y stepping increment
656C 17        :          RETC,UN
```

Line function

```
               :*
               :* Plots straight lines from (X1,Y1) to (X2,Y2)
               :* Maximum X or Y coordinate = 127
               :*
656D 20        :LINE      EORZ,R0               Clear slope prediction counter
656E CC05B2    :          STRA,R0 RUNCNT
               :*
6571 3B41      :          BSTR,UN DIRTST       Set up DELTAX, DELTAY, XINCR, YINCR
6573 E839      :          COMR,R0 DELTAX       Determine if slope > 45 degrees
6575 1D65B3    :          BCTA,GT LLOOP2       Yes, do LLOOP2
               :*
               :* Slope must be <= 45 degrees
               :*
6578 C932      :LLOOP1    STRR,R1 TEMPX        SAVE POINTERS FOR LATER
657A CA31      :          STRR,R2 TEMPY
657C 0F0409    :          LODA,R3 INDEX        PICK UP INDEX FOR POINT OP's.
657F BF6413    :          BSXA    FNTBL-0C,R3  JUMP TO HANDLER
               :*
6582 0928      :          LODR,R1 TEMPX        RECOVER POINTERS
6584 0A27      :          LODR,R2 TEMPY
               :*
6586 ED040E    :          COMA,R1 X2           IF XPLOT=X2 THEN END
6589 1C65E4    :          BCTA,EQ ENDLIN
               :*
658C 8922      :          ADDR,R1 XINCR         IF X2>X1, THEN INCR XPLOT BY 1
               :*                  IF X2=X1, IGNORE
               :*                  IF X2<X1, THEN DECR XPLOT BY 1
               :*
658E 0B1F      :          LODR,R3 DELTAY       SET R=R+DY
6590 8B20      :          ADDR,R3 RUNCNT
6592 CB1E      :          STRR,R3 RUNCNT
               :*
6594 0816      :          LODR,R0 DELTAX       DECIDE IF YPLOT IS TO BE CHANGED
6596 A3        :          SUBZ,R3
6597 E77F      :          COMI,R3 7F           If runcnt > 127, do next
6599 195D      :          BCTR,GT LLOOP1
659B 7502      :          CPSL    LCOM
659D E3        :          COMZ,R3               IF R<DX-R THEN GOTO STEP 2
659E 7702      :          PPSL    LCOM
65A0 1956      :          BCTR,GT LLOOP1
               :*
65A2 8A0D      :          ADDR,R2 YINCR         IF Y2>Y1, THEN INCR YPLOT BY 1
               :*                  IF Y2=Y1, IGNORE
               :*                  IF Y2<Y1, THEN DECR YPLOT BY 1
               :*
65A4 0B0C      :          LODR,R3 RUNCNT
65A6 AB06      :          SUBR,R3 DELTAX       SET R=R-DX
65A8 CB08      :          STRR,R3 RUNCNT
65AA 1B4C      :          BCTR,UN LLOOP1
               :* LOCAL VARIABLES USED IN LINE ROUTINE
               :*
65AC 00        :TEMPX     DATA    0            INTERMEDIATE X & Y COORDS
65AD 00        :TEMPY     DATA    0
65AE 00        :DELTAX    DATA    0            ABS(X2-X1)
65AF 00        :DELTAY    DATA    0            ABS(Y2-Y1)
65B0 00        :XINCR     DATA    0            Horiz. direction flag
65B1 00        :YINCR     DATA    0            Vertical   "       "
65B2 00        :RUNCNT    DATA    0            SLOPE PREDICTION COUNTER

               :* This loop is used if slope > 45 degrees.
               :*
65B3 C977      :LLOOP2    STRR,R1 TEMPX        SAVE POINTERS FOR LATER
65B5 CA76      :          STRR,R2 TEMPY
65B7 0F0409    :          LODA,R3 INDEX        GET INDEX TO BIT ROUTINE
65BA BF6413    :          BSXA    FNTBL-0C,R3  &DO IT
               :*
65BD 096D      :          LODR,R1 TEMPX        RECOVER POINTERS
65BF 0A6C      :          LODR,R2 TEMPY
               :*
65C1 EE0407    :          COMA,R2 Y2           IF YPLOT=Y2 THEN STOP
65C4 181E      :          BCTR,EQ ENDLIN
               :*
65C6 8A69      :          ADDR,R2 YINCR         IF Y2>Y1 THEN INCR Y BY 1
               :*                 IF Y2=Y1 IGNORE
               :*                 IF Y2<Y1 THEN DECR Y BY 1
               :*
65C8 0B64      :          LODR,R3 DELTAX       SET R=R+DX
65CA 8B66      :          ADDR,R3 RUNCNT
65CC CB64      :          STRR,R3 RUNCNT
65CE 085F      :          LODR,R0 DELTAY       DECIDE IF X IS TO BE CHANGED
65D0 A3        :          SUBZ,R3               R0=DY-R
65D1 E77F      :          COMI,R3 7F           If RUNCNT > 127, do next
65D3 195E      :          BCTR,GT LLOOP2
65D5 7502      :          CPSL    LCOM
65D7 E3        :          COMZ,R3               IF R<DY-R THEN GOTO STEP 10A
65D8 7702      :          PPSL    LCOM
65DA 1957      :          BCTR,GT LLOOP2
               :*
65DC 8952      :          ADDR,R1 XINCR         IF X2>X1 THEN INCR XPLOT BY 1
               :*                 IF X2=X1 IGNORE
               :*                 IF X2<X1 THEN DECR XPLOT BY 1
               :*
65DE AB4F      :          SUBR,R3 DELTAY       SET R=R-DY
65E0 CB50      :          STRR,R3 RUNCNT
65E2 1B4F      :          BCTR,UN LLOOP2
               :*
65E4 0D0406    :ENDLIN    LODA,R1 X2           SWAP X2,Y2 INTO X1,Y1 FOR
65E7 0E0407    :          LODA,R2 Y2           FAST CONSECUTIVE LINES
65EA CD0404    :          STRA,R1 X1
65ED CE0405    :          STRA,R2 Y1
65F0 17        :          RETC,UN               RETURN TO CALLING PROGRAM
```

Rectangle function

```
               :*
               :* PLOTS A RECTANGLE USING COORDS (X1,Y1) & (X2,Y2)
               :*   AS DIAGONALLY OPPOSITE CORNERS
               :*
65F1 3F6534    :RCTNGL    BSTA,UN DIRTST       Determine line directions

65F4 3B27      :RECT1     BSTR,UN RPLOT        Plot pixel at R1,R2
65F6 8D05B0    :          ADDA,R1 XINCR        NEXT X
65F9 ED0406    :          COMA,R1 X2           Up to start of next line yet?
65FC 9876      :          BCFR,EQ RECT1        No, keep looping.

65FE 3B1D      :RECT2     BSTR,UN RPLOT        R1=X2
6600 8E05B1    :          ADDA,R2 YINCR        NEXT Y
6603 EE0407    :          COMA,R2 Y2           More?
6606 9876      :          BCFR,EQ RECT2        Yes.

6608 3B13      :RECT3     BSTR,UN RPLOT        R2=Y2
660A AD05B0    :          SUBA,R1 XINCR        NEXT X, STEP(-XINCR)
660D ED0404    :          COMA,R1 X1           More?
6610 9876      :          BCFR,EQ RECT3

6612 3B09      :RECT4     BSTR,UN RPLOT        R1=X1
6614 AE05B1    :          SUBA,R2 YINCR        NEXT Y, STEP(-YINCR)
6617 EE0405    :          COMA,R2 Y1           More?
661A 9876      :          BCFR,EQ RECT4
661C 17        :          RETC,UN               Finished, return to caller.

661D 0F0409    :RPLOT     LODA,R3 INDEX        Pick up function index
6620 BF6407    :          BSXA    FNTBL-H'18'  Offset index & do BSTA
6623 0D04DC    :          LODA,R1 XPLOT        Pick up coords
6626 0E04DD    :          LODA,R2 YPLOT
6629 17        :          RETC,UN               Return for next point.
```

Ellipse and circle function

```
               :*
               :* R1 contains X1 centre co-ordinate
               :* R2 contains Y1 centre co-ordinate
               :* X2 contains Horiz width/2
               :* Y2 contains Vert height/2
               :*
662A 8D0406    :ELIPSE    ADDA,R1 X2           Add horiz width to R1
662D CD06EC    :          STRA,R1 FIRSTX       Save copy of first point
6630 CE06ED    :          STRA,R2 FIRSTY
6633 BF63FB    :          BSXA    FNTBL-H'24',R3 and plot first point

6636 20        :          EORZ,R0
6637 0708      :          LODI,R3 8
6639 CF46E4    :ELIP2     STRA,R0 CNTR,R3-     Initialise CNTR   to 0.00
663C 5B7B      :          BRNR,R3 ELIP2        Init SINE    to 0.00 00
663E 0501      :          LODI,R1 1            Init COSINE to 1.00 00
6640 CD06E9    :          STRA,R1 COSINE

               :* MAIN LOOP STARTS HERE
               :*
               :* SINE = SINE + COSINE/128
               :*
6643 0D06E9    :NEWSIN    LODA,R1 COSINE       Get old cosine
6646 0E06EA    :          LODA,R2 COSINE+1
6649 0F06EB    :          LODA,R3 COSINE+2
664C 3F66F0    :          BSTA,UN SHR          Calc cos/128

664F 8F06E8    :          ADDA,R3 SINE+2       Add to sine
6652 7708      :          PPSL    WC
6654 8E06E7    :          ADDA,R2 SINE+1
6657 8D06E6    :          ADDA,R1 SINE
665A CD06E6    :          STRA,R1 SINE         Save new sine
665D CE06E7    :          STRA,R2 SINE+1
6660 CF06E8    :          STRA,R3 SINE+2

               :* COSINE = COSINE - SINE/128
               :*
6663 3F66F0    :NEWCOS    BSTA,UN SHR          Calc sin/128

6666 0C06EB    :          LODA,R0 COSINE+2     Subtract R123 from cosine
6669 A3        :          SUBZ,R3
666A C3        :          STRZ,R3
666B 7708      :          PPSL    WC
666D 0C06EA    :          LODA,R0 COSINE+1
6670 A2        :          SUBZ,R2
6671 C2        :          STRZ,R2
6672 0C06E9    :          LODA,R0 COSINE
6675 A1        :          SUBZ,R1
6676 C1        :          STRZ,R1
6677 CD06E9    :          STRA,R1 COSINE       Save R123 as new cosine
667A CE06EA    :          STRA,R2 COSINE+1
667D CF06EB    :          STRA,R3 COSINE+2
               :* MULTIPLY COSINE BY WIDTH
               :*
6680 0C0406    :COSBYW    LODA,R0 X2           Mult width in R0 by COS in R1,2
6683 3FE707    :          BSTA,UN MLTPLY       (Returns RSLT in R1,23)
```

```
6686 8E0404  :          ADDA,R2 X1          Add centre X coord
6689 03      :          LODZ,R3              Test fractional portion
668A 9A02    :          BCFR,LT NORND       D7 = rounding flag
668C 8601    :          ADDI,R2 1           Round upwards
668E CE06EE  :NORND     STRA,R2 NEXTX       New Xplot coord (tentative)

             :*
             :*  MULTIPLY SINE BY HEIGHT
             :*
6691 0D06E6  :SINBYH    LODA,R1 SINE        Fetch sine into R12
6694 0E06E7  :          LODA,R2 SINE+1
6697 0C0407  :          LODA,R0 Y2          Mult height in R0 by SINE in R1.2
669A 3F6707  :          BSTA,UN MLTPLY      (RSLT in R1.23)

669D 8E0405  :          ADDA,R2 Y1          Add centre Y coord
66A0 03      :          LODZ,R3              Test fractional portion
66A1 9A02    :          BCFR,LT NORND2      D7 = rounding bit
66A3 8601    :          ADDI,R2 01          D7 = 1
66A5 CE06EF  :NORND2    STRA,R2 NEXTY

66A8 0D06EE  :TSTSAM    LODA,R1 NEXTX       Test if new coords same
66AB ED04DC  :          COMA,R1 XPLOT       as last point plotted.
66AE 9805    :          BCFR,EQ NOTSAM
66B0 EE04DD  :          COMA,R2 YPLOT
66B3 1814    :          BCTR,EQ INCTR       Same, dont plot it

66B5 CD04DC  :NOTSAM    STRA,R1 XPLOT       Update old coords
66B8 CE04DD  :          STRA,R2 YPLOT
66BB E92F    :          COMR,R1 FIRSTX      Test if same as start
66BD 9804    :          BCFR,EQ NOTSM2      to avoid double operation
66BF EA2C    :          COMR,R2 FIRSTY
66C1 1806    :          BCTR,EQ INCTR
66C3 0F0409  :NOTSM2    LODA,R3 INDEX       and plot new point
66C6 BFE3FB  :          BSXA    FNTBL-H'24',R3

66C9 0919    :INCTR     LODR,R1 CNTR        Fetch old loop counter value
66CB 0A18    :          LODR,R2 CNTR+1
66CD DA02    :          BIRR,R2 $+4         Add 0.01 (HEX) to it
66CF D900    :          BIRR,R1 $+2
66D1 C911    :          STRR,R1 CNTR        Save new loop count
66D3 CA10    :          STRR,R2 CNTR+1

66D5 7702    :ENDTST    PPSL    LCOM        Compare loop count to end value
66D7 E503    :          COMI,R1 03          of PI = 03.24 3F 6A 88 (HEX)
66D9 1E6643  :          BCTA,LT NEWSIN      More to do.
66DC 1905    :          BCTR,GT DONE        Over-shot?

66DE E624    :          COMI,R2 H'24'       MS Byte equal, test next
66E0 1E6643  :          BCTA,LT NEWSIN      More to do.
66E3 17      :DONE      RETC,UN              FINISHED, return to caller.

             :*  Local storage for circle routine

66E4 0000    :CNTR      DATA    0,0         Loop counter store
66E6 000000  :SINE      DATA    0,0,0       Sine value store
66E9 010000  :COSINE    DATA    1,0,0       Cosine store
66EC 00      :FIRSTX    DATA    0           First plot point store
66ED 00      :FIRSTY    DATA    0
66EE 00      :NEXTX     DATA    0           Tentative new plot point
66EF 00      :NEXTY     DATA    0
             :* DIVIDE BY 128 SUB-ROUTINE
```

```
66F0 0408    :SHR       LODI,R0 WC          Divides R123 by 128
66F2 93      :          LPSL                 by shifting R123 right 7 bits

66F3 D3      :          RRL,R3               Set up CAR from MSB R3
66F4 02      :          LODZ,R2
66F5 C3      :          STRZ,R3              Shift 1 byte to right
66F6 D3      :          RRL,R3               and back 1 bit (pick up CAR)

66F7 01      :          LODZ,R1
66F8 C2      :          STRZ,R2
66F9 D2      :          RRL,R2               Put old sign bit in CAR

66FA 20      :          EORZ,R0             Perform sign-extend thru into R1
66FB C1      :          STRZ,R1              Assume +ve number
66FC D0      :          RRL,R0               Test old sign bit
66FD 7508    :          CPSL    WC
66FF 14      :          RETC,EQ              Return if sign = 0

6700 05FF    :          LODI,R1 -1          Number was negative
6702 17      :          RETC,UN
             :*
             :*   16 Bit * 8 Bit Binary Multiplication Sub-routine
             :*
             :*    R0   = OPR1 = Multiplier
             :*    R1.2 = OPR2 = Multiplicand
             :*
6703 00      :OPR1      DATA    0           Input operand storage
6704 0000    :OPR2      DATA    0,0
6706 08      :MCNT      DATA    8           Multiply loop count

6707 7708    :MLTPLY    PPSL    WC
6709 C878    :          STRR,R0 OPR1        Save OPR1
670B C977    :          STRR,R1 OPR2        Save OPR2
670D CA76    :          STRR,R2 OPR2+1

670F 20      :          EORZ,R0              Clear result
6710 C1      :          STRZ,R1
6711 C2      :          STRZ,R2
6712 C3      :          STRZ,R3
6713 0408    :          LODI,R0 8           Loop count

6715 7501    :MLOOP     CPSL    CAR
6717 C86D    :          STRR,R0 MCNT        Save loop count
6719 0868    :          LODR,R0 OPR1        Shift OPR1 Right one bit
671B 50      :          RRR,R0
671C C865    :          STRR,R0 OPR1        Save it
671E 20      :          EORZ,R0              Test if add to be done
671F D0      :          RRL,R0
6720 1804    :          BCTR,EQ MNOAD       If CAR was 0, no add

6722 8A61    :MADD      ADDR,R2 OPR2+1      Add OPR2 to RSLT
6724 895E    :          ADDR,R1 OPR2

6726 51      :MNOAD     RRR,R1               Shift entire result right
6727 52      :          RRR,R2               by one bit
6728 53      :          RRR,R3

6729 085B    :          LODR,R0 MCNT        Fetch current loop count
672B FB68    :          BDRR,R0 MLOOP       More to do?

672D 7509    :          CPSL    WC+CAR
672F 17      :          RETC,UN              Finished!
```

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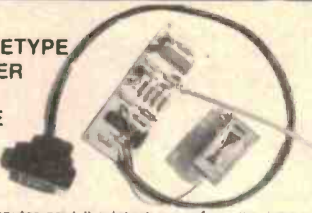

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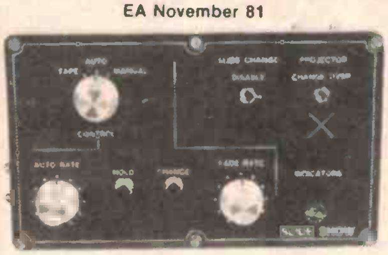

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The 'pfs:Graph' package reviewed

Ever tried to tackle the problem of producing a really flexible graph routine? Difficult isn't it? Well, this package should interest you — it runs on the Apple II and produces graphs to order from your own data. What's more, it's compatible with PFS and VisiCalc files!

Jonathan Phillips

AS ANYONE who has ever tried to produce a flexible all-purpose graph routine will know, graphs wasn't meant to be easy — to paraphrase a well known aphorism.

The first problem comes when you try to work out what the scale is going to be. That's fairly easy. Then comes the problem of labelling the axes — and if you want to do it properly (i.e: with the vertical axis labelled using letters on their side), then that means a *lot* of fiddling.

Then of course comes the question of how to show the line — just as a solid white line, or with symbols to show the data points?

When your data starts to come in the form of *comparitive* graphs — i.e: more than one graph on the same set of axes — then you are in real trouble.

The *pfs:*Graph package is the third in a series of packages designed for the business user — the sort of user who is not interested in staying up to three in the morning polishing software routines. What he wants is results without headaches.

The 'mother' package, '*pfs:*' itself, is a 'data aquisition' system — that is, it allows you to design forms on the screen and then fill them in. Packages like this are becoming very common these days, as people realise that computers are not only fun — they can work for their living, too.

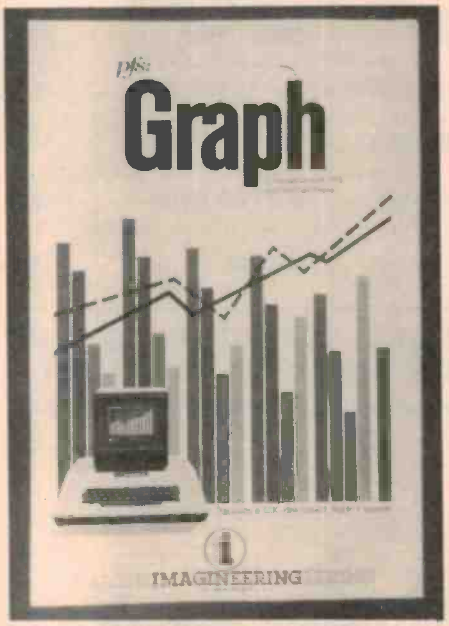
Now, *pfs:* allows you to generate 'files' of information, and to add to and change that information at will — more, it allows an *operator* to do this sort of thing, integrating the system into an office environment.

The second package produced by Software Publishing Corporation (the publishers of the *pfs:* series) was '*pfs:*Report' — a 'report generator' package, which allowed that same no-headaches business user to generate printouts formatted neatly without worrying about the details of writing a program to do so.

Cunningly, *pfs:*Report took its data from the 'files' produced by the mother *pfs:* system — *pfs:*Graph does the same thing, only instead of reports, it produces graphs.

Note that *pfs:*Graph can also be used without the mother system, entering data directly to produce a graph.

The *pfs:*Graph package runs on an Apple II (with disk drive, of course), and produces the graphs in colour on the screen. The package is also capable of interfacing with a variety of printers and plotters for hard copy.



Recommended. The 'pfs:Graph' package is distributed by *Imagineerng, 3/579 Harris St, Ultimo NSW 2007. (02)212-1411.*

How it performs

Starting up the *pfs:*Graph package is something of an experience. The disk drive whirrs for what seems like rather a long time, with the head doing what sounds like a polka across the face of the disk.

After a while, all that stops and the main menu is seen, giving you the option of retrieving/saving the graph, altering the data, altering the format of the graph or printing the results.

Operating the menu is also rather an experience — for some reason the programmer has decided to break with convention, and use CTRL-C (which, on most systems is used to mean 'interrupt') at the end of each input.

So if (as I did on a number of occasions, by mistake through long habit) you enter the menu selection followed by RETURN, nothing happens! Worse still, going back to a 'normal' system after playing with *pfs:*Graph for some time results in several unnecessary reboots!

Another problem I noticed was that, in going from the main menu to the various other parts of the system, each time I went into or out of the main menu, the disk was used.

Now this fact, coupled with the usual protection against copying the disk, will give the whole system rather a limited life — until the disk wears out, in fact.

Problems apart, the system works well — it will produce three types of graph: line graphs, bar charts and pie charts.

Bar and line graphs can be generated using up to four sets of data on the same axes, and bars and lines can be mixed on the same set of axes.

Labelling of each line, bar and pie segment is clear and easy to follow — lines are labelled either by colour, or by a symbol at each data point (depending on an option). Bars and pie segments are identified by shading or colour.

All of the graph examples that I fed into the system resulted in neat, easy to read graphs — in fact, it would be very difficult to produce results that were otherwise, using this system.

By making a few simplifying assumptions (e.g: that the first set of data on a graph using colour will always be in red), the system allows you just enough choices to define what you want the *reader* of the graph to get out of it, without burdening you with unnecessary choices.

All in all, the package is easy to use and produces good results — and now we come to the most important part of the whole deal, the manual.

In a system which is designed for use by 'business' people, excellent documentation is a must. The *pfs:*Graph manual is very much up to scratch.

It is easy to read, easy to use for reference and includes a short 'guided tour' of the features of the package, along with 'monkey-see, monkey-do' instructions of how to start the thing up.

The package also comes with a disk full of example graphs, so that the naive user can get a few ideas of what is possible. All in all, the publishers have done a very good job of making sure that the documentation is up to standard.

In summary — yes, a good product; especially for those with either the base *pfs:* system, or VisiCalc (the 'spreadsheet' package with which *pfs:*Graph is also compatible). *Recommended* for those who are into computing for profit, as well as for fun.●

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C	0-110, 0-110-130 PRICE $10.00	0-24V, 1A 0-24-28-30V 1Amp
D	0-110, 0-110-130 PRICE $10.00	0-22-24V 2A 0-27V, 1A 0-12V, 1A
E	0-240 PRICE $8.00	0-18V, 400mA 17.5-0-17.5-60-180-300V, 100mA
F	0-240 PRICE $7.00	0-18V, 2A 0-8.5V, 3A
G	0-110-240 PRICE $4.50	0-33V, 1.25A
H	0-240 PRICE $4.00	0-12.6V, 1A
I	0-240 PRICE $3.50	0-12.6V, 500mA
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TV MESSAGE MAKER/INVENTORY

W.F. Kreykes, St Albans Vic.

I initially designed this program in black and white but now I've learnt more about colour and programming techniques such as Machine Code Sub-Routines (MCSRs).

The program writes messages on a TV or monitor and has four separate memories in which you can record a full screen of writing and call it up at any time with a two-key code. With the options I have listed it is possible to print a page over a page that is already on display, for special effects.

As well as writing four pages, there is also a stack in which you can record messages. The messages can be put in the stack one after another and, after resetting the stack to the start again, they can be displayed by pressing key B. The first message will be displayed and, if key B is pressed again, the first message will be cleared and the second message in the stack will be displayed. And so on.

If you want to display a message for the second time, or a message further up in the stack, type in 'CD' followed by its address, which you have to note when recording.

The vowels, being most commonly used, have been assigned 11, 22, 33, 44, 55, i.e: A, E, I, O, U. There are several MCSRs starting at 0862 and all of them end in D4. Before calling some of these I have used the Chip 8 Axxx instruction to set register A of the 1802 to the required address. This method is slower but saves memory and so may not be suitable for those who have expanded the memory as the most significant high four bits of register A could be any value (which is not important in the previous case).

Other MCSRs manipulate the monitor's Chip 8 variable stack (0470-047F) so they communicate between each other.

The use of machine code was necessary to make the program as short as possible and colour the whole screen or line in a shorter time than the Chip 8 equivalent would do.

The MCSR shown in ETI April 1982 had to be modified so that the memory data pointed to by the SEXed register was replaced, after the OUT3 was performed, to its original value.

To prevent writing over page boundaries (not a page as 00-FF) I had to place a maximum of letters/codes per page/display. I settled on a figure of 119, which will still leave room for the BB if you want to record what is on display. This should be sufficient and any attempt to go over this limit will prove fruitless; no harm can be done to the recorded pages.

You'll know when this limit has been reached as a strange shape will be displayed after only the first key press, and a letter requires two. If this limit is reached you either have to record what's on the display, erase the last entry/line or clear the screen before you display any more messages.

The display can still be recorded even though this sign has come up. The strange shape will not be recorded as a BB is placed over it automatically.

Any invalid command will be greeted with a long beep.

Once you've got the program up and running, record from 0600 to 0970. If you are planning to demonstrate it, record all your messages and check them to see that they are what you wanted. Before recording press C00, then after reloading into the computer it will not be possible to accidentally record a message. Don't forget the colouring. Then record on another tape from 0600 to 0FFF. When you want to demonstrate your program you reload the computer, all your messages are set, and you can recall them as required.

Seven lines will be displayed with an average of 14 letters, subject to a maximum of 119 letters/codes per page/display, counting each code in tables A and B as one.

The code recorded in memory for cursor forward (key F) is recorded as one code for each time this key is held down, even though the cursor moves forward more than one space. The cursor can move to a maximum of 16 spaces before the key will have to be released but will stop short at the start of the next line.

Four separate pages can be called up at any time. The screen will be cleared first before a page is displayed.

There can be an average of 60 lines in the inventory. More lines are possible if only parts of a line are used; i.e: the message

BY
W.F. KREYKES
1983

on three lines will only take up 24 codes + BB = 25 codes; that's 17 less than the average of 14 per line, but didn't include any colouring.

Options: Less than a page or one extra full page.

Data at	No page	1 page	2 pages	3 pages	5 pages	2x½ and 1 full	
0662 and 0686	6f00	6f01	6f02	6f03	6f05	6f03	at 0930
078A	6009	600a	600a	600b	600c	600a	aa24
078C	61e8	6160	61d8	6150	6140	61d8	at 0932
Start of Inventory	09E8	0A60	0AD8	0B50	0C40	0AD8	aa60

For 2x½ pages, with a full 58 codes per ½ page (1&2), there is no provision to prevent recording over page three, so be careful.

To display a page over a page, change 0690 to 00ff. If you want to clear the screen before displaying another page use code A8 at the start of the page that requires the screen to be cleared first. This feature creates special effects when used carefully.

If you only want to recolour the bottom three lines using A9, change 175c at 0758 to 1760; this leaves the top four lines in their original colour.

After recording into the stack, the address showing where the next message will be recorded will have to be removed by pressing any key. This will then return the cursor to the start of the display.

Attempting to display a message in memory that has not been recorded will bring up rubbish; you may have to restart the program.

To change the screen colour to something other than white, change the value of V0 at 075A to 60aX; X is the colours' code 0-7. To have different colour combinations when using A9, experiment with the value added or deducted from V0 at 0757, or replace it with 00ff.

Table 'B' — These codes are recorded as for Table 'A'.

94	used to signal inventory to reset to the start (endless loop)
A0	black
A1	red
A2	blue
A3	violet
A4	green
A5	yellow
A6	p. blue
A7	white
A8	clear screen, leave cursor in present position **
A9	change back/foreground colour **
AA	show?
AB	white screen
AC	black
AD	green
AE	red
AF	blue
D	move cursor down one line
F	move cursor forward until key is released, subject to a maximum of 16 advances and/or the start of the next line.

A0 and A7 colour the whole line that the cursor is currently on

AC and AF set background colour

** Not activated when clearing stack or screen.

Table 'C' — Commands/instructions not recorded.

B	show next message in stack (inventory), clear previous one
C1-4	display selected page, clear whole screen first
CC	clear screen immediately, reset cursor to start of display
CD	go to address specified by next three key presses, and display message
C00	enforce safety lock which prevents recording
C01-4	record display into selected page
CF	reset stack/inventory to start immediately, clear previous
E	erase last entry
EE	erase last line

Note:

1. Record all your messages into the stack at once. To record into the stack after the first few messages have been recorded and the stack has been reset, simply bring up each message and when the message comes up that is previous to the one you want to record over, clear the screen (CC) and then you can record your message. Remember that recording into a page resets the stack to the start again, so be careful.
2. Don't forget to colour the lines and background as these will not change colour until instructed.
3. Code A8 should be used with care.
4. *Don't* record into the stack if the address shown after a recording is over FFF, e.g: 014. In this case you will have to see if the whole of the previous message recorded has been able to fit in.
5. You can display a page and then record it into the stack but you cannot display the stack to record into a page.
6. The first message recorded into the stack will be recorded at BC8. After each recording an address will be shown at the top of the screen; this is the address that the next message will be recorded at. If you note these as with a tape recorder you'll be able to recall them with the CD command later.

TV MESSAGE MAKER/INVENTORY

```
0600   086e 6caf 278a 275a 26a0 6200 6b00 83b0
0610   6100 a8fa d121 f40a d121 440b 179e 440c
0620   1670 440e 1816 4377 18c4 8444 8444 8444
0630   8444 8040 44d0 1640 44f0 18c0 ff0a 80f4
0640   2644 1612 4100 8b30 a404 f355 a96e f31e
0650   f055 34f0 26ce 3377 7301 00ee f60a 4600
0660   1766 6f04 8f65 4f01 16a6 6040 f018 1612
0670   f60a 460c 1608 460d 183a 460b 16a6 4600
0680   165c 460f 2786 6f04 8f65 3f01 166a 277c
0690   26a0 aXXX f31e f065 40bb 17a6 2644 1692
06A0   00e0 6d16 00ee 60bb a96e f31e f055 360b
06B0   182c a96e 087d 0862 26a0 f029 ddf5 7d06
06C0   f129 ddf5 7d06 f229 ddf5 f00a 1608 659f
06D0   8505 3f00 1716 65f0 8502 35f0 16e8 2730
06E0   40f0 00ee 70ff 16de 40a9 1744 40ab 175a
06F0   40d0 1856 40aa 185c 40a8 1744 65af 8052

0700   65ac 8502 35ac 17d4 90c0 00ee 08bd 7c01
0710   4cb0 6cac 1708 a8d0 f01e d125 67f0 8702
0720   6559 8575 3f00 172e 7101 4790 7101 7102
0730   7102 6f3d 8f15 3f00 00ee 7207 4231 6200
0740   6100 00ee 4dee 00ee 30a9 16a0 7c01 4cb0
0750   6cac 08bd 80c0 70fd 175c 60a7 ac88 089f
0760   ad68 089f 00ee 606a a67d f055 a681 f055
0770   166a a92c 8664 f61e f165 00ee 2772 a692
0780   6300 f155 173e 3d16 2792 600b 61c8 a400
0790   1782 a402 f165 a400 6dee 27b0 16a2 3d16
07A0   2792 6daa 27ac 613f 622f 1612 a400 f165
07B0   2782 a470 088f 4094 178a 40bb 00ee 26ce
07C0   17b2 6100 83b0 9830 160e a96e f31e f065
07D0   2654 17c6 ac88 4207 acb8 420e acf8 4215
07E0   ad28 421c ad68 4223 ad98 422a add8 08a3
07F0   00ee 4100 180e 7001 d121 2730 a8fa d121

0800   7f01 3f3f 1800 40ff 180e efa1 17f2 73ff
0810   264c a8fa 1616 9b30 1612 8830 a404 f365
0820   9830 17c2 26ce a404 f365 1612 2772 a400
0830   f155 a96e 087d 278a 1606 f90a fe0a 8ee4
0840   8ee4 8ee4 8ee4 f00a 8e04 2786 8090 81e0
0850   a400 f155 17a2 340e 173a 00ee a8ca d126
0860   172c f872 a78e 5727 f6f6 f6f6 3099 f839
0870   a7e7 f82c 5762 27f8 2057 62e2 d4f8 00a7
0880   47be 07ae ee4a 5ef8 bbf7 1e3a 8530 98f8
0890   00a7 47be 07ae 4e5a 8e57 279e 57e2 d4f8
08A0   c030 a5f8 20af f870 a707 fa07 bfea foae
08B0   9f5a 632a 8e5a 602f 8f3a aee2 d4e9 61d4
08C0   2644 17fa 6094 f018 1640 f090 3020 0020
08D0   4040 0000 00e0 0000 4000 4000 0000 0080
08E0   00e0 a0e0 a0a0 e0a0 a0a0 e040 4000 e020
08F0   e020 e080 e080 e080 c080 8080 a0e0 2020

0900   2020 e040 4040 4040 e080 8080 e080 e0a0
0910   e0a0 e020 e0a0 a0a0 e080 e020 e0a0 e000
0920   e0a0 e080 80a0 a0a0 a0e0 2040 80e0 a9e8
0930   aa60 aad8 ab50 abc8 f090 90b0 f0e0 9090
0940   90e0 e0f0 80b0 90f0 5070 50f0 90a0 c0a0
0950   90d0 b090 9070 2020 a0e0 f090 f0a0 9000
0960   8888 8850 2050 88d8 a888 88a8 a850
   Axxx @ 0692 set by routine at 077C
Data underlined altered by instruction C.O.O.
```

TABLE 'A'

A	11
B	77
C	38
D	6d
E	22
F	26
G	73
H	14
I	33
J	85
K	7c
L	29
M	96
N	80
O	44
P	50
Q	68
R	8a
S	48
T	32
U	55
V	90
W	99
X	92
Y	18
Z	59
?	aa
'	00
-	03
.	0b
:	07
Q	4c
0	44
1	33
2	20
3	1e
4	2a
5	48
6	3c
7	2d
8	3e
9	40

MEMORY DISPLAY UTILITY

L. Chubb, Kingsford NSW

I wrote this program because I was tired of debugging programs that didn't work, looking for errors byte by byte. It also makes finding typing mistakes a lot easier.

It's useful for those people who like to develop their own programs as it sits high in memory, out of the way of other programs (location 0F00) until it is needed.

To use this utility replace the first instruction of your program with 1F00, then run it.

It will display eight instructions at a time with the address next to each one, up to 512 bytes above the base address. The program initially displays memory locations from 0600 to 07FF.

Key F will display eight instructions from the base address (at first the base address is 0600). Key D will display the next eight instructions on from the ones currently displayed. Key 5 will display the previous eight instructions. Key C will allow the base address to be changed. To do this press key C, the screen will go blank, then press a key between 0 and F. That will then be the new base address.

If you press any other key the screen will go blank; press any correct key to bring back the display.

MEMORY DISPLAY UTILITY

0F00	6E10	1F0A	F50A	00E0
0F08	450F	2F1A	450D	2F26
0F10	4505	2F20	450C	2F7A
0F18	1F04	6700	2F26	00EE
0F20	87E5	2F26	00EE	6B00
0F28	6A00	4B30	00EE	2F34
0F30	7B06	1F28	6F00	8070
0F38	8074	6906	4F01	7901
0F40	F929	DAB5	7A06	2F5C
0F48	7A08	A600	F71E	F71E
0F50	F165	7701	2F5C	8010
0F58	2F5C	00EE	8200	63F0
0F60	8232	6300	82E5	7301
0F68	3200	1F64	F329	DAB5
0F70	7A06	F029	DAB5	7A06
0F78	00EE	F00A	AF3B	F055
0F80				

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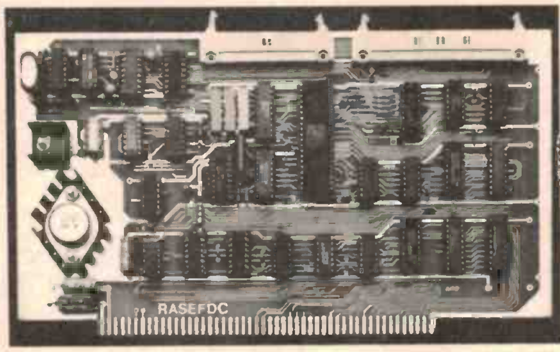

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6. Disk formatting (any type of disk).

During implementation of the above tests, any errors that may occur are fully reported back to the console for operator action.

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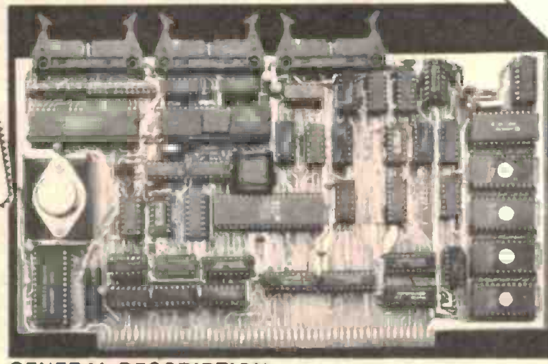

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USING YOUR MICROBEE AS AN AUDIO FREQUENCY COUNTER

Tom Moffat, 39 Pillinger Drive, Fern Tree Tasmania 7101

```
ADDR  CODE    LINE  LABEL  MNEM  OPERAND
              00100 ;MICROBEE AUDIO FREQUENCY COUNTER
              00110 ;          - Tom Moffat
              00120
0400          00130        DEFR  16
0400          00140        ORG   0400
0400 CD2700   00150        CALL  0027      ;LORES INT
              00160
              00170 ;Get frequency count into HL.
              00180
0403 110569   00190 START1 LD    DE,6905   ;TIME FOR COUNT
0406 210000   00200        LD    HL,0      ;NUMBER OF CYCLES
0409 DB02     00210 START  IN    A,(2)     ;BEGIN COUNT
040B B8       00220        CP    B         ;SET CARRY IF NEW CYCLE
040C 010000   00230        LD    BC,0
040F CB11     00240        RL    C         ;SHIFT IN CARRY, MAKE BC=1 OR 0
0411 09       00250        ADD   HL,BC
0412 47       00260        LD    B,A       ;SAVE PREVIOUS STATE
0413 1B       00270        DEC   DE        ;COUNT DOWN TIME DELAY
0414 7A       00280        LD    A,D
0415 B3       00290        OR    E
0416 20F1     00300        JR    NZ,START  ;END COUNT IF ZERO
              00310
              00320 ;Display the result.
              00330
0418 CD3E04   00340        CALL  CLS       ;CLEAR SCREEN
041B 1110F3   00350        LD    DE,0F310  ;SCREEN LOCATION
041E 011027   00360        LD    BC,2710   ;10000D
0421 CD4F04   00370        CALL  CONV
0424 01E803   00380        LD    BC,03E8   ;1000D
0427 CD4F04   00390        CALL  CONV
042A 016400   00400        LD    BC,64     ;100D
042D CD4F04   00410        CALL  CONV
0430 010A00   00420        LD    BC,0AH    ;10D
0433 CD4F04   00430        CALL  CONV
0436 010100   00440        LD    BC,1      ;1D
0439 CD4F04   00450        CALL  CONV
043C 18C5     00460        JR    START1
              00470
              00480 ;Clear the screen routine.
              00490
043E 010004   00500 CLS    LD    BC,400
0441 E5       00510        PUSH  HL
0442 2100F0   00520        LD    HL,0F000
0445 3620     00530 FILL   LD    (HL),20
0447 23       00540        INC   HL
0448 0B       00550        DEC   BC
0449 78       00560        LD    A,B
044A B1       00570        OR    C
044B 20F8     00580        JR    NZ,FILL
044D E1       00590        POP   HL
044E C9       00600        RET
              00610
```

How many times have you said, "Oh, how I wish I had a frequency counter!" But most people couldn't justify the cost of several hundred dollars just for the occasional use.

But if you load this program into your Microbee you'll be able to measure audio tones up to 12 kHz or so, with the frequency displayed in nice big characters on your television screen.

What can you use it for? Are you building the ETI-905 polyphonic organ? You'll need a frequency counter to set it up. A computer modem? An RTTY modulator? Testing your stereo? A frequency counter is almost essential for all of these projects.

Now for some details of how it works . . . The frequency to be measured is fed into the Microbee's cassette port via the interface shown in Figure 3. You insert the plug that normally goes to the 'earphone' socket into the interface socket instead. The tone is applied at the other end. Perhaps some enterprising manufacturer will offer the interface as a kit.

Within the Microbee is an IC amplifier/protection circuit that squares up the signal and presents it to bit 0 of data port 2. The program inputs the contents of the port and compares it with the result of the previous input. If bit 0 went low the carry flag is set. The carry flag, regardless of its state, is rotated into the '1' position of the BC register, which is then added to HL, the frequency count. So HL increments for each cycle.

Meanwhile register DE has been loaded with a number that takes precisely one second to count down to zero. Each time the port is tested, DE is decremented as well. When DE runs out of steam and the program exits the loop, the HL register contains a binary number that is the number of audio cycles that occurred in one second. The binary number is converted to decimal and displayed on the screen by a 'successive subtract' division routine. Then the whole procedure repeats.

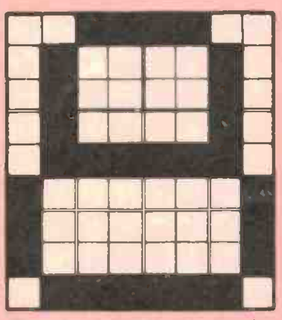


Figure 1. A complete numeral.

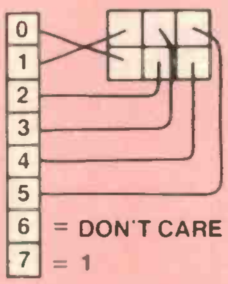


Figure 2. Graphics character format.

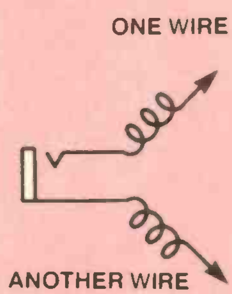


Figure 3. The interface.

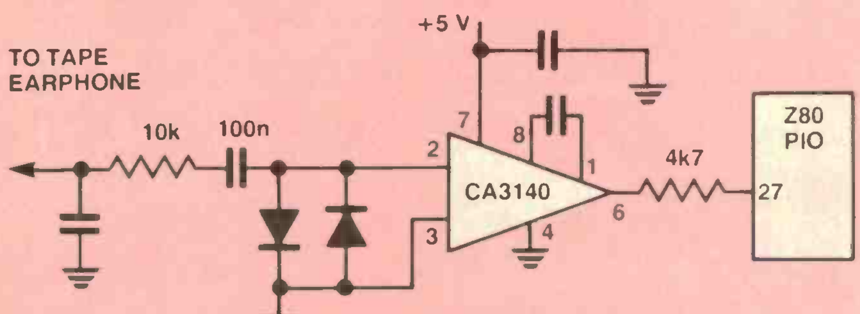


Figure 4. The Microbee's cassette input circuit.

The characters that appear on the screen are specially constructed from graphics characters available in the Microbee, although not widely known about. They're produced after you call the 'LORES' initialise subroutine. You then write characters to the screen with bit 7 set high.

There are six pixels in each graphics character, and 12 graphics characters are used for each numeral, giving 72 pixels for each character. Figure 1 shows how an '8' is formed from the 12 graphics characters. Figure 2 shows how the data is developed for each graphics character.

The resulting numerals stand 35 mm high on a 300 mm (12 inch) TV monitor; they're bigger than any LEDs you'll find on a 'proper' frequency counter.

For what it's worth, this 'graphics character' business will work on a TRS-80 as well.

The accuracy of the Microbee as a frequency counter is excellent, with the timebase being derived from the Microbee's 12 MHz crystal. The quantity for register DE in line 190 has been calibrated against a 'you-beauty' super accurate Systron Donner counter, and should hold for all Microbees if the 4 MHz crystals are any good.

Sensitivity is also quite good, about 100 mV peak-to-peak at 1 kHz. At 10 kHz, it's 200 mV and at 5 Hz, 800 mV (that 100n capacitor is obviously getting in the way at such a low frequency).

The program has been written, by the way, so you can use the 'clear screen' and 'big number' procedures in your own programs. They've been presented as separate subroutines.

All in all, it's not a bad little frequency counter, even though it's limited to audio frequencies.

If you don't feel like wrestling with all that nasty machine code, the usual offer applies: twelve dollars to the author brings the program on a cassette which can be loaded under BASIC, and an instruction sheet, all post paid.

```
ADDR   CODE     LINE   LABEL  MNEM   OPERAND
                00620 ;Convert a digit to decimal and show it.
                00630
044F 3EFF       00640 CONV    LD     A.0FFH   ;CLEAR A FOR COUNT
0451 3C         00650 CONV1   INC    A
0452 A7         00660         AND    A
0453 ED42.      00670         SBC    HL.BC
0455 30FA       00680         JR     NC,CONV1
0457 09         00690         ADD    HL.BC
0458 87         00700         ADD    A.A      ;X2
0459 87         00710         ADD    A.A      ;X4
045A 4F         00720         LD     C.A
045B 87         00730         ADD    A.A      ;X8
045C 81         00740         ADD    A.C      ;X12
045D 0600       00750         LD     B.0
045F 4F         00760         LD     C.A
0460 E5         00770         PUSH   HL
0461 217904     00780         LD     HL.ZERO
0464 09         00790         ADD    HL.BC    ;HL POINTS TO NUMBER
0465 0603       00800         LD     B,3      ;3 LINES OF CHARACTERS
0467 C5         00810 SHOW    PUSH   BC
0468 010400     00820         LD     BC,4     ;4 ROWS OF CHARACTERS
046B EDB0       00830         LDIR
046D 7B         00840         LD     A.E
046E C63C       00850         ADD    A.3CH
0470 5F         00860         LD     E.A
0471 C1         00870         POP    BC
0472 10F3       00880         DJNZ   SHOW
0474 C647       00890         ADD    A.47     ;POINT TO NEXT SCREEN LOC'N
0476 5F         00900         LD     E.A
0477 E1         00910         POP    HL
0478 C9         00920         RET
                00930
                00940 ;Data for big numerals, as graphics characters.
                00950
0479 9683       00960 ZERO    DEFW   8396
047B 83A1       00970         DEFW   0A183
047D 9580       00980         DEFW   8095
047F 80AA       00990         DEFW   0AA80
0481 A1B0       01000         DEFW   0B0A1
0483 B09A       01010.        DEFW   9AB0
0485 8088       01020 ONE     DEFW   8880
0487 9580       01030         DEFW   8095
0489 8080       01040         DEFW   8080
048B 9586       01050         DEFW   8095
048D 80A0       01060         DEFW   0A080
048F B580       01070         DEFW   80B5
0491 8E83       01080 TWO     DEFW   838EH
0493 83AF       01090         DEFW   0AF83
0495 A0B8       01100         DEFW   0B8A0
0497 8E81       01110         DEFW   818EH
0499 B7B0       01120         DEFW   0B0B7
049B 80B8       01130         DEFW   0B880
049D 8E83       01140 THREE   DEFW   838EH
049F 83AF       01150         DEFW   0AF83
04A1 8088       01160         DEFW   8880
04A3 8CB7       01170         DEFW   0B78CH
04A5 ACB0       01180         DEFW   0B0ACH
04A7 B09E       01190         DEFW   9EB0
04A9 80A0       01200 FOUR    DEFW   0A080
04AB 8695       01210         DEFW   9586
04AD B8B1       01220         DEFW   0B1B8
04AF B0B5       01230         DEFW   0B5B0
04B1 8080       01240         DEFW   8080
04B3 8095       01250         DEFW   9580
04B5 9783       01260 FIVE    DEFW   8397
04B7 8381       01270         DEFW   8183
04B9 8D83       01280         DEFW   838DH
04BB 83AC       01290         DEFW   0AC83
04BD A4B0       01300         DEFW   0B0A4
04BF B086       01310         DEFW   86B0
04C1 A09E       01320 SIX     DEFW   9EA0
04C3 8380       01330         DEFW   8083
04C5 B78C       01340         DEFW   8CB7
04C7 8CB0       01350         DEFW   0B08CH
04C9 ADB0       01360         DEFW   0B0ADH
04CB B08E       01370         DEFW   8EB0
04CD 8783       01380 SEVEN   DEFW   8387
04CF 839B       01390         DEFW   9B83
04D1 80A0       01400         DEFW   0A080
04D3 8680       01410         DEFW   8086
04D5 80AA       01420         DEFW   0AA80
04D7 8080       01430         DEFW   8080
04D9 A883       01440 EIGHT   DEFW   83A8
04DB 8394       01450         DEFW   9483
04DD 9A8C       01460         DEFW   8C9AH
04DF 8CA5       01470         DEFW   0A58CH
04E1 A5B0       01480         DEFW   0B0A5
04E3 B09A       01490         DEFW   9AB0
04E5 9E83       01500 NINE    DEFW   839EH
04E7 83AD       01510         DEFW   0AD83
04E9 838C       01520         DEFW   8C83
04EB 8CAB       01530         DEFW   0AB8CH
04ED 80A0       01540         DEFW   0A080
04EF B887       01550         DEFW   87B8
0000            01560         END
00000 Total errors

NINE     04E5   EIGHT   04D9   SEVEN   04CD   SIX     04C1
FIVE     04B5   FOUR    04A9   THREE   049D   TWO     0491
ONE      0485   SHOW    0467   ZERO    0479   CONV1   0451
FILL     0445   CONV    044F   CLS     043E   START   0409
START1   0403
```

THE VIC-20 COLUMN

☆ ENCOURAGEMENT ☆

There are obviously a lot of people who own VIC-20 computers. We're getting some really good programs coming in. No doubt the possibility of winning something is an added stimulation to making a contribution. The best software item submitted to this column each month will win a VIC-20 expansion board, donated by Ozi-Soft, in conjunction with Computer Technics.

We do have an apology to make to Computer Technics, who distribute the board, as we printed their address incorrectly. It should have been Computer Technics, P.O. Box 25, Kogarah NSW 2217.

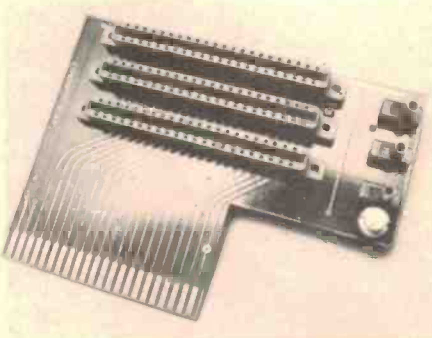
Your submissions should be original and every article published will be paid for, so send them off to the Editor now.

The first winner of a VIC-20 expansion board is (gasp, gasp! the invaders are coming) Peter Bagust, who wrote GASP.

Ozi-Soft, in conjunction with Computer Technics, is offering to donate a VIC-20 expansion board for the best software item submitted to this column every month.

The board is Australian designed and manufactured and simply plugs into the VIC-20's expansion slot. It features three sockets that can be independently switch-selected, plus an on-board reset switch. With it you can plug in up to three separate expansion units to your VIC-20 and avoid the hassle of plugging things in and out and turning the computer on and off each time. It is distributed by **Computer Technics, P.O. Box 25 Kogarah NSW 2217** and costs $59.95.

All submissions must be accompanied by a signed letter from you stating that it's your original work. The winning submission will be judged by the Editor and no correspondence will be entered into. All published submissions will be paid for.



Send entires to: **The Editor, VIC-20 Column, ETI Magazine, P.O. Box 21, Waterloo NSW 2017.**

GASP

Peter Bagust, Sans Souci NSW

This is a 1.5k game program.

Hostile invaders are destroying the earth's atmosphere and our only hope is the photon-guided missile hidden deep in the mountainside. Unfortunately the missile eats up air as it passes so use it carefully.

There are seven invaders, each getting faster and trickier. The game ends when all the invaders are destroyed or you have less than five per cent of air remaining.

Lines 10-50 are introduction.

Line 60 is initialisation, line 70 creates the atmosphere and line 80 makes the mountain range.

Line 90 reinitialises before each frame. Lines 100-130 are game finishes. Line 140 prints frame number and air remaining.

Lines 150-250 create and move the invader, 260-370 create and move the missile and 380-400 are sound effects.

Variables are 'F' = frame, 'A' = air left, 'M' = missile, 'I' = invader, 'K' = invader hit flag and 'T' = time interval.

GASP

```
 10 PRINT"          *** GASP ***         BY  P.BAGUST":POKE36879,110
 20 PRINT"  DESTROY THE INVADERS   BEFORE MORE THAN 95%  OF YOUR
    AIR IS EATEN"
 30 PRINT"KEY B LAUNCHES MISSILEKEYS Z AND C STEERS ITKEY M WILL
    DETONATE IT  QQ"
 40 PRINT" TO BEGIN HIT ANY KEY":FORT=1TO1000:NEXT
 50 PRINT" TO BEGIN HIT ANY KEY":FORT=1TO1000:NEXT:IFPEEK(197)
    =64THENGOTO40
 60 F=0:A=415:PRINT""
 70 FORZ=1TO19:PRINT"                              ":NEXTZ
 80 PRINT"                                                "
 90 M=8130:I=7680:F=F+1:POKE36879,14:K=0:T=INT(75/F)
100 IFF=8THENPRINT"      CONGRATULATIONS!    ALL ENEMYS
    DESTROYED":POKE3687 9,204
110 IFF=8THENPRINT"  CAN YOU DO IT AGAIN?":FORL=1TO10000:NEXT:RUN
120 IFA<21THENPRINT"        *** GASP ***        UNDER 5% OF AIR
    LEFT ":POKE36 879,204
130 IFA<21THENPRINT"  GIVE UP YET LOSER?":FORL=1TO10000:NEXTL:RUN
140 PRINT"FRAME"F"AIR LEFT"(INT(A/4.18))"%."
150 R=INT(RND(1)*6):POKEI,32:I=I+1
160 IFF=3ANDR<2THENI=I-R
170 IFF=4ANDR<3THENI=I-R
180 IFF=5ANDR=4ANDI<8142THENI=I+22
190 IFF=5ANDR=5ANDI>7702THENI=I-22
200 IFF>5ANDM=I+22THENI=I-22
210 IFF>5ANDM=I+2THENI=I-2
220 IFF>5ANDM=I-1THENI=I+1
230 IFPEEK(I)=160THENA=A-1
240 IFPEEK(I)=42THENPOKE36879,138:FORL=1TO999:NEXT:POKEM,32:POKEM-1,
    32:POKEM+1,3 2:GOTO90
250 POKEI,0:POKEI+30720,F
260 POKEM,32
270 IFK=1THENPOKEM+1,32:POKEM-1,32:M=8130:K=0
280 IFM<8130THENM=M-22
290 IFPEEK(197)=34ANDM<8108THENM=M+1
300 IFPEEK(197)=33ANDM<8108THENM=M-1
310 IFPEEK(197)=35ANDM>8129THENM=M-22
320 IFPEEK(197)=36ANDM<8108THENK=1
330 IFK=1ANDPEEK(M)=160THENA=A-2
340 IFPEEK(M)=160THENA=A-1
350 POKEM,30:POKEM+30720,5
360 IFM<7702THENK=1
370 IFK=1THENPOKEM-1,42:POKEM,42:POKEM+1,42:POKEM+30720,1:POKEM+30721,
    1:POKEM+30 719,1
380 IFK=1THENPOKE36877,220:FORL=15TO0STEP-1:POKE36878,L:FORN=1TO200:
    NEXTN:NEXTL:  GOTO400
390 POKE36878,15:POKE36877,220:FORL=1TOT:NEXTL
400 POKE36877,0:POKE36878,0:FORL=1TOT:NEXTL:GOTO110

READY.
```

MUSIC GENERATOR

Mark Smith, Laverton Vic

The music generator allows you to play a tune by using the table of music notes and table of decimal equivalent values in the VIC—20 Personal Computing book supplied with the computer.

You simply type in the number of notes in the music then put in the decimal equivalent value for the required note. Then you decide which speakers you want on (1-4) and how long you want the notes held for.

F1 will change the speaker values.

F2 lets you change the volume.

F3 allows you to change the period for which the notes are held on.

F7 changes the value of a note.

S varies the speed at which the music is played.

Y allows you to play again.

MUSIC GENERATOR

```
1 PRINT"]DO YOU REQUIRE OLD     DATA?":GOSUB98:IFA$="N"THEN10
2 PRINT"WHAT IS THE FILE NAME":INPUTB$:PRINT"PREPARE THE FILE":GOSUB310
3 GOTO125
10 PRINT"]HOW MANY NOTES WILL    YOU REQUIRE":INPUTA
11 DIMN(A),P(A):O=1
14 FORB=1TOA
15 PRINT"NOTE #";B;:INPUTN(B):IFN(B)>255THEN15
16 NEXTB
17 PRINT"DO YOU WANT HARMONY?":GOSUB98:IFA$="N"THEN20
18 INPUT"VOICE #1";K1:INPUT"VOICE #2";K:GOTO21LIST20
20 INPUT"WHICH VOICE";K
21 INPUT"VOLUME ";V
25 PRINT"ANY PAUSES?":GOSUB98
30 IFA$="Y"THEN100
35 FORT=1TOA:P(T)=200:NEXTT:GOTO125
40 FORT=1TOA:P(T)=P:NEXTT:GOTO125
98 GETA$:IFA$=""THEN98
99 RETURN
100 PRINT"IS IT THE ONE PAUSE":GOSUB98
105 IFA$="N"THEN120
110 INPUT"PAUSE";P:GOTO40
120 FORB=1TOA:PRINT"PERIOD #";B;:INPUTP(B):NEXTB
125 S=36873+K:S1=36873+K1
126 FORC=1TOA:POKE36878,V:POKES,N(C):POKES1,N(C):PRINTC;" ";N(C),O*P(C):FORQ=1TO
O*P(C):NEXTQ
127 POKES,0:POKES1,0:GOSUB330:NEXTC:POKES,0:POKES1,0
130 PRINT"RUN AGAIN?████████████F1-SPK,F3-VOL, F5-PAU F7-NOTE,Y-YES, S-SPD"
131 GOSUB98:IFA$=CHR$(133)THEN260
132 IFA$=CHR$(134)THEN270
133 IFA$=CHR$(135)THEN200
134 IFA$=CHR$(136)THEN225
135 IFA$="Y"THEN125
136 IFA$="S"THEN217
140 PRINT"]ARE YOU GOING TO SAVE THIS DATA":GOSUB98:IFA$="N"THEN155
145 PRINT"WHAT IS THE NAME OF   THE FILE ":INPUTB$
150 PRINT"PREPARE THE TAPE":GOTO300
155 PRINT"██DO YOU WANT TO END    THIS PROGRAM?":GOSUB98:IFA$="N"THEN125
160 END
200 INPUT"WHICH PAUSE";R:IFR>ATHEN200
201 PRINT"THIS IS WHAT IT SOUNDS LIKE":POKES,N(R):FORT=1TOP(R):NEXTT:POKES,0
205 PRINT"WHAT NEW VALUE FOR THE PAUSE DO YOU WANT":INPUTP(R)
210 PRINT"THIS IS WHAT IT SOUNDS LIKE":POKES,N(R):FORT=1TOP(R):NEXTT:POKES,0
215 PRINT"ANY MORE?":GOSUB98:IFA$="N"THEN130
216 GOTO200
217 PRINT"DO YOU WANT THE MUSIC FASTER":GOSUB98:IFA$="Y"THENY=1:GOTO220
218 PRINT"DO YOU WANT IT SLOWER?":GOSUB98:IFA$="Y"THENY=0:GOTO220
219 GOTO125
220 PRINT"BY WHAT FACTOR DO YOU WANT THE CHANGE":INPUTO:IFY>0THENO=1/O
221 GOTO130
225 PRINT"WHICH NOTE DO YOU WANT TO CHANGE":INPUTU:IFU>ATHEN225
230 PRINT"THIS IS WHAT IT SOUNDS LIKE":POKES,N(U):FORT=1TOP(U):NEXTT:POKES,0
235 PRINT"WHAT IS THE NEW VALUE THAT YOU WANT":INPUTN(U):IFN(U)>255THEN235
240 PRINT"THIS IS WHAT IT SOUNDS LIKE":POKES,N(U):FORT=1TOP(U):NEXTT:POKES,0
245 PRINT"ANY MORE?":GOSUB98:IFA$="Y"THEN225
250 GOTO130
260 INPUT"] VOICE #1";K1:INPUT"VOICE #2";K:GOTO130
270 PRINT"]HOW LOUD IS THE SOUND REQUIRED '0-15'":INPUTV
275 GOTO130
300 OPEN1,1,1,B$
302 PRINT"SAVING ";B$
304 PRINT#1,A:FORF=1TOA:PRINT#1,N(F):PRINT#1,P(F):NEXTF
308 CLOSE1:END
310 OPEN1,1,0,B$
312 PRINT"FILE ";B$;" FOUND":PRINT"LOADING"
313 INPUT#1,A:DIMN(A+1),P(A+1)
314 ZZ=A:FORA=1TOZZ:INPUT#1,N(A):INPUT#1,P(A):NEXTA
318 FORC=1TOA:PRINTC;" ";N(C),P(C):NEXTC
320 O=1:V=15:K=2:K1=3:RETURN
330 GETA$:IFA$=""THENRETURN
332 IFA$=CHR$(133)THEN260
333 IFA$=CHR$(134)THEN270
334 IFA$=CHR$(135)THEN200
335 IFA$=CHR$(136)THEN225
336 IFA$="Y"THEN125
337 IFA$="S"THEN217
338 RETURN

READY.
```

ZX COLUMN

TYPOGRAFIX

Ralph E. Morgan, Killarney Heights NSW

This program can be used on an unmodified ZX81 or ZX80 8K ROM, plus 16K RAM and a ZX printer, printing up to 32 lines of text containing both upper and lower case characters.

When the lines have been entered type 'RUN' to initialise. A string prompt (" ") will appear and a maximum length of 42 characters may be entered each time.

The allowed input characters are: A . . . Z ␣1 . . . 9 Ø + − * / [A] . . . [Z] [.] [1] . . . [9] [Ø] [+] [−] [*] [/]

The corresponding output characters are: a . . . z, ␣1 . . . 9 Ø + − * / A . . . Z . : , ; ? $ = & { } . □ < >

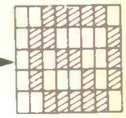
(Note: ␣ represents a space, [A] = inverse A, [1] = inverse 1, etc.)

Hence, the normal output is lower case letters and numbers 0-9 and the inverse symbols are used to obtain capital letters and other symbols.

After each string is entered approximately 15 seconds are needed to place the appropriate data from C$ into the array A$. A total of 32 strings must be entered before printing commences; use a space followed by 'NEWLINE' to quickly 'fill in' any excess lines.

Lines 1-12 are machine code for the hi-res printing facility (see ZX printer manual). Lines 13-19 accumulate the data string C$. Each letter is stored as five consecutive three-digit decimal numbers which are interpreted as follows:

character	decimal	binary
	062	00111110
	097	01100001
'O'	089	01011001
	069	01000101
	062	00111110



Hence the user can substitute his/her own symbols if desired.

Lines 20-35 calculate x and y coordinates of the symbol to be printed. Lines 49 and 50 enter data into A$. Lines 80-120 find the appropriate data in C$. Lines 9988-9999 print out A$ (see ZX printer manual).

TYPOGRAFIX

```
   1 REM [illegible] ?TAN ..
   2 IF PEEK 16365+256*PEEK 1636
9=31744 THEN GOTO 5
   3 POKE 16389,124
   4 GOTO 1
   5 FOR I=0 TO 112
   6 POKE 31744+I,PEEK (2161+I)
   7 NEXT I
   8 POKE 31600,63
   9 POKE 31857,201
  10 POKE 16417,95
  11 POKE 16524,79
  12 DIM A$(32,256)
  13 LET C$="06209708906906200000
02127000000009808107307307006706 5
07307705101500800812700807106906
90690570600740730730480970170090
05000305407307307305400607307304 1
030"
  14 LET C$=C$+"11206408412006 40
64127068068060000005606806807205 6
06806812706400000560840840720000 0
31240100002000140146146126000127 0
04004120000000125000000000006412 5
125000"
  15 LET C$=C$+"00012701604006 60
00000127064000124004124004120000
12400400412000005606806805600025
20360360240240360362521260001240
06000400400007208408405600000412 7
063000"
  16 LET C$=C$+"06006406412406 40
12048064048012060006404806406006 8
04000604006000015616009606006410
00840760040080008062006008008008 0
05008008042028008026042032016006
004002"
  17 LET C$=C$+"00000009609600 00
00000108108000000000176112000000
00018211800000020010810090060360 4
21270420180200200200200200540730
85034080000000805406506500006506 5
054008"
  18 LET C$=C$+"12600900900091 261
27073073073054062065065065034127
06506506506212707307306506512700
30080010010620650730411221270080
05008127000065127065000032064064
064063"
  19 LET C$=C$+"12700602003406 51
27064064064064127002012002127127
00200400812706206506506506212700
90090090060620650810330941270090
25041070000607307307305000100112 7
00100106306406406406301504806404
80151270320240321270990200006020 0
99003012112012000309708107306906 7
00012706506500000006506512700000
80200340650000000065034020006"
  20 FOR L=1 TO 32
  21 LET X=33-L
  22 INPUT T$
  23 IF LEN T$>42 THEN GOTO 22
  24 LET N=LEN T$
  25 IF N=0 THEN GOTO 65
  30 FOR I=1 TO N
  35 LET Y=(I-1)*6
  40 GOSUB 80
  45 FOR J=1 TO 5
  49 LET Z=15*(POS-1)+3*(J-1)
  50 LET A$(X,Y+J)=CHR$ (((CODE
C$(Z+1)-28)*100+(CODE C$(Z+2)-28
)*10+(CODE C$(Z+3)-28)))
  55 NEXT J
  60 NEXT I
  65 NEXT L
  70 GOSUB 9988
  75 STOP
  80 LET M=0
  85 LET C=CODE T$(I)
  90 IF C>=128 THEN LET M=128
  91 IF C=0 THEN GOTO 60
  95 IF M=128 AND C<153 THEN LET
 POS=C-M+57
 100 IF M=0 AND C<28 THEN LET PO
S=C+16
 105 IF M=128 AND C>=153 THEN LE
T POS=C-M+13
 110 IF M=0 AND C>=28 THEN LET P
OS=C-27
 115 IF POS<1 OR POS>80 THEN LET
 POS=1
 120 RETURN
9988 REM PRINT A$
9989 FOR I=0 TO 246 STEP 8
9990 FOR J=1 TO 32
9991 FOR K=1 TO 8
9992 POKE 32255+K+8*(J-1),CODE A
$(J,K+I)
9993 NEXT K
9994 NEXT J
9995 FOR H=0 TO 31
9996 POKE 16444+H,H
9997 NEXT H
9998 LET HPRINT=USR 31744
9999 NEXT I
```

ENCODER

Ralph E. Morgan, Killarney Heights NSW

This program accepts a text or numerical data string and then encodes it using a coding key entered by the user.

The key is then erased from RAM and the program can be saved with the encoded data. When the program is later reloaded the data can be retrieved by entry of <GOTO150> and the correct key. Hence improper retrieval is rendered impossible.

ENCODER

```
  10 PRINT "ENTER STRING"
  20 INPUT A$
  25 CLS
  30 PRINT "ENTER KEY"
  35 INPUT B$
  40 LET A=0
  45 CLS
  50 LET A=A+CODE B$
  60 IF LEN B$=1 THEN GOTO 100
  70 LET B$=B$(2 TO )
  80 GOTO 50
 100 REM   ENCRYPTION
 101 RAND A
 110 LET N=LEN A$
 115 FOR I=1 TO N
 117 LET X=CODE A$(I)+INT (RND*1
00)
 119 IF X>255 THEN LET X=X-256
 120 LET A$(I)=CHR$ (X)
 125 NEXT I
 130 PRINT "SAVE ENCODED MESSAGE
"
 135 LET B$=""
 137 CLS
 138 LET A=0
 139 PRINT A$
 140 STOP
 150 REM   DECIPHERING
 155 PRINT "ENTER KEY"
 160 INPUT B$
 170 LET A=0
 175 LET A=A+CODE B$
 180 IF LEN B$=1 THEN GOTO 200
 185 LET B$=B$(2 TO )
 190 GOTO 175
 200 RAND A
 204 FOR I=1 TO N
 205 LET X=CODE A$(I)-INT (RND*1
00)
 206 IF X<0 THEN LET X=X+256
 210 LET A$(I)=CHR$ (X)
 215 NEXT I
 220 PRINT A$
```

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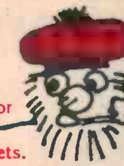
Bosch digitimer

a fully programmable Digital Computer Clock with 4 independently switched power outlets



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15 pin	Sockets	$3.58	

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PN 3567	.30	2N 5770	.30	BD 140	.50
PN 3568	.30			BD 237	.90
PN 3569	.30	MJE 2955	$1.60	BD 238	.90
PN 3568A	.30	MJE 3055	$1.60	BD 262	$1.20
PN 3641	.30	MJE 340	$1.60	BD 263	$1.20
PN 3643	.30	MJE 350	$1.60	BD 266A	$1.60
PN 3645	.30	MJ 2955	$1.60	BD 267	$1.80
PN 3566	.30	MJ 802	$3.50	BD 437	.94
2N 3866	$1.70	AC 127	$1.20	BD 438	.94
2N 3904	.36	AC 128	.60	BF 173	.69
2N 3906	.50	AC 187	80	BF 180	.75
PN 4121	.30	AC 188	$1.00	BF 469	80
PN 4250	.30	BC 207	.30	BF 470	.80
PN 4258	.30	BC 108	.30	BF 494	.22
PN 4355	.30	BC 109	.36	BFR 84	$1.22
2N 4403	.60	BC 177	.36	BFY 50	.90
2N 5088	.30	BC 178	.36	MFE 131	.98
2N 5401	.80	BC 179	40	MFE 102	.57
2N 697	.53	BC 327	22		
2N 1613	.60	BC 337	22		
2N 1711	.80	BC 338	22		
2N 2102	$1.00	BC 546	.22		
2N 2219	.80	BC 547	.22		
2N 2222	.90	BC 547B	22		
2N 2270	.65	BC 548	22		
2N 2905A	.54	BC 548C	.22		
2N 2907A	.54	BC 549	22		
2N 3019	.54	BC 549C	22		
2N 3053	.80	BC 550	22		
2N 3819	.80	BC 556	22		
2N 4036	.80	BC 557	.22		
2N 4352	$2.40	BC 557B	22		
2N 4360	.50	BC 558	22		
2N 5245	.50	BC 559	.22		
2N 5458	.50	BC 559C	22		
2N 5459	.50	BC 639	.35		
		BC 640	.35		
		BD 135	.49		
		BD 136	.49		

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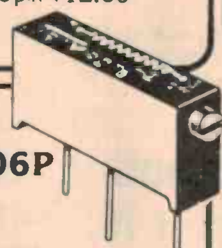

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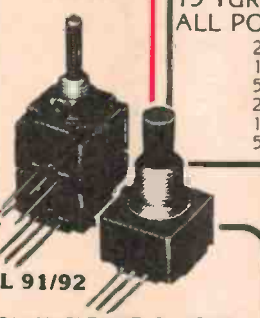

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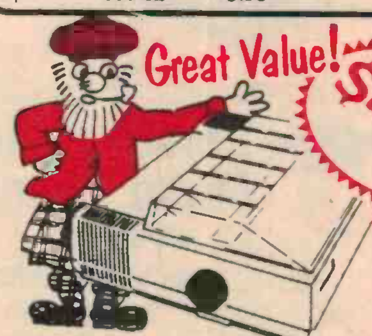

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Character set:	228 ASCII characters: Normal and italic alpha-numeric fonts, symbols and semi graphics.
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Printing direction:	Normal — Bidirectional, logic seeking
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Dot graphics density:	Dot graphics density up to 1280 dots per line. Ribbon: cartridge type.
Columns/line:	Normal size — 80 columns
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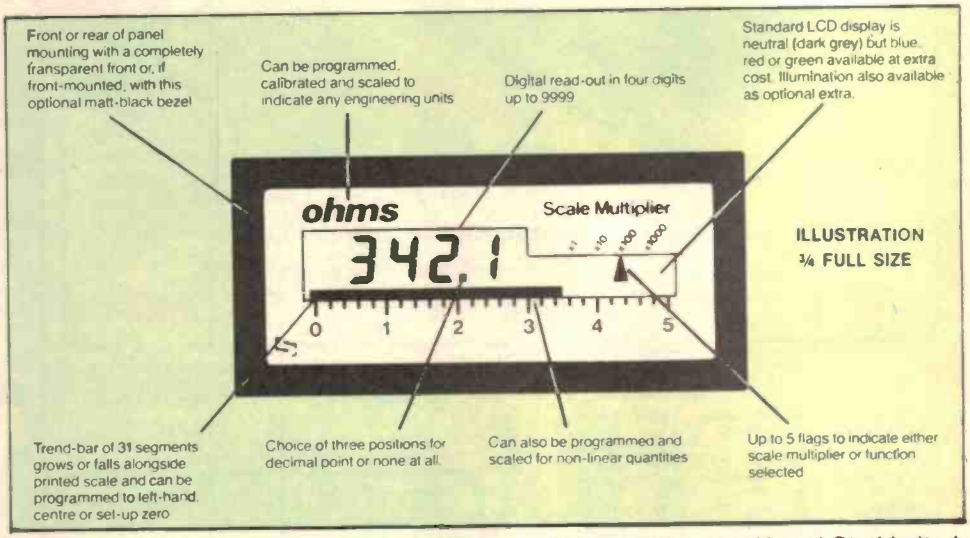

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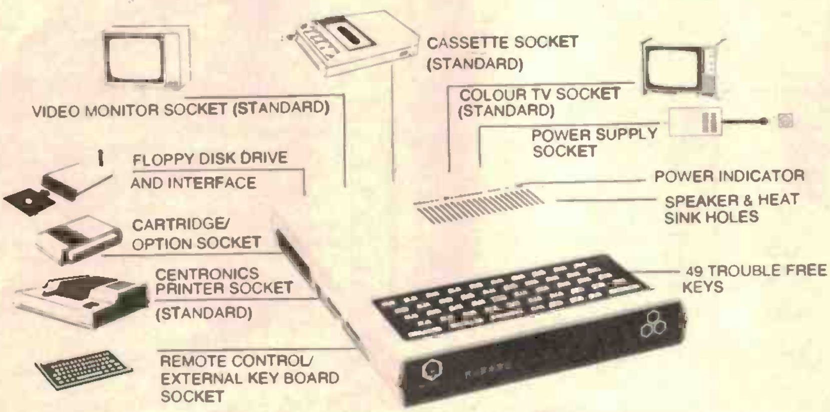

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Open-frame switching power supplies

Power-One has gone into full production with its International Series open-frame switching power supplies, distributed in Australia and New Zealand by Warburton Franki.

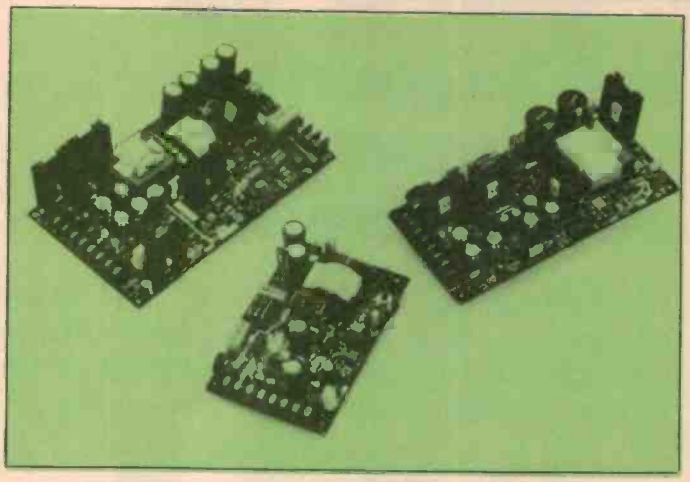
This new line incorporates the latest state-of-the-art switching technology, in eleven off-the-shelf models.

Five package sizes are available, ranging from 40 W to 250 W. Depending on the model selected, the International Series offers up to five outputs, selected to accommodate applications such as small computers, terminals, peripherals, word processors, disk drives, Winchesters, printers and other devices using microcomputer technology.

The new switches are designed to meet VDE, UL, IEC, CSA as well as most other world-wide regulatory safety agencies. They also meet the emissions limits of FCC Docket 20780 Class A and VDE 0871/6.78 Class A.

Another feature is the ability to operate from the wide variety of ac input voltages found throughout the world. The International Series ac input ranges include, as standard, both 90 V and 132 V for domestic and Asian applications, and 180 V to 264 V for European applications.

For further details contact **Warburton Franki, 372 Eastern Valley Way, Chatswood NSW 2067. (02)407-3261.**



Tektronix logic analysers

The new Tektronix 1240 logic analyser is now available in configurations which range in price from $10 500 to $28 000.

A card-modular mainframe lets the user select the data acquisition channels and speeds, data analysis and communications interface support. The mainframe accepts up to four data acquisition modules; the 1240D1 has nine channels and acquisition speeds up to 100 MHz and the 1240D2 has 18 channels and speeds up to 50 MHz.

The 1240 has a dual timebase and sophisticated triggering and software analysis tools which are optimised for a broad spectrum of software debug problems.

The functions are presented as rectangular graphic fields containing the menu label, each selectable by touching the appropriate soft key on the display.

The Sony/Tektronix 318 and 338 logic analysers are additions to the 300 series of 'ultra portable' logic analysers.

The 318, priced at $8190, provides 16 channels of data acquisition at up to 50 MHz. The 338, priced at $8960, delivers 32 channels at up to 20 MHz. They both provide glitch capture and three levels of triggering.

In the serial mode both synchronous and asynchronous data acquisitions can be executed at baud rates from 50 bps to 19.2 kbps. Captured data can be displayed in hex, binary, octal, ASCII or EBCDIC which make these analysers ideal for such applications as testing line links, analysing protocols and data checking in local area networks.

An option which includes an RS-232 serial interface and non-volatile memory is priced at $1860.

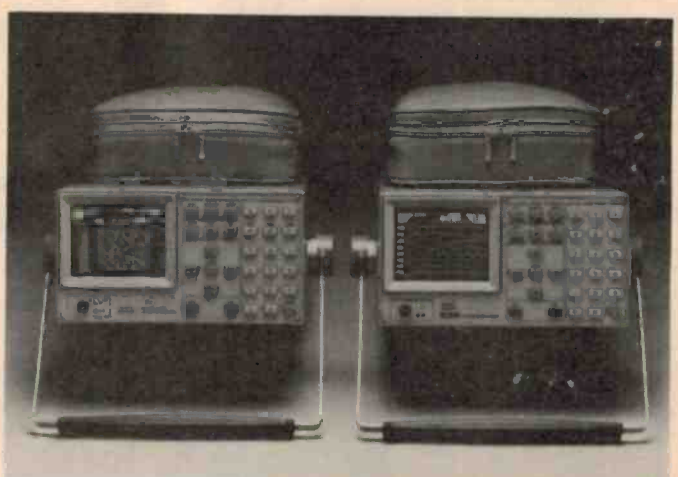
More information about these logic analysers can be obtained from **Tektronix Australia Pty Ltd, 80 Waterloo Rd, North Ryde NSW 2113. (02)888-7066.**

Weller's wall poster

Cooper Tools, the manufacturer of Weller soldering equipment, has published a colour poster of its Weller soldering and desoldering tips.

The poster depicts — by number, temperature and range — all Weller tips available for the WTCPN, EC2000D and WMCP-EC temperature-controlled soldering stations and the W60D line-voltage temperature-controlled soldering iron. Accessories are also featured.

For a complimentary copy of the poster contact the **Cooper Tool Group, P.O. Box 366, Albury NSW 2460. (060) 21-5511.**



H-P expands 10-element bargraph array

Hewlett-Packard has added a new high-performance green 10-element array to the standard-red, high-efficiency red and yellow 10-element LED array family.

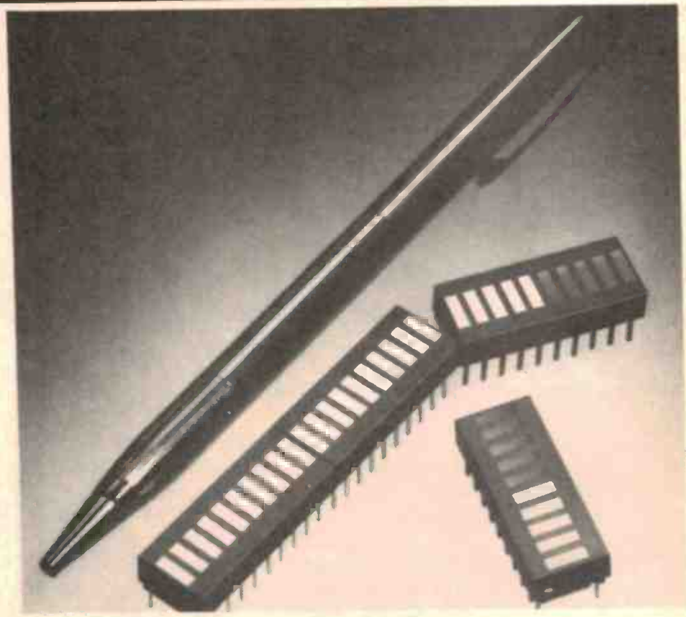
In addition, prices have been reduced by up to 20% for the HDSP-4800 bar-graph array family, which achieves both analogue and digital indication.

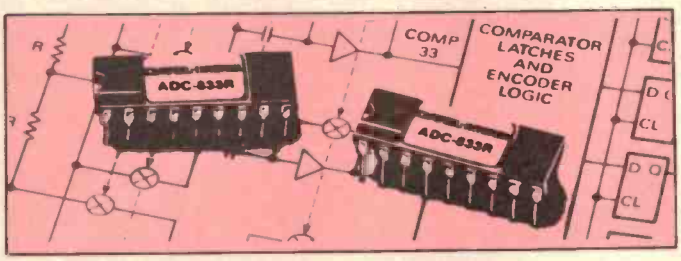
H-P bar-graph arrays are very bright, typically 1.2 mcd/segment at 10 mA for high-performance green, and also feature high segment-to-segment and on/off contrast. The segments are large (5.08 mm x 1.52 mm), which gives a wide viewing angle.

An exclusive feature is the package interlock, which ensures correct alignment for the longer arrays. A low package profile saves space between the display board and filter.

Yellow and green bar-graph arrays are categorised for dominant wavelength and all colours are categorised for luminous intensity. This assures a consistent front-panel appearance.

For more information contact **Hewlett-Packard Australia Ltd, 31-41 Joseph St, Blackburn Vic. 3130.(03)890-6351.**





Six-bit video flash A/D converter

The ADC-833 available from Datel-Intersil is a low power, six-bit video flash analogue to digital converter.

It can digitise an analogue signal at conversion rates up to 15 MHz with a power consumption of 200 mW. Two ADC-833s may be connected in parallel to increase the conversion speed from 15 MHz to 30 MHz.

The ADC-833 is available for operation over the industrial, −25°C to +85°C temperature range and is packaged in an 18-pin ceramic DIP.

The analogue input voltage range is +2.5 V to +10 V with minimal linearity error.

The digital outputs are buffered three-state and include an overflow output which allows the user to cascade two units to achieve seven-bit resolution. The buffers are controlled by two enable signals with a typical output enable delay of 20 ns.

More information is available from **Elmeasco Instruments Pty Ltd, 15 Macdonald St, Mortlake NSW 2137. (02) 736-2888.**

Telcon takes over Amtex Electronics

National Electrical Wholesaler, Telcon Australia Pty Ltd, has announced the acquisition of Amtex Electronics.

The range of products includes photovoltaic systems and components, switching power supplies and high voltage power supplies.

Telcon is located at **36 Lisbon St, Fairfield NSW 2165. (02) 727-5444.**

Tabtek's circuit-design course

Tabtek Electronics is to hold a two-week full-time seminar, covering all aspects of both NMOS and CMOS small scale to very large scale digital integrated circuit design.

To be held from August 15-26 at the University of Adelaide, the program of lectures, tutorials and project work will aim to teach participants how to rapidly implement digital systems in silicon.

The course outline is given under the headings: NMOS VLSI Design; CMOS Logic Design; CMOS Processing; Design Rules and Scaling; VLSI Design Methods; Subsystems and Chip Floor plans; Interfacing; Design Automation and Chip Assemblers; Simulation; VLSI Testing Methods and Reliability.

The principal lecturers will be Dr K. Eshraghian and Dr D. A. Pucknell; both are well-known as the authors of a series of lectures in VLSI system design. They will be supported by Tabtek engineers.

The $850 course fee covers design notes and use of the computing facilities, as well as luncheon and morning and afternoon tea.

For further information contact the **VLSI Systems Manager, Tabtek Electronics, P.O. Box 49, Rundle Street, Adelaide SA 5000. (08) 223-7267.**

General Manager for National Semiconductor

National Semiconductor (Australia) Pty Ltd has announced the appointment of John Eccleshall as General Manager.

Mr. Eccleshall will report to Curtis Reid, Managing Director.

In this newly created position, Mr. Eccleshall has responsibility for the component marketing operations in Australia, in addition to the company's research and development activities.

National Semiconductor (Australia) customises microprocessors to the specifications of the growing number of Australian manufacturers.

Texas Instruments Semiconductor guide

A new master selection guide of Texas Instruments' semiconductor products is available free of charge from Texas Instruments distributors, VSI Electronics and Rifa.

The 128 page guide covers all product areas including memory, digital logic, linear, telecommunications and microcomputers.

More information about the guide can be obtained from **Texas Instruments Australia Ltd, Semiconductor Marketing, P.O. Box 106, North Ryde NSW 2113. (02)887-1122.**

Audio remote control products

J A Wells Electronic Distributors has introduced a range of electromechanical audio frequency notch filters and tuning fork oscillators.

Both products, manufactured by the Swiss company Institut Straumann AG, are based on a tuning fork made from the temperature independent steel alloy Nivarox (as used in Swiss watches).

The tuning fork oscillator, OSC-204, is a low distortion oscillator meeting MIL specifications for shock vibration and environment. It is available at select frequencies within the range 1000-6000 Hz, with special frequencies from 960-6400 Hz on request. Ancillary modules for frequency division are also available.

The tuning fork is temperature compensated from −55°C to 85°C. Supply voltage is selected between 5 and 15 V.

The F-304 electromechanical filter employs two gas coupled metallic precision tuning forks with electromechanical transducers and is available at any frequency within the range 800-5000 Hz. The centre frequency tolerance may be specified from 50 ppm to 500 ppm with a temperature tolerance ±1 ppm/°K to ±5 ppm/°K.

We had the opportunity to briefly review the F-304 filter and a 1488 Hz OSC-204 oscillator here at ETI and can report that both performed very well indeed.

The F-304 had a −3 dB bandwidth of 2 Hz (at 20°C) and an insertion loss of only 9.5 dB (quoted spec. — 12 dB, +2, −3 dB). The centre frequency was better than 100 ppm (limit of our measurement).

The OSC-204, measured at 20°C was within 100 ppm (spec. — ±100 ppm) and the frequency variation for a supply voltage variation from 5 V to 10 V was only ±0.1 Hz.

The 'standard' F-304 sells for $170 (+S.T.) in quantities of 10-19, while the OSC-204 quality code C (pre-aging, greater than 100 hrs) sells for $62 (+S.T.).

Enquiries to **J A Wells Electronic Distributors, 8 Rainsford Court, Dingley, Vic. 3172. (03) 551-5979.**

ILP's latest transformer

ILP Electronics, of England, has added a 15 VA transformer to its range. It is fully encased in an ABS shell, with easy fixing by an M4 bush at the base.

Test runs have confirmed the demand for both the lower VA rating and the encased toroid, and the company is now planning to extend the facility to cover transformers up to 120 VA.

For further information, contact the Australian agent, **Electromark, 40 Barry Avenue, Mortdale NSW 2223. (02)533-4896.**

JAYCAR

Jaycar has had designed a high quality, high performance Video Enhancer which is specifically for the Australian 625 line 50 frame PAL-D system.
As far as we know it is the ONLY Australian-designed, Australian-built unit available!!
But, guess what? The Jaycar AV6501 Enhancer is CHEAPER than its inferior imported Asian counterparts!!
This unit is professionally designed and University tested! It works and it works well.

SPECIFICATIONS
- 1 Maximum enhancement, not less than +8.3dB @ 2MHz
- 2 Enhance disabled (Bypass) response, DC to 5MHz, −0.5+1.0dB.
- 3 Colour Subcarrier 0dB notch frequency, tunable to 4.43 MHz, −/+ 0.5dB, all settings.
- 4 Amplifier group delay, less than 0.075uS
- 5 Signal handling capability not less than 1.35 volts p-p. (Sync. is clipped first.
- 6 Power 12V AC @ 100mA
- 7 Controls, ON/OFF, ENHANCE, ENHANCE/BYPASS SWITCH, CORE/GAMMA CONTROL
- 8 Input connector, RCA socket
- 9 Output connector, RCA socket x 3

DESIGN FEATURES
- 1 A unity gain notch at the colour subcarrier frequency, whose purpose is to prevent chrominance to luminance errors at high enhance levels.
- 2 A closed loop configuration with lead lag compensation to achieve stable, well defined gain
- 3 DC coupling, eliminating large capacitors in series with the video signal and achieving DC response for applications requiring it.
- 4 Low output impedance prior to termination resistors, enabling up to three outputs to exist and be used or left unterminated
- 5 A level dependant closed loop response or Gamma control ('Core')
- 6 Clip on negative going signals at −67 volts into 75 ohms to prevent sync errors owing to overshoot.

VALUE
$49.50

Cat. AV6501

NOT A KIT
BUILT, TESTED
AND GUARANTEED
KIT VERSION
ONLY $39.50

VIDEO STABILISER

As many of you know, many video tapes — especially from the USA have the sync pulses suppressed to prevent unauthorised copying of the original dub. This process is fine because it hinders unauthorised re-recording (dubbing) of material. It is annoying though when you hire the original and find that the "Copyguard" is causing problems with your TV. The AV6502 re-inserts the sync pulses automatically and restores stability.
WARNING! The AV6502 is intended soley for the use above.
Whilst the AV6502 will virtually remove copyguard on a tape copy (and hence restore the picture) it is against the law to unlawfully copy copyright material.
Cat. AV6502

only $79

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Only $698

6 Colours

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OUTSTANDING!

Low cost colour computer with APPLE compatibility*

SPECIFICATIONS

CPU		R6502
ROM		16K Bytes
RAM		64K Bytes
BASIC	Interpreter	More than 90 instructions stronger than those for Apple II
Video	Type	Memory mapped into system RAM
Display	Mode	Text, low resolution graphics, high resolution graphics (3 modes are mixed).
	Screen Format	960 characters (24 lines, 40 columns)
	Character Set	Upper case ASCII, 64 characters
	Character Type	5 x 7 dot matrix
	Graphics Capacity	1920 blocks (low resolution) in 40 x 48 array, 53760 dots (high resolution) in 280 x 192 array
	Number of Colors	6 colors
Keyboard		49 alphanumeric and function keys
Cassette	Interface	Use various cassette tapes and cartridges
Software	Cartridge Interface	as data storage units
Printer	Interface	Connects to printers with Centronics I/F
Display	Interface	Connects to color TV or video display
Remote	Control Paddle	Used for education & entertainment
Speaker		8 ohm, 58mm, 0.25W
Power		A switching power supply is provided to convert AC power to required power supply
Dimensions		241 x 175 x 30mm

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- Text, Lo and Hi resolution graphics STANDARD
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- Easy-to-use manual included in the price (over 248 pages)
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- Centronics printer interface STANDARD
- Multitech BASIC is compatible with APPLE II BASIC. Most APPLE software will run on the Micro Professor MkII

Cat. YC1300

*Most Apple Soft II BASIC programs will run on the MPF II.

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KA1320	LE GONG	EA 3/81	$ 13.95
KA1346	PC BIRDIES SHORT FORM	EA 5/81	$ 14.95
KA1370	PHOTON TORPEDO	EA 9/81	$ 29.50
KA1400	METRONOME	EA 1/82	$ 16.95
KA1402	EPROM PROGRAMMER	EA 1/82	$ 59.00
KA1406	CUDLIPP CRICKET SHORT FORM	EA 2/82	$ 12.50
KA1408	DIGITAL STORAGE CRO ADAPTOR	EA 2/82	$110.00
KA1430	VOCAL CANCELLER	EA 4/82	$ 19.50
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KA1476	STEREO SYNTHESISER SHORT FORM	EA 9/82	$ 39.50
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KA1482	POWER UP KIT COMPLETE	EA 11/82	$ 39.50
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KA1500	LED HEAD SHORT FORM	EA 1/83	$ 9.95
KA1510	STEREO SYNTHESISER SHORT FORM	EA 4/83	$ 11.95
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KE4105	CAR ALARM	ETI 330	$ 29.50
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KE4220	150 WATT MOSFET AMPLIFIER	ETI 499	$ 79.50
KE4222	150 WATT MOSFET PREAMPLIFIER	ETI 498	$ 39.50
KE4225	BRIDGING ADAPTOR	ETI 479	$ 9.95
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Screen — 12"
Display area — 80 characters by 24 lines
Input — RCA
Bandwidth — 10Hz-20MHz
Input sig. 0.5 to 2.0 pp composite, sinc neg.
240V AC & 12V DC
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MICON DATA CASSETTE
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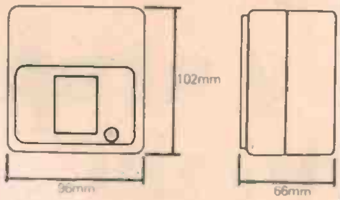
IR 20 Passive Infra-Red Detector

A truly extraordinary device. The passive IR detector is the classic adaption of military hardware for commercial use. This device is basically a box measuring 96(W) x 102(H) x 66(D)mm. On the front face is a "window" with a deep red IR filter across it. Directly behind the window is a high gain IR "antenna" or "lens" (choose which word you prefer). At the focal point of the antenna is a super-duper IR photodiode.
The heat radiated from a human body can be detected up to 20 metres away! The unit will operate reliably over a very wide temperature range and is not nearly as subject to the annoying "false triggering" found so often in microwave or ultrasonic surveillance systems. The microchip electronics in the unit ensures further reliable operation with a "memory latch" system. A LED on the panel indicates that the unit has been triggered.
Cat. LA5010



Specification

Range:	20 metres 90° field of view using 9 short range and 9 long range zones
Size:	96mm x 102mm x 66mm
Sensor:	Dual element pyro-electric detector
Temperature Range:	-10°C to 40°C
Alarm Memory:	LED alarm stored in armed state displayed in disarm state
Track Test:	LED operates in disarm state
Relay Output:	SPCO 1A 30V
Current Consumption:	25 mA typical at 12V DC
Supply Voltage:	12V DC (10-16V DC)
Weight:	200 g.

Only $149

Will directly interface with 90% of existing alarm systems. . .

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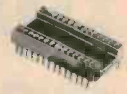

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1N914 DIODES — INCREDIBLE SAVINGS

The 1N914 (or 1N4148 if you like) is probably the most popular diode in the history of electronics. We probably use over 1,000,000 a year ourselves!!
We have made a bulk scoop purchase and for JUNE ONLY we can pass them on at great savings!
Because they are so low in price anyway, we must sell in minimum lots of 500.

Cat. No.	Description*	500	1,000	10,000
ZR1100	1N914/1N4148	0.035	0.028	0.02

Prices INCLUDE sales tax!!
* The glass envelope is really too small to have markings, however some are branded. We reserve the right to supply units that are the same size as the 1N914/1N4148 but are electrically superior.

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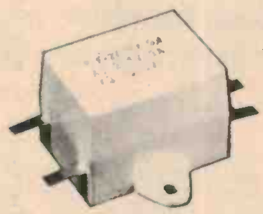

NEW

FROM $14.50

There are an enormous number of Desktop micros now having problems with mains borne interference.
Our MS4002 filter has been invaluable where mains interference is only marginal problem. This unit (illustrated) costs only $14.50 and is supplied with full data.
For much more serious problems, or when a free standing unit (not illustrated) is required the MS4004 is ideal. It will pass 2 amps (conservative) at 240V AC. This unit is a grey painted metal case that plugs into a standard mains socket. On one end of the case is an unswitched 240V outlet. Virtually the only thing that comes out of this socket is mains. All frequencies above 50 Hz are very heavily attenuated. Ideal for problem areas.

Cat. MS4002 $14.50
Cat. MS4004 $99.00

PCB MOUNT SCREW TERMINALS

FROM $1.25

We now stock two (2) types of 4 way and 8 way. Great for the rugged connection of 240V or other heavy duty wiring to PCB's when solderless disconnection may be required at a later date.

4 way Cat. HM3207 PRICE $1.25
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EXPERIMENTER'S MAGNET KIT

Magnets never cease to amaze — yet most of us know very little about them.
With this in mind Jaycar has had a special "Magnet Kit" produced.
The kit contains: 2 very powerful Ceramic magnets, flux concentrator, pole pieces and a short manual written by experts in magnetism. Magnet experiments are also shown as well as a technique to actually make your magnets stronger!!
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ONLY $4.95

9 VOLT BATTERY HOLDER/ CONNECTOR

ONLY $2.95 NEW

The 216 cell 9V battery is a common source of power for many projects. The problem is, however that they are difficult to mount. You usually end up letting the battery bounce around the box tethered to its battery snap. This great unit (pictured) enables you to secure the 9V cell as well as connect to it. Great for any portable equipment!
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New range of Super-Bright LEDs! Due to the incredible demand for our 200mCd super-bright LED, we have increased the range available. Now you can get super-bright in green & yellow as well as a new massively powerful 500mCd red! This new red LED will give you 500mCd @ 20mA or -wait for it - ONE CANDELA of light at 40mA! Remember, a typical 15 cent 5mm red LED gives only 1.8mCd at 20mA, the difference is staggering!

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ZD1790	200mCd SB Red LED	$ .69	$ .62
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JAYCAR

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A laboratory standard function and pulse generator

Part 1

Here is another of our laboratory standard test equipment projects. This function and pulse generator covers the range from 1 Hz to 1 MHz, generates sine, square, triangle ramp and pulse waveforms. It features digital readout and six output voltage ranges, from 10 V down to 30 mV peak-to-peak. It has positive- and negative-going pulse outputs and the pulse width can be set from one second to 100 ns in seven ranges. In addition, it can be swept by an external sweep generator (to come . . .).

David Tilbrook

APART FROM a good multimeter and a variable, protected power supply or two, every electronics workshop worthy of the title, and every electronics enthusiast of serious intent, *needs* a function generator of some sort with performance adequate for the various tasks the operator is likely to engage in.

Now, that's a pretty vague specification. These days, the 'various tasks' one can tackle might range from amplifier system performance checks to the design and construction of a microprocessor system. At some stage of the task being tackled, a signal source of some description will be a necessity, like as not. I had to set some sort of performance specification when setting out the initial requirements of this project and cast around for a good starting point.

The best starting point I could find was right under my nose: the Wavetek function and pulse generator we've had in the lab here at ETI for some years. Now, Wavetek is to function generators what Tektronix is to oscilloscopes, so I figured our generator was a fair place to start the process.

Our model 166 Wavetek covers 0.0001 Hz to 50 MHz. It has sine, triangle, ramp, square and pulse outputs (TTL level, positive- and negative-going). The function output can be varied from 0 to 30 V peak-to-peak (open-circuit, 15 Vp-p into 50 ohms). The output dc offset can be varied over ±10 V open circuit, ±5 V into 50 ohms. The frequency can be swept over a 1000:1 range, log. or linear. The output can be amplitude modulated and the waveforms can be triggered. On sinewave output, the distortion is less than 0.5% between 10 Hz and 100 kHz, rising outside those limits. The triangle linearity is greater than 99% between 0.005 Hz and 100 kHz.

The pulse output can be triggered, double-triggered, gated or swept. The pulse period is variable between 20 ns and 10 000 seconds while the pulse width is variable between 10 ns and 100 ms in seven ranges. The transition time is variable, too, from 7 ns to 50 ms in seven ranges. The amplitude, dc offset and frequency stability in linear mode (to 500 kHz) is ±0.05% over 10 minutes, ±0.25% over 24 hours.

They are the main performance parameters of the Wavetek 166. It has a circular frequency-setting dial with calibration markings around the skirt. The dial frequency also indicates the start frequency of a sweep range. It has served us extremely well to date. However, quite a few of the performance functions and features have not been needed.

The next question I posed was, what functions and features of the Wavetek could be done without or would not be required by the serious enthusiast or general electronics workshop?

For a start, the frequency range is probably far too wide. I settled on 1 Hz as being a practical lower limit after considerable discussion among staff and associates. This is low enough for a great many *slow* digital operations and in linear applications is good for checking loudspeaker drivers for 'poling', etc. The upper limit, I knew, would be somewhat dictated by the sort of technology I would be restricted to using, given the restraints of component availability and cost. Without looking at the latter too closely, I thought an upper frequency range of 1 MHz was a desirable goal.

GENERAL SPECIFICATIONS — ETI-166 FUNCTION/PULSE GENERATOR

Function outputs	sine triangle square sawtooth
Frequency range	1 Hz to 1 MHz in seven ranges (square to 100 kHz only)
Pulse outputs	positive going, negative going — TTL level with pullup to 5 V (repetition rate set by frequency control, 1 Hz to 1 MHz)
Pulse width range	1 sec. to 100 ns in seven ranges
Frequency display	3½-digit, 1 Hz gate time, 1.000 Hz to 1.000 MHz
Sinewave distortion	typically less than 2% THD; diode shaped
External sweep input	sweeps generator over one-decade range; 1 V peak
Output voltage ranges	10 V, 3 V, 1 V, 300 mV, 100 mV, 30 mV (peak-to-peak)

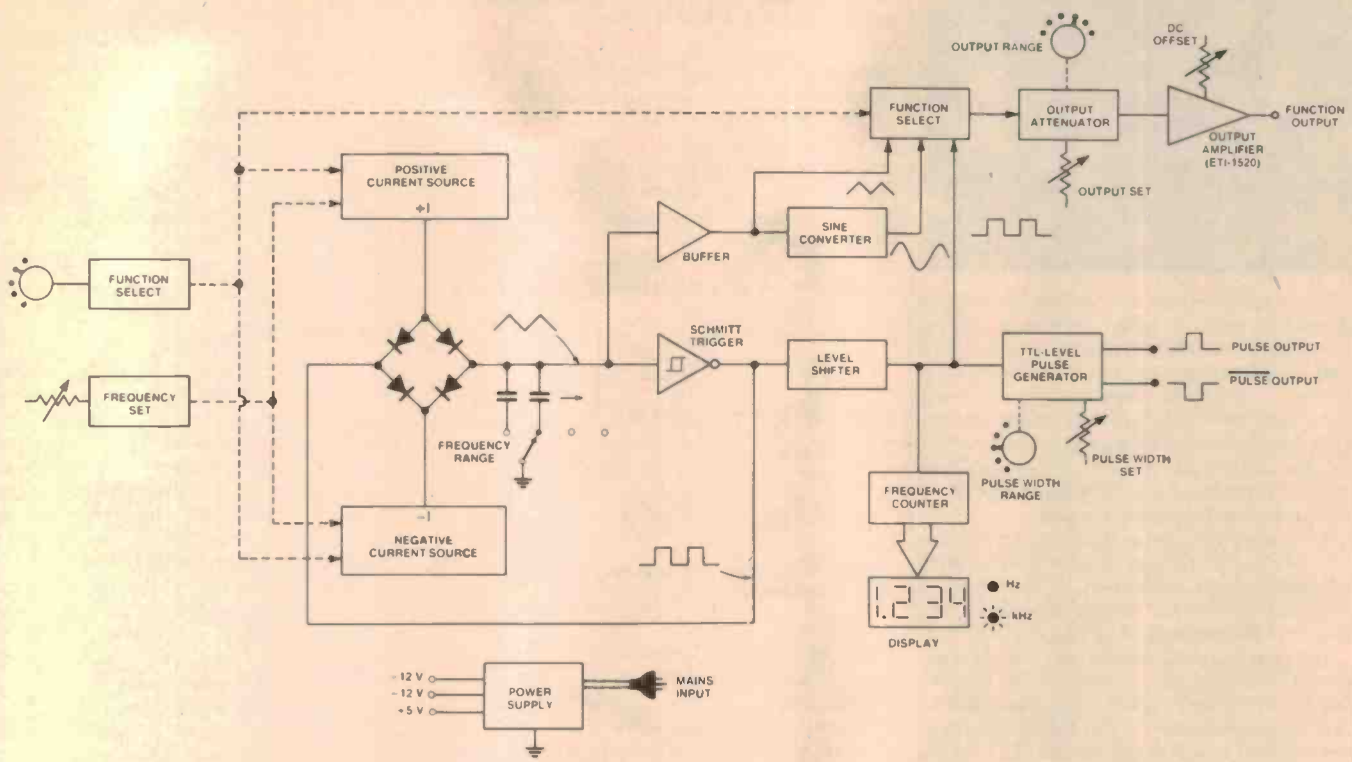


Figure 2. Block diagram of the ETI-166.

Two constant-current sources, +I and −I, are at the heart of the main oscillator. A diode 'steering' network, **diodes A-B-C-D**, allows +I to charge the integrating capacitor and −I to discharge it. The frequency range switch selects the integrating capacitor required. The oscillator works like this: let's assume the **Schmitt trigger** output is high (+ve) to start with. Diode D will be reverse-biased and diode C will be forward-biased, reverse-biasing diode B. Diode A is forward-biased and thus the integrating capacitor will be charged by +I.

The voltage on the capacitor will rise linearly until it reaches the upper threshold of the Schmitt trigger. The Schmitt's output will then swing negative, reverse-biasing diode C and forward-biasing diode D. This reverse-biases diode A, and diode B will thus be forward-biased, allowing −I (a current **sink**) to discharge the capacitor.

The voltage on the capacitor will fall linearly until it reaches the lower threshold of the Schmitt trigger, whose output will then revert to the high state, commencing the process once again.

As the diagram shows, the capacitor voltage is a triangular wave, while the Schmitt trigger output is a square wave.

By varying the actual current sourced and sunk from +I and −I, the oscillator frequency can be varied. Thus, voltage or current control of the frequency can be incorporated and the **frequency set** control is a potentiometer. To produce a sawtooth wave, the charge and discharge currents have to be different.

For a **ramp-up** wave, the integrating capacitor is discharged quickly by increasing the current sunk by −I. For a **ramp-down** wave, the capacitor charge current supplied by +I is increased.

This is achieved by the **function select** control.

The capacitor voltage signal is buffered and the triangle/sawtooth wave passed to the **function select** module. To produce a **sinewave**, the buffered triangle wave is passed to a **sine converter**, whose output passes to the **function select module**.

The Schmitt trigger output is passed to a **level shifter** so that the square wave signal swings between 0 V and the +ve supply rail. The **frequency counter** takes its input from this point, as does the TTL-level **pulse generator module**. The latter produces complementary pulse outputs with very fast rise and fall times. This employs a TTL monostable multivibrator, a switch selecting appropriate capacitors for the **pulse width range** and a pot. providing **pulse width set**.

The output of the function select module passes to the **output amplifier** via an **attenuator**. The output amp. includes a **dc offset** adjustment that can be varied with a pot.

Sweep-generation circuitry has not been included in the ETI-166, simply because we couldn't fit it in a reasonably-sized off-the-shelf case! Apart from that, we realised that a stand-alone sweep generator could be used with many of the commercially available signal generators so would be suitable as a project in its own right.

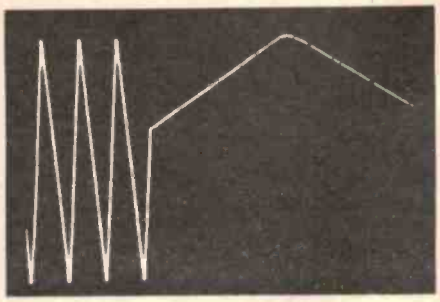
Constructionally, the ETI-166 has been divided into logical modules — the main generator, the frequency counter and display and the output amplifier. The latter has been dubbed Project 1520 and appears elsewhere in this issue. The other modules will appear in following issues.

What about the function outputs? They were obvious: sine, triangle, square, and ramp-up/ramp-down. The pulse outputs were a little trickier. The general consensus was that it would be desirable to set the pulse width over a wide range and that variable transmission time was rarely required. As TTL level outputs with resistive pull-up suit both CMOS and TTL circuitry, TTL level outputs only were settled on. Complementary outputs (negative- and positive-going pulses) were considered to be desirable.

The function output level, and the desirability of dc offset adjustment, came in for much discussion. Should the generator be capable of driving a 50 ohm load at some tens of volts peak-to-peak, or was some other arrangement tolerable and easier to achieve? A search through the data books and a little quick experimentation soon settled the question. The former was certainly possible and considered generally desirable.

The goal was to get a maximum output level of 10 Vp-p into 50 ohms (20 Vp-p open circuit) right across the frequency range — a tall order, because the output stage is required to deliver around a quarter of a watt. In addition, it would need to have a bandwidth of at least five times or more than the frequency range of the generator to accommodate the harmonics that go to make up the non-sinusoidal functions.

The ability to vary the output range between zero and a defined maximum is desirable. The Wavetek has an 'output attenuator' variable in 20 dB steps, but from experience we had found the intervals too great on many occasions so I settled on having 10 dB steps for the output attenuator on this generator. As the dc offset facility had come in handy — particularly when working with digital circuitry — provision had to be made for that, too. Much digital work is done with high-level signals, while much audio work is done with low- and high-level signals, ranging from millivolts to volts. The output attenuator has to cope with those requirements. ▶



◀ **A real smoothie.** Output of the triangle wave generator at 1 MHz; expanded trace on the right.

Then came *sweep*. The ability to sweep a generator over a given frequency range, particularly where you can preset the 'start' and 'stop' frequencies, can be extremely handy. It might be something rarely used, but when you need it, there's *no satisfactory substitute*. Some applications, particularly in the audio field, require sweep facilities often. There was no getting away from it — the sweep facility was necessary.

Triggered and gated signals are used less often, except in certain specific fields — such as loudspeaker evaluation. It was decided that this generator could do without the nicety of triggering and gating facilities.

An important consideration on any generator is frequency readout. There are two fundamental ways one can approach this — the mechanical way or the digital way. The mechanical way has the advantage of being cheap and pretty direct. The Wavetek 166 has a calibrated skirt on the frequency knob. That's fine, except in those (increasingly numerous) applications where you need to know the frequency to, say, 1 Hz in 1 kHz. Out with the digital counter! That's all right, except where you need to use the counter for other things while you're using the generator.

I opted for digital frequency display. This gave me an additional option — the ability to use a 10-turn potentiometer in place of a conventional pot. for the frequency setting control. You don't have to, but the possibility is there.

The basic functions and features settled on turned out to be:

- 1Hz to 1 MHz frequency range
- sine, triangle, square, sawtooth (ramp-up and ramp-down) and pulse outputs
- TTL level positive- and negative-going pulse outputs with variable width
- sweep facility
- output voltage range from millivolts to at least 10 V
- dc offset provision
- digital frequency display.

As the project was to be part of the 'lab-standard' series, I next had to define 'lab-standard' with regard to function generators.

The definition

This proved a difficult task as there are conflicts between *desirable* performance and *reasonably achievable* performance. It's like saying a desirable goal for a jogger would be to jog up Mount Everest and back, but it's one that is hardly reasonable to achieve. Keeping that in mind, I set about putting numbers to the various performance figures required of the generator project.

An obvious first one is sinewave distortion. Wavetek's lower cost, lower performance function generators quote a sinewave distortion figure of 1% to 500 kHz for a generator going to 5 MHz. Other brands quote 2% to 5% distortion figures. If you want to measure the total harmonic distortion of an audio amplifier, then you really need a special low-distortion oscillator. Thus, it seems to me that a sinewave output distortion of 1% to 2% would be tolerable, if not more than adequate.

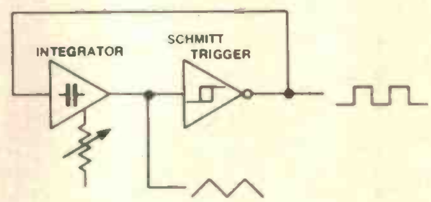


Figure 1. Fundamental arrangement of a function generator oscillator.

Triangle and sawtooth linearity should be at least 95%, preferably close to 99%, right across the frequency range.

Frequency readout is important. When messing around with audio filters, modems and the like, the ability to measure at least 1 Hz in 1 kHz is highly desirable. A simple 3½-digit counter will allow you to read 1 Hz in 2 kHz (for argument's sake . . .), which is quite sufficient in a huge variety of applications. If you want more accuracy than that, then it's time to dig out your six- or eight-digit counter!

The output attenuator, as stated earlier, needs to be able to provide signals down in the millivolt region on one hand, yet the maximum output level desirable was set at 10 Vp-p. Then there's the 10 dB steps. Well, all that's pretty simple. A six-range attenuator will give steps of 10 V, 3 V, 1 V, 300 mV, 100 mV and 30 mV. A pot. simply allows infinite variation over whatever maximum level range is set on the attenuator.

The pulse width range was not so difficult to define. From experience, pulses greater than one second wide are not often encountered or required, so that fixed a reasonable upper limit. Pulses around 100 nanoseconds wide are encountered more often, as well as a whole host in between. A vernier control would permit variation up to a set maximum pulse width. Thus, I made the pulse width ranges 100 ms-1 s, 10 ms-100 ms, 1 ms-10 ms, 100 us-1 ms, 10 us-100 us, 1 us-10 us and 100 ns-1 us.

For the sweep function, being able to sweep over a three-decade range (1000:1) is desirable, but problematical to achieve. I settled for being able to sweep the generator over any one-decade range.

We found the modulation facility of the lab. Wavetek was rarely used. That sort of thing's essential on an RF signal generator (. . . all right, all right — we'll get round to it), but of rare application in a function generator such as this. Hence, no modulator.

I decided that providing gating facilities on the function output was a specialised application. If you need it, then the ETI-124 Tone Burst Gate (Nov, '75) should suit most applications.

The technology

The fundamental circuit of a function generator is shown in Figure 1. This consists of an op-amp integrator followed by a Schmitt trigger with a feedback path between the Schmitt trigger's output and the integrator's input. Such a circuit is arranged such that, at power-on, the Schmitt trigger output goes hig and charges the integrator's capacitor. The integrator's output rises linearly until the Schmitt trigger's upper threshold is reached, where the output goes low. The integrator's capacitor then discharges linearly until the Schmitt trigger's lower threshold is reached, where the output reverts to the high state once again.

The variable resistor in the diagram is there to indicate that the integrator's charge and discharge rate can be varied (the rates will be the same), thus varying the oscillation frequency as the time taken to reach the Schmitt trigger's upper and lower threshold is varied.

To obtain a sinewave, the triangular wave output is rounded, or 'shaped', with a special circuit. Sawtooth waveforms are generated by having different charge and discharge times for the integrator. A 'ramp-up' waveform is generated by charging the integrator's capacitor slowly and discharging it quickly. A 'ramp-down' waveform is obtained by charging the capacitor quickly and discharging it slowly.

There are a number of special ICs available that provide the fundamental circuit blocks to make a function generator. The XR2206 and the 8038 are probably the most well-known ones. Unfortunately, neither meets most of the performance requirements set down earlier in this article. At best, the XR2206 will only get to 150 kHz and the waveform 'trueness' begins to fall off once it gets past about 20 kHz. It's a fine IC for non-critical applications, such as a low-cost 'knockabout' function generator. The 8038 is better — it will comfortably get to 500 kHz, but, again, waveform trueness is nothing wonderful well below that limit.

To meet the requirements set down earlier, I had to tackle the project in discrete 'blocks'. The block diagram in Figure 2 is the result. That is the overall block diagram of the ETI-166 Function/Pulse Generator.

Constructionally, the ETI-166 has been divided into logical modules — the main generator, the frequency counter and display and the output amplifier. The latter has been dubbed Project 1520 and appears elsewhere in this issue. The other modules will appear in following issues. ●

Wideband amplifier module

Here is a wideband amplifier capable of driving a 50 ohm load with an output capability of 10 volts peak-to-peak. It has many applications, e.g: improving the sensitivity of a CRO or a counter, as a video amplifier or boosting the output of a signal generator.

David Tilbrook

THIS PROJECT is, in effect, the first part of the ETI-166 Function Generator, the remainder of which will be described over the next few issues. We decided to publish this section of the function generator separately so that a separate pc board could be designed and made available for any application needing a low distortion, wideband amplifier, such as a transmission line driver or video amplifier.

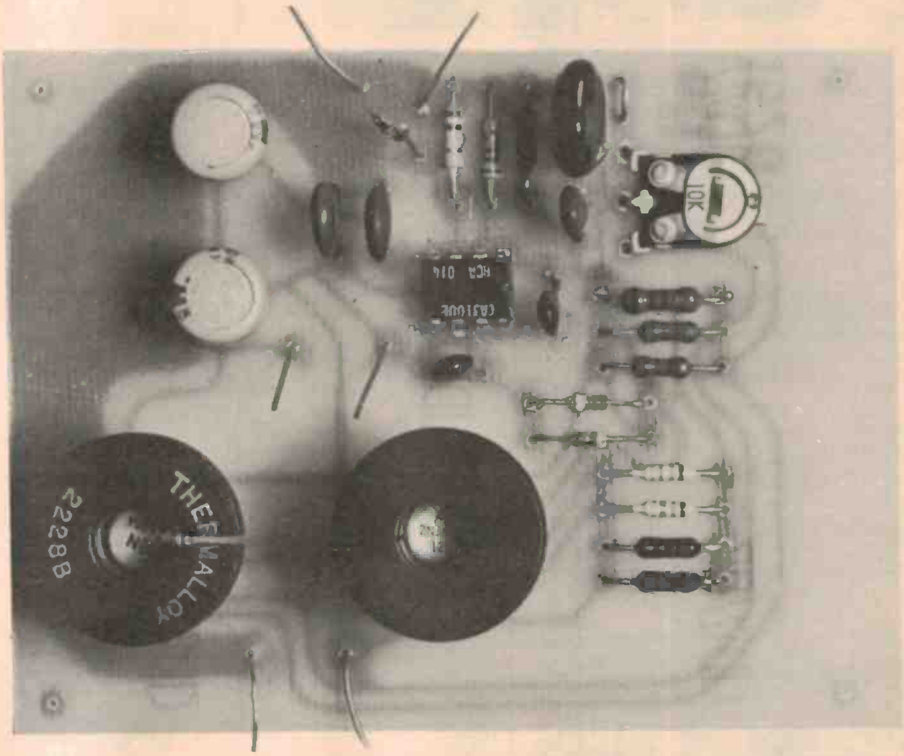
In the Function Generator this project is used as the output amplifier since its wide frequency response and 50 ohm output impedance enable it to provide large signal level sine and triangle waves (up to around 8 V peak on a 12 V supply) to a broad range of load impedances.

In order to keep both the design and the construction relatively simple it was decided to use an integrated circuit, if possible, to form the basis of the project. The main problem was to find a device capable of the necessary speed.

In order to produce a 10 V peak-to-peak triangle wave at a frequency of around 1 MHz, a slew rate of approximately 30 volts/microsecond would be a necessary minimum. Although this is not beyond the capability of a number of high speed operational amplifiers, some of these devices achieve a high slew rate by means of a relatively complicated 'feed forward' technique which can make the device prone to instability on some types of load. Furthermore, some of these devices have poor gain at high frequencies even though their slew rate figures are good.

After a look at the devices available, the CA3100 wideband op-amp was chosen. This device is manufactured by RCA and is almost ideally suited to this application. It combines both high slew rate and good gain at high frequencies. It is also convenient to use since it has a standard op-amp pinout.

The output drive capability is, of course, not sufficient but this is easily solved by following the op-amp with a unity gain emitter follower stage. This results in a general purpose wideband amplifier capable of driving a 50 ohm load and having a slew rate around 40 V/us. The bandwidth of the circuit is approximately 15 MHz for a 1 V RMS output signal level.



SPECIFICATIONS ETI-1520 WIDEBAND AMP MODULE

Gain	9.2 x (approx. 20 dB) depends on R4		
Maximum output voltage swing	10 V peak-to-peak into 50 ohm load with +/−15 V supply (20 Vp-p no load)		
Frequency response before slew rate limiting (power bandwidth)	dc — 1.3 MHz (20 Vp-p output) dc — 2.2 MHz (10 Vp-p output) dc — 4.5 MHz (5 Vp-p output) (below 5 Vp-p output, feedback limits top end frequency response)		
Frequency response	dc — 5 MHz +0, −3 dB dc — 13 MHz +0, −10 dB dc — 30 MHz +0, −20 dB		
Distortion (at 1 V RMS output)	@ 20 Hz 0.03%	@ 1 kHz 0.03%	@ 20 kHz 0.03%
Noise (20 kHz bandwidth)			
Input terminated by 1k	10 nV/ Hz		
Input short circuited	8 nV/ Hz		
Current consumption +/−15 V supply rails)	25 mA (no load)		

ALTRONICS KITS COST MORE

[Around $1 more]

REASONS ★ PREMIUM COMPONENTS USED eg. MOTOROLA, FAIRCHILD etc. ★ QUALITY INSTRUMENT CASES SUPPLIED WHERE INDICATED ★ EVERY LAST NUT AND BOLT SUPPLIED, EVEN SOLDER ★ IC SOCKETS SUPPLIED WHERE INDICATED.

Your finished product will look so good your friends won't believe you built it.

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Based on EA LM 317K Project
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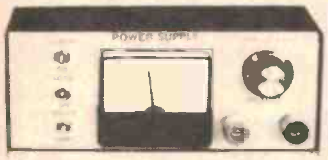
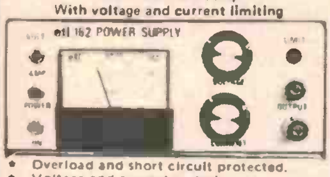


- Fully projected from thermal runaway and short circuits.
- Voltage and current metering.
- To–3 regulator plus powerfin heatsink.
- Fully documented, every last part included.

K3200. . . . . $42.50

ETI 162 BENCH SUPPLY

1.3 – 30V @ 1 Amp
With voltage and current limiting



- Overload and short circuit protected.
- Voltage and current metering.
- Regulation — better than 0.2% zero to full load
- Hum and noise on output — less than 1MV at full load.
- LED indication of current limit.

Exclusive — fully S.E.C. Certified Mains Transformer supplied.
If you're considering buying this kit from your local supplier or one of our competitors — first ring and ask them if the mains transformer is S.E.C. certified to ASC126 — chances are that it won't be.

K3205. . . . . $49.50

DUAL TRACKING POWER SUPPLY

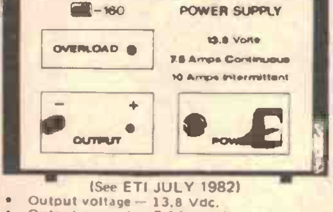
± 1.3 to ± 22V @ 2 AMPS : + 5V @ 0.9 AMPS

The ideal power supply for the audiophile experimenting with linear OP amp designs in which split supply operation ensures improved distortion and noise figures.

- Fully protected against short circuits, overloads and thermal runaway.
- LED indicator for regulator dropout.
- Floating ground.
- Uses 0.25% linearity 10 turn pot — tracks within 1MV.
- Voltage adjustable to within 10MV.

K3220. . (EA MARCH 1982) . . $86.00

13.8V HIGH CURRENT SUPPLY



(See ETI JULY 1982)

- Output voltage — 13.8 Vdc.
- Output current — 7.5A continuous 10A intermittent
- Regulation — 0 to 7.5A : 50MV

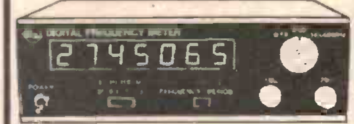
Save the expense of a mains powered rig. Kit complete in every way.

K3250. . . . . $84.00

DIGITAL FREQUENCY METER

7 Digit Resolution, measures period and frequencies to • 500 MHz

Professional unit — cost a fraction of similar built-up units.



This project is "so easy to construct", virtually all components mount on one single PCB, ensuring success even for the "not so experienced" constructor.

Use of the latest LSI circuitry ensures impeccable performance from the completed unit. This is further ensured by our use of top grade components.

NOTE: (Altronics use only the specified intersil LSI — beware of inferior kits that do not conform to the original design.

Frequency measurement to 500mHz (with optional Prescaler) in 3 ranges — 0–10MHz, 0–50MHz, 10–500MHz • 4 gating times — 0.01, 0.1, 1, 10 seconds.

Period measurement for accurate low frequency counts, 4 ranges — 1, 10, 100, 1000 input cycles • resolution 0.1us.

High input Sensitivity — 10MV to 30MHz, 100MV at 50MHz @ 1MOHM input impedance, 200MV @ 500MHz @ 75 OHMS input impedance.

Accuracy — typically better than 0.005% uncalibrated.

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- IC sockets provided throughout
- low aging 10.000 MHz XTAL.
- Genuine Fairchild High Brightness FND 507 display's.
- Quality ABS plastic case — deluxe front panel.
- Complete kit as specified by EA includes instructions, all cables and every last nut, bolt and washer.

K2500 . . . . $119.50

DECIMAL POINT FOR K2500

READ FREQUENCY DIRECTLY IN MHz and PERIOD IN US.

K2502. . . . . $7.50

PRESCALER FOR K2500

ALLOWS FREQUENCY MEASUREMENT TO 500MHz

K2501. . . (essential option) . . . $26.00

TRANSISTOR TESTER

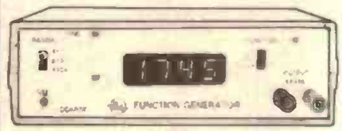
Electronics Australia Project. Tests Bipolar Transistors, Diodes, Fets, SCR's and PUT's. Excellent service aid for the hobbyist and serviceman. Complete kit and instructions.

K 2525. . . . . $19.75

FUNCTION GENERATOR

(with digital display)

Sine, triangle and squarewaves : 15Hz – 250KHz.



The most essential piece of test gear (second only to a good multimeter) on any hobbyist's bench is some kind of audio signal generator. This design utilizes the latest circuit techniques to produce stable, low distortion waveforms.

A truly versatile unit at a bargain price.

- 4 digit frequency readout (eliminates tiresome dial calibration) —typical accuracy ± 2%.
- 3 overlapping ranges x1, x10, x100.
- 600 OHM Nominal Output — continuously variable 3MV–2.5V P–P.
- Distortion — sinewave : less than 0.7% @ 1KHz.
- Linearity — triangle wave : better than 1% @ 1KHz.
- Squarewave rise time — 6V/uz maximum output.
- Amplitude stability — better than 0.1dB on all ranges.

With the exception of the display all components mount on a single PCB making this kit suitable for all constructors.

K2505 . . . . $85.00

DIGITAL LED CAPACITANCE METER

K 2521 . ONLY $55.00

with Deluxe Instrument Case

NEW DELUXE FINISH

We are pleased to announce the release of the Digital Capacitance Kit housed in our Deluxe H 0480 ABS Insrument Case.

This superb Test Instrument Kit now compliments our top selling Digital Frequency Counter and Function Generator Project Kit.

Electronics Australia Project. Measures capacitance of both polarized and non-polarized capacitors from 1 picofarad to 99.99 microfarads in 3 ranges.

Check values of unmarked capacitors, especially those little trimmers that are never coded.

Select precise values for filters and timing networks within ease.

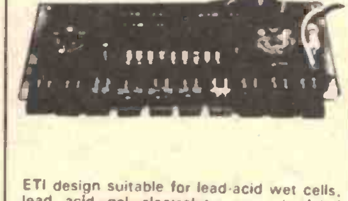
• • • EXCLUSIVE TO ALTRONICS • • •

Each kit includes precision measured capacitors for accurate calibration of each range.

STANDARD VERSION K 2520
(In metal case) Same Specifications. . $49.50

EXPANDED SCALE LED VOLTMETER

HAS MANY APPLICATIONS



ETI design suitable for lead-acid wet cells, lead acid gel electrolyte, vented nickel cadmium types and so on and so on.

Unit covers range of 10.5v to 15v.

Determine battery condition instantly

Easy to Build!

K 4326. . . . . $9.50

ANALOG / DIGITAL STORAGE CRO ADAPTER

(See EA Nov 1980 and March 1981).

Unit enables indefinite storage of non-repetitive waveforms at a fraction of the cost of conventional storage CRO's. National semiconductors A—D/D—A conversion techniques allow analog signals up to 100KHz to be stored • two channels while in digital mode • positive and negative edge triggering • AC/DC/HF and LF rejection • timebase tracer for accurate frequency measurement • accurate down to 1.9Hz Analog mode — 1us Digital Mode • delayed trigger 10us-1s • sensitivity — 160MV P—P @ 1 MEG (Analog)• standard TTL and CMOS levels 3-15 volt supply (Digital).

The features of this unit are to numerous to list, yet is simple to operate.

Be assured of quality with an Altronics Kit.

1. Genuine National A—D conversion chips not second sourced dropouts.
2. All IC sockets provided (27 total — you pay no more)
3. Low capacitance coax and a full metre of rainbow cable.
4. Full instructions and every last nut, bolt and washer.
5. Deluxe mini rack cabinet.

K2600. . . . . $189.00

MICROWAVE OVEN LEAK DETECTOR

ETI PROJECT
Completely passive project receives microwaves via an antenna which develops a voltage across a detector diode driving the meter.

Monitor your microwave oven with this easy to build kit. All components mount on single PCB, including the meter.

Genuine Hewlett Packard Hot Carrier Diode supplied.

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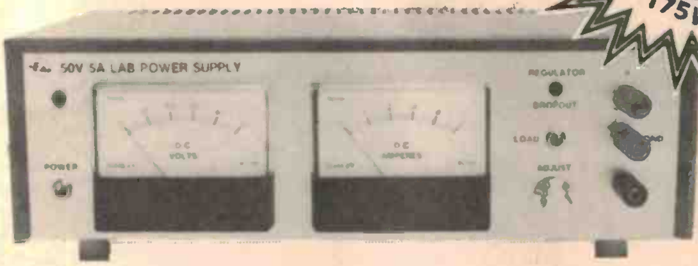
2-50V DC at a massive 175W



See Ea May and June 1983

Over the last 2 or 3 years we have had literally dozens of requests for a universal 5 amp Bench Power Supply Kit. Naturally we passed this on to the design team at Electronics Australia and at last it is now a reality. Just look at the design concept! A fully mains transformer isolated supply with a very clever "Switch Mode" low voltage circuit.
Most importantly it's dead easy to build (ours worked first time!).

Specifications
Input 240V 50Hz
Output Variable 2 – 50V at up to 5 amps

K3300.................. **$139.50**

10 TURN VOLTAGE CONTROL OPTION

K3301..........(ONLY)... **$10.00**

HANDY + / – 12 V OPTION (SEE EA JULY 1982)

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WHY PAY OVER $250 FOR AN INFERIOR COMMERCIAL UNIT?

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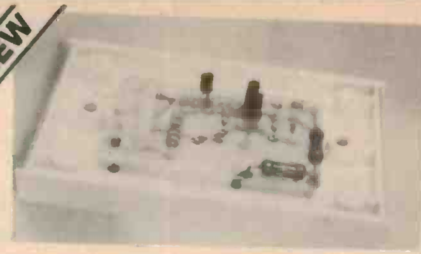

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Instantly turn lamps on and off with just a light touch on a wall panel, or provide mood lighting by touching the panel for a few seconds.
The Altronics Kit is complete in every way, including satin silver touch plates for that prestigous look.

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DESIGNED FOR THE MICROBEE

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Display RTTY encoded messages on your VIDEO Monitor.
Simple circuit uses PLL TECHNIQUES, most components mount on a single PLB simplifying construction. Complete Kit includes D15 Plug for connection to Microbee IN/OUT PORT.

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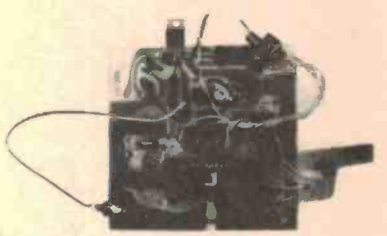

VERSATILE, LOW COST & EASY TO BUILD
Great new project from ETI (Jan. 1983). All components mount on a single printed circuit board. Unit simply plugs into the Microbee I/O port. Suitable for 2716, 2732, 2532, 2732A and 2764's. Burn your games programmes and eliminate cassette loading times ★ Zero insertion force IC socket for eproms ★ Sockets for all other IC ★ 1 x 2716 supplied — get started straight away. ★ Kit supplied in deluxe jiffy box, all mounting hardware included

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VIDEO RF MODULATOR

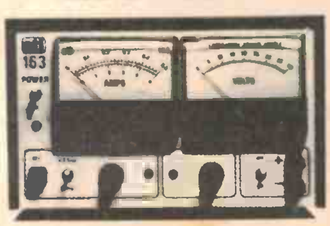
(SEE ETI OCT. 1981)

If you cannot afford a Video Monitor for your computer this is the kit for you. Super stable oscillator design and very low modulation distortion ★ Works with both B & W and Colour TV sets ★ Suitable for computers, TV games, TV pattern generators or what have you. Deluxe kit featuring heavy duty diecast box for RF shielding ★ Input and output sockets.

K9760 **$17.50**

LABORATORY POWER SUPPLY 0-40 VOLT/5 AMP

(SEE ETI MAY & JUNE 1983)



FEATURING: VARIABLE CURRENT LIMIT·DUAL METERING

A Laboratory Supply requires specifications second to none!

Output voltage	0-40 V, variable
Output current	0-0.5 A, variable limiting 0-5 A, variable limiting
Output regulation	<50 mV at up to 2.5 A <100 mV up to 5 A
Maximum output power	200 watts
Metering Voltage	0-40 V in 1 V divisions
Current	0-0.5 A in 20 mA divisions 0-5 A in 200 mA divisions

Series regulator design enables design and development of sensitive high gain audio and RF circuitry free from hum and noise sometimes associated with other techniques.

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GO ANYWHERE 240V PWR. KITS

See EA May and June 82. These great new inverter kits enable you to power 240V appliances for your car, caravan or boat. (From Standard 12V car battery.)

40 WATT

Suits small appliances, i.e. turntable, tape deck, shaver etc. Variable frequency adjustment enables accurate speed control of turntable motors.

IC Sockets Provided

K6700 .... **$55.00**

300 WATT

Fully regulated and overload protected XTAL locked frequency.

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NOW USING HIGH EFFICIENCY TRANSFORMER

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Use to power hi-fi, TV sets and for emergency lighting.

- Gold plating on both PCB edge and edge connector.
- Low age rate parallel resonant XTAL used.
- Sockets for all IC's.

K6750 .... **$199.50**

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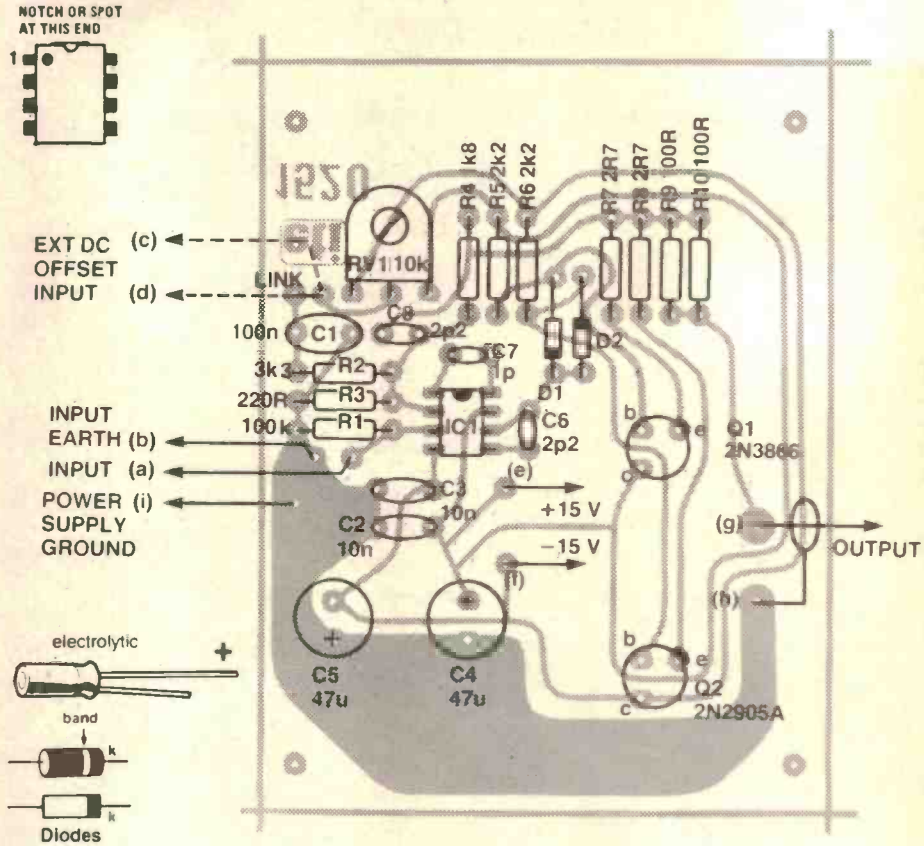
Since the amplifier is dc coupled, a dc offset control has been included to enable the output dc level to be set to any voltage required.

In the ETI-166 Function Generator the output dc level is adjustable by means of a front panel potentiometer and this is accommodated using the optional dc offset input provided on the amplifier.

If this is not required in a specific application the on-board dc offset preset can be selected by fitting the appropriate link on the pc board.



Construction

Construction is fairly simple using the ETI-1520 pc board layout. Since relatively high frequencies are encountered, the layout and construction will affect performance. For this reason, an IC socket should not be used. The pc board layout should not be altered unless you have access to the test equipment required to ensure that performance has not been degraded.

Commence construction in the usual way by soldering the resistors and capacitors in place first. Be careful to orient C4 and C5 correctly since these are electrolytic capacitors. Keep all lead lengths as short as possible.

Solder the diodes, transistors and the IC in place, again ensuring that these devices are inserted with the correct orientation. Pin 1 of the IC is shown on the diagram accompanying the main circuit diagram.

A diagram showing the pinout of the transistors has also been included. The emitter of these devices is the pin closest to the metal tag on the case of the device.

If the internal dc offset preset is to be used solder this in place after bending the leads so that the preset will lie flush against the pc board. Fit a link as shown on the component overaly to select the preset.

Once all the components are soldered correctly make a final check of the orientation of all polarised components. If all is well connect a ±15 V supply and power up.

Usually the dc offset will be required to be zero to ensure maximum output signal level and symmetrical clipping. Connect a voltmeter between the output and earth and adjust the offset pot so that the dc voltage on the output is zero.

The amplifier will work correctly on lower supply voltages than the ±15 V recommended, except that slew rate and frequency response are decreased. The RCA data sheet includes a curve showing the relationship between open-loop bandwidth and supply voltage (see opposite page). The supply voltage should not be allowed to increase above ±15 V since this is the maximum voltage recommended for the op-amp.

If the amplifier is to be operated from the same supply as other circuitry, ensure that the supply is reasonably free of noise. Although the amplifier has supply decoupling capacitors on the pc board most devices responsible for noise on supply lines tend to have low source impedances.

The noise generators are therefore capable of charging and discharging the filter capacitors at the frequency of the noise. Increasing the value of the capacitors is usually ineffective since a very large increase is usually required.

The only effective solution is to increase the source impedance of the noise generators, and this is best done by fitting small value resistors in series with the supply lines. These resistors have not been included on the pc board since the value required (if they are required at all) is determined entirely by the particular application.

A good choice for most applications would be around 3R3, producing only a 1 V drop at the maximum possible output current. This value may be insufficient if the supplies are extremely poor. In most cases these resistors will be entirely unnecessary and should only be used if a definite problem exists.

In some applications it may be necessary to fit the output transistors with small heatsinks. If, for example, the amplifier is used to drive a 50 ohm load at low frequencies the instantaneous power dissipation in the output transistors will be around 1 W and a small heatsink should be used.

The best way to determine if a heatsink is required is to power up the unit and check the temperature of the output transistors. The transistor cases should be kept at a temperature that is comfortable to touch, and this will correspond to around 40 or 50 degrees Celsius.

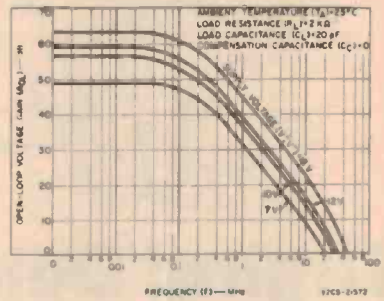
PARTS LIST — ETI-1520

Resistors	all ¼ W, 5% unless noted
R1	100k
R2	3k3
R4	1k8
R5,R6	2k2
R7,R8	2R7
R9,R10	100R, ½ W
RV1	10k vert. mount trimpot
Capacitors	
C1	100n greencap
C2,C3	10n ceramic
C4,C5	47u/25 V single-ended electro.
C6	3p3 ceramic
C7	1p ceramic
C8	10p ceramic
Semiconductors	
D1,D2	1N914
IC1	CA3100E
Q1	2N3866
Q2	2N2905A

Miscellaneous

ETI-1520 pc board; transistor heatsinks — Thermalloy 2228B or similar (if needed).

Price estimate $12-$15



Performance. Open-loop gain versus frequency for the CA3100.

HOW IT WORKS ETI-1520

The project employs a wideband, high-speed op-amp (IC1) operated from split supply rails, followed by a unit gain emitter follower stage (Q1, Q2) that provides some output current gain so that the amplifier can drive low impedance loads.

The op-amp chosen is a CA3100. Input signals are applied to its non-inverting input via terminal (a). R1 determines the overall input impedance. The output of the op-amp, pin 6, drives the emitter follower output stage. As split supplies are used, a complementary pair of transistors is employed, Q1 and Q2. Diodes D1 and D2 maintain a potential of about 1.2 V between the bases of Q1 and Q2.

As pin 6 of IC1 swings positive Q1 turns further on and Q2 turns further off and the output voltage goes toward positive. As pin 6 of IC1 swings negative, Q2 turns further on, Q1 turns further off, and the output voltage goes toward negative.

Resistors R5 and R6 provide a small amount of bias for the emitter follower stage, while resistors R7 and R8 ensure current sharing between Q1 and Q2. Resistors R9 and R10 establish the output impedance at 50 ohms.

Overall feedback is provided by R4 and R3 and the gain is equal to:

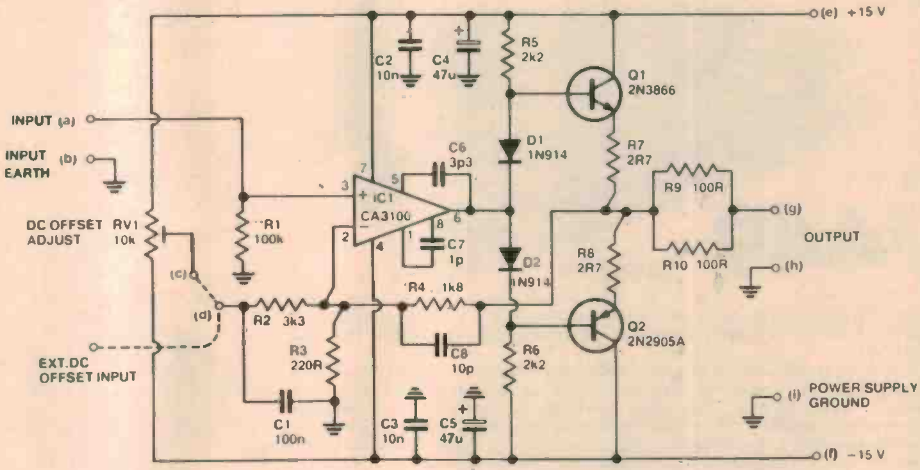
(R4 + R3)/R3

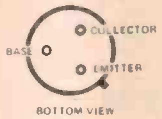
If you need to increase the gain, increase R4. Capacitor C8 provides frequency compensation in the main feedback loop. Capacitor C7 provides phase compensation for the op-amp for overall stability, while C6 provides a little negative feedback at high frequencies to ensure high frequency stability.

To provide dc offset adjustment, a small bias voltage is applied to the op-amp's inverting input via R2. This can be obtained on-board or off-board.

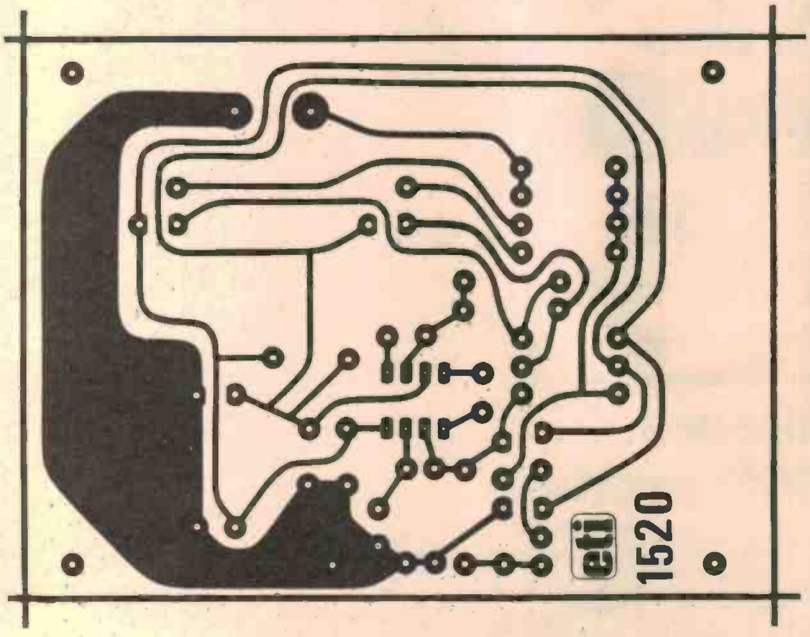
On-board dc offset is provided by linking terminals (c) and (d). This connects the wiper of RV1 to R2. Thus, adjusting RV1 will adjust the output dc offset voltage. Capacitor C1 is a bypass for this input.

Supply rail bypassing is provided by a 10n ceramic capacitor on each supply line, near the op-amp, and a 47u electrolytic capacitor on each supply rail.





Q1 Q2



JAYCAR

Digital Delay Line

400ms VERSION **KIT**

ONLY

$449 COMPLETE

The Digital Delay Line is designed to produce a huge variety of electronic effects. It works very well but the amazing thing is the low, low price!

The effects depend on the time delay selected and some of those included are: Phasing, Flanging, Chorous, ADT (Automatic Double Tracking), Echo, and Vibrato. The delay time can be varied from 0.32ms to 1.6 seconds! Because the signal is stored in digital form there is, unlike analog systems, no degeneration of the signal with time and unlimited repetition is provided by use of the Freeze control.

All the controls mount directly upon PCB's to eliminate wiring and to further simplify construction the main board is 'plated-through' i.e. there are no wire links or link-through pins. The whole of the memory whether for the basic 400ms machine or the fully expanded 1.6 second model all fits on the main board. The cabinet, which is free standing but also suitable for 19" rack mounting, is fully finished to a very high standard. The panel is deep blue whilst the cover is sprayed with a durable black enamel. The kit is available right now from Jaycar at only $449 – compare that with inferior units that can cost over $2,000!!

Cat. KJ6621 $449

low cost hi fi

That's right a 3 – WAY HI FI speaker kit from only $19.98!!

Each kit contains a massive 10" (250mm) woofer, cone midrange and DOME tweeter!! You also get, at no extra charge, the special cross-over capacitors!

The system is rated at approximately 20 watts RMS so it is ideal as an economical but reasonably powerful main Hi Fi unit or as a second system for another room or outdoors.

Each 3-way kit comes with a recommended enclosure design which you can build yourself easily!

You would normally pay well over $60 for the equivalent from major kit speaker suppliers so this is an outstanding bargain. Sensitivity of system 93dB/1m/1 watt. Cat. AK3700

HURRY LIMITED STOCKS and they are made in JAPAN!!

2 SETS (6 SPKR) FOR STEREO ONLY $39.95

Woofer not to same scale as other components

3–WAY SYSTEM $24.95 a set

FROM ONLY **$1998**

8 CHANNEL MIXER KIT

SEE OTHER KIT PAGES FOR FURTHER DETAILS ON THIS KIT...

Ref: EA March/April 1983

This great 8 channel 'live' mixer is perfect for bands, churches, theatre groups, home recording, disco etc.

Each input channel accepts either microphone (balanced) or line (1V) levels. Powerful equalisation foldback effects facilities are provided. The left and right master channels can drive balanced or unbalanced lines with 5 band "graphic" equalisation. Separate foldback and "effects" are provided.

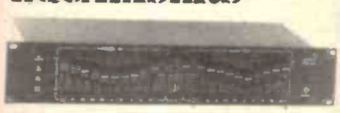
The unit can be rack mounted or housed in a console chassis (which accommodates the power supply). Attractive wooden end-pieces finish the console to form a professional looking unit.

Complete 8 channel mixer (19" rack mount) Cat. KJ6504 $495.00

Console mount chassis, power supply and wooden end pieces Cat. KJ6505 $98.00

You end up with a $1500+ unit for under $600

5000 SERIES GRAPHIC EQUALISERS



SPECIFICATIONS:
Signal to Noise: –102dB with respect to 1 Volt
Frequency Response: 12Hz – 105kHz to –1dB
Boost/Cut: 14dB (28dB total)
Distortion: 100Hz 0.0U2%, 1kHz 0.00?%, 10kHz 0.008% (essentially irrespective of cut or boost)
Current consumption (DC) Approx 100mA at ± 15V (Requires 30V AC CT)
Output short circuit proof.

$199

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AUSTRALIAN (NOT HONG KONG) MADE – SPECIAL BUILT RACK CABINET – QUALITY!!!

ALL IC SOCKETS PROVIDED

Cat. KE4204

NEW MAGNUM 200

NEW! – LOW COST 5000 SERIES AMP

ONLY $299

Black Monolith $319

REF: ETI JAN/MARCH 1981. Cat. KE4200

"Blueprint" 5000 preamp

"BLUEPRINT"

FUNCTIONS
- MOVING COIL INPUT
- MOVING MAGNET (DYNAMIC CART)
- INPUTS (2 OFF)
- TUNER INPUT
- AUX INPUTS (2 OFF)
- TAPE INPUTS (2 OFF)
- INPUT LEVEL CONTROL
- TAPE OUTPUTS (2 OFF)
- 400Hz CALIBRATION OSCILLATOR
- LED AVERAGE (VU) & PEAK
- LEVEL METERS –48dB TO +9dB
- MODE SWITCH, STEREO BALANCE CONTROL LINE OUT, MONITOR OUT, MONITOR VOLUME CONTROL

FEATURES
- EXTREMELY CLOSE TRACKING TO RIAA PHONO EQ.
- GOLD PLATED CONNECTORS ON ALL INPUTS
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- LOW NOISE 1% 50ppm METAL FILM RESISTORS USED
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- LOW CAPACITANCE SCREENED CABLE USED THROUGHOUT
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- SPECIAL REAR PANEL
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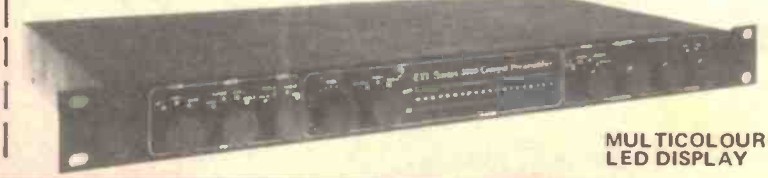
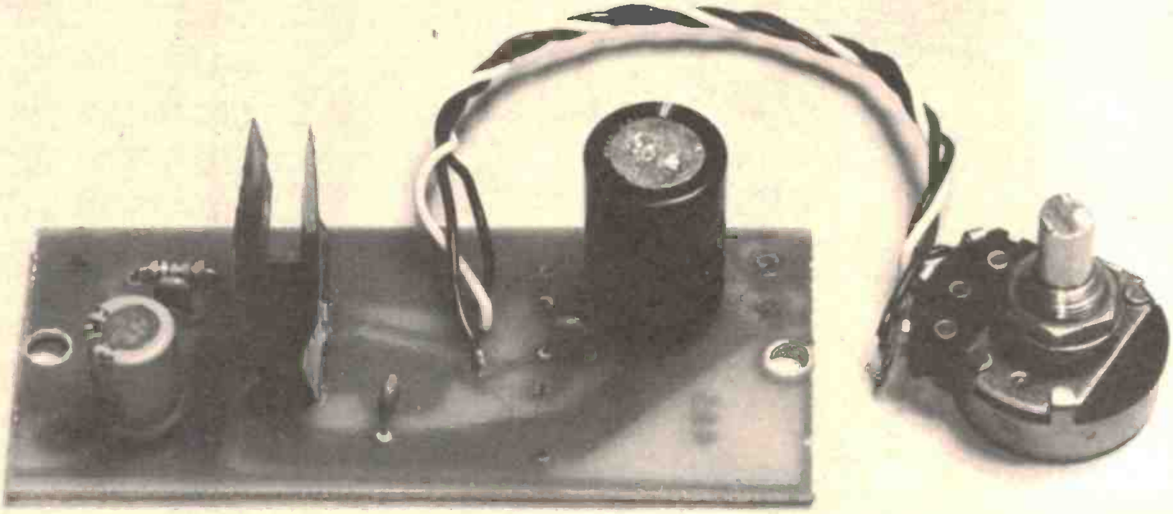
Cat. KE4202



ONLY $299

MULTICOLOURED LED DISPLAY



A general purpose IC audio amplifier module

This is an ideal project for the beginner. In fact, most constructors will find it handy to have at least one around. A general purpose small audio amplifier finds many useful applications. Just two described here are an intercom and a 'baby minder'.

Geoff Nicholls

A VERY USEFUL object for any electronics enthusiast to have around is a simple audio amplifier. It can be used to test the operation of many circuits or employed in some practical item of equipment — such as an intercom.

This simple, yet versatile, module is easy to construct and can be powered from a variety of supply voltages, depending on your application. It will drive loudspeakers of 4, 8 or 16 ohms impedance and can deliver a maximum output of five watts.

The project has been designed around an integrated circuit audio power amplifier, the LM380 (from National Semiconductor) or the uA380 (from Fairchild). This is quite a versatile little IC and, using it, an audio amplifier is very simple indeed to make.

The '380 is generally available in a 14-pin dual-in-line package, and this is what I have employed here. An 8-pin version is available, but cannot be used in the pc board I have designed for this project. Pins 3, 4 and 5 plus 10, 11 and 12 of the 14-pin package are all connected together by a copper bar inside the '380 package, on which the chip is mounted. These pins can be soldered to a large area of copper on the pc board to act as a heatsink in relatively low power applications.

Where the full power output capability of the '380 may be used, copper shim or tinplate heatsink 'flags' are soldered to these pins to get rid of more heat and keep the temperature of the IC down.

The '380 has a gain of 50 times. That is, it will amplify the input signal level by 50, which is a gain of 34 decibels (34 dB). That is:

$$\begin{aligned}\text{Gain in dB} &= 20 \log_{10}(50)\\ &= 20 \times 1.7\\ &= 34\ \text{dB}.\end{aligned}$$

The gain of the '380 is fixed by the manufacturer. But what if you want a volume control, as is so often necessary on an audio amplifier? That can be simply arranged by connecting a potentiometer as a voltage divider to the input of the IC. You can see how that's done from the circuit and construction diagrams.

You can use this project to amplify the output of a crystal set or one-transistor receiver to loudspeaker level simply by connecting the output directly to the input of the module.

You can make a 'baby minder' — for keeping an ear on the baby in its cot, from another room — as shown later in this article, or you can make a simple intercom — which is also illustrated later. Another article in this issue shows how to use the module in a loudhailer.

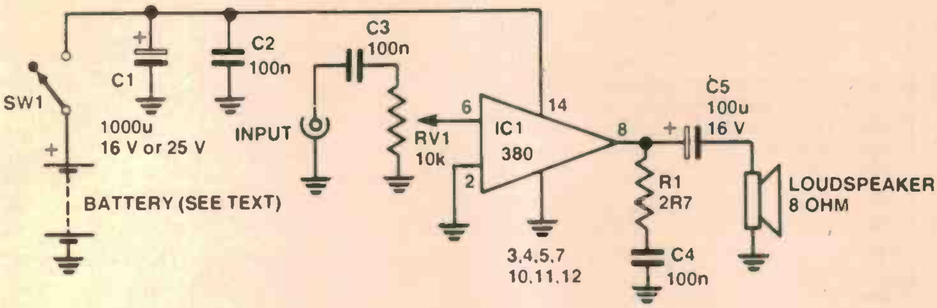
Right, let's get down to the business of building it.

Construction

As you can see from the overlay and wiring diagrams, there's very little to it. Start with the pc board. Whether you've made your own or purchased one, just give it a quick check-over to make sure all the holes are drilled correctly, that there are no small copper 'bridges' between closely spaced tracks (particularly between the IC pins) and no tiny cracks in any tracks. It's unlikely you'll have trouble, but it's always a good idea to check, *before* you run into trouble!

Note that mounting holes are located at either end of the board. These should be drilled to suit a 4 BA bolt, or whatever size you are using.

You can commence assembling the board by soldering resistor R1 in place, followed by capacitors C2, C3 and C4. All components



HOW IT WORKS — ETI-464

There's not much you can say about this! The whole job is done by the '380 IC audio power amplifier. The input is coupled to the '380 via a capacitor (C3) and the volume control, RV1. The latter is just a voltage divider, applying less or more voltage to the IC's input as the potentiometer is varied, thus varying the volume.

The output of IC1, pin 8, is biased at half the supply rail (e.g: it will be at 4.5 V if the supply is 9 V). For this reason, the output is capacitively coupled to the loudspeaker via a large value electrolytic capacitor, C5. This presents a low impedance in series with the loudspeaker, which is a relatively low impedance device.

Any tendency to instability of the amplifier is suppressed by the network of R1-C4 connected from the output to common.

The supply rail is bypassed by an electrolytic capacitor, C1, at the low frequencies, and a greencap or ceramic capacitor, C2, at the higher audio frequencies.

Note that provision has been made on the pc board for powering an electret type microphone, simply by adding a resistor adjacent to C3.

mount on the non-copper side of the board. Next identify the positive and negative leads of the two electrolytic capacitors. These are 'polarised' devices and can only go in one way. Solder them in place, putting the positive lead of each in the hole marked with a '+' on the overlay diagram.

The '380 IC can be soldered in place next. Make sure you place it in the board the right way round before soldering the pins. Do not use an IC socket as the board is designed to act parially as a heatsink and pins 3, 4, 5, 10, 11 and 12 *must* be soldered to the copper area for this purpose.

The heatsink flags can be constructed next if you need to use them. Use heavy gauge copper 'shim' or tinplate sheet (obtainable at hardware and motor spares stores). Two are required and the dimensions and cutting details are shown in the accompanying diagram.

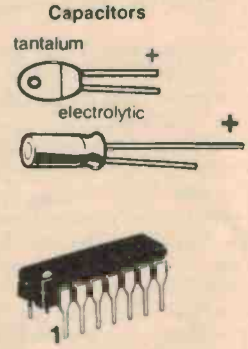
General details for wiring up the speaker, volume control and an on/off switch are also provided with the overlay diagram. Note that the input lead should be run in shielded cable, in general, especially if this lead needs to be more than 300 mm or so long. This prevents hum pickup from house mains wiring. For short runs, a pair of tightly twisted hookup wires will suffice.

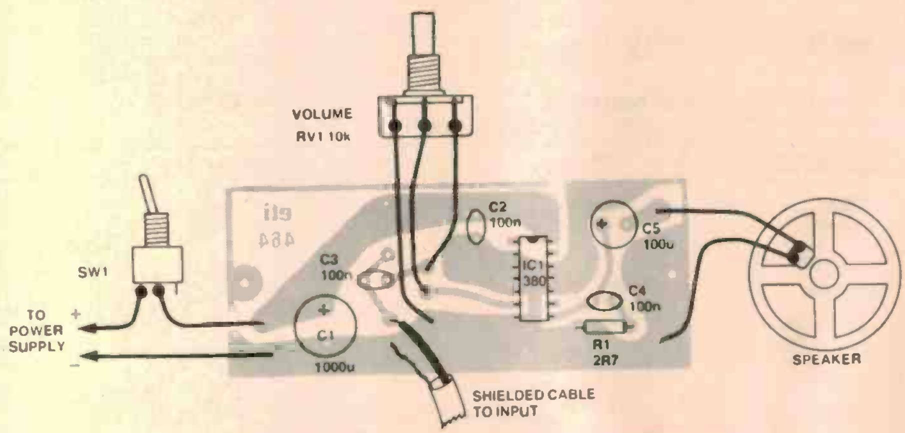
This module will drive any size loudspeaker, from the tiny 50 mm 'transistor radio' types to 400 mm diameter 'monsters'. In fact, the larger a loudspeaker, the more sensitive it's likely to be and the louder it will sound! You don't need more power to drive a larger loudspeaker, despite what you might at first think.

The bigger loudspeakers generally have a more powerful magnet than the smaller types. This makes them more sensitive to the currents flowing in the voice coil. This and the larger cone combine to produce a louder sound. ▶

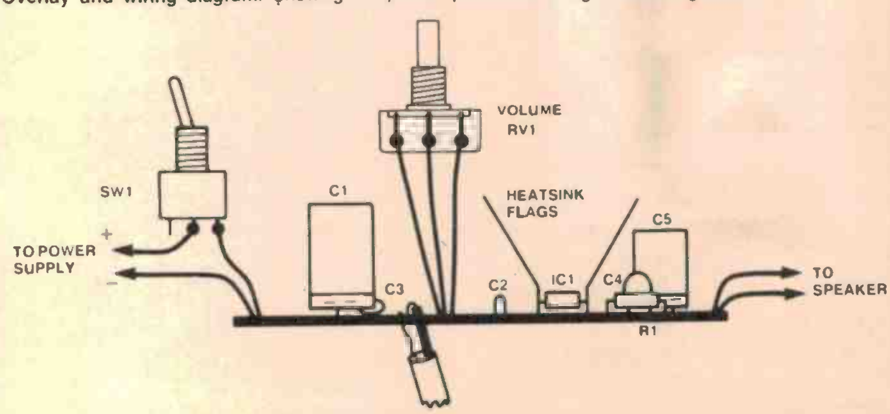
COMPONENT PINOUTS

Capacitors





Overlay and wiring diagram. Showing component placement and general wiring details.



Side view. Showing assembly of the heatsink flags.

PARTS LIST — ETI-464

Resistors	all ¼ or ½ W/5%
R1	2R7
RV1	10k log. pot.
Capacitors	
C1	1000u/16 VW or 25 VW RB electro.
C2,C4	100n ceramic bypass
C3	100n greencap
C5	100u/16 VW RB electro.
Semiconductors	
IC1	LM380

Miscellaneous
ETI-464 pc board; SPST switch; shielded cable; wire, etc.

Price estimate $7-$8

Testing it

The easiest way to test it is simply to connect a 9 V battery to the module and turn up the volume control. Then, touch your finger to the 'top' end of the volume control — the right hand lug when looking at the rear of the pot. You should hear hum and noise, or perhaps a loud 'blurting' sound. If not, check that the battery is connected the right way round and that the speaker and volume control wires are all intact and correct. Check that you have the IC correctly orientated.

Connecting a 9 V battery in reverse to the module is unlikely to destroy the IC, but any higher supply voltage connected in reverse sure will, so watch this point.

If the amplifier tends to be unstable, 'squealing' or otherwise 'acting up', try connecting a 4u7/16 V tantalum capacitor between pin 1 of the IC and the adjacent grounded area of the pc board, directly on the underside of the board. The positive lead goes to pin 1. Keep the lead lengths short. This should cure it.

Always keep the amplifier's input leads away from the speaker leads, to avoid feedback which may result in 'howl round' — an uncomfortable whistling or howling sound that is affected by moving the leads.

Power supplies

This module can be powered form batteries, a suitable plugpack or transformer and rectifier to suit yourself. The power output depends on the supply voltage and the speaker impedance. As stated earlier, the '380 can drive 4, 8 or 16 ohm speakers. By far the better speaker to use is an 8 ohm impedance type. Fortunately, they're also the most common type.

Powered from a nine volt battery, you will get about half a watt (500 mW) output, which is more than adequate for 'personal' listening stations; e.g: providing loudspeaker output from a crystal set or one-transistor radio, etc. The power dissipated by the IC under these circumstances is about three quarters of a watt maximum, so no heatsink flags would be necessary. The module draws only about 5 mA with no signal (called the 'quiescent current').

The *absolute maximum* supply voltage the IC will tolerate is 22 V. With an 8 ohm speaker, the project will deliver five watts output, which is remarkably loud! Under these circumstances, the power dissipated by the '380 will be a little over three watts maximum and heatsink flags will definitely be necessary. The quiescent current is about 8 mA on a 22 V supply.

A plugpack or transformer and rectifier supply suitable for powering this module should provide 12 Vdc at 200 mA or so. Using such a supply, the project will deliver about one to 1½ watts to an eight ohm speaker, which is quite suitable for an intercom, for example. The heatsink flags are not entirely necessary with this sort of application, especially in an intercom where the amplifier is only used intermittently.

Two nine volt batteries connected in series will supply 18 Vdc or so to the module, which will deliver about three watts to an 8 ohm speaker. Heatsink flags are necessary in this case. Note that, when using a 4 ohm speaker, the supply should not exceed 15 volts.

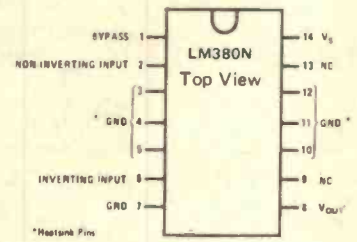
LM380 audio power amplifier

general description

The LM380 is a power audio amplifier for consumer application. In order to hold system cost to a minimum, gain is internally fixed at 34 dB. A unique input stage allows inputs to be ground referenced. The output is automatically self entering to one half the supply voltage.

The output is short circuit proof with internal thermal limiting. The package outline is standard dual-in-line. A copper lead frame is used with the center three pins on either side comprising a heat sink. This makes the device easy to use in standard p-c layout.

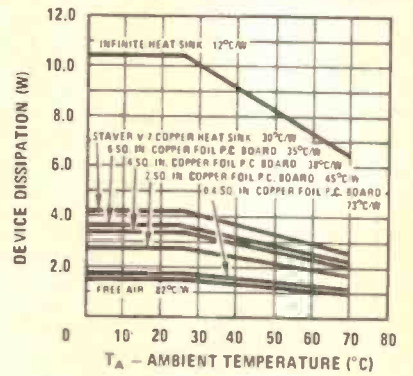
Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, power converters, etc.



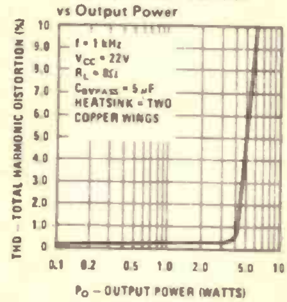
features

- Wide supply voltage range
- Voltage gain fixed at 50
- High peak current capability
- Input referenced to GND
- High input impedance
- Low distortion
- Quiescent output voltage is at one-half of the supply voltage
- Standard dual-in-line package

Device Dissipation vs Ambient Temperature



Total Harmonic Distortion vs Output Power



absolute maximum ratings

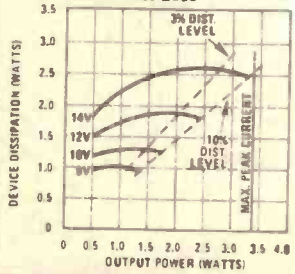
Supply Voltage	22V
Peak Current	1.3A
Package Dissipation 14-Pin DIP (Notes 6 and 7)	10W
Input Voltage	±0.5V
Storage Temperature	−65°C to +150°C
Operating Temperature	0°C to +70°C
Junction Temperature	+150°C
Lead Temperature (Soldering, 10 sec)	+300°C

electrical characteristics

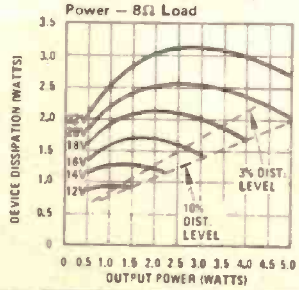
Note 1: V_S = 18V and T_A = 25°C unless otherwise specified.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Power	$P_{OUT(RMS)}$	R_L = 8Ω, THD = 3%	2.5			W
Gain	A_V		40	50	60	V/V
Output Voltage Swing	V_{OUT}	R_L = 8Ω		14		V_{pp}
Input Resistance	Z_{IN}			150k		Ω
Total Harmonic Distortion	THD			0.2		%
Power Supply Rejection Ratio	PSRR			38		dB
Supply Voltage	V_S		8		22	V
Bandwidth	BW	P_{OUT} = 2W, R_L = 8Ω		100k		Hz
Quiescent Supply Current	I_Q			7	25	mA
Quiescent Output Voltage	V_{OUTQ}		8	9.0	10	V
Bias Current	I_{BIAS}	Inputs Floating		100		nA
Short Circuit Current	I_{SC}			1.3		A

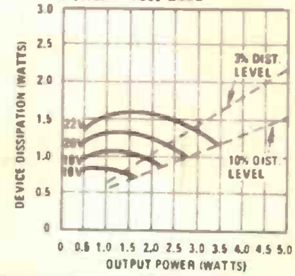
Device Dissipation vs Output Power — 4Ω Load



Device Dissipation vs Output Power — 8Ω Load



Device Dissipation vs Output Power — 16Ω Load



A 'baby minder'

You can 'keep an ear' on a baby asleep (or supposed to be!) in its cot in another room by organising some sort of microphone to pick up sounds from the baby's room to be amplified and heard in another room.

The general wiring diagram for a baby minder is shown in Figure 1. Here, a small 8 ohm loudspeaker is employed as a microphone — and they're remarkably effective. A transformer is needed to 'step up' the tiny voltages produced by the speaker-microphone. A suitable type is generally described as a 'transistor output transformer, 1k centre-tapped to 8 ohm'. Dick Smith Electronics lists a suitable type — cat. no. M-0216. Altronics have a similar one. Tandy lists one also, no. 273-1380.

The '8 ohm' side is connected to the speaker-microphone — this is the side with just two leads. The 1k side of the transformer is connected to the input of the module. Mount the transformer close to the module. The module could be mounted in a suitable cabinet with the speaker, volume controls and on/off switch mounted on the front.

The speaker-microphone could be mounted in a small jiffy box placed in a convenient position in the baby's room, near the cot. This connects to the amplifier via a length of 'twisted pair' cable or light 'figure-8' flex. Try and avoid running this lead adjacent to house mains wiring to avoid possible hum pickup.

I have specified an 8 ohm speaker as a microphone as it is of such a low impedance that the possibility of hum pickup on the cable between the microphone and the amplifier is greatly reduced.

You can either use a battery supply or a 12 Vdc plugpack.

Intercom

The general details for wiring a simple intercom are shown in Figure 2. You'll need two single-pole, double-throw (SPDT) toggle switches with a spring return. Double-pole types are also suitable, just use one side (e.g: C&K type 7208 or similar). You'll also need an M-0216 transformer, or similar, as for the Figure 1 circuit.

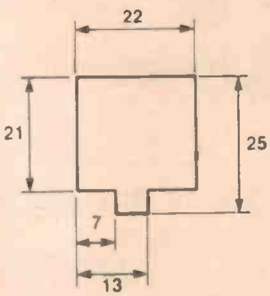
Two small 8 ohm speakers are used as both speaker and microphone at each end of the intercom.

A volume control is necessary on an intercom and a small 'trimpot' can be mounted on the pc board where the volume control connections are made. The hole spacings are suitably placed for soldering a common vertical mounting trimpot in place. Use on of the same value — i.e: 10k. Test out the intercom and set the volume control to suit yourself.

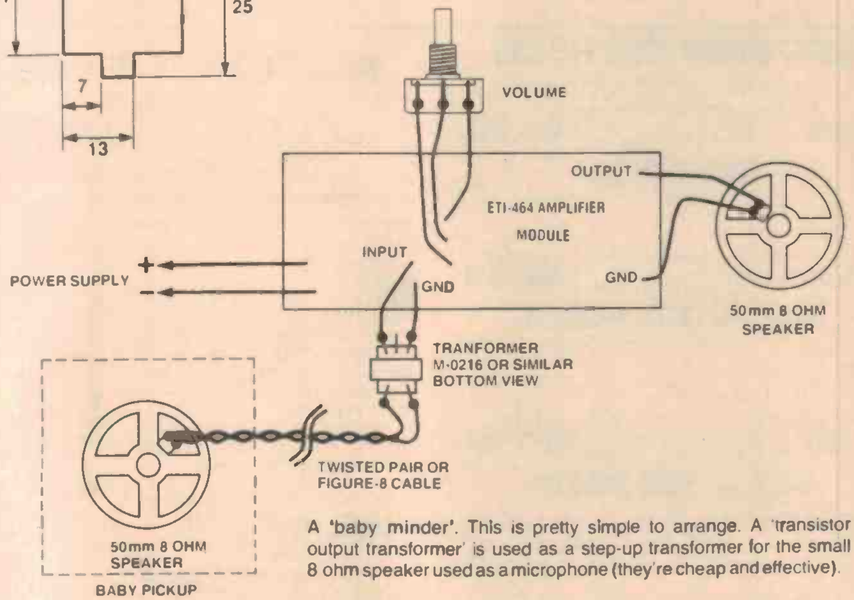
A suitable cable can be made by twisting together three strands of light hookup wire or buying a suitable length of light multicore cable. Note how the various common, or earth, connections are made to the one ground point on the pc board.

Conclusion

Well, I've described how to build yourself a general purpose audio amp module and how to use it in a couple of applications — the rest is up to you. Have fun!

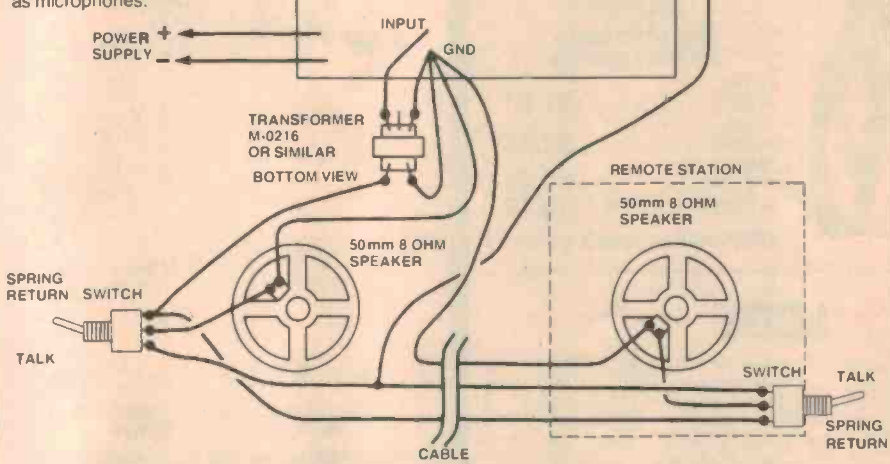


HEATSINK (TWO REQUIRED) TO BE ATTACHED TO EITHER SIDE OF IC AS SHOWN IN MAIN PICTURE. ALL DIMENSIONS IN mm

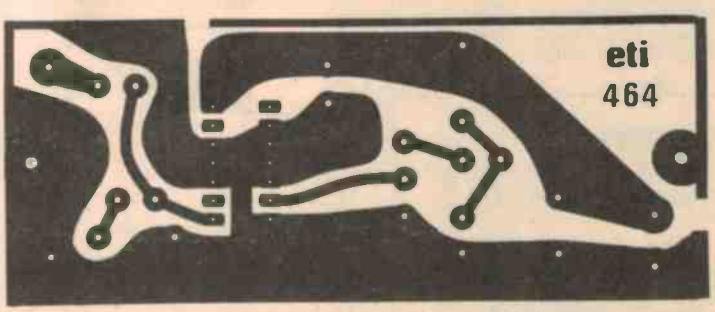


A 'baby minder'. This is pretty simple to arrange. A 'transistor output transformer' is used as a step-up transformer for the small 8 ohm speaker used as a microphone (they're cheap and effective).

Intercom. A transistor output transformer is used here too because the loudspeakers at each 'station' of the intercom double as microphones.



Printed circuit artwork. Full-size reproduction of the pc board layout.



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Jack O'Donnell

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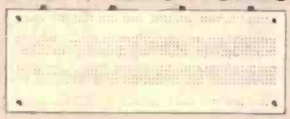

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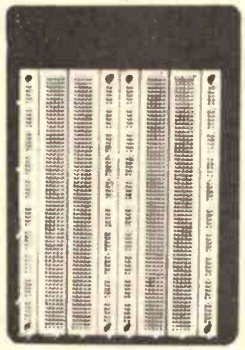

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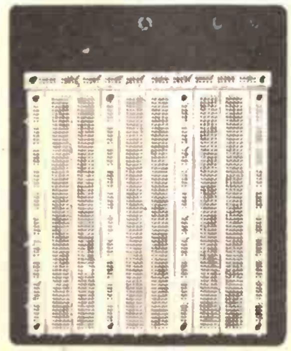

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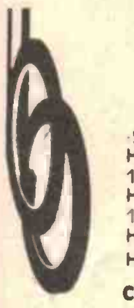

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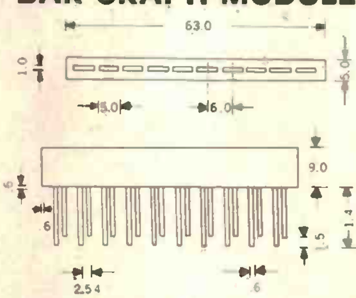

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Y 1006	2.0000 mHz	Parallel	7.50	6.75
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Y 1012	4.0000 mHz	Parallel	5.00	4.50
Y 1015	4.1940 mHz	Parallel	5.00	4.50
Y 1017	5.0000 mHz	Parallel	5.00	4.50
Y 1018	6.0000 mHz	Series	5.00	4.50
Y 1019	8.0000 mHz	Series	5.00	4.50
Y 1020	10.0000 mHz	Series	5.00	4.50
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Z 0140	Led 3mm Red	.14	.10
Z 0141	Led 3mm Green	.20	.18
Z 0143	Led 3mm Yellow	.22	.20
Z 0150	Led 5mm Red	.14	.10
Z 0151	Led 5mm Green	.20	.18
Z 0152	Led 5mm Yellow	.22	.20
Z 0154	Led 5mm Orange	.25	.22
Z 0159	Led 5mm Flashing FRL4403	.49	.45
Z 0160	Led Rectangular Red	.22	.19
Z 0162	Led Rectangular Green	.25	.22
Z 0164	Led Rectangular Yellow	.25	.22
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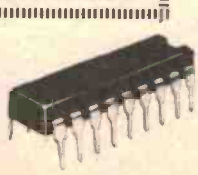

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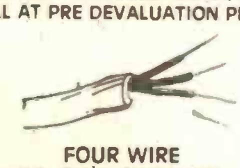

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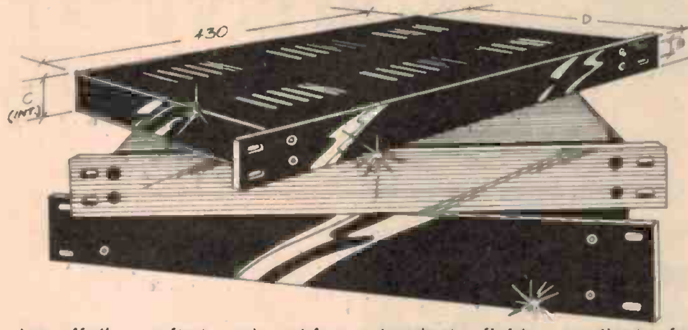

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Cat. No.	Finish	A	B	C	ea.	5 +
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H 0403	Natural	132	89	126	55.00	49.95
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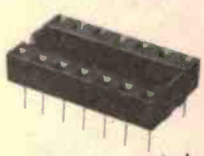

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P 0565 16 Pin	.30	.25	.20
P 0567 18 Pin	.40	.35	.30
P 0570 24 Pin	.60	.50	.45
P 0575 40 Pin	.80	.70	.65

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Z 0308	3V9	1N4730	Z 0334	13V	1N4743
Z 0310	4V3	1N4731	Z 0336	15V	1N4744
Z 0312	4V7	1N4732	Z 0338	18V	1N4746
Z 0314	5V1	1N4733	Z 0340	20V	1N4747
Z 0316	5V6	1N4734	Z 0342	22V	1N4748
Z 0318	6V2	1N4735	Z 0344	24V	1N4749
Z 0320	6V8	1N4736	Z 0346	27V	1N4750
Z 0322	7V5	1N4737	Z 0348	30V	1N4751
Z 0324	8V2	1N4738	Z 0350	33V	1N4752
Z 0326	9V1	1N4739	Z 0352	36V	1N4753
Z 0328	10V	1N4740	Z 0375	75V	1N4761

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Ta ra, ta ra . . . the ETI loudhailer!

Build this loudhailer and make yourself heard at rallies, picnics or sporting events. Using the ETI-464 General Purpose Amp. Module mounted in the back of a locally available horn speaker, it's simple to build and quite effective.

Geoff Nicholls

PROJECTING your voice outdoors is quite a difficult task without some means of 'directing' your voice and amplifying it. Generally, you'll want to address a group of people located some distance away, or a group of people spread out in front of you for some distance. If you can direct your voice over a narrow 'beam', then less of the sound you make is wasted.

The old-fashioned megaphone did that job before 'electronics' entered the picture. Outdoor public address systems came into being with the advent of valves. For many years PA systems were cumbersome, hardly portable beasts until minaturisation came along post World War II. The first 'loudhailer' PA systems portable by one person used miniature valves, a small horn speaker and a set of cumbersome, heavy batteries that didn't last all that long.

When power transistors came along, loudhailers proliferated. They could be held in one hand, used a small number of 'torch' batteries and did the job better than before.

The horn speaker

The horn loudspeaker is by far the best type for outdoor use. Horns can be made weatherproof and have an efficiency of better than 20% compared to a few per cent for ordinary speakers. This allows an amplifier of lower power to be used, with consequent savings in power consumption, physical size and weight.

Horns are intrinsically limited in their frequency response, and their efficiency is inversely proportional to their bandwidth. PA horns are designed to operate over the voice band at maximum efficiency. The horn itself is essentially an impedance transforming device which increases the acoustic loading on the driving diaphragm to allow better 'matching' to the air. The throat area of the horn increases exponentially as you move away from the driver.

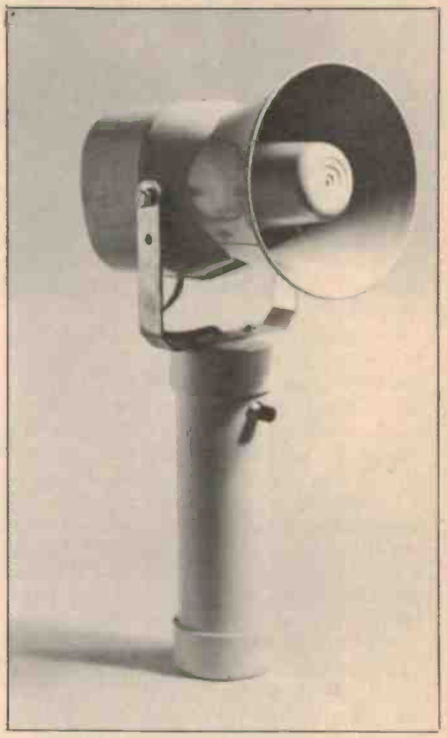
The horn may be straight, as shown in Figure 1, or folded, as shown in Figure 2. The folded horn is physically smaller and is the most common type in low cost PA systems. Folding the horn reduces the efficiency slightly but increases the coverage or dispersion, which is usually an advantage.

The straight horn has a long 'throw' and is useful for narrow sound coverage at greater distances, but is more cumbersome, especially for handheld applications!

The project

For our loudhailer, we had to search around for a suitable small folded horn. There is a variety available and prices vary widely. Probably the most common are 130 mm diameter (5") low power folded (or 'reflex') horns generally sold for boat or CB PA use. Rectangular folded horns are also available, having an opening of 200 mm wide by 120 mm or so high.

Efficiencies vary widely and are best judged by the weight! Drivers with larger, heavier magnets are more efficient than those with smaller, lighter magnets. Most have a 'dispersion angle' — the angle over which the majority of sound is dispersed from the horn — of between 60° and 90°. The narrower the dispersion angle, the greater sound level you get at a given distance from the speaker.



Your shout! Not beautiful, but effective.

The horn we chose for our prototype is imported and marketed by Benelec Pty Ltd, model no. 8-224. It is a 130 mm diameter folded horn, measuring 170 mm long overall. There is a cover on the rear of the horn with plenty of room inside to mount the power amp. module. It has a mounting ▶

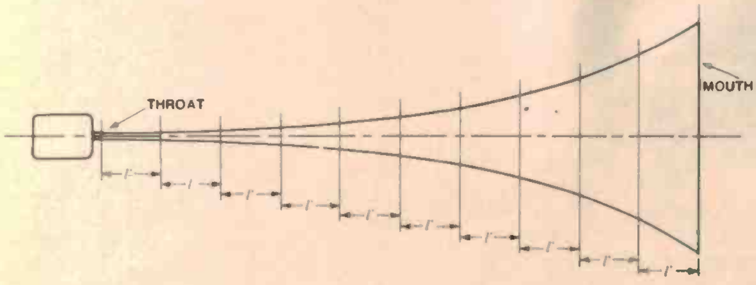


Figure 1. A straight horn has the width of the throat growing exponentially larger with increasing distance from the driver.

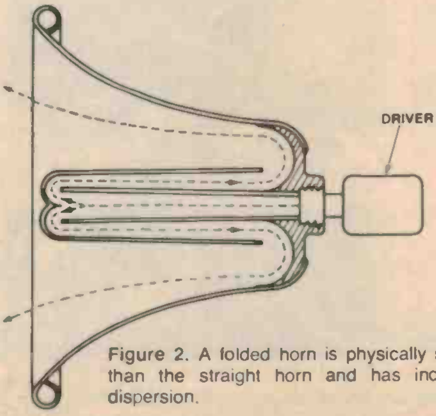


Figure 2. A folded horn is physically smaller than the straight horn and has increased dispersion.

bracket that allows the horn to be swivelled over a wide range of angles. It is available with driver impedances of 4 ohms or 8 ohms, though the latter is best in this application. The dispersion angle is quoted as 60°, which we saw as desirable, and the output is quoted as being 122 dB (presumably with 1 W drive at one metre). It weighs 1.15 kg, which is not too heavy, yet ensures the sort of driver efficiency desirable for maximum effectiveness.

Using this horn, and constructing the loudhailer as described here, you can make yourself heard at 100 metres. If you don't need that much throw, then a lower cost, less efficient horn will suffice, but construction details will have to be worked out to suit yourself. See Shoparound in this issue for horn suppliers.

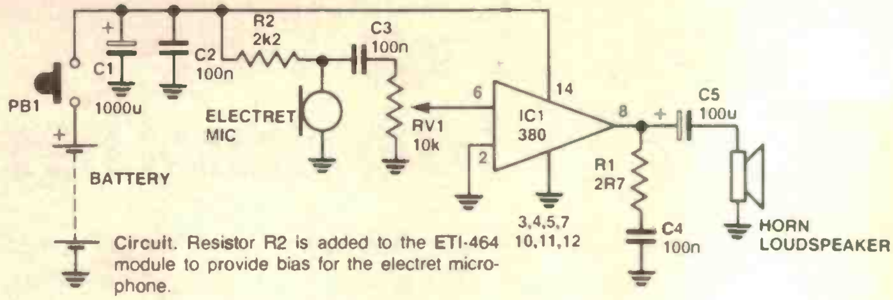
An electret microphone insert was employed to make a microphone. It proved cheap and effective. To provide a handle and battery case, a short length of 50 mm (i.d.) PVC water pipe was used, along with two end caps. This mounts, via one end cap, on the horn's mounting bracket and the batteries are slipped inside. A momentary action pushbutton switch, mounted on the 'handle', serves as an on/off switch.

Originally, I tried mounting the mic insert in the centre of the horn's rear cover, but feedback proved a problem and I couldn't utilise the full gain and output of the amplifier module. A little experimentation solved the feedback problem and improved an operator's visibility at the same time.

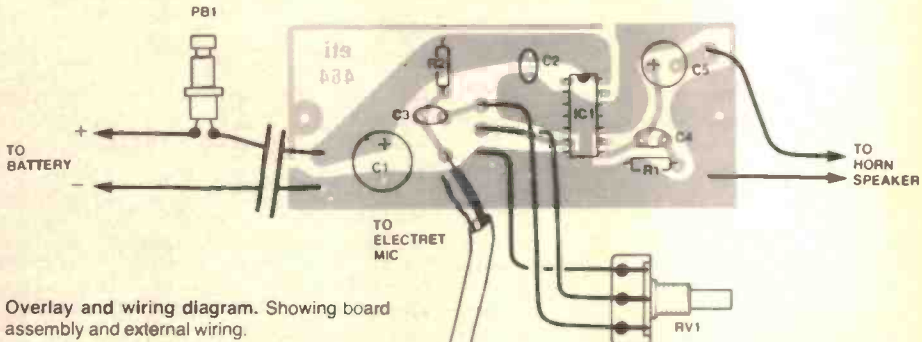
I mounted the mic insert in a DIN plug which plugs into a socket mounted at the top of the horn's rear cover. I also mounted a gain control pot on the cover. These measures overcame feedback problems and allowed you to see over the top of the horn.

The maximum output a '380 will deliver is five watts into an 8 ohm load using a 20 V supply. With an 18 V supply, the '380 will deliver a maximum of four watts (@ 10% distortion — which is tolerable) into an 8 ohm load. With a 4 ohm load the maximum supply voltage you can use is 14 V without exceeding the '380's dissipation rating, and you only get three watts' output. In a loudhailer, every watt counts.

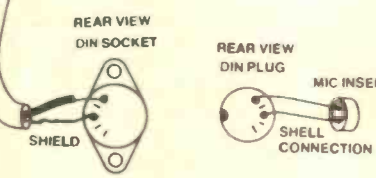
Hence, I opted to use an 18 V supply. There are two ways you can arrange this with batteries. Two no. 2362 9 V batteries can be 'snapped' in series. These are 75 mm long with a male snap clip at the positive end and a female snap clip at the negative end. Alternatively, you can use 12 AA cells mounted in three four-cell battery holders. There are two advantages to the latter: the batteries last longer and the whole assembly is considerably cheaper.



Circuit. Resistor R2 is added to the ETI-464 module to provide bias for the electret microphone.



Overlay and wiring diagram. Showing board assembly and external wiring.



PARTS LIST — ETI-465

This requires construction of the ETI-464 amp. module with the addition of the following components:

R2	2k2, ¼ W/5%
RV1	10k/C panel mount pot.

Electret mic. insert (e.g: D.S.E. no. C-1160); 5-pin DIN plug and socket; knob; horn loudspeaker — Benelec no. 8-224 8 ohm (see text); three 4-cell AA battery holders and clips plus 12 x AA batteries or 2 x 2362 9 V batteries and snap clips; DPDT momentary action pushbutton (e.g: D.S.E. no. C-1220); length cr 50 mm PVC pipe and two end caps; wire, etc.

Price estimate $45-$50

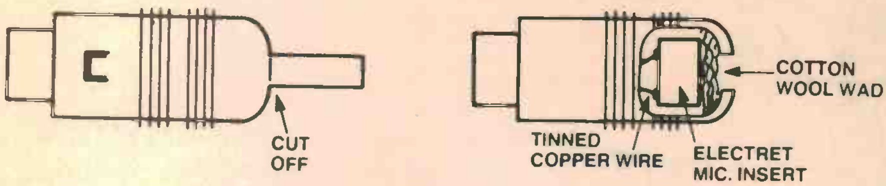
Insides out. The amplifier board mounts inside the rear cover of the Benelec 8-224 horn.

Construction

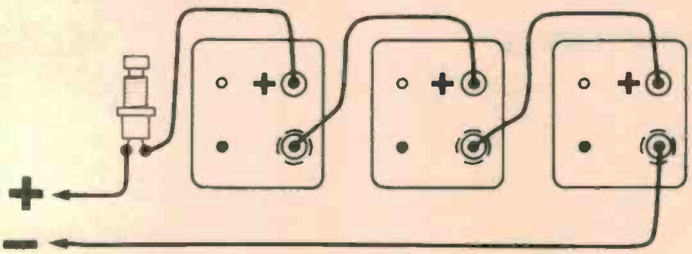
Putting the loudhailer together is quite straightforward. The ETI-464 pc board has mounting holes which match the mounting posts on the inside of the 8-224 horn speaker's rear cover. Self-tapping screws are used to mount the board and the mounting holes should be drilled to size before assembling the components to the pc board.

Assemble the power amp module according to the instructions given in the previous article on the ETI-464. Note that R2 has to be added, as shown on the overlay diagram. Don't attach any wires yet until the mechanical assembly has been completed.

Drill the mounting holes for the volume pot and the DIN socket in the speaker's rear



Making the microphone. A DIN plug is modified as shown to house the electret mic insert.



Battery holder wiring. If you use a dozen AA cells, as I did, this is how the battery holders are wired up to provide 18 volts.

cover. The DIN socket goes at the top, the volume pot at the bottom. Also drill a hole in the bottom lip of the cover so that the leads from the battery may be passed through.

Now tackle the handle/battery compartment. Cut a 200 mm length of 50 mm i.d. PVC pipe. File the ends smooth and square and slip the end caps on. Holding them in place with masking tape, drill holes on either side, right through the cap and pipe, so that self-tapping ('PK') screws can be used to secure the end caps in place. Drill these holes to the root diameter of the PK screws.

Remove the end caps and enlarge the holes to the appropriate clearance diameter for the PK screws. Drill holes in one end cap to suit the speaker mounting bracket and to pass the battery leads. Bolt it in place.

Now take the tube and mark a hole position at the 'top' end for the on/off pushbutton switch. It should be located such that it clears the upper end cap, yet is not too far down the tube so that access to the switch connections is restricted.

Now wire up all the battery connectors, the pushbutton switch, the DIN socket, the volume pot, the speaker and the pc board. Check it all carefully when finished, then screw it all together. A little wad of sponge rubber in the upper end of the handle secures the batteries.

Now you can make the microphone. The basic assembly is shown in the accompanying diagram. We found that angling the mic insert *down* (when the unit is plugged in) helped reduce feedback problems and a tendency to 'breathiness'.

The accompanying photographs show the internal and overall assembly, when completed.

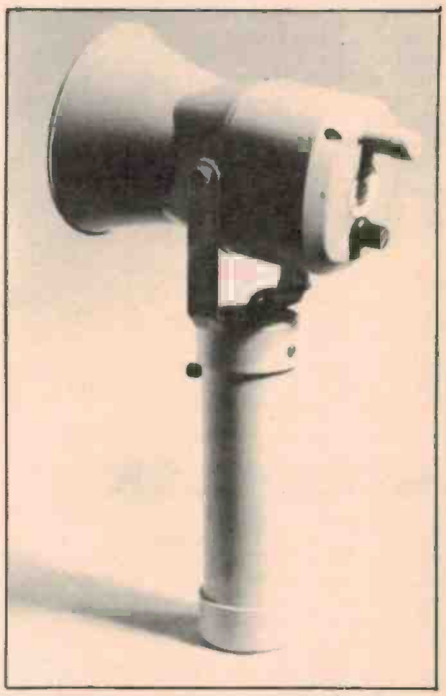
Using it

For an initial try-out, set the volume pot about halfway advanced, plug in the microphone, position your mouth about 10 mm or so from the mic, press the button and say a few words. No 'howl round' feedback or 'ringing' should be experienced, except perhaps if you're in a small room. Best try the unit outdoors.

Adjust the setting of the volume control for maximum output without feedback or ringing being evident. Always speak very close to the microphone.

If you wish, it may be convenient in some applications to have a 'remote' microphone. An electret insert can be readily installed in a CB-type handheld mic case, with the push-to-talk switch wired in parallel with the loudhailer's on/off pushbutton via the DIN plug and socket.

Happy hailing!



Rear view. The mic plugs into the DIN socket at the top. The volume control is below it. The 'handle' houses the batteries.

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- Self-starting one-second stepping motor has strong torque
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Complete with data sheet, instructions and wall hanger bracket.

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Use this device with your Communications Receiver and Microbeee to watch the teletype newswire services from around the world!
This short form kit contains PCB, 15 pin 'D' connector, all board components, centre zero tuning meter.
This is an amazingly low price project for what you get!!

Ref: ETI April 1983

$19.95

Cat. KE4654

IEC Cable Connectors

NEW INCREASED RANGE

Most imported equipment these days now uses IEC-320 style AC power inlet connectors. Indeed, the electronics mags will soon be specifying these connectors on many of their mains-powered projects to simplify (and therefore make safer) mains wiring. Jaycar now stocks a range of ELECTRICITY AUTHORITY APPROVED mains line cords.
We have them in straight entry, left and right entry with and without standard 240V mains moulded plug. Each cord is a generous 2 metres long and is rated at 7.5 amp continuous. They are only available in grey.

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PP2302	IEC 320 CHASSIS PLUG	$2.95

BT151-650R

This is the 650 volt version (for extra safety) of the C122E SCR which we use in the popular 'Fluorescent Lamp Starter' Kit as described in October 1982 EA. Normally $1.50 each. This month only $0.95 each! (Minimum 5 pieces). Makes the Fluoro starter kit very cheap!
(PCB's for the kit) Cat. HP8747 ONLY $1.95

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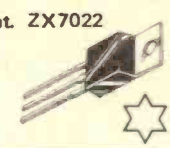
Cat. ZX7022



(8 amp 650V SCR)

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WE HAVE THEM...

WERE $12.50
NOW $9.95
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That's right, a pin-for-pin equivalent to the popular LM3900 for only 25 cents! We have heaps of LM 3401 (made by National Semiconductors). 14 pin plastic DIL IC's. The LM3900 normally sells for around a Dollar. NOW you can have 4 for a Dollar! (Minimum buy 4 pieces)

Cat. ZL3901
Quad OP-amp in a 14 pin DIL package —
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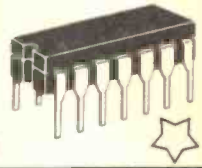

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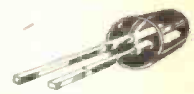

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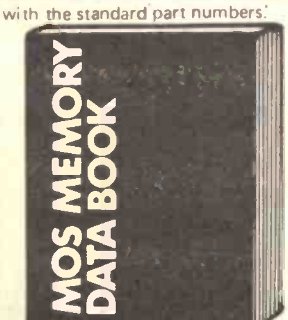

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The 'power down' mains appliance timer

Have you ever turned on your electric radiator to warm a room in the morning and forgotten to turn it off on your way out? What about the patio light — ever turned that on and forgotten to turn it off until the next day? This project will not only solve those problems, but has many applications besides.

Geoff Nicholls

THIS IS a press-button mains appliance timer. You plug the project into a wall socket, plug your appliance into the project, then press the button to turn the appliance on. Some predetermined time later, the project will automatically *'power down'* (or turn off) your appliance.

No doubt you're familiar with those time switches installed in the stair wells of apartment buildings that control the stairway lights. You press the big button and the lights come on just long enough for you to *not quite* make it up the stairs! These devices employ a mechanical timer, their major problem being that, with use, the period decreases. In addition, you can't preset them to a convenient time over a wide range.

Many 'deluxe' electric heaters these days incorporate a timer of some sort so that the heater can be turned on for a preset period, then turn itself off. 'Super deluxe' models go so far as having a timer with digital display and programming facilities to turn it on and off whenever you like each day for a fortnight! That's probably going a bit far for many applications, though.

Getting 'closer to home', so to speak, take the case of an EPROM eraser. This basically comprises an ultraviolet lamp and a period timer. You bung your EPROMs under the lamp and turn on the timer. The timer then turns the lamp off the required period later (typically, 20 minutes).

In photographic work, film and print exposure times are often handled with a simple period timer. When making multiple exposures for comparisons, etc, binary-related exposure times are frequently used, e.g: print exposures of eight minutes, then four minutes, then two minutes, etc.

This versatile little timer will handle all the above applications and can be configured to suit a huge variety of other applications, probably only limited by your imagination.

This project can be set up for timing periods ranging from one minute up to at least 50 hours. Although I haven't tried it, it is certainly possible to extend the period to around 400 hours (16-17 days). Binary 'segments' of the basic period can be selected by the simple addition of a suitable switch. The project is low in cost and can be built into an appliance if you so wish.

Design

The unit is quite straightforward. Figure 1 shows a block diagram. It consists of an oscillator, a divider, a flip-flop, a relay driver and relay. The relay contacts are used to connect and disconnect the mains power from an attached appliance.

The oscillator output is divided down 8192 times. The divider's output drives the 'reset' input of the 'reset-set' (RS) flip-flop. The flip-flop has two outputs — A and B. In the initial, or reset, state, output A is high, resetting the divider in preparation for counting. Output B of the flip-flop is low and the relay is not operated.

When the start button is pressed, the RS flip-flop is 'set'. Output B goes high, operating the relay and turning on the appliance connected via the relay. Output A goes low, enabling the divider to count down.

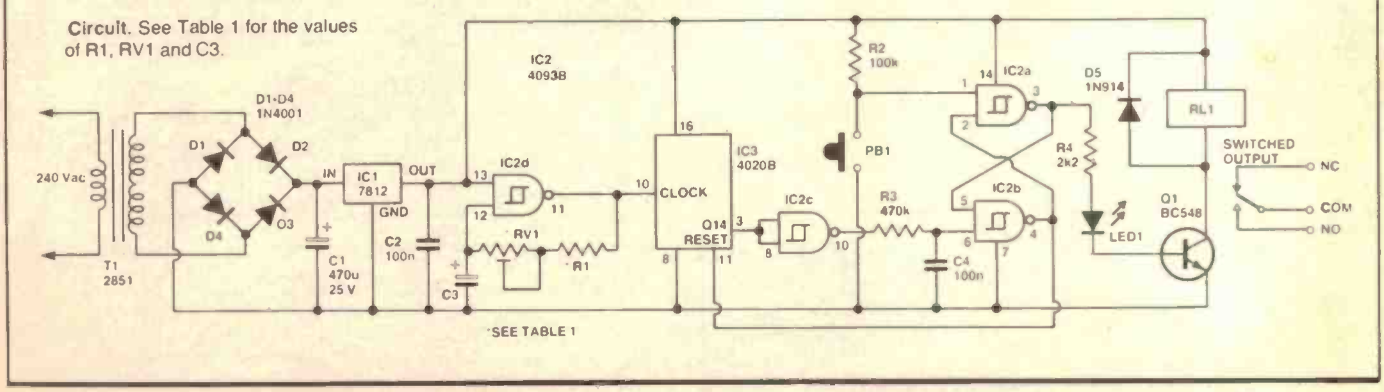
At the end of its count, the divider's output goes low, resetting the flip-flop. Output A goes high again, stopping the divider, and output B goes low. The relay then drops out, turning off the appliance connected via its contacts.

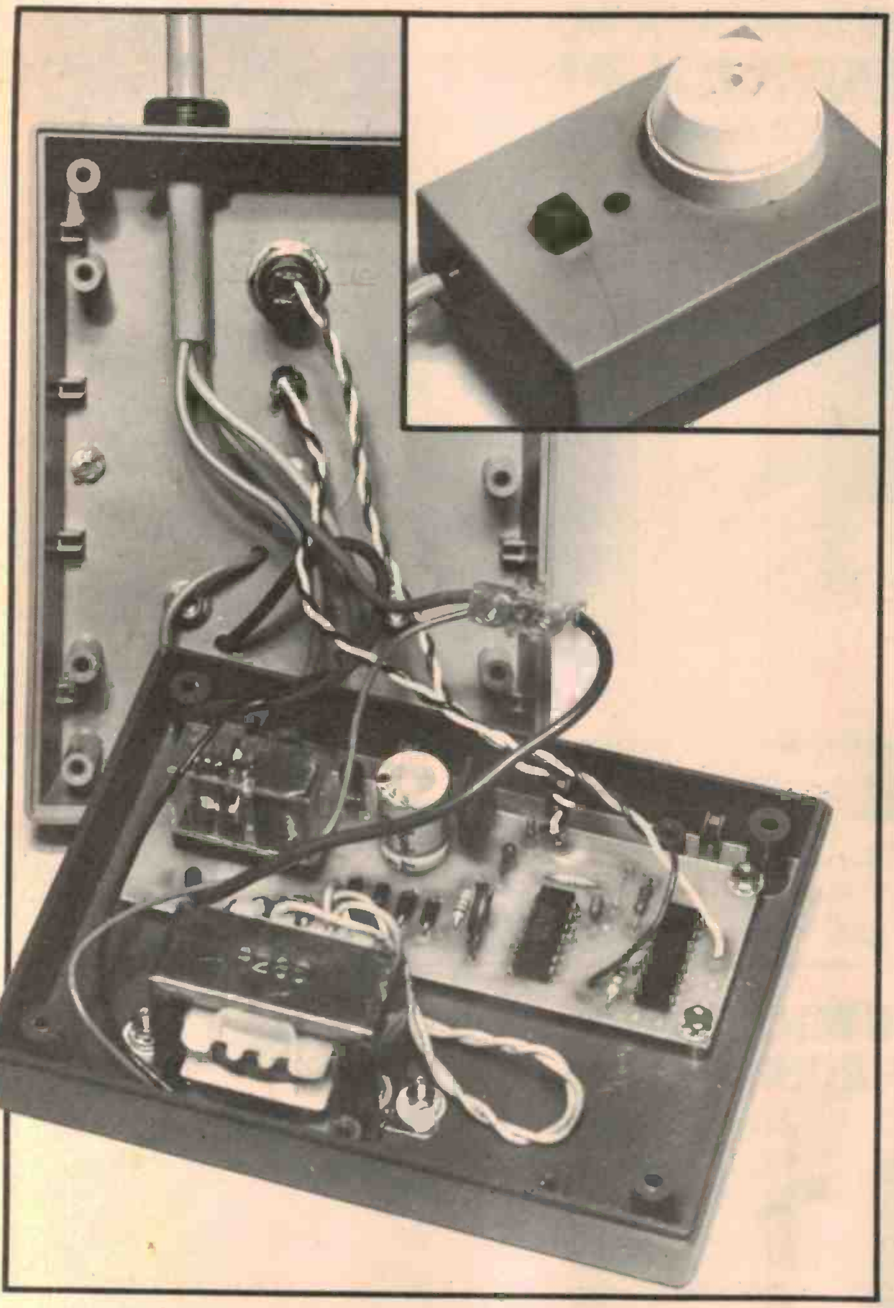
The oscillator's frequency will determine the basic period. Because the division ratio is so high, minor drifts or variations in the oscillator frequency will not materially affect the timing period, hence a simple oscillator can be used.

As the required timing period is determined by R1, RV1 and C3, the values you need for these components should be determined from Table 1 before commencing construction. It would be reasonable to expect a kit supplier *not* to include these in a kit, or to perhaps only include, say, a 1u RBLL or tantalum for C3 and perhaps a 1M trimpot, as these would cover a wide range of timing periods, leaving the choice of R1 to you.

Note that C3 should either be a tantalum type or single-ended 'low leakage' electrolytic for repeatable results. ▶

Circuit. See Table 1 for the values of R1, RV1 and C3.





▲ On the inside. Showing construction of the project and how I mounted it inside the Unibox case. Note that one of the internal pillars is cut down to provide clearance for the transformer. Inset. The completed project.

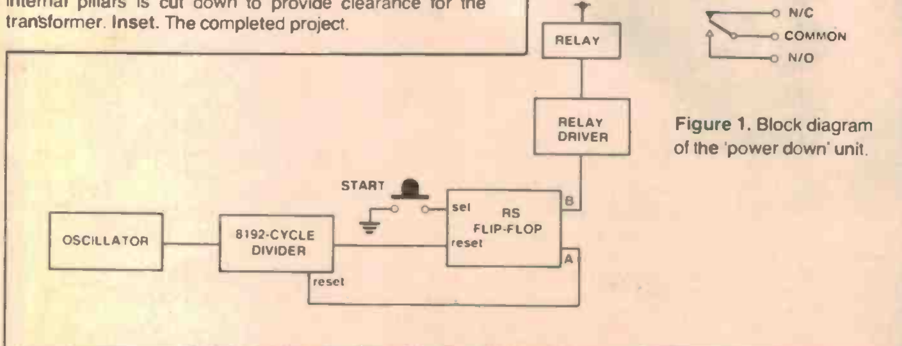


Figure 1. Block diagram of the 'power down' unit.

HOW IT WORKS — ETI-265

The overall design of the project is discussed in the text, so this shall largely be a blow-by-blow description of how it works. Let us start at the 'rear end' first.

Two gates from the 4093, IC2a and b, form the reset-set (RS) flip-flop. This is in the SET state when pin 3 of IC2 is high and pin 4 is low. It is in the RESET state when pin 4 is high and pin 3 low.

When the flip-flop is SET, Q1 is turned on as the high on pin 3 of IC2 biases on its base via R4 and LED1, which lights, indicating the unit is 'active'.

A momentary low on pin 1 of IC2 will SET the flip-flop, while a momentary low on pin 6 will RESET it.

On power-up, C4 will look like a short circuit and keep pin 6 of IC2 low long enough to RESET the flip-flop. Thus, pin 4 of IC2 will be high and reset IC3, a 4020B 14-stage binary counter with a division ratio of 8192:1.

Pin 3 of IC3 (the stage 14 output) will be low after the IC is reset and IC2 will invert this, pin 10 driving pin 6 high, allowing the flip-flop to be set when PB1 is pushed momentarily.

As soon as PB1 is pushed, the counter begins to count cycles of the Schmitt gate oscillator comprising IC2d, R1, RV1 and C3. The frequency of the oscillator is determined by RV1, R1 and C3 and the threshold voltages of the inputs of IC2d. (See 'Why some CMOS circuits don't work as you expect', Lab Notes, in this issue.)

After 8192 cycles of the oscillator, pin 3 of IC3 goes high, thus resetting the flip-flop via IC2c. Pin 3 of IC2 will thus go low and the relay will drop out.

The oscillator works as follows: At power-up, pin 12 of IC2d will be low as C3 appears as a short circuit. Pin 13 will be high and thus pin 11 will be driven high. C3 will charge via R1 and RV1. When the voltage on C3 reaches the gate's upper threshold, pin 11 will go low and C3 begin to discharge via RV1 and R1. When the voltage on C3 falls to the gate's lower threshold, pin 11 will again go high and the cycle will be repeated.

The oscillator frequency is related to the timing interval (or period) as follows:

$$f_o = \frac{8192}{T}$$

where f_o is the oscillator frequency in Hertz, and T is the period in seconds. Expressing this in terms of the period:

$$T = \frac{8192}{f_o}$$

Table 1 allows you to set up the project for a particular timing interval. The range of adjustment provided should compensate for most of the variation in threshold voltages of the different manufacturers' 4093s. The time interval shown in the table refers to the prototype project. If you add the rotary switch to give four ranges, the longest interval will be as per the table, the next will be half that, then quarter that, etc.

The power supply is quite straightforward. Transformer T1 drops the mains voltage to 12.6 V RMS. This is rectified by a bridge diode comprising D1 to D4. Capacitor C1 is the rectifier reservoir. About 18 volts is developed across C1 and this is regulated to 12 V by a 7812 three-terminal regulator, IC1. Capacitor C2 ensures regulator stability.

Diode D5, across the relay, shorts the reverse-emf generated by the relay coil when Q1 switches off, preventing the high voltage generated from destroying Q1.

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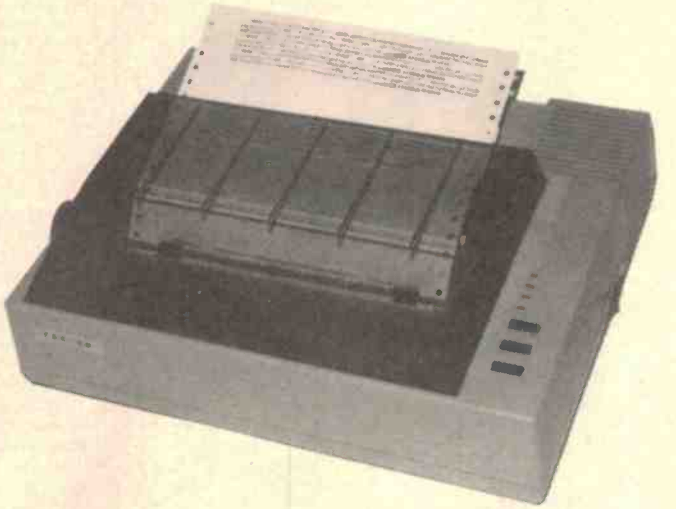

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Printing method:
Serial impact dot matrix.
Printing format:
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Semi-graphic (character graphic) — 7 x 8 dot matrix.
Bit image graphic — Vertical 8 dots parallel, horizontal 640 dots serial/line.
Character size:
2.1mm (0.083")-W x 2.4mm (0.09")-H/7 x 8 dot matrix.
Character set:
228 ASCII characters; Normal and italic alpha-numeric font, symbols and semi-graphics.
Printing speed:
80 CPS, 640 dots/line per second.
Printing direction:
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Superscript and bit image graphics — Unidirectional, left to right.
Line spacing:
Normal — 4.23mm (1/6").
Programmable in increments of 0.35mm (1/72") and 0.118mm (1/216").
Columns/line:
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Double width — 40 columns.
Compressed print — 142 columns.
Compressed/double width — 71 columns.
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Paper type:
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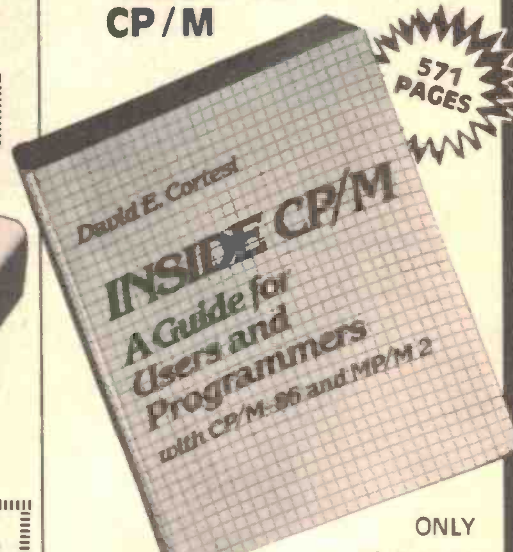

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See Review June EA, p.137.

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Construction

I built one prototype and mounted it in a plastic case, which you see in the photographs here, and another unit which I mounted inside an appliance (ask no questions and . . .)

I used an all-plastic Unibox (P/N144) measuring 135 mm long by 100 mm wide by 50 mm deep. (Magraths in Melbourne are a major supplier of these.) It has ample room inside. You could use a UB-1 zippy box (50 x 90 x 150 mm), but an all-plastic case is recommended for safety's sake. Jaycar stock a range of smart, all-plastic (ABS) cases in various colours. The HB6150, 1, 2, 3 series (orange, grey, blue, black) would suit.

First thing to do is determine the mounting positions of the printed circuit board and transformer. Lay the unassembled pc board and the transformer in the base of whatever box you're using and mark the positions of the mounting holes.

Then mark out suitable positions for the mains cable entry, the pushbutton, the LED and the mains socket. For the mains cable entry, I used a Heyco clamp-type grommet to suit the mains cable I used (grommet #1210, SR-6P-4). There are plenty of similar types available. If you don't use a clamp-type grommet, then use an ordinary rubber grommet and a nylon cable clamp.

The mains socket requires holes to be drilled in the box to allow cables to the active, neutral and earth pins to pass through to the socket terminals. I first loosened the grub screws on the socket terminals, then positioned the socket where I wanted it and drilled pilot holes in the case through the terminals.

After drilling all the holes, mount the transformer, output socket, LED and pushbutton, but not the pc board — you've got to assemble that yet! To mount the transformer, I used insulating washers from a TO-3 power transistor mounting kit. An alternative is to use nylon bolts. The latter were used to mount the pc board.

Note that, if you wish, the section of the board on which the relay mounts can be severed from the rest of the board, allowing the relay to be mounted away from the main portion of the electronics.

Assembly of the board is pretty straightforward. Start with the smaller components. Solder all the resistors in place, then the five diodes, C2, C3 and C4. Watch the orientation of C3 and the diodes. Solder a link of tinned copper wire in the position shown, between C4 and R4. Now you can solder IC2 and IC3 in place.

These are CMOS ICs. Use an iron with an earthed tip and only handle the ICs with your thumb and forefinger gripping the ends of the package. Avoid touching the pins. When you have each in place, solder pins 7 and 14 of IC2 first and pins 8 and 16 of IC3 first, before going on to solder the other pins. If you wish, IC sockets may be used without affecting operation of the project.

Next solder Q1 in place. Its orientation can be ascertained from the pinout diagram and the component overlay.

Now solder the electrolytic, C1, in place, taking care to orientate it correctly, followed by IC1 (get it the right way round) and RV1. The relay can be soldered to the board last of all.

Wires are run from the pc board to the mains circuitry, the pushbutton and the LED. Only ordinary light hookup wire (10 x 0.12 mm) need be used to connect up the LED and the pushbutton. The 2851 transformer primary wires are generally coloured red and black. It has three secondary wires, two the same colour. These are wired to the rectifier diodes D1-D4, as shown in the overlay/wiring diagram.

Wire the transformer primary very carefully. The brown active wire from the mains input cable goes to a terminal connector, where it joins the red wire from the transformer. Take a length of brown mains wire and connect it between this terminal connector and the COMMON relay terminal pad on the pc board. Another length of brown mains wire is run from the normally open (N/O) relay contact pad on the pc board to the active terminal of the mains output socket.

The blue neutral wire runs from the mains input cable direct to the neutral terminal on the mains output socket, along with the black wire from the transformer.

The green and yellow striped earth wire from the mains input cable goes direct to the earth terminal on the mains output socket. This wire should be longer than the other two from the mains input cable for safety reasons. Should the mains cable be accidentally pulled out from the case, the earth wire will be the last to break.

All finished? *Check everything thoroughly.*

That's all there is to it. Next thing to do is test and calibrate it.

Test and calibration

Set RV1 to the middle of its travel, then close the case so that you can't accidentally come in contact with the lethal mains voltage present.

Plug a bedside lamp into the output socket, plug the project into the mains and switch on. Nothing should happen. If all's well, press the pushbutton and the lamp should light. Now time how long it remains on (if it's 50 hours or more, you're going to need a *lot* of patience!).

If you have access to a frequency counter, then setting the timer is much easier. Just attach the frequency counter to pin 11 of IC2. The oscillator frequency is related to the timing period as follows:

$$\text{Frequency} = \frac{8192}{T}$$

where T is the desired period in seconds and the frequency is in Hertz.

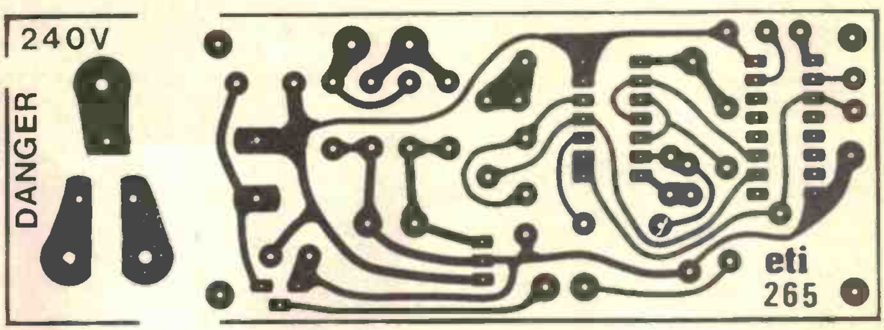
For a timing period of ten minutes, the frequency should be 13.65 Hz. For really long times, you're better off measuring the period of the oscillator output.

All you need do is to adjust RV1 for the correct frequency.

Binary periods

As mentioned earlier, the simple addition of a switch can give you binary (half, quarter, eighth) segments of the basic period. Details are shown in Figure 2.

Cut the track that runs beneath the body of IC3, then wire a single-pole, four-position switch as shown. Position 4 gives you the full period. Position 3 gives the half period, position 2 one-quarter and position 1 gives one-eighth the period. ●

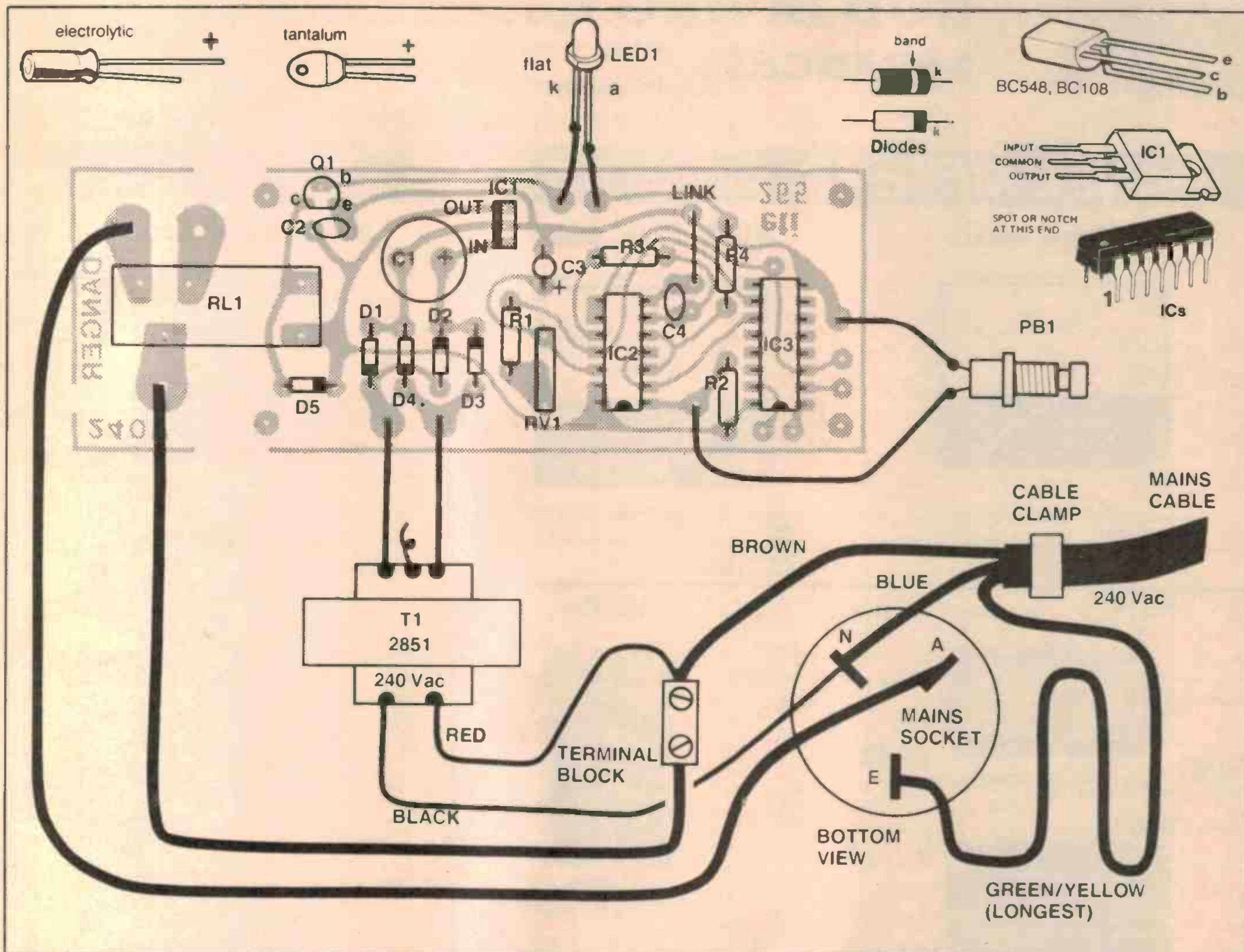


PARTS LIST — ETI-265

Resistors	all ¼ W, 5% unless noted
R1	47k
R2	100k
R3	470k
R4	2k2
Capacitors	
C1	470u/25 V single-ended electro.
C2,C4	100n greencap
C3	1u/16 V tantalum
Semiconductors	
D1-D4	1N4001, 1N4002 or similar
D5	1N914, 1N4148
IC1	7812
IC2	4093B
IC3	4020B
LED1	TIL220R red LED
Q1	BC548
Miscellaneous	
PB1	momentary action pushbutton, large (e.g: D.S.E. no. S-1199 or similar)
RL1	pc mount relay, 12 V coil SPDT/5 A contacts (e.g: D.S.E. S-7125, or similar)
T1	2851 transformer, 12.6 V CT @ 150 mA

ETI-265 pc board; case to suit (e.g: Unibox P/N 144, 100 x 135 x 50 mm, or similar); LED mount; 240 V wall socket; mains cable plug, cable and clamp; wire, etc.

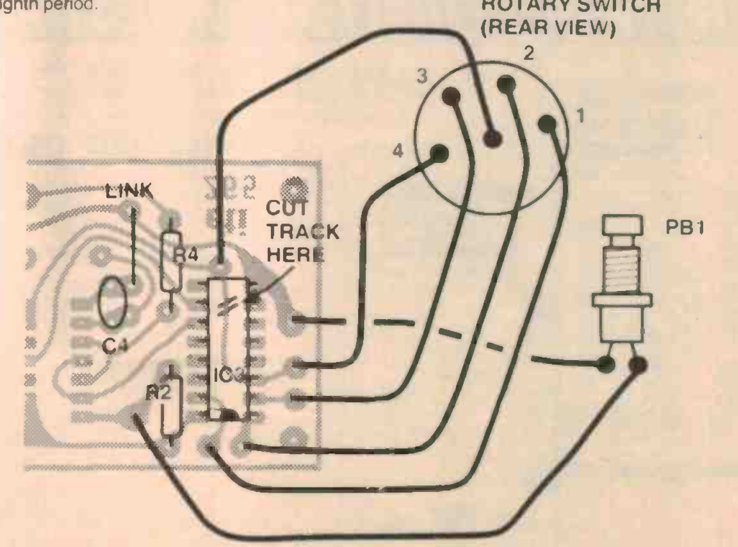
Price estimate $32-$37



Timing Interval	C3	R1	RV1
1 minute	100n	47k	100k
5 minutes	100n	270k	500k
10 minutes	100n	470k	1M
20 minutes	1u	100k	220k
30 minutes	1u	150k	220k
45 minutes	1u	270k	500k
1 hour	1u	270k	500k
1½ hours	1u	390k	1M
2 hours	1u	680k	1M
4 hours	1u	1M2	2M2
10 hours	100u	27k	50k
20 hours	100u	56k	100k
50 hours	100u	150k	200k
100 hours	100u	270k	500k
200 hours	100u	560k	1M
400 hours	100u	1M2	2M

TABLE 1

Binary period switching. How to add a switch to get selections of full period, half period, quarter period and eighth period.



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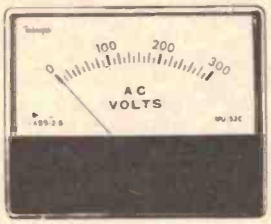
PANEL METERS

MU45 Panel Meters



Mounting hole distance between centres.
38mm x 38mm.
Hole required 45mm overall dimension.
Outside dimension.
58mm x 52mm.

MU52E Panel Meters

Mounting hole distance between centres.
64mm x 48mm
Hole required 51mm overall dimension.
Outside dimension.
80mm x 66mm.

MU65 Panel Meters

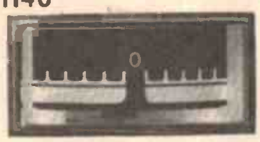
Mounting hole distance between centres.
80mm x 64mm.
Hole required 65mm overall dimension.
Outside dimension.
100mm x 82mm.

HR15

	1-9	10+
Q10400	4.50	3.95

250 ua Sensitivity Panel cut-out 36mm x 16mm.
Mounting hole centres at 49mm.

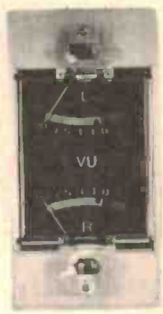
H46



	1-9	10+
Q10405	4.95	4.50

250 ua Sensitivity centre 'O' very useful for balanced circuit and applications needing a centre 'O' or null indication.

HW15



	1-9	10+
Q10410 Stereo VU Meter.	9.95	8.95

PANEL METERS			1-9	10+
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Q10502	MU45	50-0-50uA	9.75	7.95
Q10504	MU45	0-100uA	9.75	7.95
Q10505	MU45	0-50uA	9.75	7.95
Q10518	MU45	0-1A	9.75	7.95
Q10510	MU45	0-5A	9.75	7.95
Q10515	MU45	0-10A	9.75	7.95
Q10520	MU45	0-20V	9.75	7.95
Q10525	MU45	0-30V	9.75	7.95
Q10535	MU45	VU	10.95	9.95
Q10530	MU52E	0-1mA	10.95	8.95
Q10533	MU52E	0-5A	10.95	8.95
Q10538	MU65	0-50uA	13.95	11.95
Q10540	MU65	0-1mA	13.95	11.95
Q10550	MU65	0-100uA	13.95	11.95
Q10560	MU65	0-20V	13.95	11.95

Errors and omissions excepted.

Please ignore scales on Panel Meter photos

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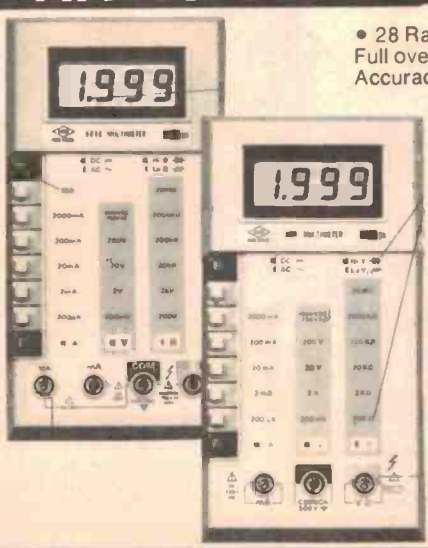

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RANGES	VOLT			AMP			OHM	
	UNIT	DC	AC	UNIT	DC	AC	UNIT	Hi & Lo OHM
[illegible]	mV			µA			Ω	0.5 + 3
2	V			mA			kΩ	
20	V	[illegible]	0.3 + 5	mA	0.3 + 1	0.5 + 5	kΩ	0.3 + 1
[illegible]	V			[illegible]			kΩ	
[illegible]	V							
[illegible]	V		[illegible]					
[illegible]				mA	1 + 1	1.5 + 5	kΩ	[illegible]
20							MΩ	1 + 1
10				A	[illegible]	[illegible]		

Q17040

2000 hour battery life 1–4 $89.95 5+ $84.95

RANGES	VOLT			AMP			OHM	
	UNIT	DC	AC	UNIT	DC	AC	UNIT	Hi & Lo OHM
[illegible]	mV			µA			Ω	[illegible]
2	V			mA			kΩ	
20	V	[illegible]	0.3 + 5	mA	[illegible]	[illegible]	kΩ	0.3 + 1
[illegible]	V			mA			kΩ	
[illegible]	V							
750	V		[illegible]					
[illegible]				mA	1 + 1	1.5 + 5	kΩ	[illegible]
20							MΩ	1 + 1
10				A	1.5 + 5	2 + 5		

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- Microcomputer-based self diagnostics

8062A

As 8060A above but without frequency and dB ranges. Provides true rms to 30kHz and relative reference functions.

	4½-Digit Resolution	Wideband True RMS AC	Continuity (Audible & Visual)	dBm, Relative dB	Frequency	Relative Reference (Offset)	Autoranging Megohms	Conductance	Constant-Current Diode Test	Self Diagnostics	Basic DC Accuracy
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8062A	•	30 kHz	•			•	•		•	•	0.05%

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- Audible and visible indicators
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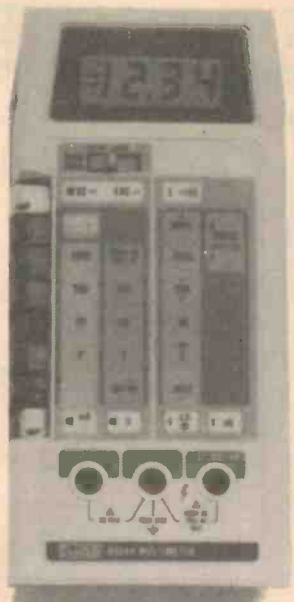

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8021B	•	•	•	•	•	•		•				0.25%
8020B	•	•	•	•	•	•	•	•				0.1%
8024B	•	•	•	•	•	•	•	•	•	•	•	0.1%

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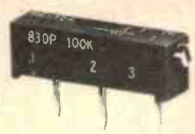

Resistance	Cat	Resistance	Cat	Resistance	Cat
100 R	R 2410	5K	R 2423	200 K	R 2433
200 R	R 2415	10 K	R 2425	500 K	R 2435
500 R	R 2417	20 K	R 2427	1 M	R 2437
1 K	R 2419	50 K	R 2429	2 M	R 2439
2 K	R 2421	100 K	R 2431		

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SPECIFICATIONS

• Vertical deflection	
Sensitivity	5mV/div to 5V/div ·5%. 10 calibrated steps 1mV/div to 1V/div ·6% (When using ·5 amplifier) Uncalibrated continous control between steps 1 · 2.5 (provided with click-positioning function)
Bandwidth	DC to 15MHz, -3dB (at 4div) DC to 7MHz, -3dB (at 4div) (When using ×5 amplifier)
Rise time	24ns, (for ×5) 70ns typ
Signal delay line	—
Max input voltage	600Vp-p or 300V (DC · AC peak, at 1kHz)
Input Coupling	AC, GND, DC
Input impedance	Direct 1M ohm, approx 30pF
Operating modes	CH1, CH2, DUAL, ADD, DIFF
X Y operation	CH1 X axis, CH2 Y axis
Sensitivity	5mV/div to 5V/div (when using ·5 amplifier 1mV/div)
Phase difference	DC to 10kHz within 3
X bandwidth	DC to 500kHz, -3dB
Dynamic range	4div or more
CH1 output	
Output voltage	20mV/div or more (terminated into 50Ω)
Band width	50Hz to 5MHz, -3dB
Output impedance	Approx 50Ω

• Horizontal deflection	
Trigger modes	AUTO, NORM, TV (+), TV (-)
Trigger source	CH1, CH2, LINE, EXT
Trigger coupling	AC
TV sync	TV sync-separation circuit
Internal	1div or more (V sync-signal)
External	1Vp-p or more (V sync-signal)
Trigger sensitivity	Frequency / Internal / External: 20Hz to 2MHz / 0.5div / 200mV; 2 to 15MHz / 1.5div / 800mV
AUTO low bandwidth	30Hz
Trigger slope	±
External trigger input	Input impedance approx. 1M ohm, 30pF or less Max input voltage 100V (DC + AC peak, at 1kHz)
Sweep time	0.2µs/div to 0.2s/div ·5%. 19 calibrated steps Uncalibrated continuous control between steps 1 <2.5 (provided with click-positioning function)
Sweep time magnifier	10 times (·7%)
Max sweep time	100ns/div (20ns/div and 50ns/div, not calibrated)
• Amplitude calibrator	
Waveform	Approx. 1kHz ±10% (typ), square wave
Voltage	0.5V ±5%
• Power requirements	100/120/220/240V ±10% 50 to 60Hz, approx. 40W
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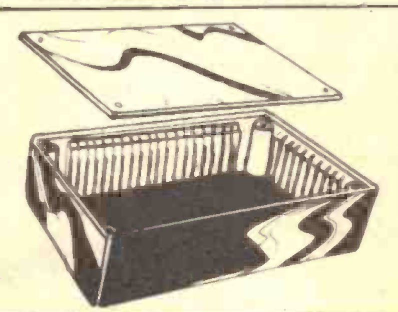
H 0105	83 x 54 x 28	50	47	$1.20



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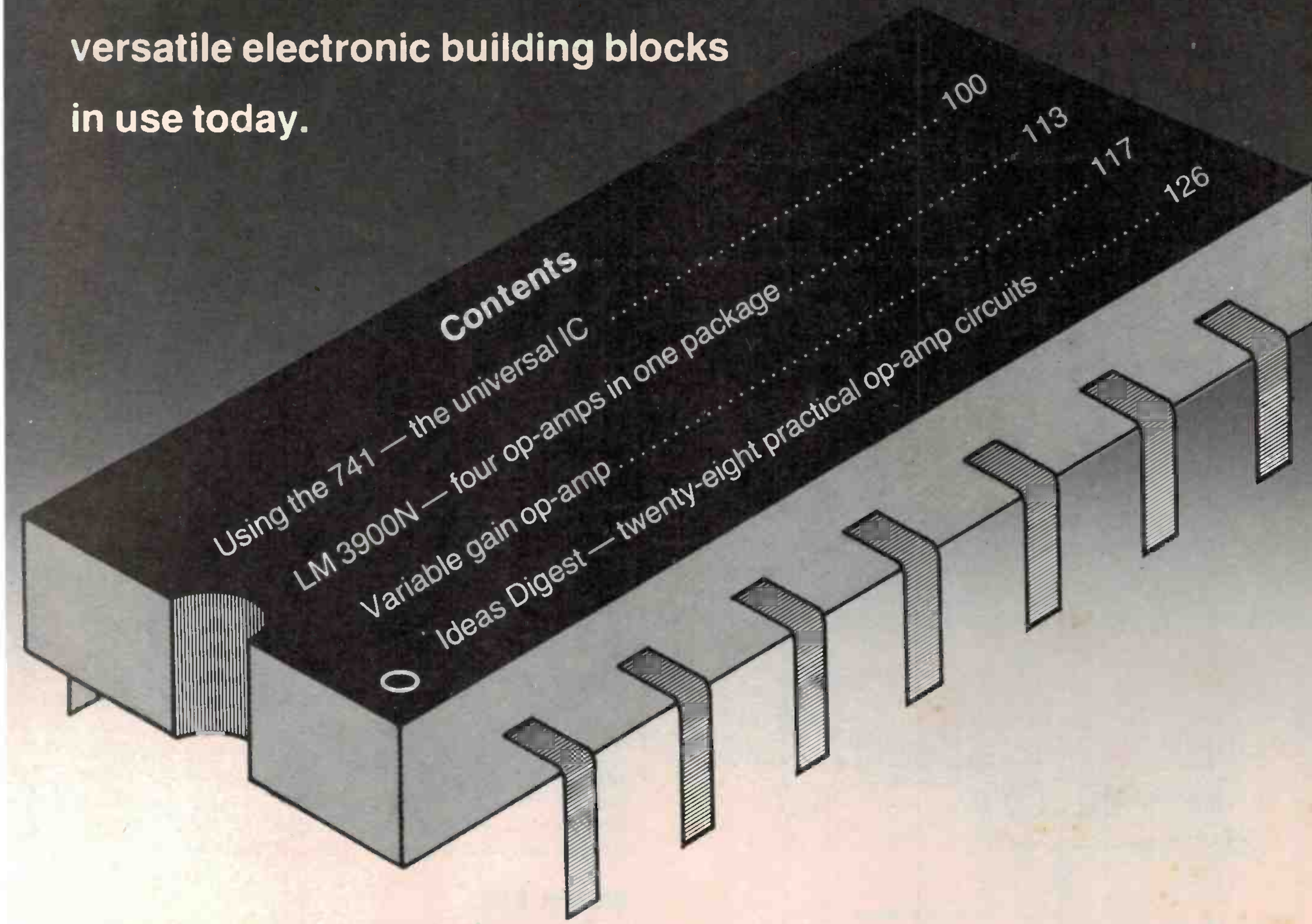
OP-AMP COOKBOOK

ETI's practical guide to one of the most versatile electronic building blocks in use today.



The op-amp cookbook — using the 741

Here's how to use the 741 op-amp — one of the most versatile building blocks of all time.

OPERATIONAL AMPLIFIERS (OP-AMPS) CAN be simply described as high-gain direct-coupled voltage amplifier 'blocks' that have a single output terminal but have both inverting and non-inverting input terminals. Op-amps can readily be used as inverting, non-inverting, and differential amplifiers in both a.c. and d.c. applications, and can easily be made to act as oscillators, tone filters, and level switches, etc.

Op-amps are readily available in integrated circuit form, and as such act as one of the most versatile building blocks available in electronics today. One of the most popular op-amps presently available is the device that is universally known as the "741" op-amp In this article we shall describe the basic features of this device, and show a wide variety of practical circuits in which it can be used.

BASIC OP-AMP CHARACTERISTICS AND CIRCUITS

In its simplest form, an op-amp consists of a differential amplifier followed by offset compensation and output stages, as shown in Fig. 1a. The differential amplifier has inverting and non-inverting input terminals, a high-impedance (constant current) tail to

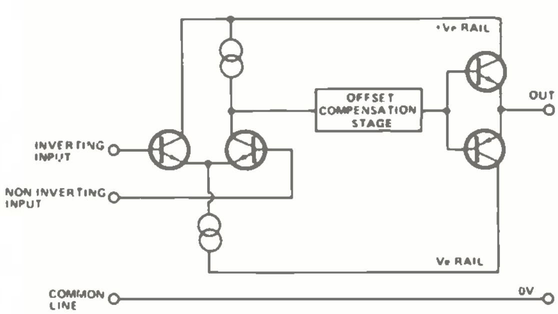


Fig. 1a Simplified op-amp equivalent circuit.

give a high input impedance and a high degree of common mode signal rejection. It also has a high-impedance (constant current) load to give a high degree of signal voltage stage gain.

The output of the differential amplifier is fed to a direct-coupled offset compensation stage, which effectively reduces the output offset voltage of the differential amplifier to zero volts under quiescent conditions, and the output of the compensation stage is fed to a simple complementary emitter follower output stage, which gives a low output impedance.

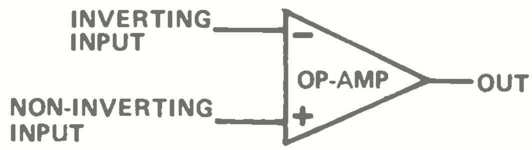


Fig.1b Basic op-amp symbol.

LINES OF SUPPLY

Op-amps are normally powered from split power supplies, providing +ve, −ve, and common (zero volt) supply rails, so that the output of the op-amp can swing either side of the zero volts value, and can be set at a true zero volts (when zero differential voltage is applied to the circuits input terminals.)

The input terminals can be used independently (with the unused terminal grounded) or simultaneously, enabling the device to function as an inverting, non-inverting, or differential amplifier. Since the device is direct-coupled throughout, it can be used to amplify both a.c. and d.c. input signals. Typically, they give basic low-frequency voltage gains of about 100 000 between input and output, and have input impedances of 1M or greater at each input terminal.

Fig. 1b shows the symbol that is commonly used to represent an op-amp, and 1c shows the basic supply connections that are used with the device. Note that both input and output signals of the op-amp are referenced to the ground or zero volt line.

SIGNAL BOX

The output signal voltage of the op-amp is proportional to the DIFFERENTIAL signal between its two input terminals, and is given by

$$e_{out} = A_0(e_1 - e_2)$$

where A_o = the open-loop voltage gain of the op-amp (typically 100 000).

e_1 = signal voltage at the non-inverting input terminal.

e_2 = signal voltage at the inverting input terminal.

Thus, if identical signals are simultaneously applied

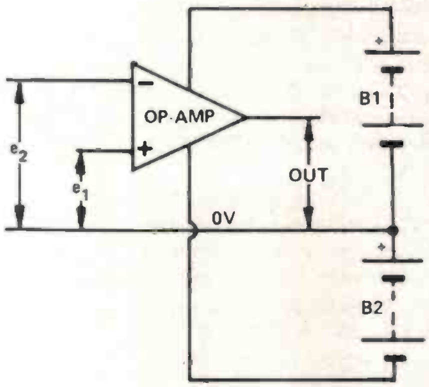


Fig. 1c Basic supply connections of an op-amp.

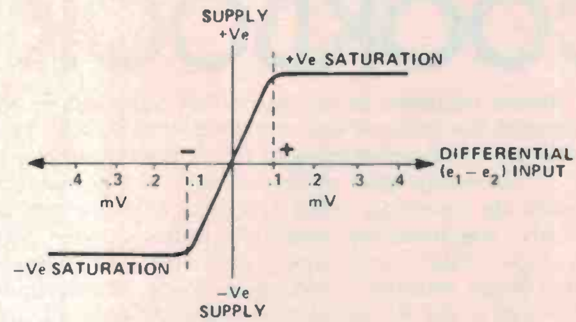


Fig. 2b Transfer characteristics of the differential voltage comparator circuit.

to both input terminals, the circuit will (ideally) give zero signal output If a signal is applied to the inverting terminal only, the circuit gives an amplified and inverted output If a signal is applied to the non-inverting terminal only, the circuit gives an amplified but non-inverted output.

By using external negative feedback components, the stage gain of the op-amp circuit can be very precisely controlled.

GOING TO GROUND

The op-amp can be made to function as a low-level inverting d.c. amplifier by simply grounding the non-inverting terminal and feeding the input signal to

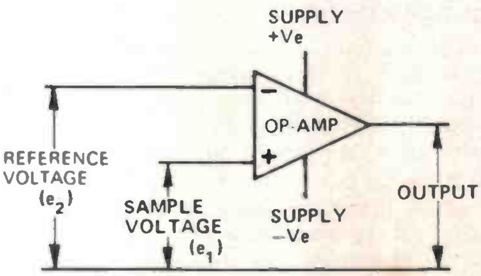


Fig. 2a Simple differential voltage comparator circuit.

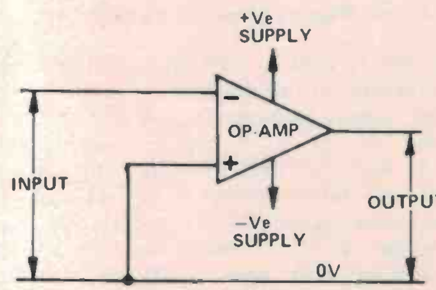


Fig. 3a Simple open-loop inverting d.c. amplifier.

TRANSFER REQUEST

Fig. 2a shows a very simple application of the op-amp. This particular circuit is known as a differential voltage comparator, and has a fixed reference voltage applied to the inverting input terminal, and a variable test or sample voltage applied to the non-inverting terminal. When the sample voltage is more than a few hundred microvolts above the reference voltage the op-amp output is driven to saturation in a positive direction, and when the sample is more than a few hundred microvolts below the reference voltage the output is driven to saturation in the negative direction.

Fig. 2b shows the voltage transfer characteristics of the above circuit. Note that it is the magnitude of the differential input voltage that dictates the magnitude of the output voltage, and that the absolute values of input voltage are of little importance. Thus, if a 1V reference is used and a differential voltage of only 200uV is needed to switch the output from a negative to a positive saturation level, this change can be caused by a shift of only 0.02% on a 1V signal applied to the sample input. The circuit thus functions as a precision voltage comparator or balance detector.

the inverting terminal, as shown in Fig. 3a. The op-amp is used 'open-loop' (without feedback) in this configuration, and thus gives a voltage gain of about 100 000 and has an input impedance of about 1M. The disadvantage of this circuit is that its parameters are dictated by the actual op-amp, and are subject to considerable variation between individual devices.

CLOSING LOOPS

A far more useful way of employing the op-amp is to use it in the closed-loop mode, i.e., with negative feedback. Fig. 3b shows the method of applying negative feedback to make a fixed-gain inverting d.c. amplifier. Here, the parameters of the circuit are controlled by feedback resistors R_1 and R_2. The gain, A of the circuit is dictated by the ratios of R_1 and R_2, and equals R_2/R_1.

The gain is virtually independent of the op-amp characteristics, provided that the open-loop gain (A_o) is large relative to the closed-loop gain (A). The input impedance of the circuit is equal to R_1, and again is virtually independent of the op-amp characteristics.

OP-AMP COOKBOOK

It should be noted at this point that although R_1 and R_2 control the gain of the complete circuit, they have no effect on the parameters of the actual op-amp, and the full open-loop gain of the op-amp is still available between its inverting input terminal and the output. Similarly, the inverting terminal continues to have a very high input impedance, and negligible signal current flows into the inverting terminal. Consquently, virtually all of the R_1 signal current also flows in R_2, and

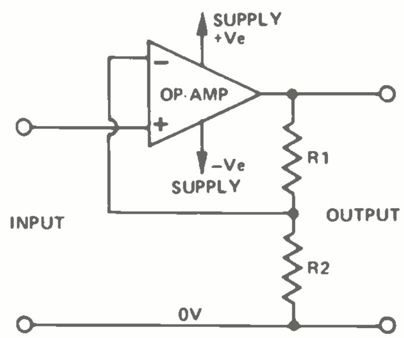


Fig. 4a Basic non-inverting d.c. amplifier

signal currents i_1 and i_2 can be regarded as being equal, as indicated in the diagram.

Since the signal voltage appearing at the output terminal end of R_2 is A times greater than that appearing at the inverting terminal end, the current flowing in R_2 is A times greater than that caused by the inverting terminal signal only. Consequently, R_2 has an apparent value of R_2/A when looked at from its inverting terminal end, and the R_1–R_2 junction thus appears as a low-impedance VIRTUAL GROUND point.

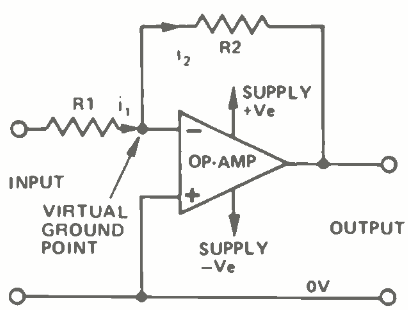


Fig. 3b Basic closed-loop inverting d.c. amplifier.

INVERT OR NOT TO INVERT . . .

It can be seen from the above description that the Fig. 3b circuit is very versatile. Its gain and input impedance can be very precisely controlled by suitable choice of R_1 and R_2, and are unaffected by variations in the op-amp characteristics. A similar thing is true of the non-inverting d.c. amplifier circuit shown in Fig. 4a. In this case the voltage gain is equal to $(R_1+R_2)/R_2$ and the input impedance is approximately equal to (A_0/A)Zin where Zin is the open-loop input impedance of the op-amp. A great advantage of this circuit is that it has a very high input impedance.

FOLLOW THAT VOLTAGE

The op-amp can be made to function as a precision voltage follower by connecting it as a unity-gain non-inverting d.c. amplifier, as shown in Fig. 4b. In this case the input and output voltages of the circuit are identical, but the input impedance is very high and is roughly equal to $A_0 \times Z_{in}$.

The basic op-amp circuits of Figs. 2a to 4b are shown as d.c. amplifiers, but can readily be adapted for a.c. use. Op-amps also have many applications other than as simple amplifiers. They can easily be made to function as precision phase splitters, as adders or subtractors, as active filters or selective amplifiers, as precision half-wave or full-wave rectifiers, and as oscillators or multivibrators, etc.

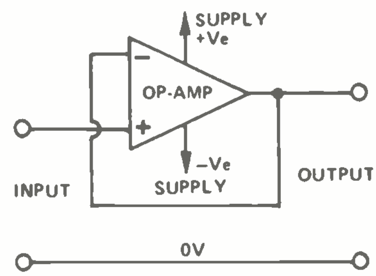


Fig. 4b Basic unity-gain d.c. voltage follower

OP-AMP PARAMETERS

An ideal op-amp would have an infinite input impedance, zero output impedance, infinite gain and infinite bandwidth, and would give perfect tracking between input and output. Practical op-amps fall far short of this ideal, and have finite gain, bandwidth, etc., and give tracking errors between the input and output signals. Consequently, various performance parameters are detailed on op-amp data sheets, and indicate the measure of "goodness" of the particular device. The most important of these parameters are detailed below.

OPEN-LOOP VOLTAGE GAIN, A_o. This is the low-frequency voltage gain occuring directly between the input and output terminals of the op-amp, and may be expressed in direct terms or in terms of dB. Typically, d.c. gain figures of modern op-amps are 100 000, or 100dB.

INPUT IMPEDANCE, Z_{in}. This is the impedance looking directly into the input terminals of the op-amp when it is used open-loop, and is usually expressed in terms of resistance only. Values of 1M are typical of modern op-amps with bi-polar input stages, while F.E.T. input types have impedances of a million meg or greater.

OUTPUT IMPEDANCE, Z_o. This is the output impedance of the basic op-amp when it is used open-loop, and is usually expressed in terms of resistance only. Values of a few hundred ohms are typical of modern op-amps.

INPUT BIAS CURRENT, I_b. Many op-amps use bipolar transistor input stages, and draw a small bias current from the input terminals. The magnitude of this current is denoted by I_b, and is typically only a fraction of a microamp.

SUPPLY VOLTAGE RANGE, V_s. Op-amps are usually operated from two sets of supply rails, and these supplies must be within maximum and minimum limits. If the supply voltages are too high the op-amp may be damaged, and if the supply voltages are too low the op-amp will not function correctly. Typical supply limits are ±3V to ±15V.

INPUT VOLTAGE RANGE, $V_{i(max)}$. The input voltage to the op-amp must never be allowed to exceed the supply line voltages, or the op-amp may be damaged. $V_{i(max)}$ is usually specified as being one or two volts less than v_s.

OUTPUT VOLTAGE RANGE, $V_{o(max)}$. If the op-amp is over driven its output will saturate and be limited by the available supply voltages, so $V_{o(max)}$ is usually specified as being one or two volts less than V_s.

DIFFERENTIAL INPUT OFFSET VOLTAGE, V_{io}. In the ideal op-amp perfect tracking would exist between the input and output terminals of the device, and the output would register zero when both inputs were grounded. Actual op-amps are not perfect devices, however, and in practice slight imbalances exist within their input circuitry and effectively cause a small offset or bias potential to be applied to the input terminals of the op-amp. Typically, this DIFFERENTIAL INPUT OFFSET VOLTAGE has a value of only a few millivolts, but when this voltage is amplified by the gain of the circuit in which the op-amp is used it may be sufficient to drive the op-amp output to saturation. Because of this, most op-amps have some facility for externally nulling out the offset voltage.

COMMON MODE REJECTION RATION, c.m.r.r. The ideal op-amp produces an output that is proportional to the difference between the two signals applied to its input terminals, and produces zero output when identical signals are applied to both inputs simultaneously, i.e., in common mode. In practical op-amps, common mode signals do not entirely cancel out, and produce a small signal at the op-amps output terminal. The ability of the op-amp to reject common mode signals is usually expressed in terms of common mode rejection ratio, which is the ratio of the op-amps gain with differential signals to the op-amps gain with common mode signals. C.m.r.r. values of 90dB are typical of modern op-amps.

TRANSITION FREQUENCY, f_T. An op-amp typically gives a low-frequency voltage gain of about 100dB, and in the interest of stability its open-loop frequency response is tailored so that the gain falls off as the frequency rises, and falls to unity at a transition frequency denoted f_T. Usually, the response falls off at a rate of 6dB per octave or 20dB per decade. Fig. 5 shows the typical response curve of the type 741 op-amp, which has an f_T of 1MHz and a low frequency gain of 100dB.

Note that, when the op-amp is used in a closed-loop amplifier circuit, the bandwidth of the circuit depends on the closed-loop gain. If the amplifier is used to give a gain of 60dB its bandwidth is only 1kHz, and if it is used to give a gain of 20dB its bandwidth is 100kHz. The f_T figure can thus be used to represent a gain-bandwidth product.

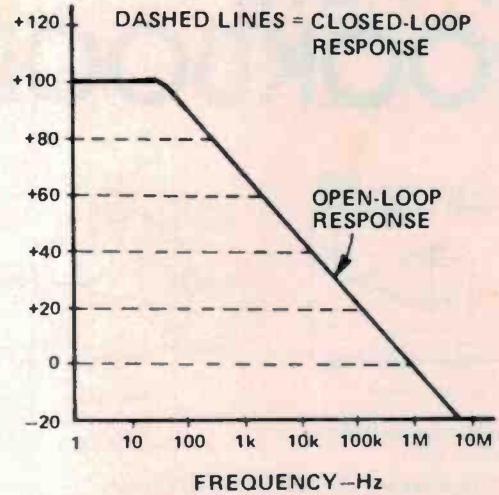


Fig. 5 Typical frequency response curve of the 741 op-amp.

	PARAMETER	741 VALUE
A_o	OPEN-LOOP VOLTAGE GAIN	100dB
Z_{IN}	INPUT IMPEDANCE	1M
Z_o	OUTPUT IMPEDANCE	150R
I_b	INPUT BIAS CURRENT	200nA
$V_{s\,(MAX)}$	MAXIMUM SUPPLY VOLTAGE	±18V
$V_{i\,(MAX)}$	MAXIMUM INPUT VOLTAGE	±13V
$V_{o\,(MAX)}$	MAXIMUM OUTPUT VOLTAGE	±14V
V_{io}	DIFFERENTIAL INPUT OFFSET VOLTAGE	2mV
c.m.m.r.	COMMON MODE REJECTION RATIO	90dB
F_T	TRANSITION FREDUENCY	1MHZ
S	SLEW RATE	1V/uS

Table 1 Typical characteristics of the 741 op-amp.

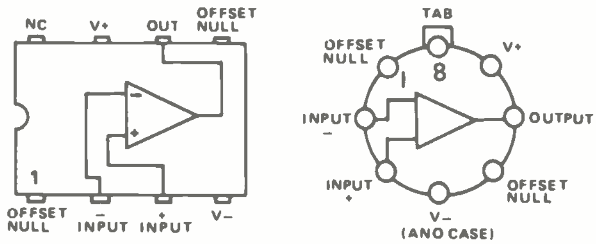
SLEW RATE. As well as being subject to normal bandwidth limitations, op-amps are also subject to a phenomenon known as slew rate limiting, which has the effect of limiting the maximum rate of change of voltage at the output of the device. Slew rate is normally specified in terms of volts per microsecond, and values in the range 1V/us to 10V/us are common with most popular types of op-amp. One effect of slew rate limiting is to make a greater bandwidth available to small output signals than is available to large output signals.

THE 741 OP-AMP.

Early types of i.c. op-amp, such as the well known 709 type, suffered from a number of design weaknesses. In particular, they were prone to a phenomenon known as INPUT LATCH-UP, in which the input circuitry tended to switch into a locked state if special precautions were not taken when connecting the input signals to the input terminals, and tended to self-destruct if a short circuit were inadvertently placed across the op-amp output terminals. In addition, the op-amps were prone to bursting into unwanted oscillations when used in the linear amplifier mode, and required the use of external frequency compensation components for stability control.

These weaknesses have been eliminated in the type 741 op-amp. This device is immune to input latch-up problems, has built-in output short circuit protection, and does not require the use of external frequency compensation components. The typical performance

OP-AMP COOKBOOK



8 pin Minidip or DIP 741 (Top View)

T05 741 (TOP VIEW)

Fig. 6 Outlines and pin connections of the two most popular 741 packages.

characteristics of the device are listed in Table 1.

The type 741 op-amp is marketed by most i.c. manufacturers, and is very readily available. Fig. 6 shows the two most commonly used forms of packaging of the device Throughout this chapter, all practical circuits are based on the standard 8-pin dual-in-line (D.I.L. or DIP) version of the 741 op-amp.

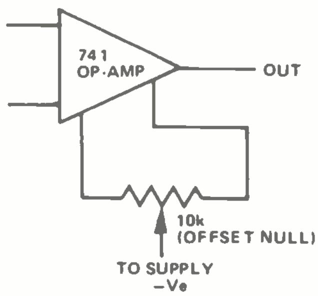


Fig. 7 Method of applying offset nulling to the 741 op-amp.

The 741 op-amp can be provided with external offset nulling by wiring a 10k pot between its two null terminals and taking the pot slider to the negative supply rail, as shown in Fig. 7.

Having cleared up these basic points, let's now go on and look at a range of practical applications of the 741 op-amp.

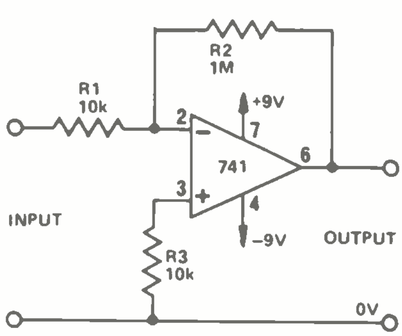


Fig. 8a x100 inverting d.c. amplifier.

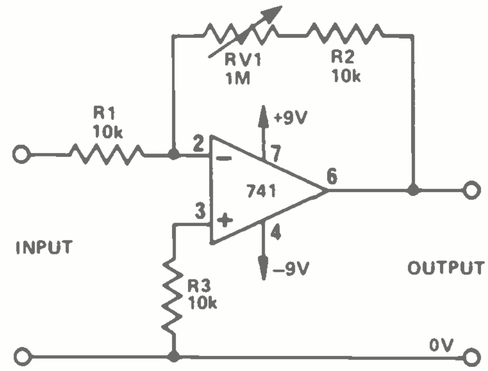


Fig. 8b Variable gain (x1 to x100) inverting d.c. amplifier.

BASIC LINEAR AMPLIFIER PROJECTS. (Figs. 8 to 11).

Figs. 8 to 11 show a variety of ways of using the 741 in basic linear amplifier applications.

The 741 can be made to function as an inverting amplifier by grounding the non-inverting input terminal and feeding the input signal to the inverting terminal. The voltage gain of the circuit can be precisely controlled by selecting suitable values of external feedback resistance. Fig. 8a shows the practical connections of an inverting d.c. amplifier with a pre-set gain of x100· The voltage gain is determined by the ratios of R_1 and R_2, as shown in the diagram.

The gain can be readily altered by using alternative R_1 and/or R_2 values. If required, the gain can be made variable by using a series combination of a fixed and a variable resistor in place of R_2, as shown in the circuit of Fig. 8b, in which the gain can be varied over the range x1 to x100 via R_2.

VARIATIONS

A variation of the basic inverting d.c. amplifier is shown in Fig. 9a. Here, the feedback connection to R_2 is taken from the output of the R_3–R_4 output potential divider, rather than directly from the output of the op-amp, and the voltage gain is determined by the ratios of this divider as well as by the values of R_1 and

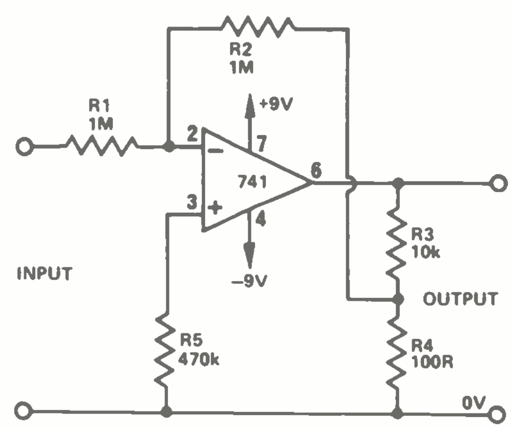


Fig. 9a High impedance x100 inverting d.c. amplifier.

R_2. The important feature of this circuit is that it enables R_1, which determines the input impedance of the circuit, to be given a high value if required, while at the same time enabling high voltage gain to be achieved.

The basic inverting d.c. amplifier can be adapted for a.c. use by simply wiring blocking capacitors in series with its input and output terminals, as shown in the x100 inverting a.c. amplifier circuit of Fig. 9b.

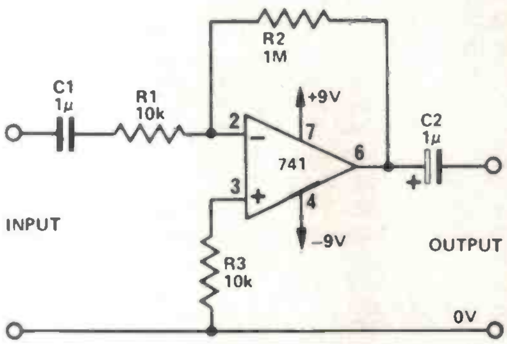


Fig. 9b x100 inverting a.c. amplifier.

NON-INVERTING . . .

The amp can be made to function as a non-inverting amplifier by feeding the input signal to its non-inverting terminal and applying negative feedback to the inverting terminal via a resistive potential divider that is connected across the op-amp output. Fig. 10a shows the connections for making a fixed gain (x100) d.c. amplifier.

The voltage gain of the Fig. 10a circuit is determined by the ratios of R_1 and R_2. If R_2 is given a value of zero the gain falls to unity, and if R_1 is given a value of zero the gain rises towards infinity (but in practice is limited to the open-loop gain of the op-amp). If required, the gain can be made variable by replacing R_2 with a

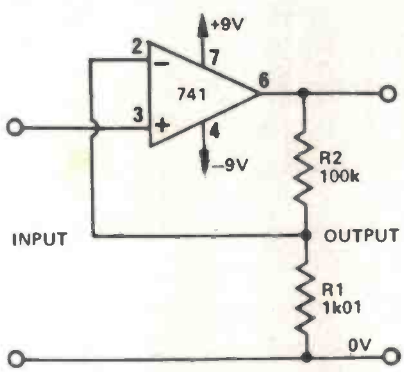


Fig.10a Non-inverting x100 d.c. amplifier.

potentiometer and connecting the pot slider to the inverting terminal of the op-amp, as shown in the circuit of Fig. 10b. The gain of this circuit can be varied over the range x1 to x100 via R_1.

. . . AND RESISTANCE TO INPUTS

A major advantage of the non-inverting d.c. amplifier is that it has a very high input resistance. In theory, the input resistance is equal to the open-loop input resistance (typically 1M) multiplied by the open-loop voltage gain (typically 100 000) divided by the actual circuit voltage gain. In practice, input resistance values of hundreds of megohms can readily be obtained.

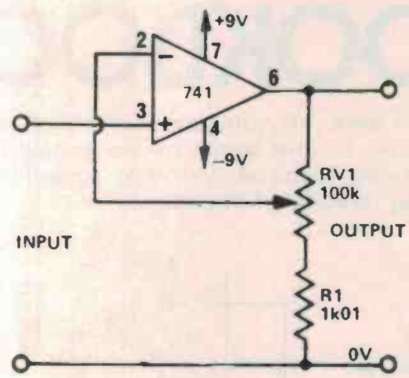


Fig. 10b Non-inverting variable gain (x1 to x100) d.c. amplifier.

BLOCKING OUT

The basic non-inverting d.c. circuit of Fig. 10 can be modified to operate as a.c. amplifiers in a variety of ways. The most obvious approach here is to simply wire blocking capacitors in series with the inputs and outputs, but in such cases the input terminal must be d.c. grounded via a suitable resistor, as shown by R_3 in the non-inverting x100 a.c. amplifier of Fig. 11a. If this resistor is not used the op-amp will have no d.c. stability, and its output will rapidly drift into saturation. Clearly, the input resistance of the Fig. 11a circuit is equal to R_3, and R_3 must have a relatively low value in the interest of d.c. stability. This circuit thus loses the non-inverting amplifier's basic advantage of high input resistance.

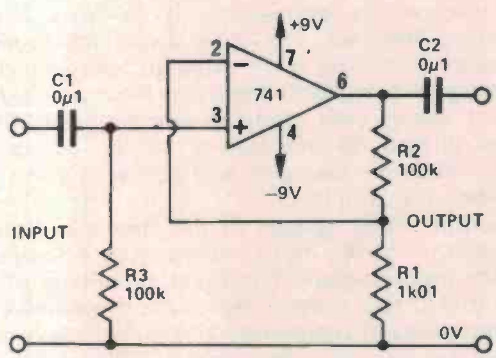


Fig. 11a Non-inverting, high input-impedance, x100 a.c. amplifier.

DRIFTING INTO STABILITY

A useful development of the Fig. 11a circuit is shown in Fig. 11b. Here, the values of R_1 and R_2 are increased and a blocking capacitor is interposed between them. At practical operating frequencies this capacitor has a negligible impedance, so the voltage gain is still determined by the ratios of the two resistors. Because of the inclusion of the blocking capacitor, however, the inverting terminal of the op-amp is subjected to virtually 100% d.c. negative feedback from the output terminal of the op-amp, and the circuit thus has excellent d.c. stability. The low end of R_3 is

OP-AMP COOKBOOK

connected to the C_3–R_1 junction, rather than directly to the ground line, and the signal voltage appearing at this point is virtually identical with that appearing at the non-inverting terminal of the op-amp·

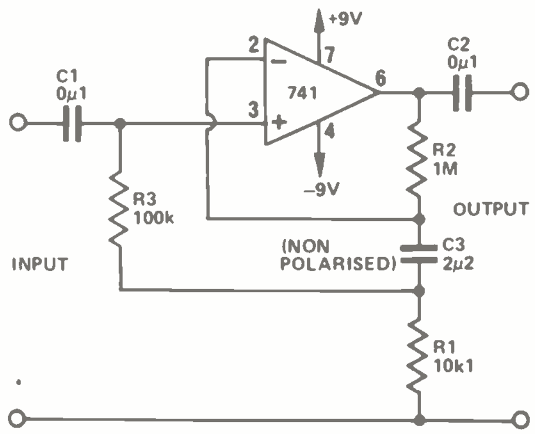


Fig. 11b Non-inverting x100 a.c. amplifier.

Consequently, identical signal voltages appear at both ends of R_3, and the apparent impedance of this resistor is increased close to infinity by bootstrap action.

This circuit thus has good d.c. stability and a very high input impedance· In practice, this circuit gives a typical input impedance of about 50M.

VOLTAGE FOLLOWER PROJECTS (Figs. 12 to 13).

A 741 can be made to function as a precision voltage follower by connecting it as a unity-gain non-inverting amplifier. Fig. 12a shows the practical connections for making a d.c. voltage follower. Here, the input signal is applied directly to the non-inverting terminal of the op-amp, and the inverting terminal is connected directly to the output, so the circuit has 100% d.c. negative feedback and acts as a unity-gain non-inverting d.c. amplifier.

The output signal voltage of the circuit is virtually identical to that of the input, so the output is said to 'follow' the input voltage. The great advantage of this circuit is that it has a very high input impedance (as high as hundreds of megohms) and a very low output impedance (as low as a few ohms). The circuit acts effectively as an impedance transformer.

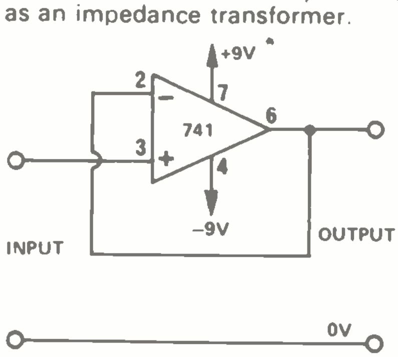


Fig. 12a d.c. voltage follower.

PRACTICE, AND ITS LIMITS

In practice the output of the basic Fig. 12a circuit will follow the input to within a couple of millivolts up to magnitudes within a volt or so of the supply line potentials. If required, the circuit can be made to follow to within a few microvolts by adding the offset null facility to the op-amp.

The d.c. voltage follower can be adapted for a.c. use by wiring blocking capacitors in series with its input and output terminals and by d.c.-coupling the non-inverting terminal of the op-amp to the zero volts line via a suitable resistor, as shown by R_1 in Fig. 12b. R_1 should have a value less than a couple of megohms, and restricts the available input impedance of the voltage follower.

LACED UP OHMS

If a very high input-impedance a.c. voltage follower is needed, the circuit of Fig. 12c can be used. Here, R_1 is boostrapped from the output of the op-amp, and its apparent impedance is greatly increased. This circuit has a typical impedance of hundreds of megohms.

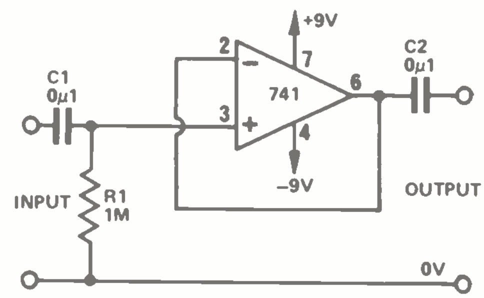


Fig. 12b a.c. voltage follower.

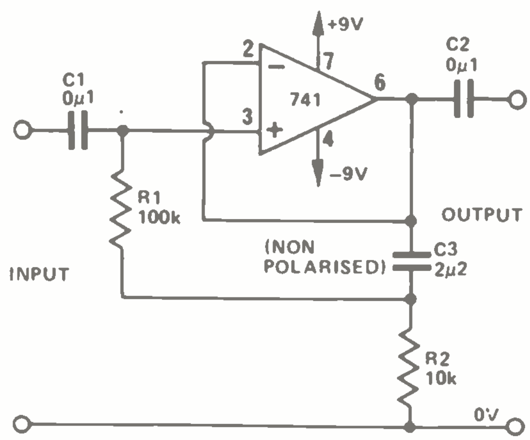


Fig. 12c Very high input-impedance a.c. voltage follower.

DRIVING CIRCUITS AMP-LY

The 741 op-amp is capable of providing output currents up to about 5mA, and this is consequently the current-driving limit of the three voltage follower circuits that we have looked at so far. The current-driving capabilities of the circuits can readily be increased by wiring simple or complementary emitter follower booster stages between the op-amp output terminals and the outputs of the actual circuits, as shown in Figs. 13a and 13b respectively.

Note in each case that the base-emitter junction(s) of the output transistor(s) are included in the negative feedback loop of the circuit. Consequently, the 600mV knee voltage of each junction is effectively reduced by a factor equal to the open-loop gain of the op-amp, so the junctions do not adversely effect the voltage-following characteristics of either circuit.

The Fig. 13a circuit is able to source current only, and can be regarded as a unidirectional, positive-going, d.c. voltage follower. The Fig. 13b circuit can both source and sink output currents, and thus gives bidirectional follower action. Each circuit has a current-driving capacity of about 50mA. This figure is dictated by the limited power rating of the specified output transistors. The drive capability can be increased by using alternative transistors.

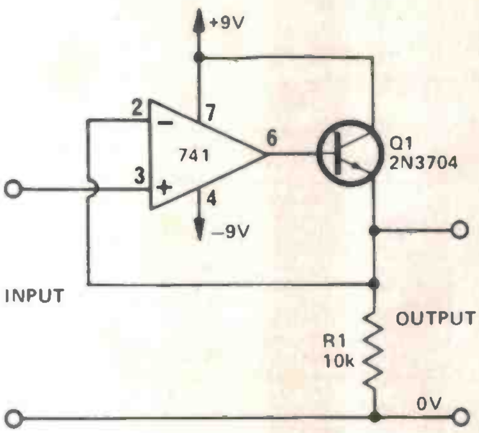


Fig. 13a Unidirectional d.c. voltage follower with boosted output (variable from 0V to +8V at 50mA.)

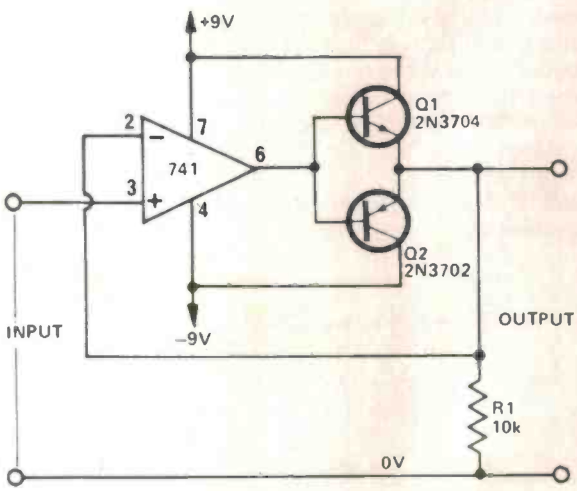


Fig. 13b Bidirectional d.c. voltage follower with boosted output (variable from 0V to± ±8V at 50mA).

MISC AMP PROJECTS (Figs. 14 to 22)

Figs. 14 to 22 show a miscellaneous assortment of 741 amplifier projects, ranging from d.c. adding circuits to frequency-selective amplifiers.

Fig. 14 shows the circuit of a unity-gain inverting d.c. adder, which gives an output voltage that is equal to the sum of the three input voltages. Here, input resistors R_1 to R_3 and feedback resistor R_4 each have the same value, and the circuit thus acts as a unity-gain inverting d.c. amplifier between each input terminal and the output. Since the current flowing in each input resistor also flows in feedback resistor R_4, the total current flowing in R_4 is equal to the sum of the input currents, and the output voltage is equal to the negative sum of the input voltages. The circuit is shown with only three input connections, but in fact can be provided with any number of input terminals. The circuit can be made to function as a so-called 'audio mixer' by wiring blocking capacitors in series with each input terminal and with the output terminal.

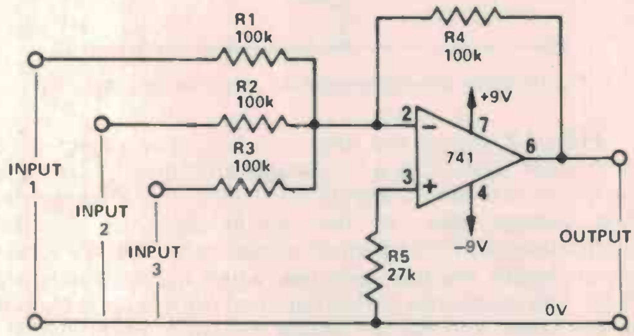


Fig. 14 Unity-gain inverting d.c. adder, or 'audio mixer'.

FIG. 15 shows how two unity-gain inverting d.c. amplifiers can be wired in series to make a precision unity-gain balanced phase-splitter. The output of the first amplifier is an inverted version of the input signal, and the output of the second amplifier is a non-inverted version.

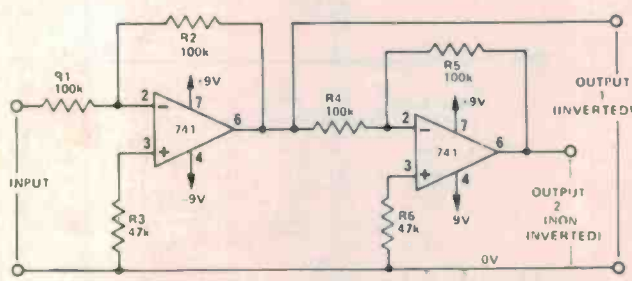


Fig. 15 Unity-gain balanced d.c. phase-splitter.

FIG. 16 shows how a 741 can be used as a unity-gain differential d.c. amplifier. The output of this circuit is equal to the difference between the two input signals or voltages, or to e_1-e_2. Thus, the circuit can also be used as a subtractor. In this type of circuit the component values are chosen such that $R_1/R_2 = R_4/R_3$, in which case the voltage gain $A_v = R_2/R_1$. The circuit can thus be made to give voltage gain if required.

OP-AMP COOKBOOK

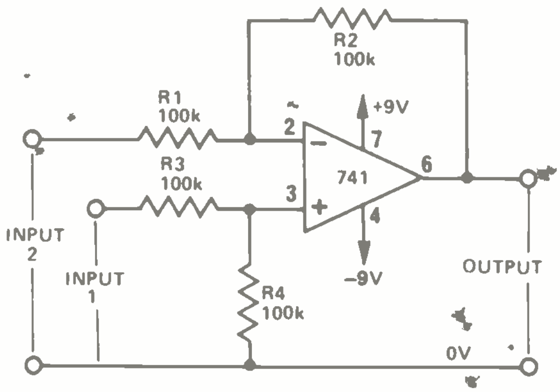
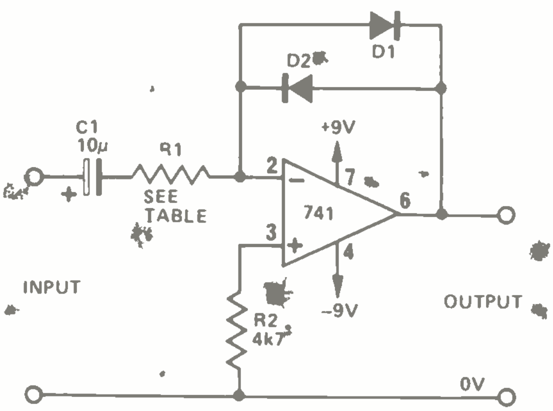


Fig. 16 Unity-gain differential d.c. amplifier, or subtractor.

FIG. 17 shows the amp can be made to act as a non-linear (semi-log) a.c. voltage amplifier by using a couple of ordinary silicon diodes as feedback elements. The voltage gain of the circuit depends on the magnitude of applied input signal, and is high when input signals are low, and low when input signals are high. The measured performance of the circuit is shown in the table, and can be varied by using alternative R_1 values.

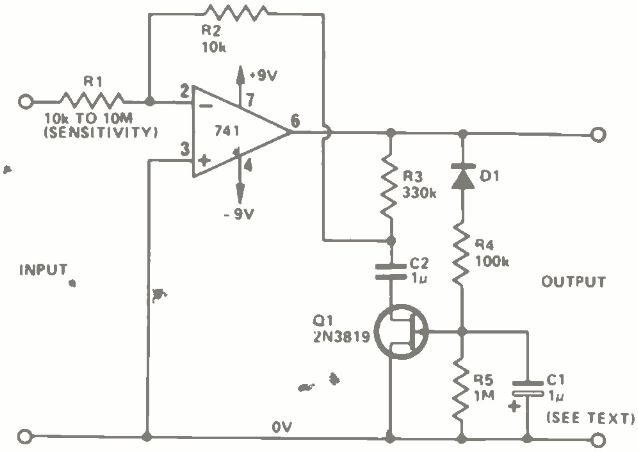


INPUT VOLTS (RMS)	R_1 = 1kΩ		R_1 = 10kΩ	
	V_{out} (R.M.S.)	GAIN	V_{out} (R.M.S.)	GAIN
1 mV	110 mV	X 110	21 mV	X 21
10mV	330 mV	X 33	170mV	X 17
100mV	450 mV	X4.5	360mV	X 3.6
1V	560 mV	X0.56	470mV	X 0.47
10V	600 mV	X0.07	560mV	X0.056

Fig. 17 Circuit and performance table of non-linear (semi-log) a.c. voltage amplifier.

FIG. 18 shows how the 741 can be used together with a junction-type field-effect transistor (JFET) to make a so-called constant-volume amplifier. The action of this type of circuit is such that its peak output voltage is held sensibly constant, without distortion, over a wide range of input signal levels, and this particular circuit gives a sensibly constant output over a 30dB range of input signal levels.

The measured performance of the circuit is shown in the table. C_1 determines the response time of the amplifier, and may be altered to satisfy individual needs.



V_{IN} (R_1 = 10KΩ)	V_{IN} (R_1 = 100KΩ)	V_{IN} (R_1 = 1MΩ)	V_{IN} (R_1 = 10MΩ)	V_{OUT}
50 mV	500 mV	5 V	50 V	2.85 V
20 mV	200 mV	2 V	20 V	2.81 V
10 mV	100 mV	1 V	10 V	2.79 V
5 mV	50 mV	500 mV	5 V	2.60 V
2 mV	20 mV	200 mV	2 V	2.03 V
1 mV	10 mV	100 mV	1 V	1.48 V
500 µV	5 mV	50 mV	500 mV	0.89 V
200 µV	2 mV	20 mV	200 mV	0.40 V
100 µV	1 mV	10 mV	100 mV	0.20 V
50 µV	500 µV	5 mV	50 mV	0.10 V

Fig. 18 Circuit and performance details of constant-volume amplifier.

ACTION TAKEN

The action of the Fig. 18 circuit relies on the fact that the JFET can act as a voltage-controlled resistance which appears as a low value when zero bias is applied to its gate and as a high resistance when its gate is negatively biased. The JFET and R_3 act as a gain-determining a.c. voltage divider (via C_2), and the bias to the JFET gate is derived from the circuits output via the D_1-C_1 network. When the circuit output is low the JFET appears as a low resistance, and the op-amp gives high voltage gain.

When the circuit output is high the JFET appears as a high resistance, and the op-amp gives low voltage gain. The output level of the circuit is thus held sensibly constant by negative feedback.

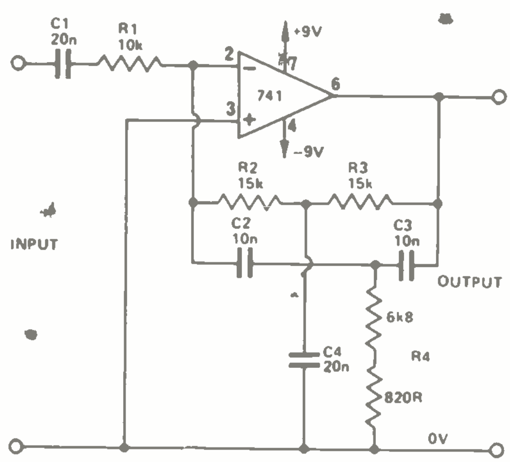


Fig. 19 1kHz tuned (acceptor) amplifier (twin-T).

CHOOSE YOUR FREQUENCY

The 741 op-amp can be made to function as a frequency-selective amplifier by connecting frequency-sensitive networks into its feedback loops. Fig. 19 shows how a twin-T network can be connected to the op-amp so that it acts as a tuned (acceptor) amplifier, and Fig. 20 shows how the same twin-T network can be connected so that the op-amp acts as a notch (rejector) filter. The values of the twin-T network are chosen such that $R_2 = R_3 = 2 \times R_4$, and $C_2 = C_4/2$, in which case its centre (tuned) frequency $= 1/6.28\ R_2 C_2$. With the component values shown, both circuits are tuned to approximately 1kHz.

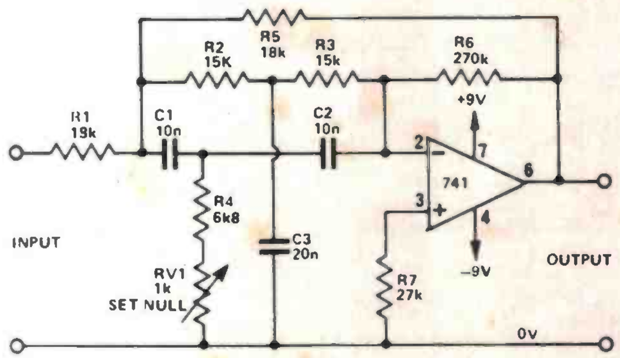


Fig. 20 1kHz notch (reject) filter.

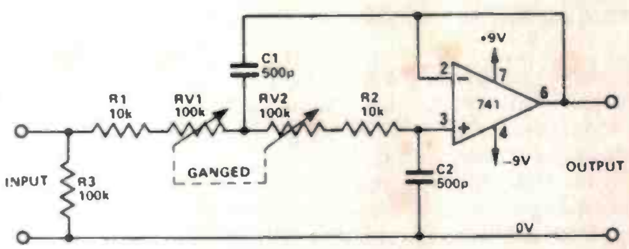


Fig. 21 Variable low-pass filter, covering 2.2kHz to 24kHz.

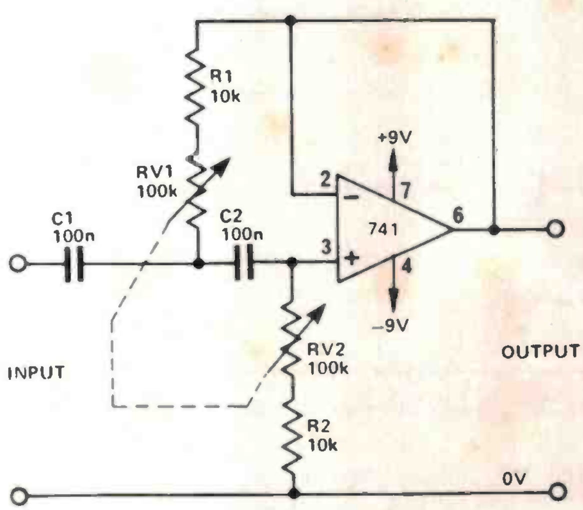


Fig. 22 Variable high-pass filter, covering 235Hz to 2.8kHz.

Finally, to complete this section, Figs. 21 and 22 show the circuits of a couple of variable-frequency audio filters. The Fig. 21 circuit is that of a low-pass filter which covers the range 2.2kHz to 24kHz, and the Fig. 22 circuit is that of a high-pass filter which covers the range 235Hz to 2.8kHz. In each case, the circuit gives unity gain to signals beyond its cut-off frequency, and gives a 2nd order response (a change of 12dB per octave) to signals within its range.

INSTRUMENTATION PROJECTS (Figs. 23 to 31)

Figs. 23 to 31 show a variety of instrumentation projects in which the 741 can be used. The circuits range from a simple voltage regulator to a linear-scale ohmmeter.

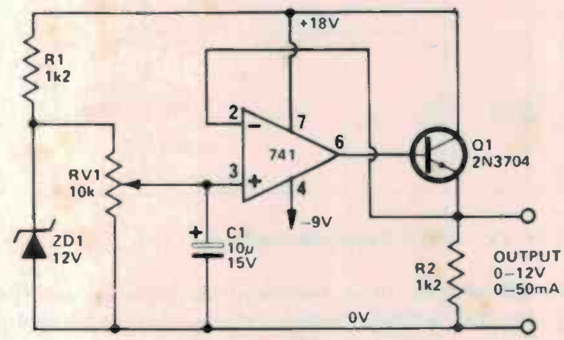


Fig. 23 Simple variable-voltage supply.

FIG. 23 shows the circuit of a simple variable-voltage power supply, which gives a stable output that is fully adjustable from 0V to 12V at currents up to a maximum of about 50mA. The operation of the circuit is quite simple. ZD_1 is a zener diode, and is energised from the positive supply line via R_1. A constant reference potential of 12V is developed across the zener diode, and is fed to variable potential divider RV_1.

The output of this divider is fully variable from 0V to 12V, and is fed to the non-inverting input of the op-amp. The op-amp is wired as a unity-gain voltage follower, with Q_1 connected as an emitter follower current-booster stage in series with its output.

Thus, the output voltage of the circuit follows the voltage set at the op-amp input via RV_1, and is fully variable from 0V to 12V. Note that the circuit uses an 18V positive supply and a 9V negative supply.

Also note that the voltage range of the above circuit can be increased by using higher zener and unregulated supply voltages, and that its current capacity can be increased by using one or more power transistors in place of Q_1.

FIG. 24 shows how a 741 op-amp can be used as the basis of a stabilised power supply unit (P.S.U.) that covers the range 3V to 30V at currents up to 1A. Here, the voltage supply to the op-amp is stabilized at 33V via ZD_1, and a highly temperature-stable reference of 3V is fed to the input of the op-amp via ZD_2.

The op-amp and output transistors Q_1-Q_2 are wired as a variable-gain non-inverting d.c. amplifier, with gain variable from unity to x10 via RV_1, and the output voltage is thus fully variable from 3V to 30V via RV_1. The output voltage is fully stabilized by negative feedback.

OP-AMP COOKBOOK

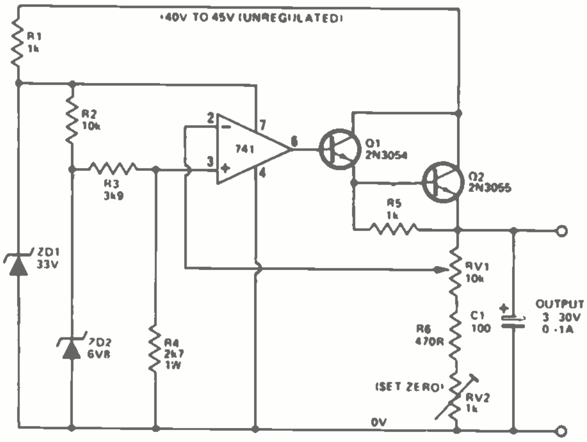


Fig. 24 3V - 30V, 0-1 amp stabilised p.s.u.

FIG. 25 shows how overload protection can be applied to the above circuit. Here, current-sensing resistor R_7 is wired in series with the output of the regulator, and cut-out transistor Q_3 is driven from this resistor and is wired so that its base-collector junction is able to short the base-emitter junction of the Q_1-Q_2 output transistor stage.

Normally, Q_3 is inoperative, and has no effect on the circuit, but when P.S.U. output currents exceed 1A a potential in excess of 600mV is developed across R_7 and biases Q_3 on, thus causing Q_3 to shunt the base-emitter junction of the Q_1-Q_2 output stage and hence reducing the output current. Heavy negative feedback takes place in this action, and the output current is automatically limited to 1A, even under short-circuit conditions.

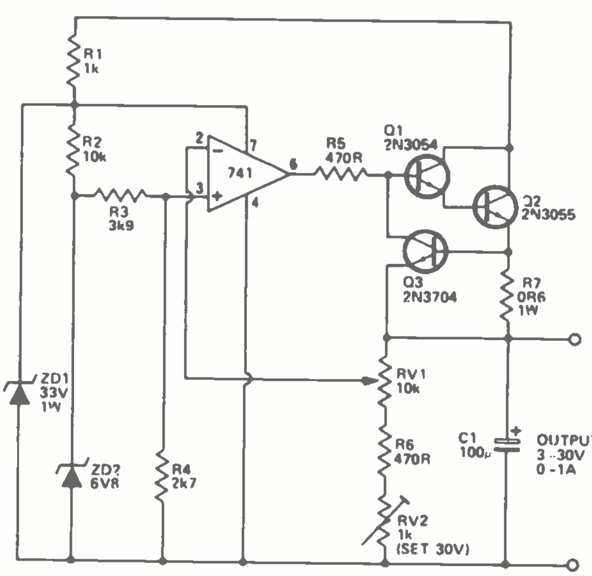


Fig. 25 3V - 30V stabilised p.s.u. with overload protection.

FIG. 26a shows how a 741 can be used in conjunction with a couple of silicon diodes as a precision half-wave rectifier. Conventional diodes act as imperfect rectifiers of low-level a.c. signals, because they do not begin to conduct significantly until the applied signal voltage exceeds a 'knee' value of about 600mV.

When diodes are wired into the negative feedback loop of the circuit as shown the 'knee' voltage is effectively reduced by a factor equal to the open-loop gain of the op-amp, and the circuit thus acts like a near-perfect rectifier

The overall voltage gain of the Fig. 26a circuit is dictated by the ratios of R_1 and R_2 to R_3, as in the case of a conventional inverting amplifier, and this circuit thus gives a gain of unity. The circuit can be made to

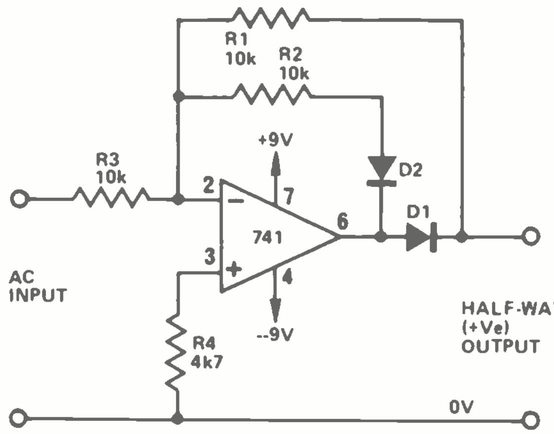


Fig. 26a Precision unity-gain half-wave rectifier.

act as a precision half-wave a.c./d.c. converter by designing it to give a voltage gain of 2.22 to give form-factor correction, and by integrating its rectifier output, as shown in Fig. 26b.

Note that each of the Fig. 26 circuits has a high output impedance, and the outputs must both be fed into loads having impedances less than about 1M.

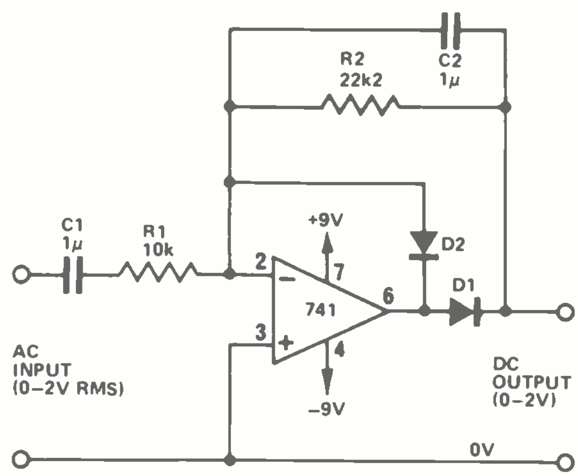
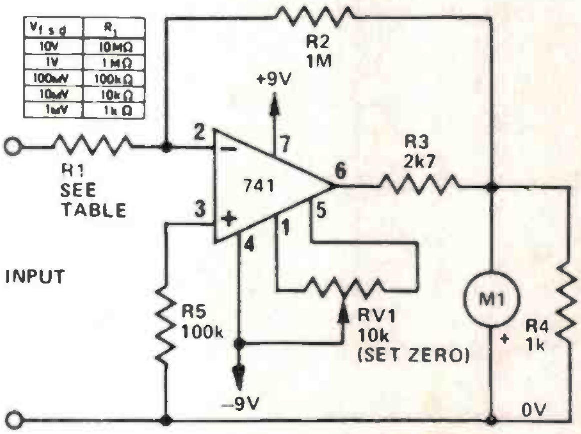


Fig. 26b Precision half-wave a.c./d.c. converter.

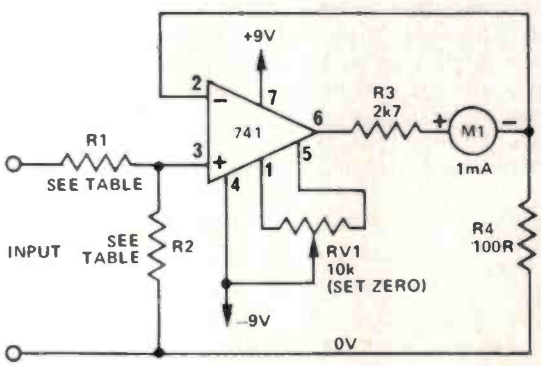
FIG. 27 shows how op-amp can be used as a high-performance d.c. voltmeter converter, which can be used to convert any 1V f.s.d. meter with a sensitivity better than 1k/V into a voltmeter that can read any value in the range 1mV to 10V f.s.d. at a sensitivity of 1M/V. The voltage range is determined by the R_1 value, and the table shows some suitable values for common voltage ranges.

FIG. 28 shows a simple circuit that can be used to convert a 1mA f.s.d. meter into a d.c. voltmeter with any f.s.d. value in the range 100mV to 1000V, or into a d.c. current meter with any f.s.d. value in the range 1uA to 1A. Suitable component values for different ranges are shown in the tables.



V_{fsd}	R_1
10V	10MΩ
1V	1MΩ
100mV	100kΩ
10mV	10kΩ
1mV	1kΩ

Fig. 27 High-performance d.c. voltmeter converter.



VOLTMETER		
f.s.d.	R_1	R_2
1000V	10MΩ	1kΩ
100V	10MΩ	10kΩ
10V	10MΩ	100kΩ
1V	900kΩ	100kΩ
100mV	0Ω	100kΩ

CURRENT METER		
f.s.d.	R_1	R_2
1A	0Ω	0 1Ω
100mA	0Ω	1Ω
10mA	0Ω	10Ω
1mA	0Ω	100Ω
100µA	0Ω	1kΩ
10µA	0Ω	10kΩ
1µA	0Ω	100kΩ

Fig. 28 Simple d.c. voltage or current meter.

FIG. 29 shows the circuit of a precision d.c. millivoltmeter, which uses a 1mA f.s.d. meter to read f.s.d. voltages from 1mV to 1000mV in seven switch-selected ranges.

FIG. 30 shows the basic circuit of a precision a.c. volt or millivolt meter. This circuit can be used with any moving-coil meter with a full scale current value in the range 100uA to 5mA, and can be made to give any full scale a.c. voltage reading in the range 1mV to 1000mV. The tables show the alternative values of R_1 and R_2 that must be used to satisfy different basic meter sensitivities, and the values of R_3 and R_4 that must be used for different f.s.d. voltage sensitivities.

HOME OHM

Finally, to conclude, Fig. 31 shows how the 741 op-amp can be used in conjuncton with a 1mA f.s.d. meter to make a linear-scale ohmmeter that has five decade ranges from 1k to 10M.

The circuit is divided into two parts, and consists of a voltage generator that is used to generate a standard test

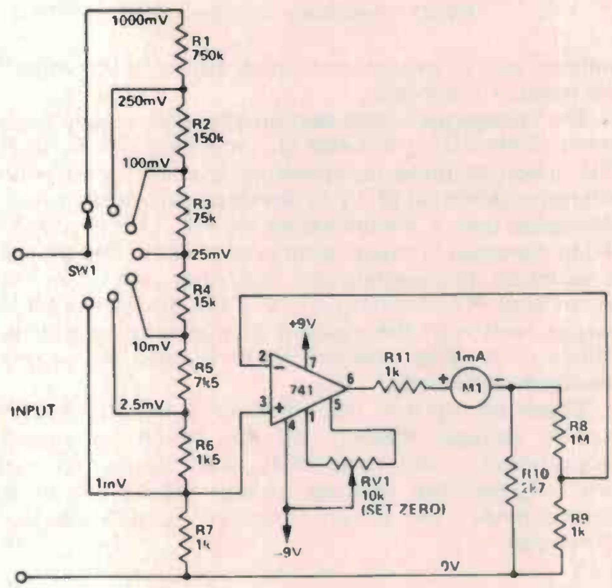
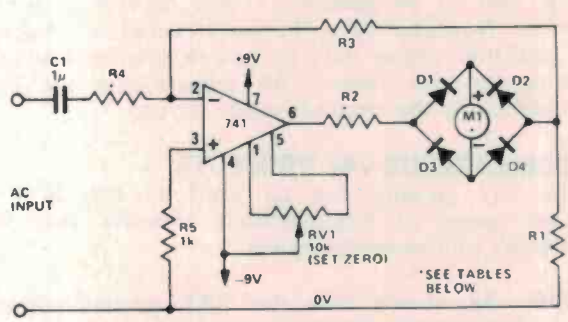


Fig. 29 Precision d.c. millivoltmeter.



M_1	R_1	R_2
100µA	9kΩ	27kΩ
500µA	1 8kΩ	5 6kΩ
1mA	900Ω	2 7kΩ
2 5mA	360Ω	1 5kΩ
5mA	180Ω	470Ω

VALUES FOR USE WITH DIFFERENT METER MOVEMENTS

V_{fsd}	R_4	R_3
1000V	10MΩ	10kΩ
100V	10MΩ	100kΩ
10V	10MΩ	1MΩ
1V	1MΩ	1MΩ
100mV	100kΩ	1MΩ
10mV	10kΩ	1MΩ
1mV	1kΩ	1MΩ

DIFFERENT f.s.d. VOLTAGE SENSITIVTIES

Fig. 30 Precision a.c. volt/millivolt meter.

OP-AMP COOKBOOK

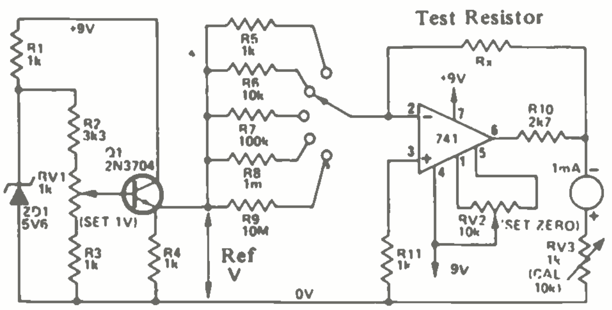


Fig. 31 Linear-scale ohmmeter.

voltage, and a readout unit which indicates the value of the resistor under test.

The voltage generator section of the circuit comprises zener diode ZD_1, transistor Q_1, and resistors R_1 to R_4. The action of these components is such that a stable reference potential of 1V is developed across R_4, but is adjustable over a limited range via RV_1. This voltage is fed to the input of the op-amp readout unit. The op-amp is wired as an inverting d.c. amplifier, with the 1mA meter and RV_3 forming a 1V f.s.d. meter across its output, and with the op-amp gain determined by the values of ranging resistors R_5 to R_9 and by negative feedback resistor R_x.

Since the input to the amplifier is fixed at 1V, the output voltage reading of the meter is directly proportional to the value of R_x, and equals full scale when R_x and the ranging resistor values are equal. Consequently, the circuit functions as a linear-scale ohmmeter.

CALIBRATION

The procedure for initially calibrating the Fig. 31 circuit is as follows: First, switch the unit to 10k range and fix an accurate 10kΩ resistor in the R_x position. Now adjust RV_1 to give an accurate 1V across R_4, and then adjust RV_2 to give a precise full scale reading on the meter. All adjustments are then complete, and the circuit is ready for use.

MISCELLANEOUS 741 PROJECTS

The 741 op-amp can be used as the basis of a vast range of miscellaneous projects, including oscillators and sensing circuits.

FIG. 32 shows how the 741 op-amp can be connected as a variable-frequency wien-bridge oscillator, which covers the basic range 150Hz to 1.5kHz, and uses a low-current lamp for amplitude stabilisation. The output amplitude of the oscillator is variable via RV_4 and has a typical maximum value of 2.5V r.m.s. and a t.h.d. value of 0.1%. The frequency range of the circuit is inversely proportional to the C_1-C_2 values. The circuit can give a useful performance up to a maximum frequency of about 25kHz.

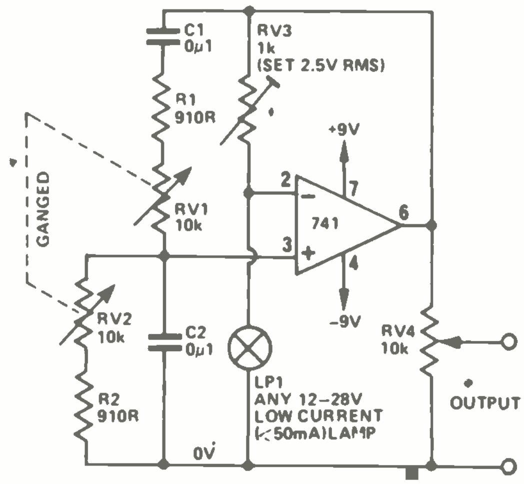


Fig. 32 150Hz - 1.5kHz Wien-bridge oscillator.

Fig. 33 shows how either a 741 or a 709 op-amp can be connected as a simple variable-frequency square-wave generator that covers the range 500Hz to 5kHz via a single variable resistor. (The circuit produces a good symmetrical waveform.)

The frequency of oscillation is inversely proportional to the C_1 value, and can be reduced by increasing the C_1 value, or vice-versa. The amplitude of the square wave output signal can be made variable, if required, by wiring a 10kΩ variable potential divider across the output terminals of the circuit and taking the output from between the pot slider and the zero volts line.

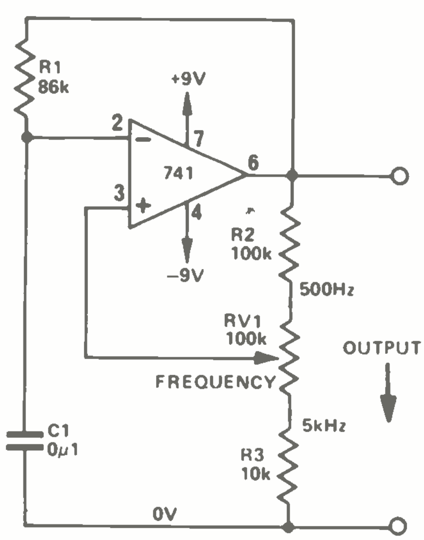


Fig. 33 Simple 500Hz - 5kHz square wave generator.

The op-amp cookbook — using the LM 3900N

Four op-amps in a single 14-pin package — at less than 25 cents per amplifier.

THESE days it's nothing unusual to find four op-amps in a single integrated circuit package, but when the LM3900 was released by National Semiconductor in the mid-seventies very few linear devices were so closely-packed. The LM3900 contains four independent, internally compensated amplifiers in a single 14-pin dual-in-line encapsulation.

All four amplifiers are fabricated on a single silicon chip. Each amplifier contains seven transistors, a diode and a capacitor, whilst other internal components are used in the bias and power supplies.

The LM3900 has maintained its popularity over the years, partly because of its low cost (less than a dollar in 1982), but mainly because of its versatility and reliability.

CONNECTIONS

The connections of the four separate amplifiers are shown in Fig.1. Each amplifier has a non-inverting input (marked +), an inverting input (marked –) and an output connection. In addition, there is a single common positive supply connection and a common ground connection (negative supply line) for the whole device.

INTERNAL CIRCUIT

Conventional high gain amplifiers employ a differential input stage to provide inverting and non-inverting inputs, but a rather different approach is employed in the LM3900N. A 'current mirror' is employed in the non-inverting input circuit, the current 'reflected' in this mirror being subtracted from that which enters the inverting input.

This type of amplifier therefore acts as a differential stage by amplifying the difference between two *currents* rather than the difference between two voltages (as in a conventional amplifier).

The type of amplifier used in the LM3900N may be referred to as a 'Norton' amplifier, since Norton is the name of the person who developed a theorem relating the *current* flowing in a circuit to the equivalent current generator and shunt impedance.

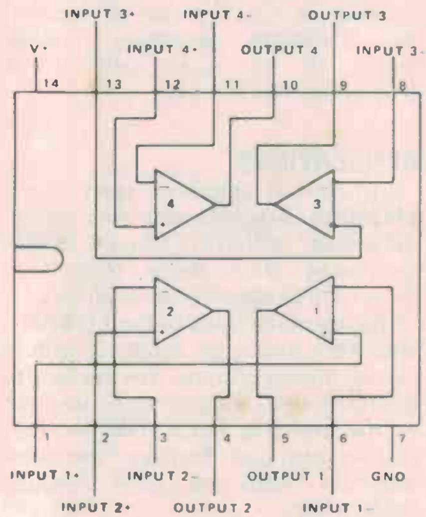


Fig.1. The connections of the LM3900N.

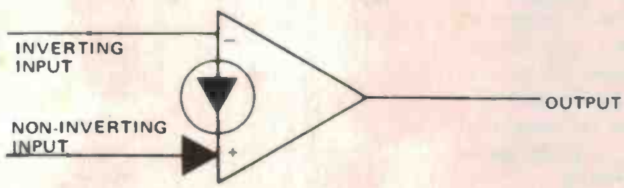


Fig.2. The symbol for one of the Norton amplifiers of the LM3900N.

SYMBOL

The symbol recommended for each of the four Norton amplifier stages in the device is shown in Fig.2. This symbol distinguishes this type of amplifier from the standard operational amplifier symbol and avoids confusion in circuits.

The symbol of Fig. 2 contains an indication that there is a current source between the inverting and non-inverting inputs and implies that the amplifier uses a current mode of operation. In addition, the circuit symbol indicates that current is removed from the inverting input, whilst the arrow on the non-inverting input shows that this functions as a current input.

PERFORMANCE

The LM3900N has the advantage that it can operate from a single supply voltage over the range of four volts to 36 volts. Most conventional operational amplifiers require supplies symmetrical with respect to ground (typically ± 15 V); the LM3900N can be used with such supply lines if desired.

The maximum peak to peak output amplitude of an LM3900N amplifier is only 1 V less than the supply voltage employed. The current consumed from the power supply is typically 6.2 mA (maximum 10 mA).

The typical voltage gain of each amplifier is 2800 or nearly 70 dB. The

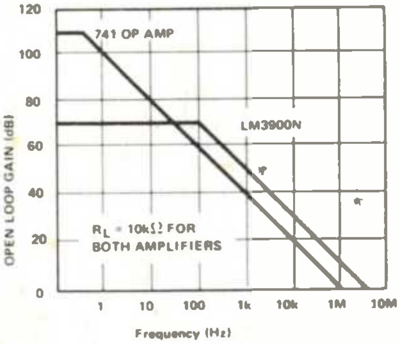


Fig. 3. Comparison of the gain of the LM3900N with that of a 741 amplifier at various frequencies.

minimum gain of any amplifier is 1200. The variation of this gain with frequency is compared with that of the well known type 741 operational amplifier in Fig. 3. It can be seen that the LM3900N amplifiers provide about 10 dB more gain at all frequencies above 1 kHz.

APPLICATIONS

The Norton amplifiers used in the LM3900N device entail the use of somewhat different circuit design techniques than those used with conventional operational amplifiers.

The inverting input of the LM3900N amplifiers must be supplied with a steady biasing current. The current to the non-inverting input modulates that to the inverting input. The fact that current can pass between the input terminals leads to some unusual applications.

Both inputs of each of the amplifiers in the LM3900N are clamped by diodes so as to keep their potentials almost constant at one diode voltage drop (about 0.5 V) above the ground potential of pin 7. External input voltages must therefore be converted to input currents by placing series resistors in each input circuit.

USE AS AN AC AMPLIFIER

The LM3900N forms a useful ac amplifier, since its output can be baised to any desired steady voltage within the range of the output voltage swing. The ac gain is independent of the biasing level and the single power supply required greatly simplifies circuit design.

A simple ac amplifier circuit is shown in Fig.4. The gain is approximately equal to R2/R1 or 10 with the circuit values shown. The mean potential at the output is half the supply voltage. The value of R3 should be twice that of R2 since the current passing through each of these two resistors is then the same. The positive supply and ground connections are not shown in Fig.4

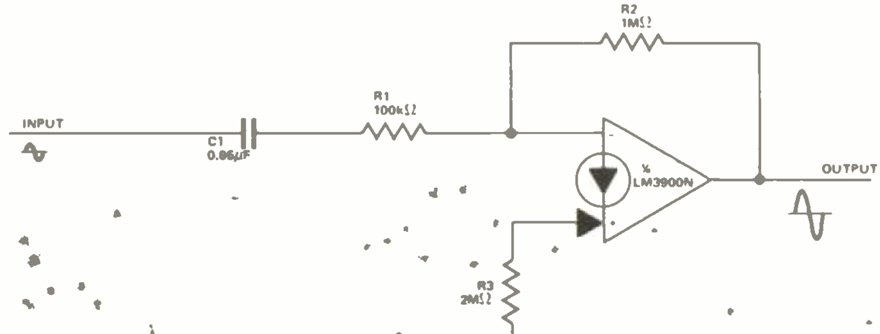


Fig.4. A simple a.c. amplifier circuit.

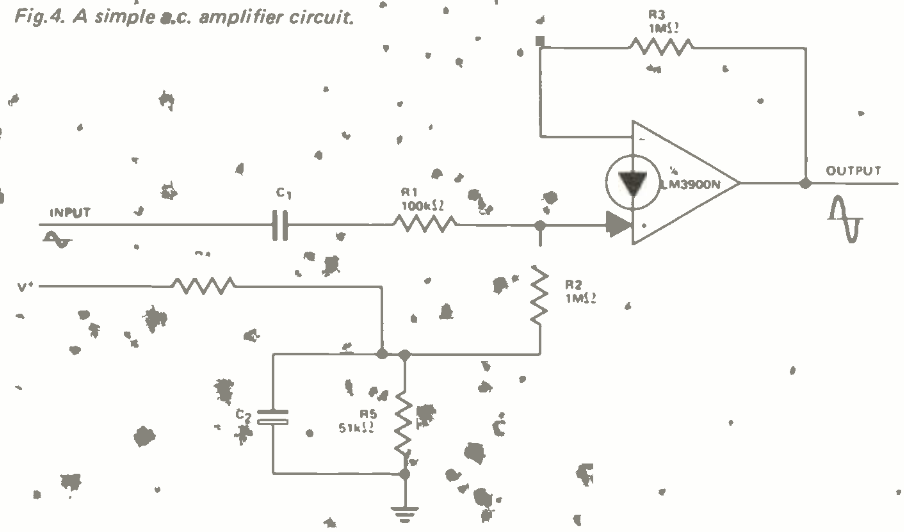


Fig.5. A simple non-inverting a.c. amplifier.

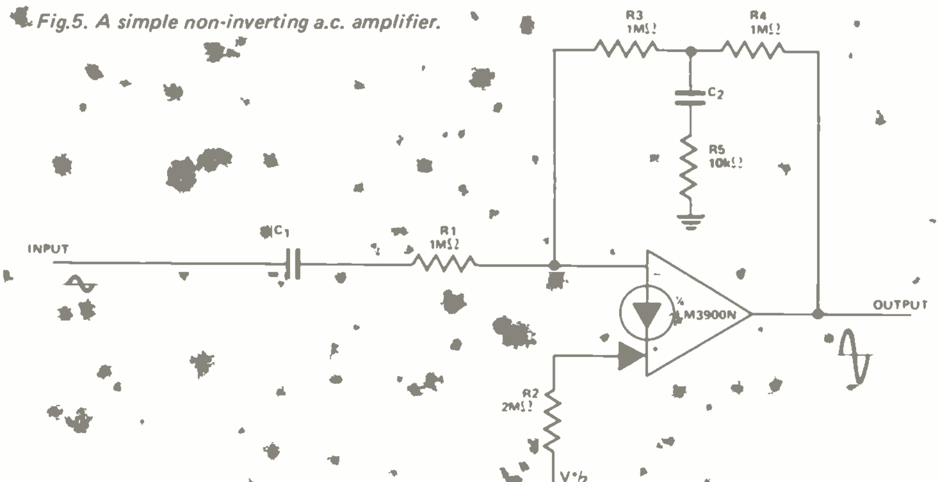


Fig.6. An amplifier which has a high gain and a high input impedance.

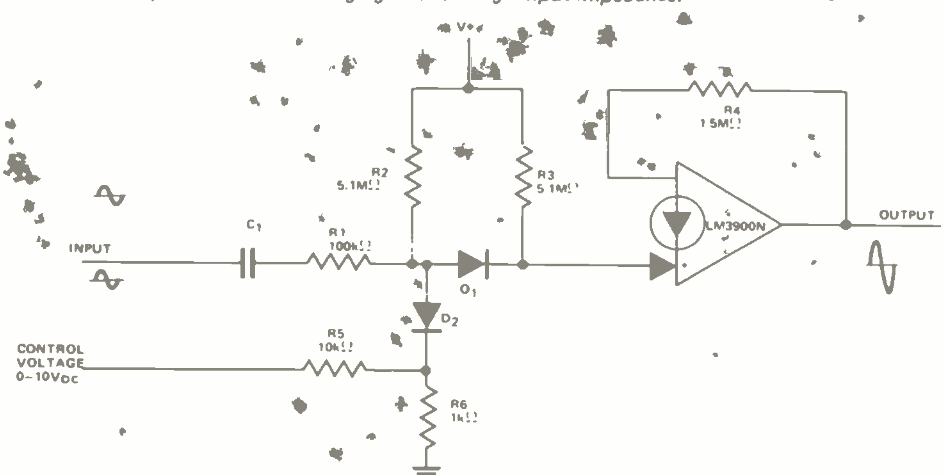


Fig.7. An amplifier which has a gain controlled by an input voltage.

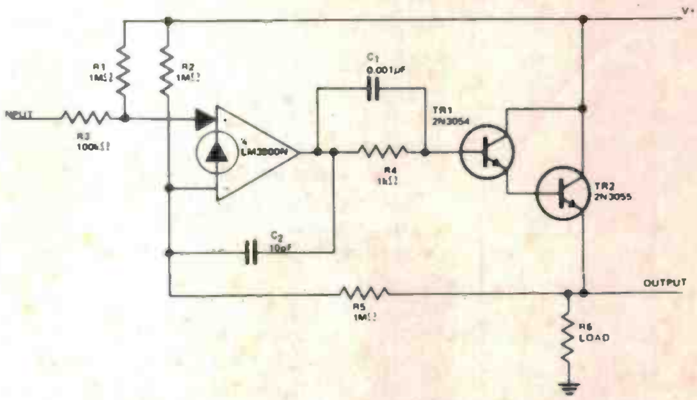


Fig.8. A direct coupled power amplifier.

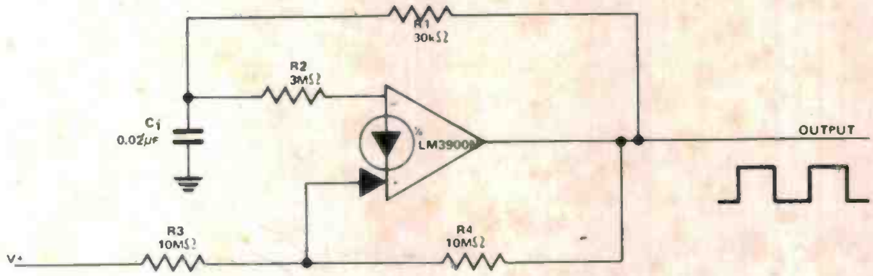


Fig.9. A simple square-wave generator.

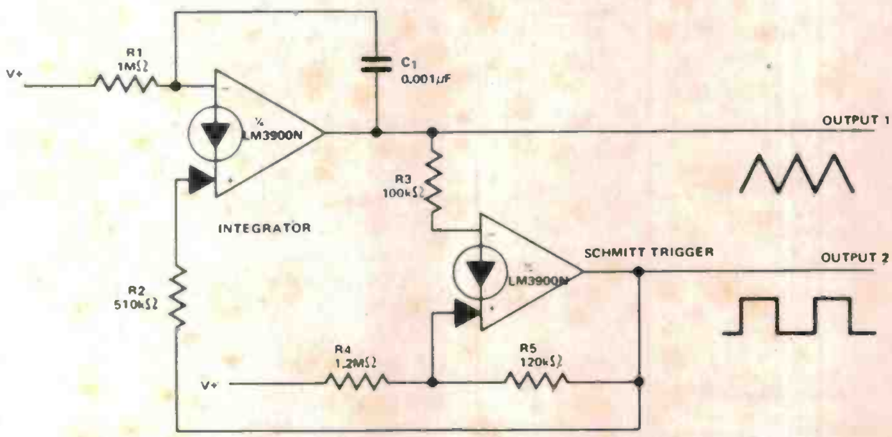


Fig.10. A circuit for generating triangular and square-wave.

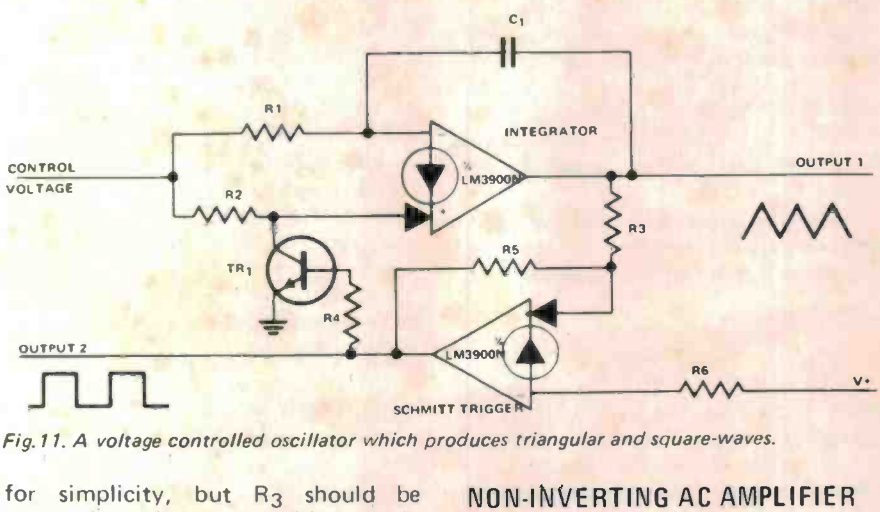


Fig.11. A voltage controlled oscillator which produces triangular and square-waves.

for simplicity, but R_3 should be returned to the same positive supply line as that used to feed pin 14.

The circuit of Fig. 4 provides a phase inverted output. Any ripple on the power supply line will appear on the output at half amplitude.

NON-INVERTING AC AMPLIFIER

The circuit of Fig. 5 shows an amplifier which provides an output in phase with the input. The gain is equal to $R_3/(R_1 + r_d)$ where r_d is the small signal impedance of the input diode. The value of r_d is equal to 0.026 divided by the current passing through R_2 to the non-inverting input.

The capacitor values should be chosen so that the impedance of these components is considerably less than the circuit impedance at the points concerned.

HIGH IMPEDANCE AND HIGH GAIN

The circuits of Figs. 4 and 5 have an input resistance, R_1 or 100 k ohm. If this resistor is increased to provide a higher input impedance, the gain of the circuit will fall. However, the circuit of Fig. 6 has been designed so that it provides both a high input impedance and a high gain using a simple amplifier. With the component values shown, the input impedance is one megohm and the gain 100.

The voltage applied to R_2 is made equal to the output voltage (which is half the supply voltage). The value of R_2 is equal to the sum of R_3 and R_4; these resistors set the dc bias. If desired, R_2 may be made four megohms and its lower end connected to the V+ supply.

Resistors R_4 and R_5 form a potential divider so that only 1/100 of the alternating output voltage is developed across the C_2 – R_5 circuit. This fraction of the output voltage is fed back to the inverting input via R_3. As R_3 and R_1 are equal, the gain is $R_4 R_5$. As R_5 is decreased, the gain approaches the open loop gain of the amplifier.

VOLTAGE CONTROLLED GAIN

An amplifier with a gain which can be controlled by the value of a steady applied voltage is shown in Fig. 7.

A current flows from the positive supply through R_3 to provide a bias which prevents the output of the amplifier from being driven to saturation as the control voltage is varied. When D_2 is non-conducting, the currents passing through both R_2 and R_3 enter the non-inverting input and the gain is of maximum. This occurs when the control voltage approaches 10 V.

The gain is a minimum when the control voltage is zero. In this case D_2 is conducting and only the current passing through R_3 enters the non-inverting input of the amplifier.

DIRECT COUPLED POWER AMPLIFIER

In the circuit of Fig. 8, the output from an LM3900N amplifier is fed to a Darlington pair of power transistors. This circuit can deliver over three amps into a suitable load when the transistors are correctly mounted on heat sinks.

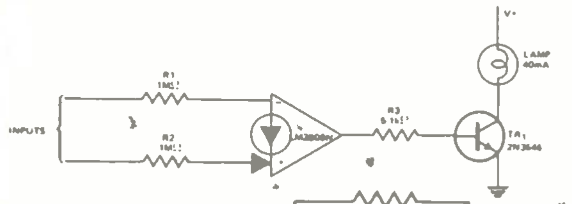


Fig.12. A voltage comparator with an indicator lamp.

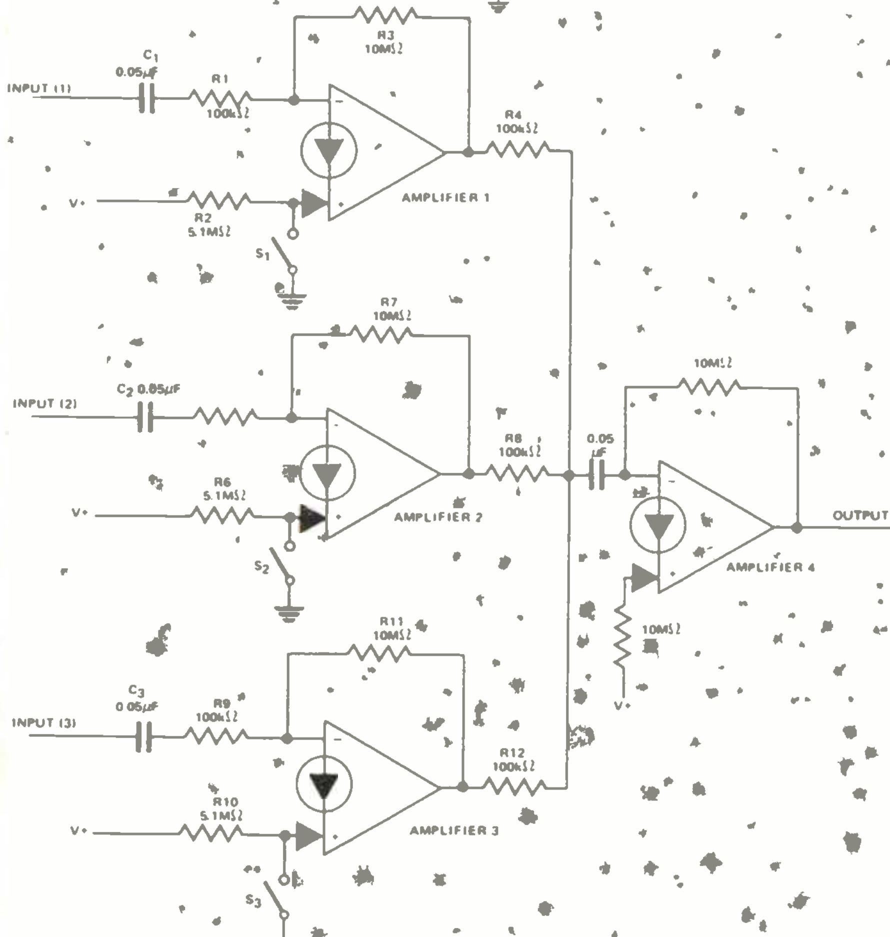


Fig.13. An audio mixer unit.

SQUAREWAVE GENERATOR

The multiple amplifiers in the LM3900N device are very suitable for use in waveform generators at frequencies of up to about 10 kHz. Voltage controlled oscillators (the frequency of which is dependent on an input voltage) can also be designed using the device.

A simple square wave generator is shown in Fig. 9. The capacitor C_1 alternately charges and discharges between voltage limits which are set by R_2 R_3 and R_4. The circuit is basically of the Schmitt trigger type, the voltages at which triggering occurs being approximately V+/3 and 2V+/3.

TRIANGULAR WAVEFORM GENERATOR

A triangular waveform generator can be made by using one amplifier of a LM3900N device as an integrator and another amplifier as a Schmitt trigger circuit. A suitable circuit is shown in Fig. 10; it has the unusual advantage that only the one power supply is required.

When the output voltage from the Schmitt trigger circuit is low, the current flowing through R_2 is integrated by C_1 to produce the negative slope of the triangular wave at output 1. When the output 2 voltage from the Schmitt trigger is high, current flows through R_2 to produce the rising part of the waveform at output 1.

The output waveform will have good symmetry if $R_1 = 2R_2$. The output frequency is given by the equation:

$$f = \frac{V^+ - V_{BE}}{2R_1C_1\,V}$$

where $R_1 = 2R_2$, V_{BE} is the steady voltage at the inverting input (0.5 V) and V is the difference between the tripping points of the Schmitt trigger.

VOLTAGE CONTROLLED OSCILLATOR

A simple voltage controlled oscillator circuit which produces both triangular and square wave outputs is shown in Fig. 11. As in Fig.10, one amplifier is employed as an integrator.

When the output of the Schmitt trigger is high, the clamp transistor TR_1 is conducting and the input current passing through R_2 is shunted to ground. The current passing through R_1 causes a falling ramp to be formed.

When the Schmitt circuit changes state, its output switches TR_1 to the non-conducting state. The current flowing through R_2 can be made twice that flowing through R_1 ($R_2 = R_1/2$) so that the rising part of the ramp has a similar slope to the negative part.

The greater the value of the control voltage in Fig.11, the greater the frequency of oscillation. However, the voltage must exceed the constant input voltage (V_{BE}) or the circuit will fail to oscillate.

VOLTAGE COMPARATOR

The circuit of Fig. 12 shows how an LM3900N amplifier may be employed to compare two input voltages and to indicate the result by means of a small lamp. If the input voltage connected to the non-inverting input is appreciably more positive than the other input, the output of the amplifier will provide a positive voltage which renders TR_2 conducting. The lamp will then be illuminated.

One of the inputs may be a reference voltage so that one can then compare a single input voltage against this constant reference.

AUDIO MIXER

The amplifiers of a LM3900N device can be conveniently used to make a mixer unit for audio purposes; the unit enables three separate audio signals to be mixed together to produce a composite output. The circuit shown in Fig. 13 provides this facility using only a single LM3900N device and also enables any one channel to be selected by switches. The currents passing through the resistors R_4 R_8 and R_{12} are summed in the input circuit of the fourth amplifier.

If S_1 is open, amplifier 1 will be driven to saturation by the current passing through R_2. It will therefore be inactive.

CONCLUSION

This short article has attempted to show a few of the numerous applications of this economical integrated circuit. Many more applications (such as phase locked loops, temperature sensing circuits, differentiators, tachometers, staircase generators, active filters, etc) are given in a report AN-72 produced by National Semiconductor.

The op-amp cookbook — using the 3080

A 'control' current varies the gain of this op-amp, which makes it very useful in some special applications.

THE CA3080 IS KNOWN as an *operational transconductance amplifier* (OTA). This is a type of op-amp, the gain of which can be varied by means of a control current, (I_{ABC}). The device has a differential input, a control input known as the 'amplifier bias input' and a current output. It differs in many respects from conventional op-amps and it is these differences that can be used to realise many useful circuit blocks.

Voltage controlled amplifier

The CA3080 can be used as a gain controlling device. A useful circuit is shown in Figure 1. The input signal is attenuated by R1, R2 such that a 20 mV peak-to-peak signal is applied to the input terminals. If this voltage is much larger, then significant distortion will occur at the output. In fact, this distortion is put to good use in the triangle-to-sinewave converter. (Figure 3, but we're jumping the gun).

The gain of the circuit is controlled by the magnitude of the current I_{ABC}. This current flows into the CA3080 at pin 5, which is held at one diode voltage drop above the −Vcc rail. If you connect pin 5 to 0 V, then this diode will get zapped (and so will the IC!). The maximum value of I_{ABC} permitted is 1 mA and the device is 'linear' over four decades of this current. That is, the gain of the CA 3080 is 'linearly' proportional to the magnitude of the I_{ABC} current over a range of 0.1 uA to 1 mA. Thus, by controlling I_{ABC}, we can control the signal level at the output.

The output is a current output which has to be 'dumped' into a resistive load (R5) to produce a voltage output. The output impedance seen at IC1 pin 6 is 10k (R5), but this is 'unloaded' by the voltage follower (IC2) to produce a low output impedance.

The circuit involving IC3 is a precision voltage-to-current converter and this can be used to generate I_{ABC}. When Vin (control) is positive, it linearly controls the gain of the circuit. When it is negative, I_{ABC} is zero and so the gain is zero.

This type of circuit is known by several names. It is a *voltage controlled amplifier*, (VCA), or an *amplitude modulator*, or a *two quadrant multiplier*.

One problem that occurs with the CA3080 is that of the 'input offset voltage'. This is a small voltage diffe-

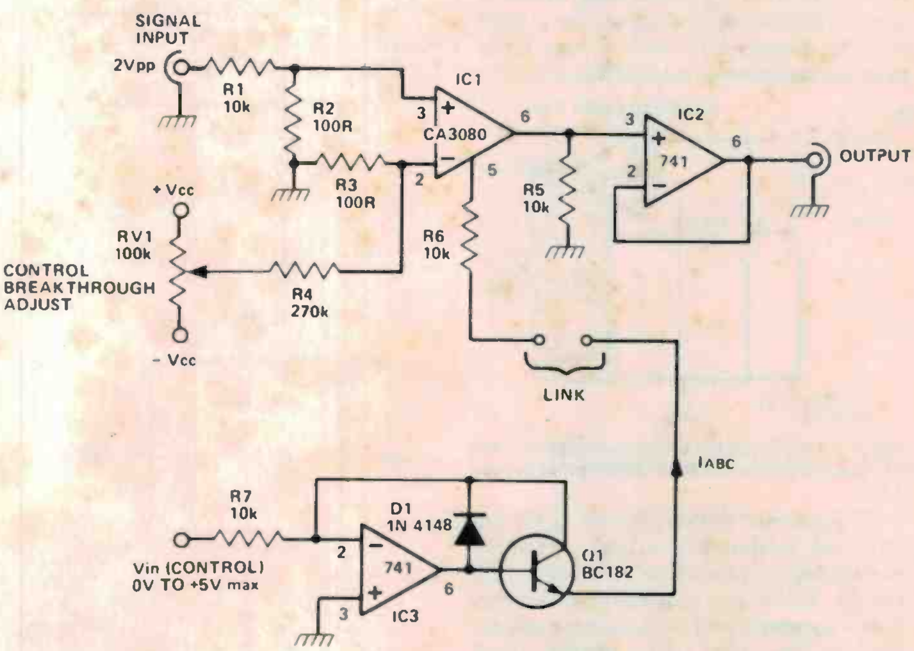


Figure 1. **A voltage controlled amplifier. Gain is varied by varying RV1. You can modulate a signal passing through the amplifier by joining the 'link' and applying a modulating signal to the input of IC3 (at R7). This sort of circuit is also known as a 'two quadrant multiplier'.**

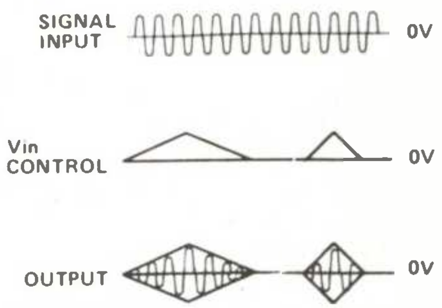


Figure 2. **Illustrating the operation of the voltage controlled amplifier shown in Figure 1.**

rence, or 'offset', between its input terminals. When there is no signal input and the control input is varied, a voltage similar to the control input will appear at the output. By adjusting RV1 it is possible to null out most of this control breakthrough.

The effect of modulating Vin (control) is illustrated in Figure 2.

Triangle to sinewave converter

By overloading the input of a CA3080 it is possible to produce a 'sinusoidal' transfer function. That is, if a triangle waveform of the correct magnitude is applied to the CA3080 input, the output will be distorted in such a way as to produce a sinewave approximation.

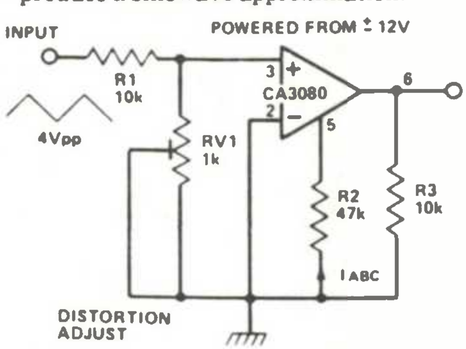


Figure 3. **This circuit will convert a triangle wave to a sinewave with a resultant distortion of around 1.8%.**

In the circuit shown (Figure 3), RV1 is adjusted so that the output waveform resembles a sinewave. I tested this circuit using an automatic distortion analyser and found the sinewave distortion to be only 1.8%, mostly third harmonic distortion which, for such a simple arrangement, seems very reasonable indeed. This could be used to produce a sinewave output from a triangle/square wave oscillator.

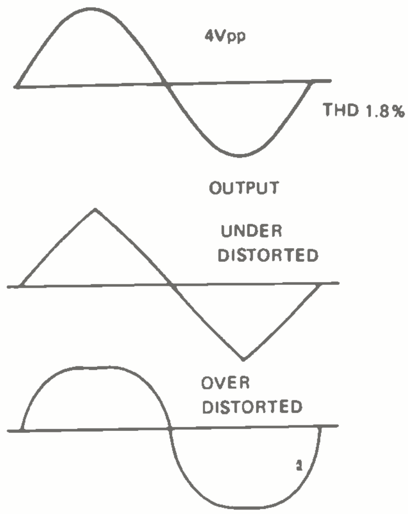


Figure 4. **The output of the Figure 3 circuit should be adjusted (by RV1) to produce the waveform shown at top.**

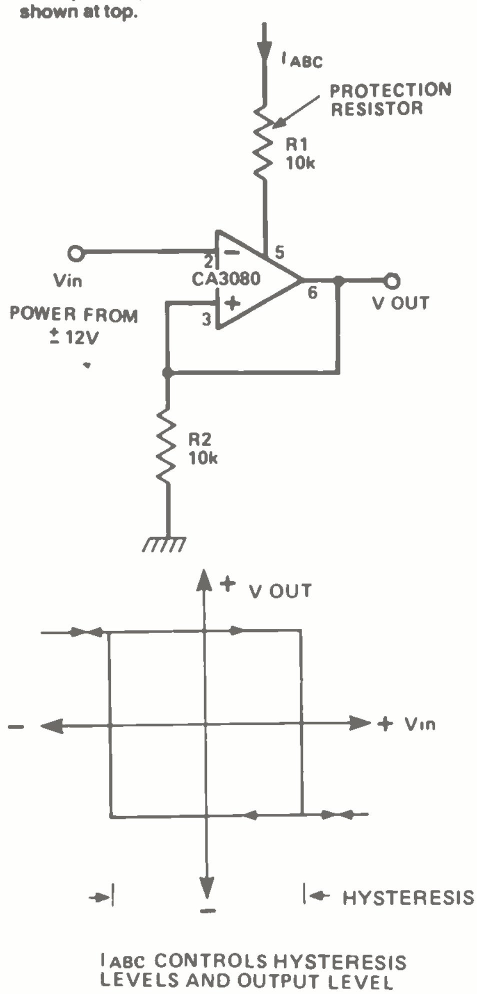


Figure 6. **This sort of Schmitt trigger is not only simple but you can specify the hysteresis levels as well!**

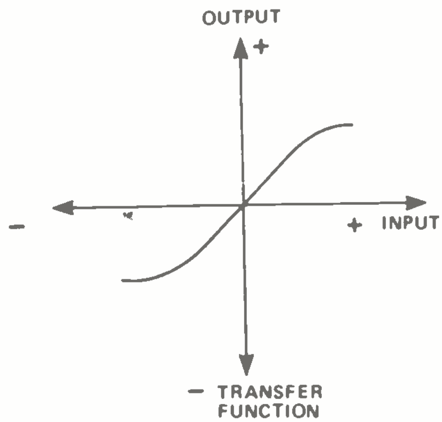


Figure 5. **Transfer function of the Figure 3 circuit.**

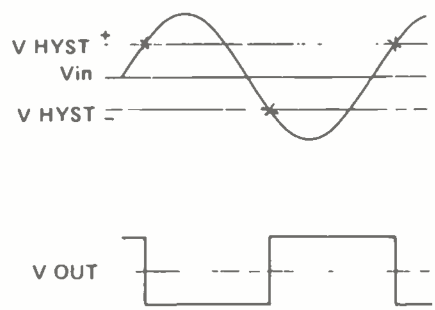


Figure 7. **How the Schmitt trigger of Figure 6 works.**

The result of varying RV1 is illustrated in Figure 4 and the transfer function of the circuit is shown in Figure 5.

Schmitt trigger

Most Schmitt trigger circuits prove to be very complicated when it comes to calculating the hysteresis levels. However, by using the CA3080 these calculations are rendered trivial, plus there is the added bonus of fast operation. The hysteresis levels are calculated from the simple equation,

$$V_{HYST} = +/- (I_{ABC} \times R2)$$

The output squarewave level is in fact equal in magnitude to the hysteresis levels. The circuit operation is as follows (referring to Figure 7):

Imagine the output voltage is high. The output voltage will then be equal to $(R2 \times I_{ABC})$ which we will call $+V_{HYST}$. If V_{IN} becomes more positive than $+V_{HYST}$, the output will start to move in a negative direction, which will increase the voltage between the input terminals which will further accelerate the speed of the output movement. This

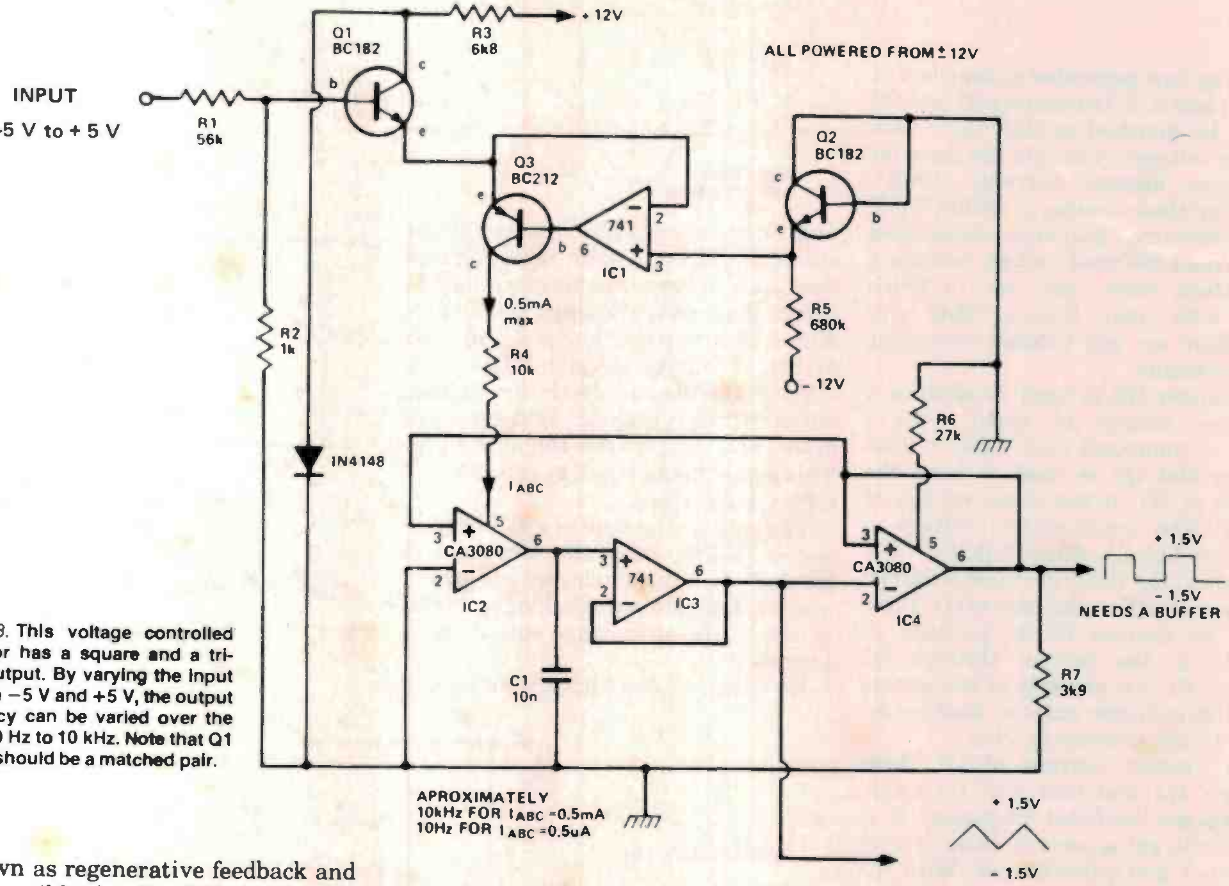


Figure 8. **This voltage controlled oscillator has a square and a triangle output. By varying the input between −5 V and +5 V, the output frequency can be varied over the range 10 Hz to 10 kHz. Note that Q1 and Q2 should be a matched pair.**

is known as regenerative feedback and is responsible for the Schmitt trigger action. The output snaps into a negative state at a voltage equal to $-(R2 \times I_{ABC})$ which is designated as $-V_{HYST}$. Only when V_{IN} becomes more negative than $-V_{HYST}$ will the output change back to the $+V_{HYST}$ state.

The Schmitt trigger is a very useful building block for detecting two discrete voltage levels and finds many uses in circuit designs.

Voltage controlled oscillator

By using two CA3080s and some 741 op-amps it is possible to make an oscillator, the frequency of which is voltage controllable. This unit finds many applications in the fields of electronic music production and test equipment.

The circuit (Figure 8) has been given a logarithmic control law, that is, the frequency of operation doubles for every volt increase in the control voltage. This makes it ideal for musical applications where linear control voltages need to be converted into musical intervals (which are logarithmically spaced) and also for audio testing where frequencies are generally measured as logarithmic functions.

One CA3080, IC2, is an integrator. The I_{ABC} current that drives this IC is used to either charge or discharge C1. This produces triangular waveforms which are buffered by IC3, which then drives the Schmitt trigger IC4. The hysteresis levels for this device are fixed at +/−1.5 V, being determined by R6 and R7.

The output of the Schmitt trigger is fed back in such a way as to control the direction of motion of the integrator's output. If the Schmitt output is high, then the integrator will ramp upwards and vice versa.

Imagine that the integrator is ramping *upwards*. When the integrator's output reaches the *upper* hysteresis level, the Schmitt will flip into its *low* state, and the integrator will start to ramp downwards. When it reaches the *low* hysteresis level the Schmitt will flip back into its *high* state. Thus the integrator ramps up and down in between the two hysteresis levels.

The speed at which it does this, and hence the oscillating frequency, is determined by the value of I_{ABC} for IC2. The larger the current, the faster the capacitor is charged and discharged.

Two outputs are produced, a triangle wave (buffered) from IC3 and a squarewave (unbuffered) from IC4. If the squarewave output is loaded, then the oscillation frequency will change so a buffer is advisable.

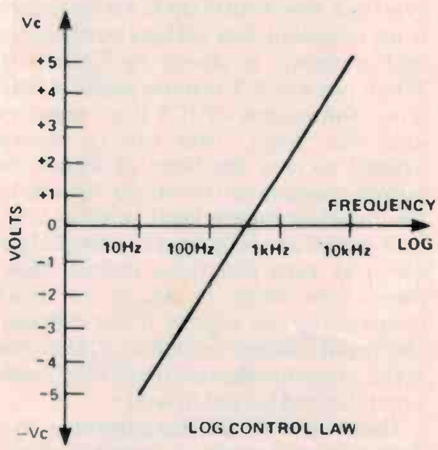


Figure 9. **Voltage versus frequency characteristic of the Figure 9 circuit.**

OP-AMP COOKBOOK

The log. law generator is composed of Q1, 2, 3 and IC1. Transistors Q1 and Q2 should be matched so that their base emitter voltages (Vbe) are the same for the same emitter current, (50uA). Matching these devices to within 5 mV is satisfactory, although unmatched pairs could be used. When matching transistors, take care not to touch them with your fingers. This will heat them up and produce erroneous measurements.

Transistor Q2 is used to produce a reference voltage of about −0.6 V, which is connected to IC1 pin 3. This op-amp and Q3 is used to keep the emitter of Q1 at the same voltage of −0.6 V. The input control voltage is attenuated by R1, R2 such that a +1 V increase at the input produces a change of only +18 mV at the base of Q1. However, the emitter of Q1 is fixed at −0.6 V, so the current through Q1 doubles. (It is a property of transistors that the collector current doubles for every 18 mV increase in Vbe).

The emitter current of Q1 flows through Q3 and into IC2, thus controlling the oscillator frequency. It is possible to get a control range of over 1000 to 1 using this circuit. With the values shown, operation from 10 Hz to 10 kHz is achieved. Reducing C1 to 1n will increase the maximum frequency to 100 kHz, although the waveform quality may be somewhat degraded.

Changing C1 to 1uF (non-polarised) will give a minimum frequency of 0.1 Hz.

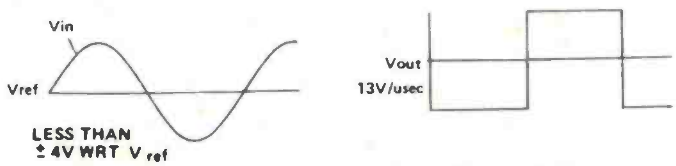
Fast comparator

The high slew rate of the CA3080 makes it an excellent fast voltage comparator and a circuit is shown in Figure 10. When pin 2 of IC1 is more positive than Vref, the output of IC1 goes negative and vice versa. Vref can be moved around so that the point at which the output changes can be varied. As long as the input sinewave level is quite large (1 V say) then the output can be made to move at very fast rates indeed. However, care must be taken to avoid overloading the inputs. If the differential input voltage exceeds 5 V, then the input stage breaks down and may cause an undesired output to occur.

One use of a fast comparator is in a *tone burst generator*. A circuit is shown in Figure 11. This device produces bursts of sinewaves, the burst starting and finishing on axis crossings of the sinusoid. The CA3080 is configured here as a voltage comparator, used to detect these axis crossings and to produce a square wave output which then drives a binary divider (IC3). The divider produces a 'divide by sixteen' output which is high for eight sinewave cycles and then low for the next eight. This signal is then used to gate ON and OFF the sinewave.

The gate mechanism is a pair of transistors which short the sinewave to ground when the divider output is high and let it pass when the divider output is low. The resulting output is a toneburst.

However, if the comparator is not ▶



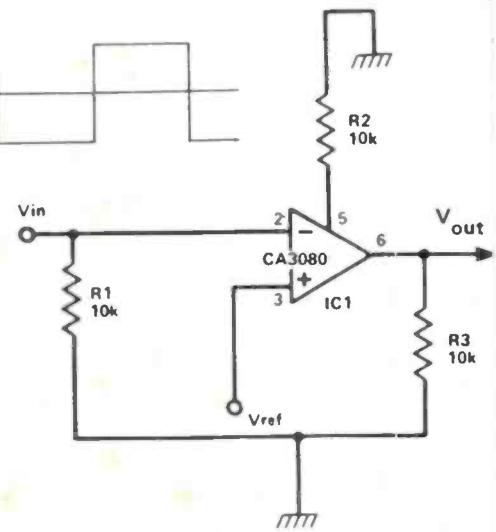


Figure 10. **Example of a fast comparator.**

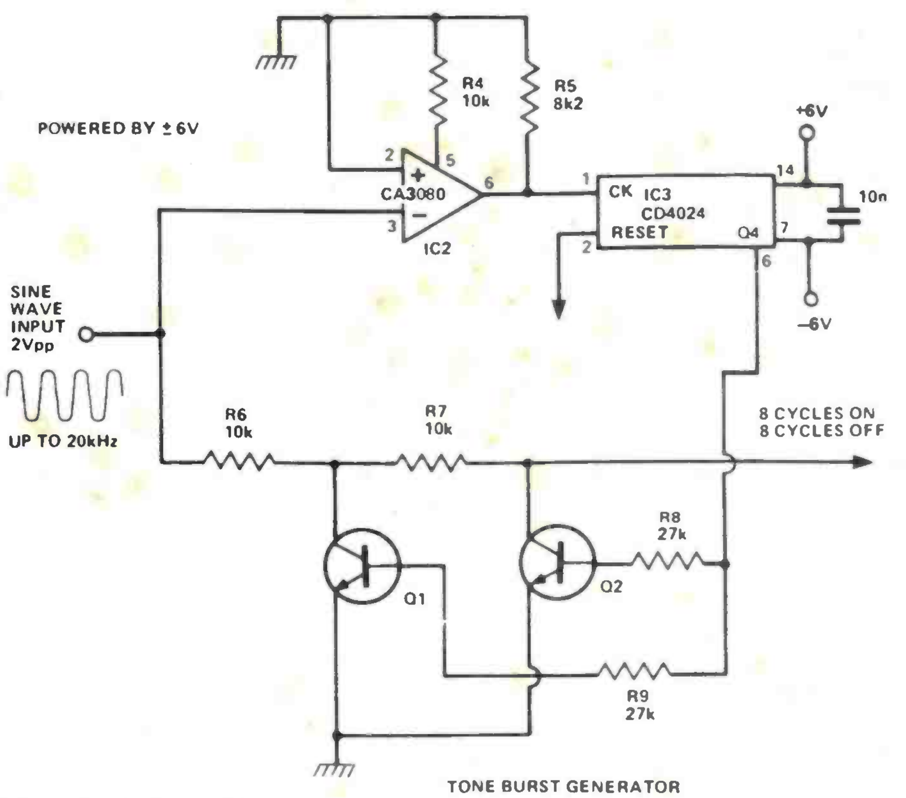
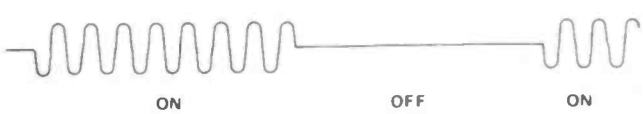


Figure 11. **A fast comparator is used in this tone burst generator, producing eight cycles of tone with eight cycle breaks starting and finishing at on-axis crossings.**



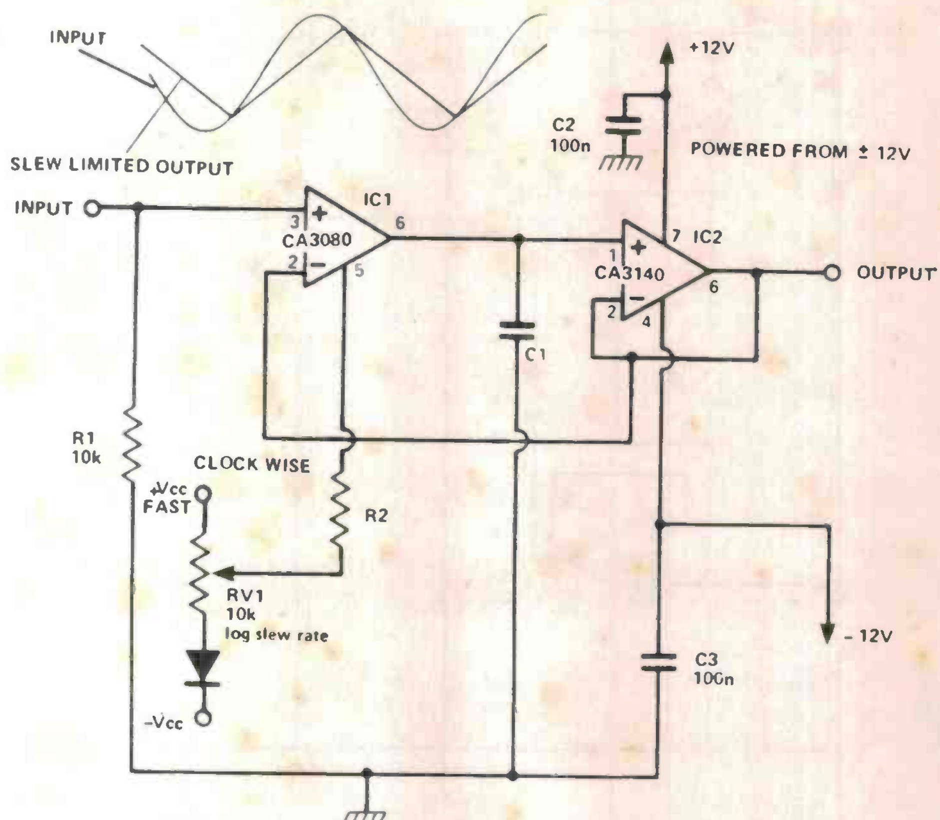


Figure 12. **This slew rate limiter circuit produces a linear ramp on signals which exceed the slew rate limit, the output amplitude stopping when it reaches the signal level.**

very fast then there will be a delay in generating the gate and so the tone burst will not start or finish on axis crossings.

Using the circuit shown, operation up to 20 kHz is obtainable.

Slew limiter

The current output of a CA3080 can be used to produce a controlled slew limiter. By connecting the output current to a capacitor, the output voltage cannot move faster than a rate given by

$$\text{Slew Rate} = \frac{I_{ABC}}{C1} \text{ Volts per sec.}$$

Note that I_{ABC} determines the slew rate and as I_{ABC} is a variable then so is the slew rate.

A suitable circuit is shown in Figure 12. The output voltage is buffered by a voltage follower, IC2. This is a MOSFET op-amp which has a very high input impedance, which is necessary to minimise the loading on C1.

When an input signal is applied to IC1 the output tries to move towards this voltage but its speed is limited by the slew rate. Thus, the output produces a linear ramp which stops when it reaches the input signal level.

Sample and hold

A typical application of the slew limiter circuit is in a *sample and hold* circuit. The circuit in Figure 13 could be termed an analogue memory. When the control voltage is high, the circuit will 're-member' or 'hold' the input voltage level present at the time. The result is shown in Figure 14.

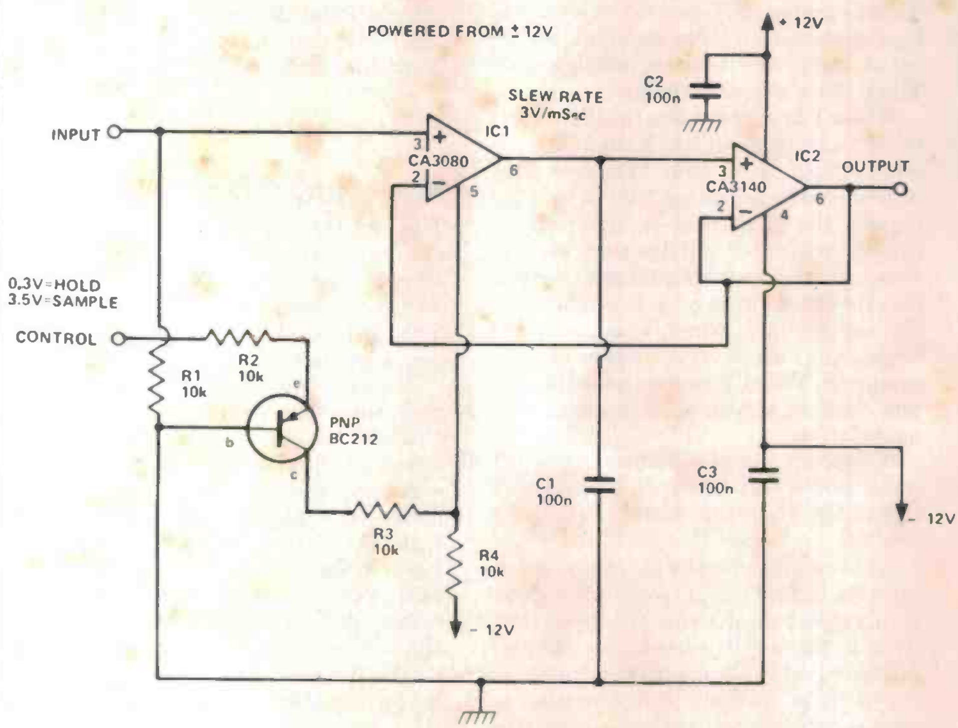


Figure 13. **A typical application of the slew rate limiter is this sample and hold circuit.**

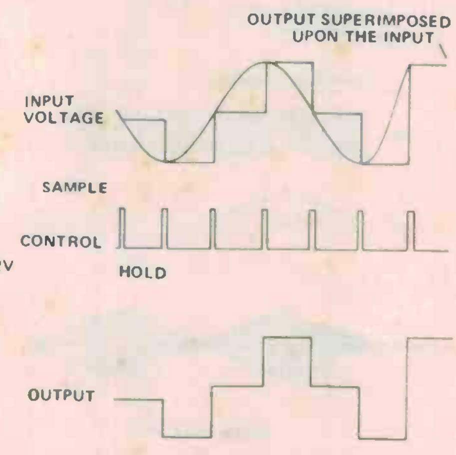


Figure 14. **Illustrating the operation of the sample and hold circuit of Figure 13.**

OP-AMP COOKBOOK

In this circuit, I_{ABC} is either hard ON (sample) or completely OFF (hold). In the sample mode, the output voltage quickly adjusts itself so that it equals the input voltage. This enables a short sample period to be used.

In the HOLD mode, I_{ABC} is zero and so the voltage on C1 should remain fixed.

Such circuits are used in music synthesizers (to remember the pitch), in analogue-to-digital converters and many other applications.

A multiplier/modulator

The CA3080 is basically a two-quadrant multiplier, that is, it has two inputs, one of which can accept bipolar signals (positive and negative going) — the inverting or the non-inverting input — the other can only accept a unipolar signal — the control input, pin 5.

Whilst a two-quadrant multiplier is very useful in a wide variety of applications, a four-quadrant multiplier has extra advantages. For example, apart from amplitude modulation, it can perform frequency doubling and ring modulation. See Figure 16. Now, a four-quadrant multiplier has two inputs, both of which can accept bipolar signals. An example of a four-quadrant multiplier is a frequency converter in a radio receiver. The familiar diode ring mixer is another example of a four-quadrant multiplier.

The circuit in Figure 15 is fairly similar to that of the two-quadrant multiplier shown in Figure 1. This circuit has several important differences.

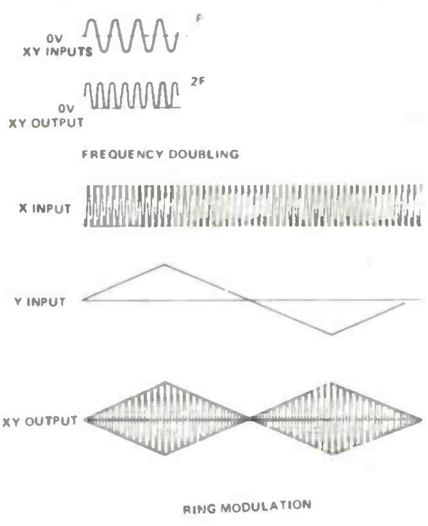


Figure 16. **Illustrating the various operations of the four quadrant multiplier of Figure 15.**

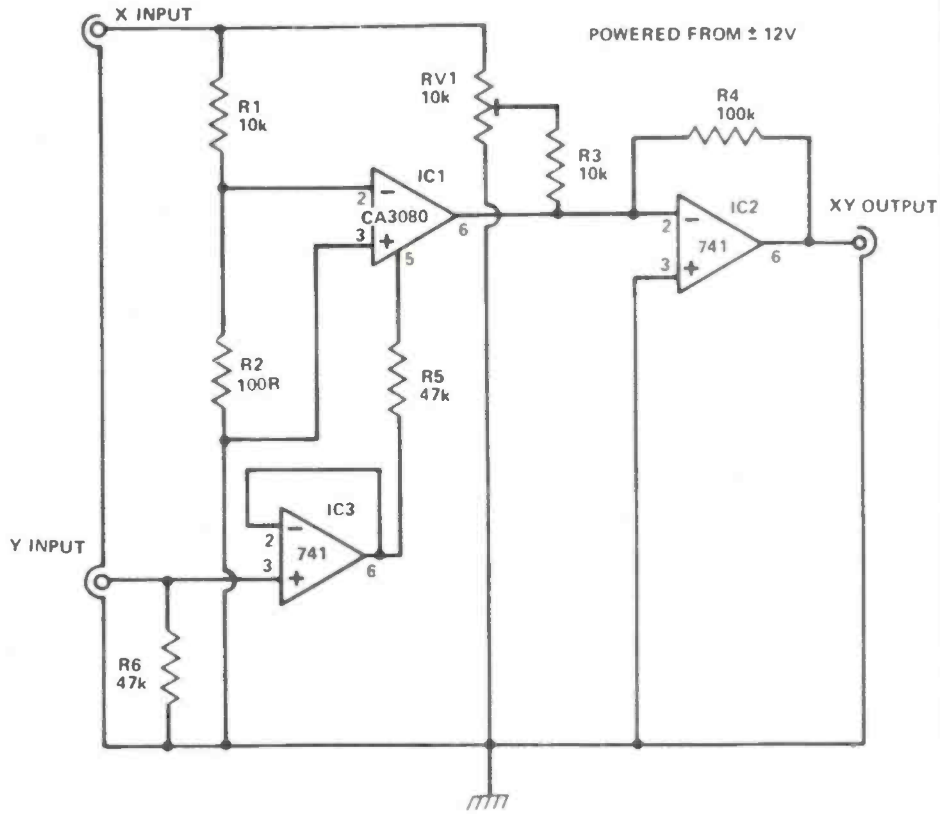


Figure 15. **This multiplier/modulator can be used to produce a 'Dalek' voice when working as a ring modulator. It can also be used as a frequency doubler.**

A 741 op-amp, IC3, is used to generate I_{ABC} in such a way that its input, the 'Y' input, can go both positive and negative. Thus, the Y input is bipolar.

When Y is at zero volts (no input) and there is a signal on the X input the desired output (X x Y) should be zero. This is achieved by adjusting RV1 so that the signal via IC1 (this is inverted) is exactly cancelled out by that via R3. Now, when Y is increased positively, a non-inverted value of X is produced at the output and, when Y is increased negatively, an inverted value of X is produced. When Y is zero, so is the output. This is known sometimes as ring modulation.

If a speech signal is connected to the X input and an audio oscillator to the Y input, the resulting sound is that of a 'Dalek'.

Also, if a sinewave is connected to both the X and Y inputs, the XY product is a sinewave of twice the frequency. This is known as a frequency doubler, but it will only work with sinewaves.

For more theoretical information on four-quadrant multipliers, especially the variable transconductance type, see "Operational Amplifiers" (second edition), by G.B. Clayton, published by Newnes-Butterworths.

Single pole filter/wah wah

The guitar 'wah wah' effects unit employs a filter which can be manually 'swept' across the middle of the audio frequency range, generally from around 500 Hz to 5 kHz or so, producing the peculiar 'wah wah' sound.

A single pole, voltage-controlled, low pass filter can be constructed using a CA3080 as a current-controlled resistor. The circuit is showh in Figure 17.

A simple, low pass RC filter configuration is employed, the controllable 'R' is the CA3080 and the 'C' is C1. Varying I_{ABC} varies the amount of current drive to C1. This circuit configuration would normally be a slew limiter, except that the signal level to the input of the CA3080 is kept deliberately low (R1 and R2 form a 100:1 attenuator) so that the IC operates in its linear mode. This enables it to look like a variable resistor.

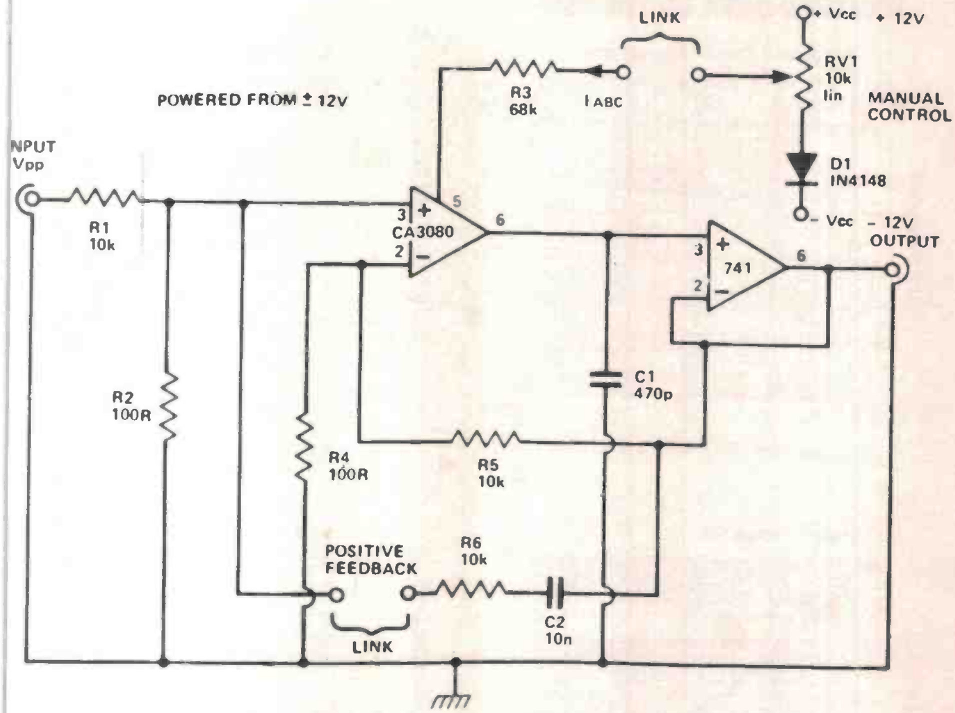


Figure 17. A guitar wah-wah unit can be made with a swept frequency single pole filter.

When this resistor is varied, the break frequency of the filter also varies.

By applying some positive feedback around the filter (R6, C2) it is possible to produce a peaky filter response. The peak actually increases with frequency, producing the wah wah effect.

The circuit as shown can be swept from about 400 Hz at the lower extreme to about 4 kHz at the upper extreme. See Figure 18.

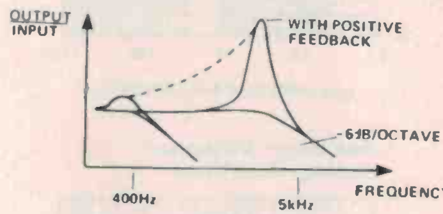


Figure 18. How the single pole filter affects the frequency response of the signal passed through the wah wah unit.

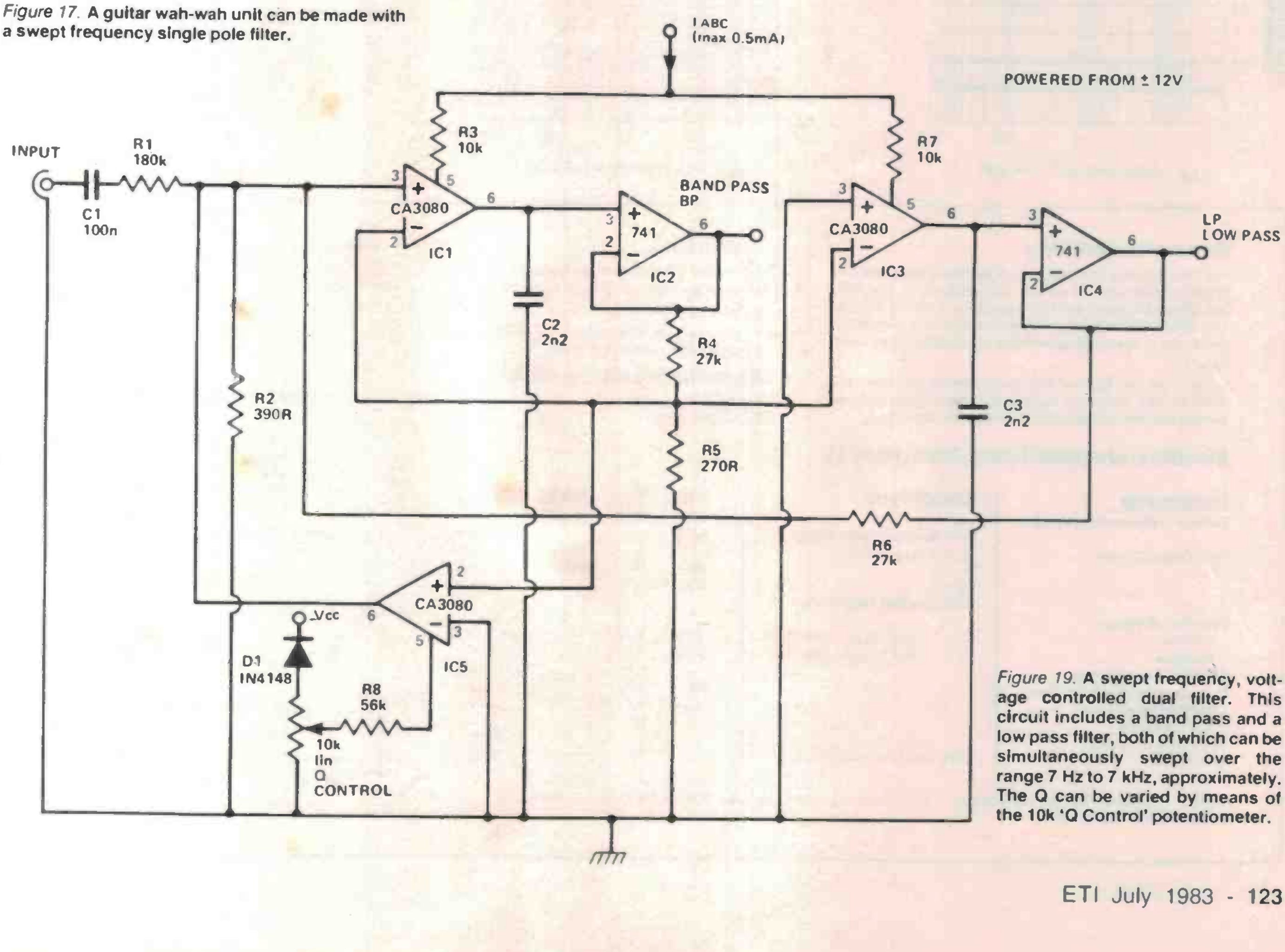
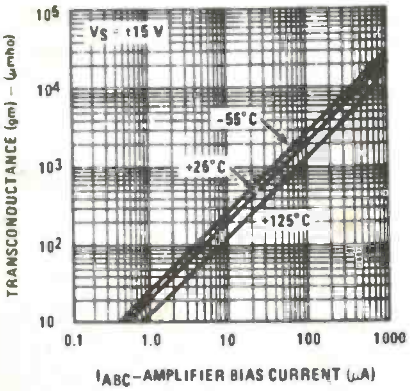


Figure 19. A swept frequency, voltage controlled dual filter. This circuit includes a band pass and a low pass filter, both of which can be simultaneously swept over the range 7 Hz to 7 kHz, approximately. The Q can be varied by means of the 10k 'Q Control' potentiometer.

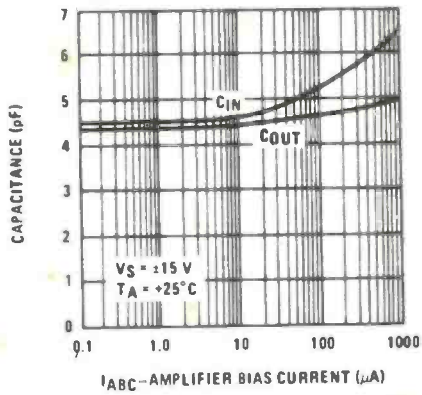
OP-AMP COOKBOOK

SELECTED DATA ON THE 3080

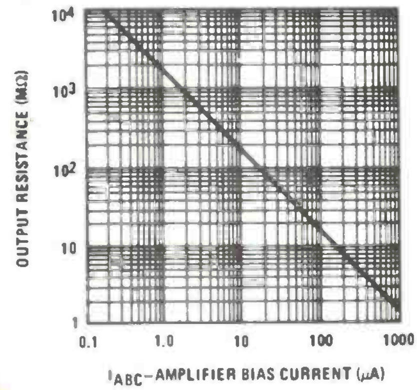
Transconductance



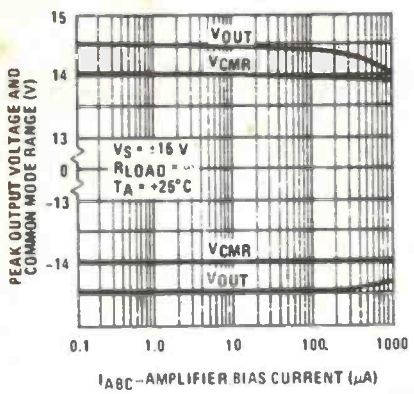
Input and Output Capacitance



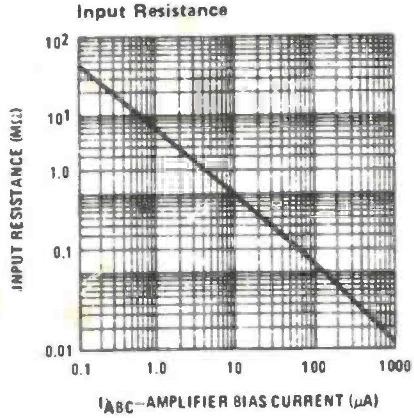
Output Resistance



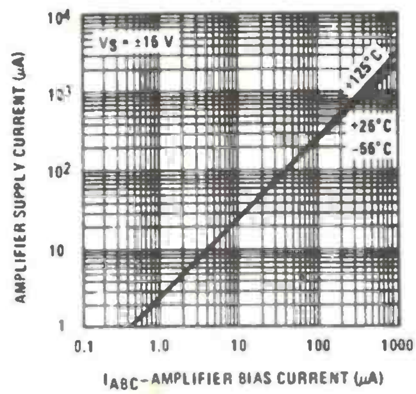
Peak Output Voltage and Common Mode Range



Input Resistance



Amplifier Supply Current



General description

The 3080 is a programmable transconductance block intended to fulfil a wide variety of variable gain applications. The 3080 has differential inputs and high impedance push-pull outputs. The device has high input impedance and its transconductance (gm) is directly proportional to the amplifier bias current (I_{ABC}).

High slew rate together with programmable gain make the 3080 an ideal choice for variable gain applications such as sample and hold, multiplexing, filtering, and multiplying.

Features

- Slew rate (unity gain compensated): 50 V/us
- Fully adjustable gain: 0 to gm R_L limit
- Extended gm linearity
- Flexible supply voltage range: +/−2 V to +/−18 V
- Adjustable power consumption

Absolute maximum ratings

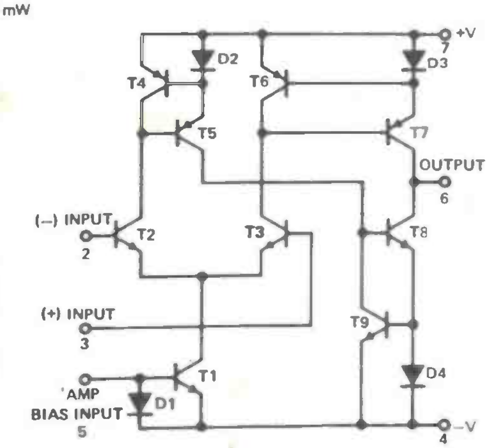
Supply Voltage 3080	+/−18 V
Power Dissipation	250 mW
Differential Input Voltage	+/−5 V
Amplifier Bias Current (I_{ABC})	2 mA
DC Input Voltage	$+/V_s$ to $-V_s$
Output Short Circuit Duration	Indefinite

Electrical characteristics, 3080 (Note 1).

Parameter	Conditions	Min.	Typ.	Max.	Units
Forward Transconductance (gm)		6700	9600	13000	umho
	Over Specified Temp. Range	5400			umho
Peak Output Current	R_L = 0, I_{ABC} = 5uA		5		uA
	R_L = 0	350	500	650	uA
	R_L = 0, Over Specified Temp.Range	300			uA
Peak Output Voltage					
Positive	R_L = , 5uA I_{ABC} 500uA	+12	+14.2		V
Negative	R_L = , 5uA I_{ABC} 500uA	−12	−14.4		V
Amplifier Supply Current			1.1		mA
Common Mode Rejection Ratio		80	110		dB
Common Mode Range		+/−12	+/−14		V
Input Resistance		10	26		k
Open Loop Bandwidth			2		MHz
Slew Rate	Unity Gain Compensated		50		V/us

Note 1: These specifications apply for V_S = +/−15 V and T_A = 25°C, amplifier bias current (I_{ABC}) = 500uA, unless otherwise specified.

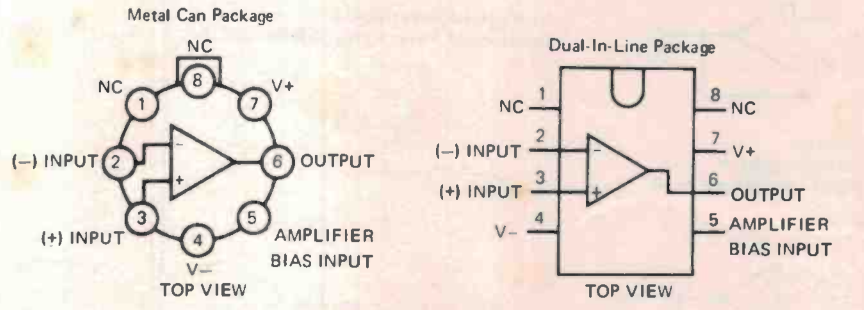
Internal circuit of the 3080



Voltage controlled filter

A standard dual integrator filter can be constructed using a few CA3080s. By varying I_{ABC}, the resonant frequency can be swept over a 1000 to 1 range. IC1 and IC3 are two current-controlled integrators. IC2 and IC4 are voltage followers which serve to buffer the high impedance outputs of the integrators. A third CA3080 (C5) is used to control the Q factor of the filter. Q factors as high as 50 can be obtained. The resonant frequency of the filter is linearly proportional to I_{ABC} and hence this unit is very useful in electronic music production.

There are two outputs, a low pass and a band pass response. Minimum frequency is around 7 Hz to 10 Hz, upper frequency is around 7 kHz or so. Changing C2 and C3 will alter the upper and lower frequency limits. ●



PIN CONNECTIONS FOR THE 3080 IC

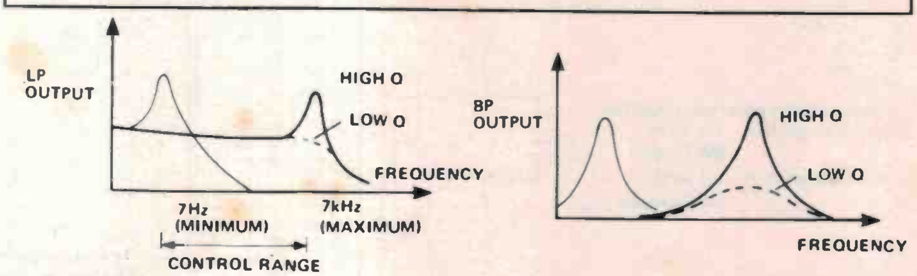
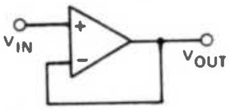


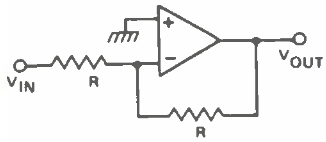
Figure 20. **Illustrating the operation of the filters in the Figure 19 circuit.**

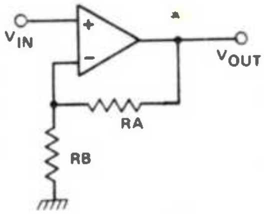
Basic Op-amp Building Blocks



Voltage follower/buffer
Input must have a DC path to ground

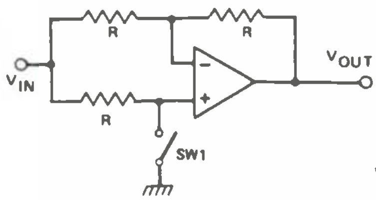
Inverter
Voltage gain = −1
input impedance = R

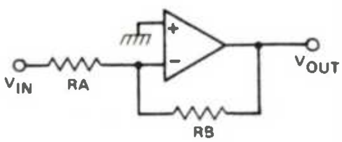




Non-inverting amplifier
Input must have a DC path to ground
Voltage gain = (RA + RB)/RP

Inverter/non-inverter amplifier
Voltage gain = +1 with SW1 open
Voltage gain = −1 with SW1 closed

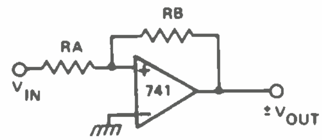




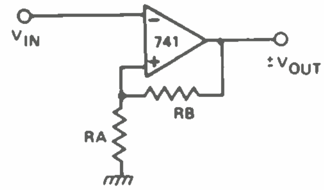
Inverting Amplifier
Voltage gain = −RB/RA
Input impedance = RA

The power supply and compensation are omitted from these diagrams. If internally compensated devices are used no additional compensation is necessary, i.e: 741, TL071, TL072, TL074, etc. If additional compensation is required consult the data sheets on the particular device used.

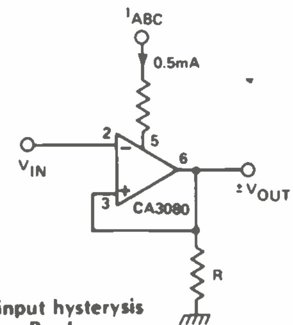
Schmitt Triggers



Non-inverting; input hysterysis levels = ±(RA/RB)) x V_{OUT}



Inverting; input hysterysis levels = ±(RA/(RA + RB)) x V_{OUT}
Note that V_{OUT} depends on the supply voltage and the individual op-amp

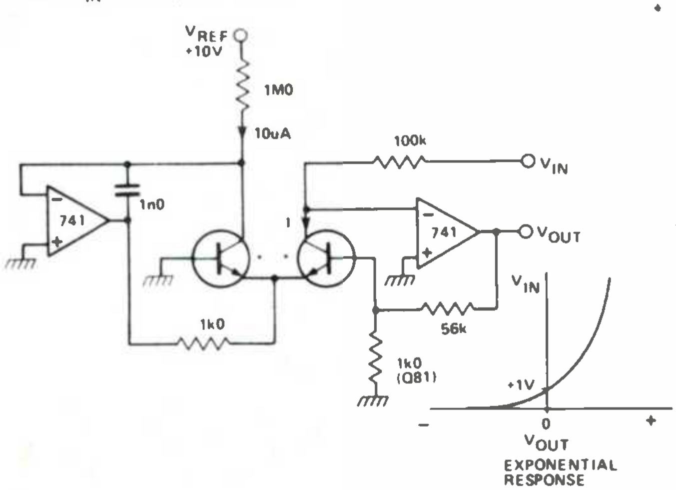


Transconductance type; input hysterysis levels = ±V_{OUT}; V_{OUT} = R x I_{ABC}
R can be replaced by two 1N4148 diodes back-to-back

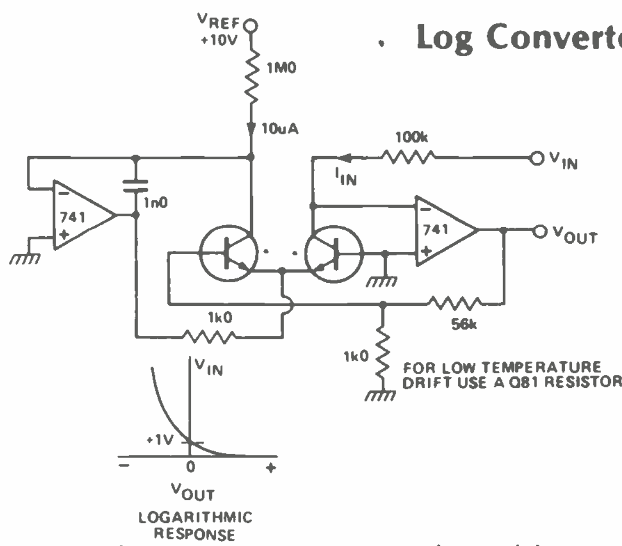
When trying to convert a slowly changing voltage into a step function with a well-defined leading edge a good Schmitt trigger is invaluable. This is a simple but effective trigger capable of good results in the audio passband. Once again, for higher frequency use substitute a faster op-amp for the 741. The Schmitt trigger works by using positive feedback to establish a 'deadband', a range of input voltages within which the output state will not change. The input voltage must exceed the higher limit in order to force the output high. Similarly, the input voltage must be taken below the lower limit to force the output low. The extent of this deadband is given in the equations.

Antilog (Exponential) Converter

V_{OUT} = I x 100k
The current I doubles for every 1 V increase of V_{IN}
When V_{IN} = 0 V, I = 10 uA



Log Converter



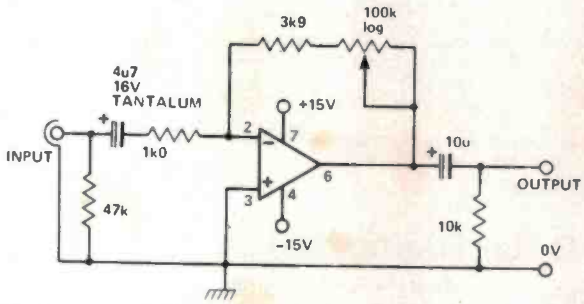
V_{OUT} changes by 1 V for every octave change of the I_{IN} current

*The matched transistors can be two BC212L in thermal contact, or a dual transistor (LM394), or pat of an array (CA3046)

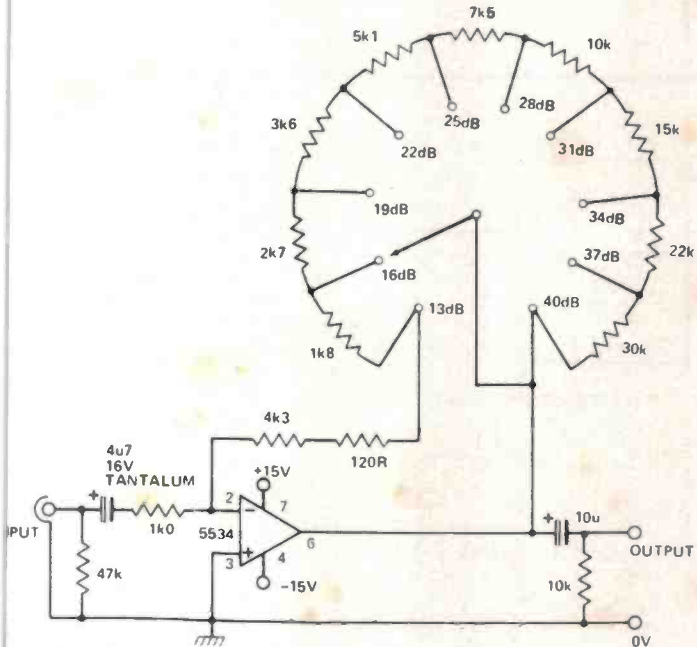
OP-AMP COOKBOOK

Low Impedance Source Preamp

Very low input noise
Input noise = 4 nV$\sqrt{Hz}$
Equivalent input noise voltage = 0.56 uV$_{RMS}$ (20 kHz bandwidth)
Input impedance = 1k0 (suitable for microphone)



Variable gain; x 3.9 to x 100 (12 dB to 40 dB)

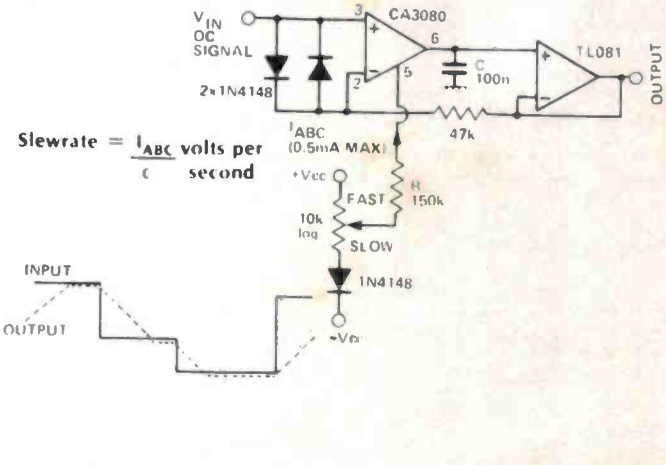


Switched gain; 3 dB steps

The NE5534N is a very low-noise op-amp specifically intended for audio applications. The device boasts one of the lowest noise figures of all op-amps combined with good slew rate and large signal bandwidth figures.

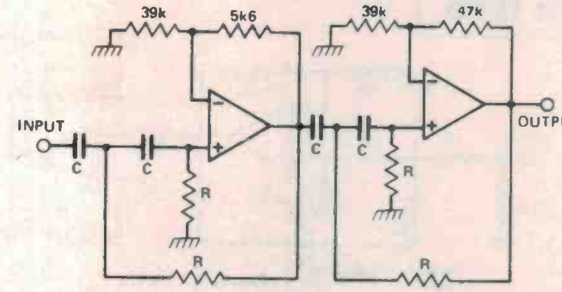
The lowest-noise devices have the designation NE5534AN. Suitable supply decoupling is essential if best results are to be obtained.

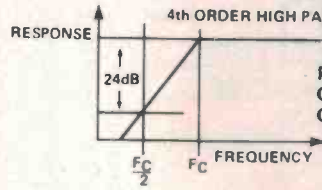
Slew Limiter



Slewrate = $\frac{I_{ABC}}{C}$ volts per second

Rumble Filter





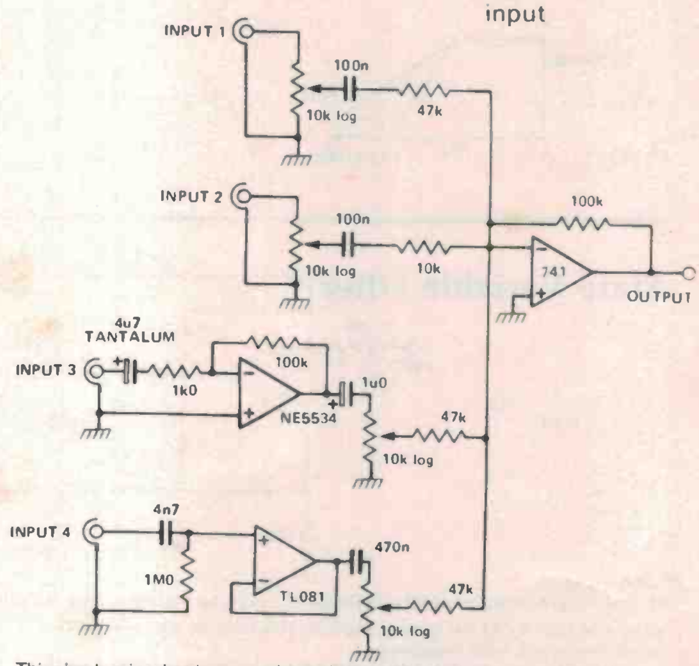
Roll-off slope = 24dB/octave
Overall voltage gain = x 2.6 (8.3 dB)
Op-amps are 741's or RC4558

F_C	C	R
25 Hz	100n	62k
50 Hz	100n	30k
100 Hz	100n	15k
200 Hz	100n	7k5

(5% tolerance)

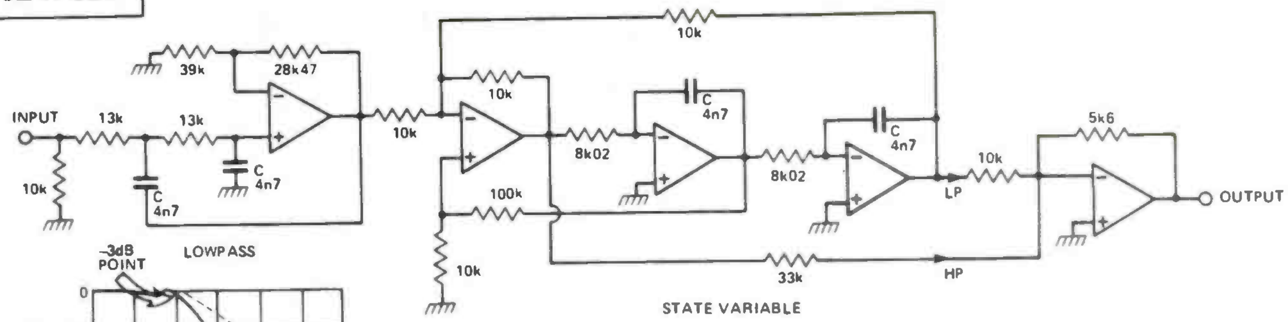
Simple Mixer

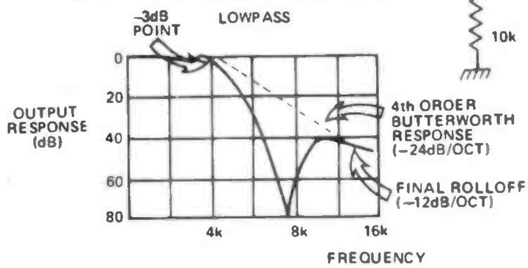
INPUT	MAX GAIN	INPUT IMPEDANCE	SOURCE
1	+6 dB	10k	line level
2	+20 dB	5 to 10k	line level
3	+46 dB	1k0	low impedance microphone
4	+6 dB	1M0	high impedance input



This simple mixer has been provided with four different types of input circuit. Any combination of these could however be used. Once again, the 741 limits the high frequency response and slew rate capabilities. To improve performance substitute the 741 for a faster device such as an NE5534N or TL071, etc.

FILTERS





4th Order Elliptic lowpass

Cutoff frequency is 4 kHz. To change cutoff frequency, scale capacitor C (four off)

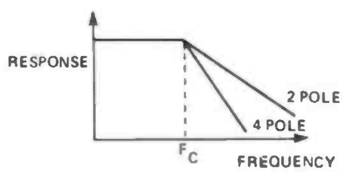
Lowpass Active Filters

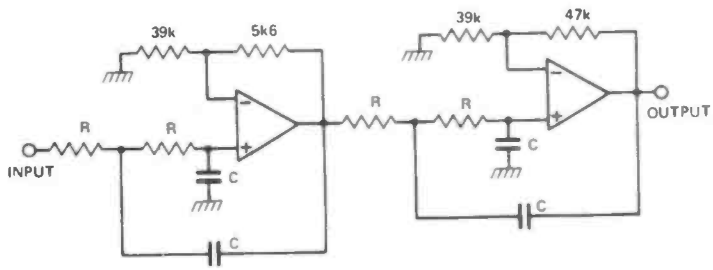
Inputs must have a DC path to ground

$$F_c = \frac{1}{2\pi RC}$$

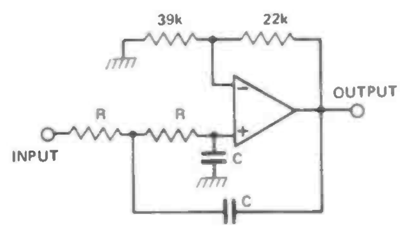
2 pole roll-off = −12 dB/octave
4 pole roll-off = −24 dB/octave

R	C	F_c
107k	15n	100 Hz
10k7	15n	1 kHz
10k7	1n5	10 kHz





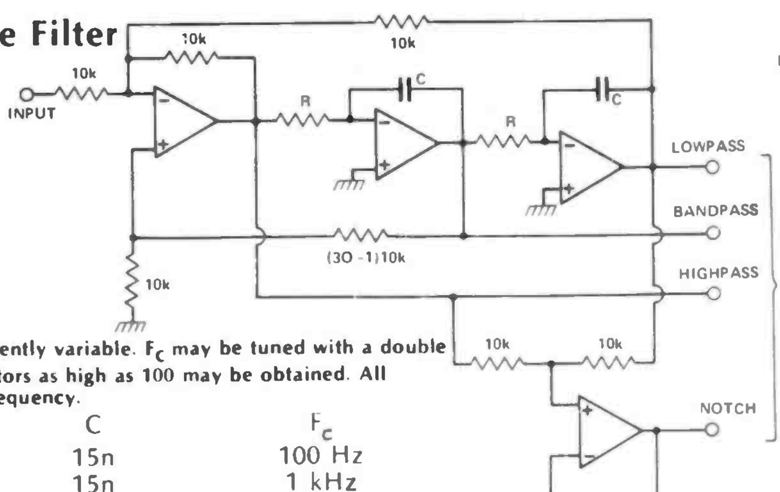
4 pole Butterworth

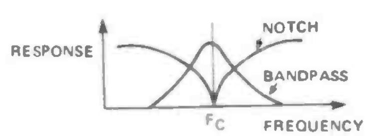


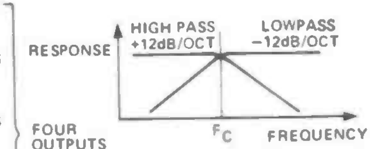
2 pole Butterworth

State Variable Filter

$$F_c = \frac{1}{2\pi RC} \text{ Hz}$$







Gain = Q

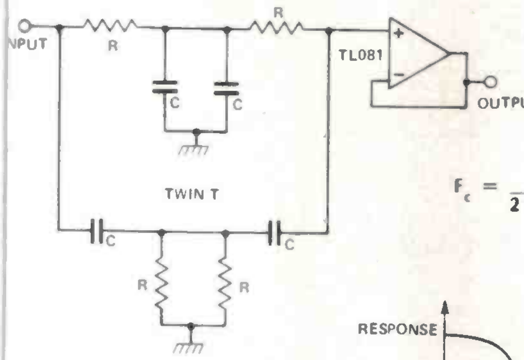
Q and F_C are independently variable. F_C may be tuned with a double gang pot (for R). Q factors as high as 100 may be obtained. All responses track with frequency.

R	C	F_c
107k	15n	100 Hz
10k7	15n	1 kHz
10k7	1n5	10kHz

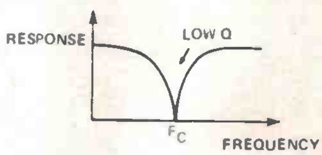
OP-AMP COOKBOOK

Active Notch Filter

The two R's in parallel represent R/2
The two C's in parallel represent 2C
For 50 Hz, R = 680k, C = 4n7 (a hum remover)

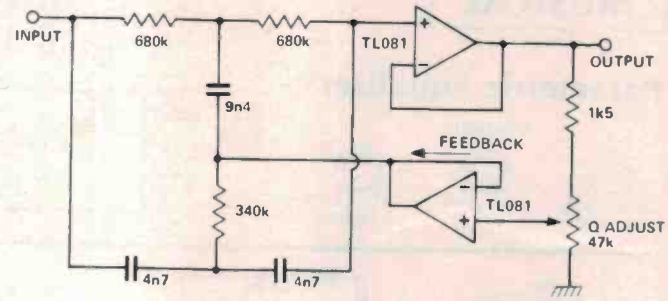


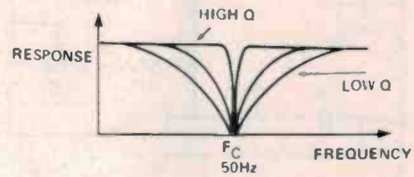
$$F_c = \frac{1}{2\pi RC}$$



A basic Twin-Tee notch. Rejection depends on component matching, so for best results use high-stability components.

50 Hz Notch, Variable Q

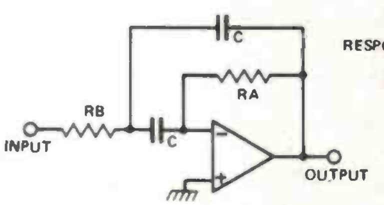


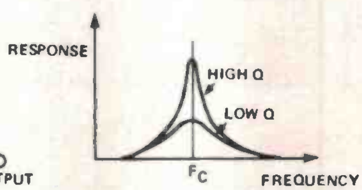


This is a modified version of the basic Twin-Tee notch filter. The Q can be adjusted by controlling the amount of feedback with the 47k potentiometer. The rejection offered by the circuit is determined by the matching of the passive components, but even with ordinary components a figure of 30 dB to 40 dB should be obtained.

Bandpass Active Filter

$F_C = 1/2\pi C\sqrt{RA + RB}$
$Q = 1/2\sqrt{RA/RB}$
Gain $= 2Q^2$





F_C = 1kHz, C = 15n

RA	RB	Q	GAIN
10k6	10k6	0.5	x 0.5
21k2	5k3	1.0	x 2.0
42k4	2k65	2.0	x 8.0
84k8	1k32	4.0	x 32.0

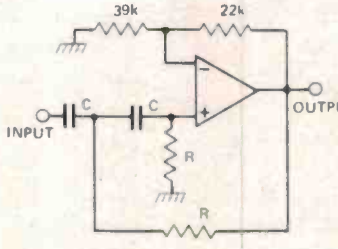
This is probably the most common bandpass filter. The circuit is really only useful for the relatively low Q shown. For a higher Q one of the more complex bandpass circuits should be used, such as the state variable filter.

Highpass Active Filters

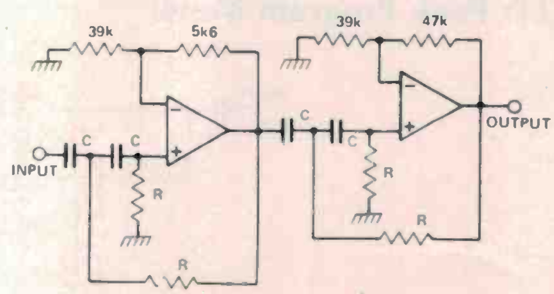
$$F_c = \frac{1}{2\pi RC}\ \text{Hz}$$

2 pole roll-off = + 12 dB/octave
4 pole roll-off = + 24 dB/octave

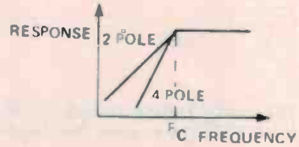
R	C	F_c
107k	15n	100 Hz
10k7	15n	1 kHz
10k7	1n5	10 kHz



2 pole Butterworth



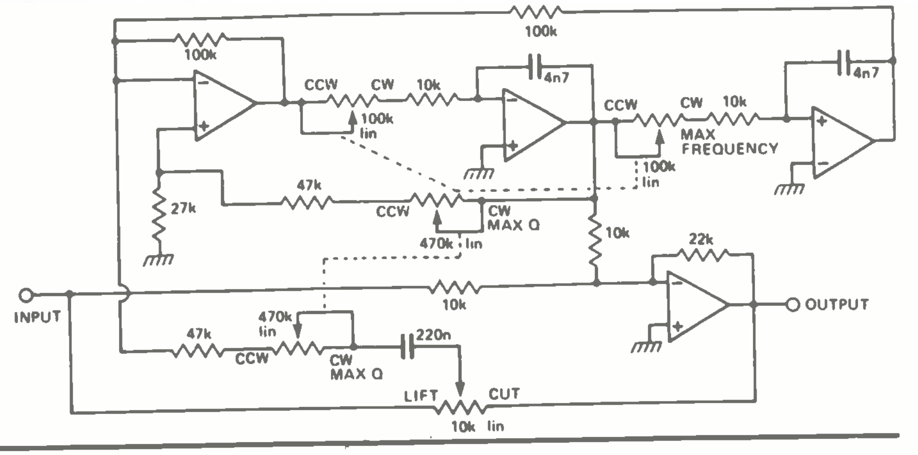
4 pole Butterworth



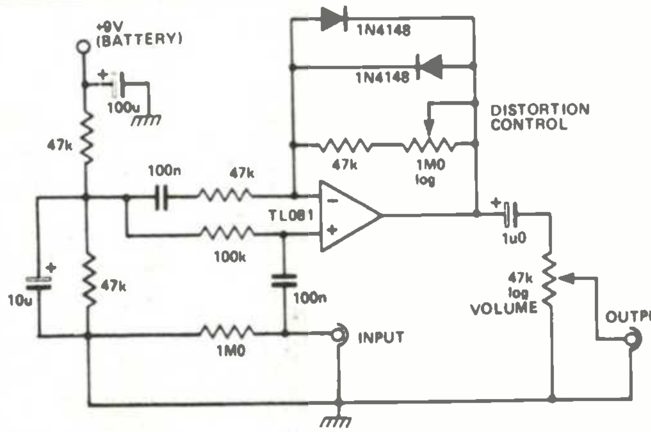
OP-AMP COOKBOOK

MUSICAL

Parametric Equaliser

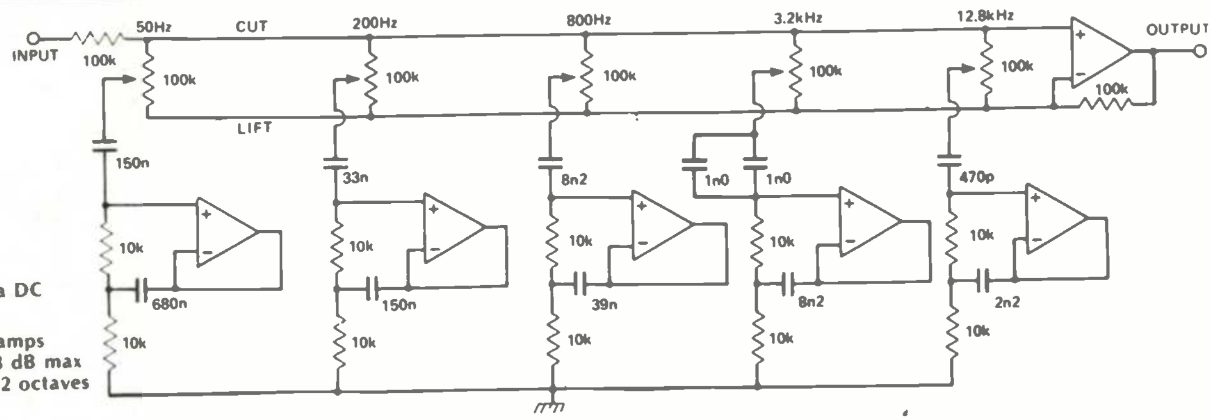


Fuzz Unit For Guitar



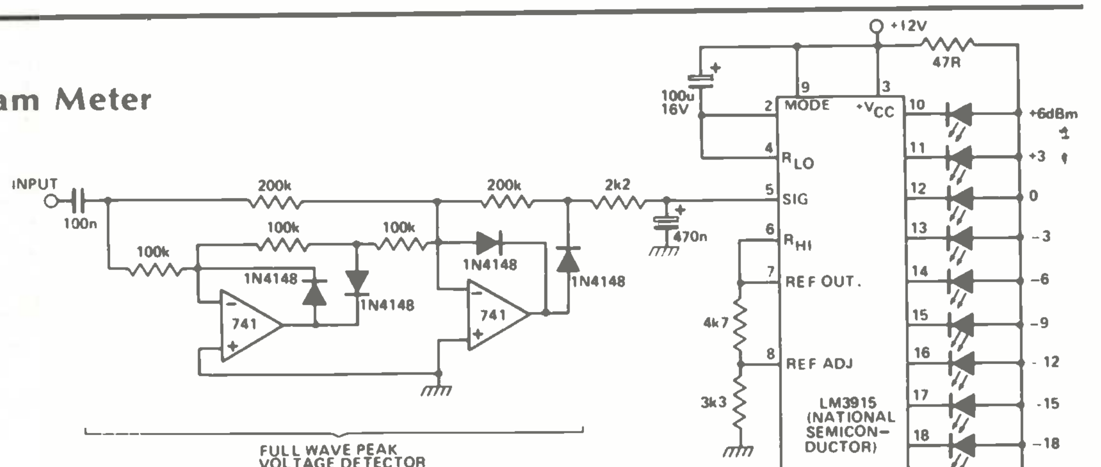
The battery can be switched on via the jack socket (a stereo jack can be used).

Graphic Equaliser



Input must have a DC path to ground
Use 741's for op-amps
Cut and lift = 13 dB max
Filter spacing = 2 octaves

LED Peak Program Meter



Leave pin 9 open circuit for dot operation
If an LM3914 is used the display is linear, not logarithmic

VP-5512A

We increased the range to 100MHz, the channels to 4 and the trace to 8, but you'd never know it from the price.

A Scope that does more and tells more
Here, for the bottom liner, is a scope that really performs! You get your 100MHz with an alternate sweep function in a compact package. You get a 4-channel, 8-trace format so that a large number of signals can be simultaneously observed with ease. And you not only watch 4 different kinds of waveforms at the same time but you also get measurements of phase differences in signals and their timing.

Features galore in a unit you can trust
And that's not all. Listen to these outstanding features: an Auto-Fix circuit for easy triggering, a National exclusive; bright, clear waveforms on an advanced domed-mesh CRT, a National speciality; 2mV/DIV sensitivity; 2 nSec/DIV maximum sweep rate; ±2% time axis accuracy; a TV sync separation circuit for video signals; variable hold-off function for trigger stabilization; alternate triggering; drift compensation; and more.

Ideal for lab, line or field service
You also get that world renowned National reliability in every National oscilloscope. We have, for example, reduced parts by one-quarter, which means, of course, less wiring and less failures. We have installed glass epoxy circuit boards which have far greater resistance to shock and heat. There is also a 15,000-hour MTBF (Mean Time Between Failures) rate, certainly one of the finest in the industry.
So the next time you're looking for a reliable scope that's been fully upgraded in range, channels and trace—everything, in fact, except price—remember the VP-5512A Pana Scope. From National.

VP-5234A
- DC-40MHz.
- 15,000 hours MTBF.
- Triggering waveform on CH 3.
- Auto-Fix and Hold-Off control.
- Delayed sweep.
- Alternate triggering function.
- TV sync separation circuit.

VP-5256A
- DC-60MHz.
- 15,000 hours MTBF.
- Alternate sweep function.
- Auto-Fix and Hold-Off control.
- Alternate triggering function.
- Triggering waveform on CH 3.
- Domed-mesh CRT with illuminated internal graticules.

PRICE: $2,200–
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National

Why some CMOS circuits don't work as you expect

Stephen Dolding

A 4093 is a 4093, right? Well . . . yes, and no. There are quite a few pitfalls in the CMOS 'jungle' and it's handy to know about them before venturing forth.

CMOS '4000' SERIES integrated circuits are manufactured by at least six major manufacturers and the 74C series by at least two major manufacturers, but it must not be assumed that a 4XXX from one manufacturer is interchangeable with a 4XXX device from another manufacturer. This article explains some of these differences.

Schmitt gate oscillator

What could be simpler than the oscillator circuits shown in Figures 1(a) and 1(b)? There are so few components that you would expect these circuits to work first time.

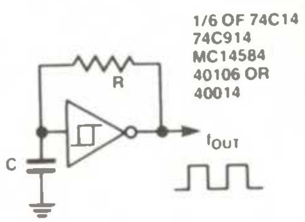


Figure 1a. Different manufacturers ICs will produce different results.

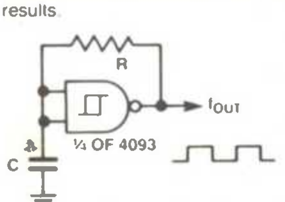


Figure 1b. Such a simple circuit but the value of f_{out} can vary from 52.9 Hz to 249 Hz, depending on the brand of 4093 used.

You have selected stable, close tolerance components and calculated the frequency according to the formula:

$$f_{out} = \frac{1}{CR\log_e\left[\left(\frac{V_{cc}-V_{t-}}{V_{cc}-V_{t+}}\right)\left(\frac{V_{t+}}{V_{t-}}\right)\right]}$$

where C = capacitor value in uF
R = resistor value in kilohms
f_{out} = frequency out in kHz
V_{cc} = supply voltage
V_{t+} = upper trigger level of Schmitt trigger
V_{t-} = lower trigger level of Schmitt trigger

Now, the question is, "what are the values of V_{t+} and V_{t-}?" We need to refer to the manufacturer's data sheet for an answer. But which manufacturer? There are at least six different manufacturers to choose from and each one gives a different range of possible values for V_{t+} and V_{t-}.

Considering the 4093 IC (Figure 1(b)); if all the databooks are consulted it is found that for V_{cc} = +5 V the *highest* typical value of V_{t+} = 3.6 V (extreme = 4.3 V).

The *lowest* typical value of V_{t+} = 2.7 V (extreme = 1.7 V).

The *highest* typical value of V_{t-} = 2.2 V (extreme = 3.3 V).

The *lowest* typical value of V_{t-} = 1.4 V (extreme = 0.7 V.

Now if V_{t+} = 3.6 V, V_{t-} = 1.4 V, V_{cc} = +5 V, C = 100 nF and R = 10k, then from the formula above f_{out} = 52.9 Hz.

With the same type from another manufacturer, V_{t+} could be 2.7 V and V_{t-} could be 2.2 V, in which case recalculation gives a frequency of 249 Hz!

These figures are based on typical values of trigger level. Extremes of high and low trigger levels could give frequencies ranging from 27.5 Hz to 961 Hz with the same values of C = 100 nF and R = 10k. This gives a frequency range of almost 35:1 if the whole spectrum of possibilities is considered.

Now it will be clear why the circuit may oscillate at a frequency which is considerably different from what was expected or intended by the designer who only consulted one manufacturer's databook!

The monostable

Now let us look at another CMOS circuit often used by the hobbyist — the 4528 dual monostable, shown in Figure 2.

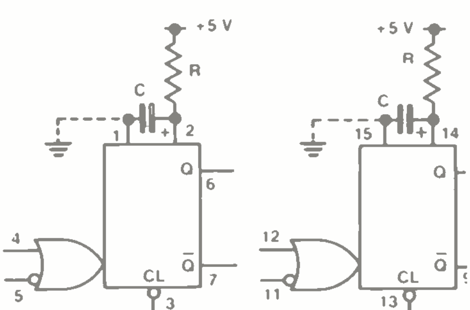


Figure 2. The 4528 dual monostable can have variations in its performance of up to ±50%

Here again, different manufacturers give different formulae for the monostable time constant. A typical formula (for +5 V supply) is

$$t = 0.37CR$$

However, it could vary from $t = 0.32CR$ to $t = 0.42CR$ typical, with variations up to ±50%.

The pulse width depends very much on the supply voltage. Some manufacturers' 4528s give increasing pulse width with increasing supply voltage, others give a reverse effect.

The formula given above depends on the value of C being greater than 10n. For smaller values of capacitance the manufacturers' data sheets need to be consulted.

It should also be noted that some manufacturers require pins 1 and 15 to be grounded externally for correct operation. To overcome the variations in timing formula, a CMOS 4538 integrated circuit can be used in place of the 4528. The 4538 is pin compatible with the 4528 IC and the formula is:

$$t = CR$$

with variations of only ±5%.

In all timing circuits using CMOS ICs it is wise to make provision for trimming the value of the timing resistor to allow for adjustment.

The counter/divider

Next we come to a well-known decade counter/divider IC — the 4017.

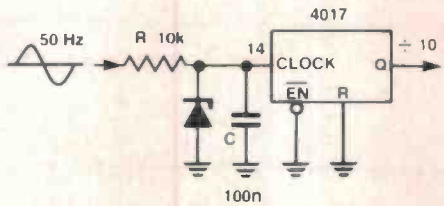


Figure 3. This circuit will only work correctly with particular brands of 4017 decade counter/dividers. The wrong choice can result in false counting.

Will the circuit in Figure 3 always work correctly? No, only with a Motorola 14017 or an RCA 4017, because these have an internal Schmitt trigger on the clock input. Other manufacturers' 4017s do not, so false counting may result.

BCD decoder

Another fairly common integrated circuit likely to give problems is the 4028 BCD-to-10-line decoder. We now come to see that actual logical differences can occur between one manufacturer's 4XXX and another manufacturer's 4XXX.

With the 4028, some manufacturers (Motorola and RCA) do not decode the six 'illegal' binary codes 1010 to 1111 (i.e. 10-15), while other manufacturers (including National, Fairchild and Philips) decode these outputs as if the input was 8 (1000) or 9 (1001).

The problem of logical differences between one manufacturer's device and another manufacturer's device (with supposedly the same type number) applies also to the 4585 four-bit comparator and even to the ubiquitous 555 and 556 timers. There may be other examples too. The problem fortunately does not occur with the range of quad gates.

The moral

The above-mentioned examples were all encountered during the design of one piece of industrial equipment which made use of these common CMOS parts.

You may well ask "If design engineers, who have ready access to all the data books, can run into such problems, what about the unsuspecting hobbyist, who has no data?"

The moral of this article is that "forewarned is forearmed". It is hoped that this article may at least prevent some construction projects from being abandoned because they do not appear to work correctly at first sight. Designers who publish projects should check that there are at least two manufacturers' ICs which will work in the circuit as intended and, if necessary, spell out the names of suitable manufacturers in the parts list. Best of all, only design circuits that will work with all manufacturers devices of the same basic type number (though this may not always be possible).

If problems occur, all that may be required is to try an IC from a different manufacturer. ●

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.

Monster flasher

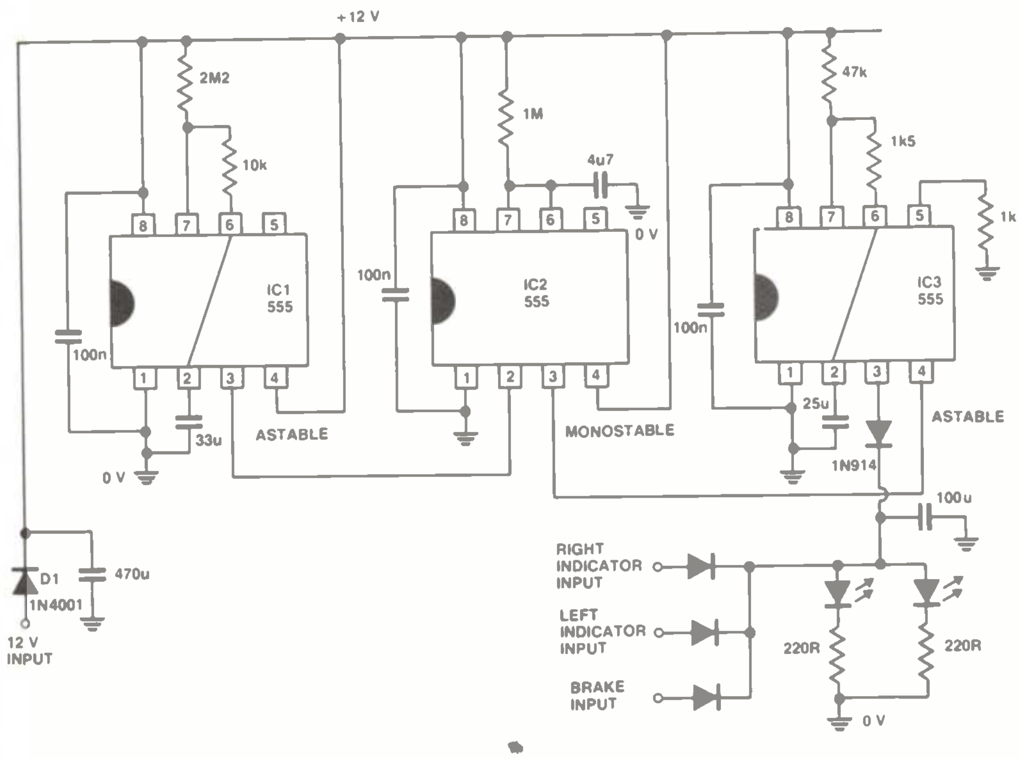
Andrew Stewart of **Gumdale Queensland** has a little monster which sits on the dashboard of his car and flashes its eyes (LEDs) with the indicator and brake lights. Now many of his friends want a 'flashing eyed' monster. He sent us a copy of his most advanced unit.

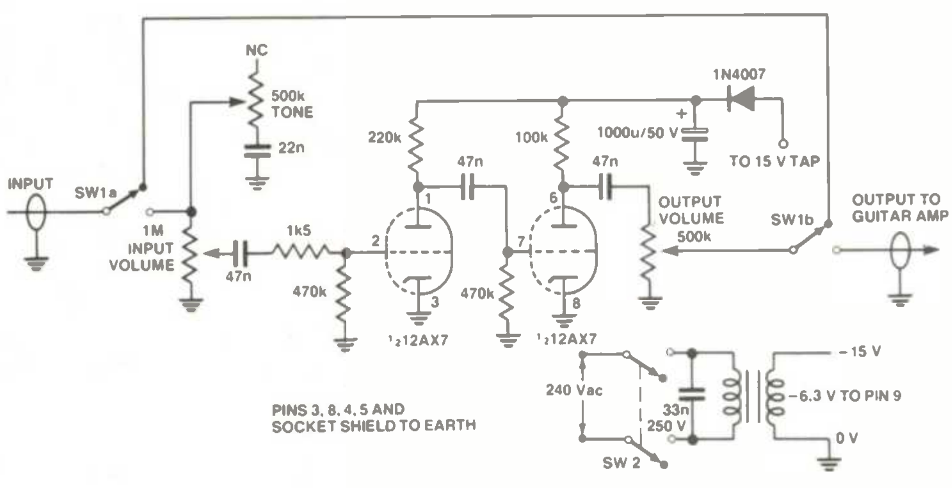
As the ignition system in a car is often noisy D1 is needed to isolate the 470u capacitor from the 12 V supply.

IC1 555 gives a time delay of over a minute and when it finishes counting it sends a pulse to IC2 555. The output of IC2 then goes high for approximately 4-5 seconds. This, in turn, causes IC3 to oscillate and the monster's eyes blink.

The 1k resistor brings the duty cycle close to 50%. The 100 uF capacitor on the output of IC3 makes the eyes look as if they are fading in and out.

The monster I used for mounting the LEDs in was a cheap plastic lizard. The ICs can be mounted on Vero board and placed inside a matchbox up under the dashboard.





Valve distortion unit

If you really want a valve distortion unit, **Jeff Parkes** of **Collingwood Victoria** has designed one.

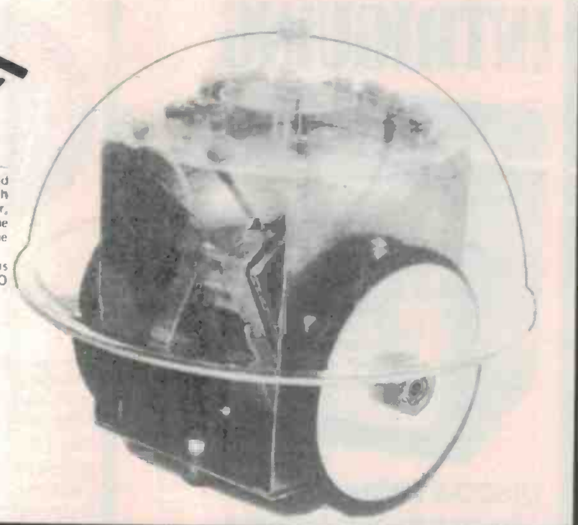
I built this effect pedal in an aluminium box with dimensions of 130 mm x 75 mm x 55 mm. It is almost hum and noise free and sounds great with a gutsy guitar such as the 'Les Paul' type.

I have left it running for several days and the performance has remained constant. The transformer is a 2155 and SW1 is an audio quality DPDT footswitch.

JAYCAR

Robot Turtle Hebot 11

NEW



The HEBOT 11 turtle is not just a fun device, it is a positive aid to education, it takes programming out into the real 3 dimensional world instead of the flat two dimensional world of the VDU. When connected to the I/O ports of your computer and given a DC supply of 9–15V the turtle runs around under computer control moving forwards, backwards, right and left with independent control of each wheel, it has blinking eyes, will bleep with a choice of two tones and when ordered by the computer, presses down a pen to chart its progress and provide hard copy of the results of the program. When set free to run around the turtle discovers its enviroment. When the turtles shell bumps into an unmovable obstacle touch sensors send back data to the computer for it to calculate evasive or exploratory action.
If the computer has no I/O ports it doubtless has an expansion bus and the turtle can be controlled and listened to using this bus together with the universal computer Interface board. This board enables the turtle to be treated as a memory mapped I/O device.

COMPLETE "HEBOT II" KIT INCLUDING ALL HARDWARE, DOME, WHEELS etc. Cat. XR1020

$399 inc tax

Brand new

UNIVERSAL INTERFACE CARD KIT Cat. XR1022

$39.50

16 BIT COLOUR COMPUTER KIT

NEW

At last a high quality 16 BIT micro (mini?) Computer Kit is available in Australia. This extremely powerful machine is based on the Texas TMS9995 processor.
We simply do not have room to list all of the features of this machine. A few:

- High speed 24K byte extended basic interpreter
- 48 bit floating point gives 11 digit accuracy
- High resolution (256 x 192) colour graphics
- Screen memory does not use up user memory space
- 16 colours available on the screen together in Graphic mode
- Fast line drawing and point plotting basic commands
- High speed colour shape manipulation from basic
- Full textual error messages
- String and Array size limited only by memory size
- Real time clock included in basic
- Interval timing with 10mS resolution via TIC function
- Named load and save of basic or machine code programs
- Auto-run available for any program
- Powerful machine code monitor
- Assembler and Disassembler included as standard
- Auto line numbering facility
- Full renumber command
- Simple but powerful line editor
- Buffered I/O allows you to continue executing the program while still printing
- Flexible CALL statement allows linkage to machine code routines with up to 12 parameters
- Basic programs may contain spaces between key words to make programs readable without using more memory
- Over 34K bytes available for basic programs even when extended basic includes IF-THEN-ELSE
- Supports up to 16 output devices: Screen and cassette included as standard
- Supports bit manipulation of variables from basic
- Error trapping to a basic routine included
- Basic supports Hexadecimal numbers
- Includes UHF modulator, tape interface and power supply with extra capacity for extra interfaces

If you want to know more about this machine send SAE for more details.
(Disc drives NOT included)

COMPLETE KIT INCLUDING METALWORK
Cat. KJ3660
$1299

Low Cost **Super Value**

RS-232 INTERFACE
Cat. KJ6631
$49.50

FM Transmitter Module

NEW

We have been working on this one for years!!
Basically we wanted something akin to the $6.50 kit "wireless microphone" transmitter but with greater signal strength and far, far greater frequency stability.
WE NOW HAVE IT!
Basically the (potted) unit measures a small 90 x 22 x 15mm and has connections for power, antenna and input. An AC signal between 20 and 15kHz will modulate the transmitter. The signal can be coded single or multiple frequency tone bursts etc.

FEATURES

- Ultra low noise output (–60dB or better attainable with a suitable tuner)
- Excellent frequency stability
- Not a kit – ready for immediate use
- Connections required
  (a) Power supply or battery
  (b) Antenna
  (c) Audio input
- Full instructions supplied
- Suits any application where a stable low noise FM link is required

SPECIFICATIONS

- Frequency – 88 - 108MHz adjustable
- Useable range – 50 metres
- Supply – 6 to 9V at 20mA
- Input sensitivity – adjustable – maximum 30mV
- Pre-emphasis – 50μ/second standard
- Dimensions – 90 x 22 x 15mm (approx)

$49.95 Cat. DT5450

WIRELESS GUITAR LINK

Cat. AZ5010

SAVE $50

We have made a SCOOP PURCHASE of the MUSOLINK FM Wireless system.
The MUSOLINK enables a guitarist (for example) to operate live without trailing cables. This low cost system transmits a rock-steady signal to any commercial FM tuner. The signal is restricted to the largely unused low end of the 88 108MHz FM band. Many MUSOLINKS can be used in, say, 1MHz of FM band width as they have excellent frequency stability.
Normally this unit sells for $149 but we have bulk purchased and now pass on great savings!!

NOW $99 LIMITED STOCK
NEW LOW PRICE

BACK AGAIN! ULTRA VIOLET LAMPS $3.95

Ultra violet lamps – New "Mini Flood" design. Powerful 100 watt rating. Standard domestic bayonet fitting. Cat. SL2680

CMOS SENSATION

Huge scoop buy of the scarce 4026AE device means that you save!
For years the 4026 decade counter/7 segment decoder driver has been one of the most difficult parts to obtain. Jaycar has made a scoop purchase of this device in the "AE" form (we are not certain that it was ever made as a "B" suffix device). It has been largely replaced by the 4426 (which is not an exact equivalent). The 4426 sells for $2.20 and so to does the 4026 when it is available but for JULY only the 4026 price has been slashed. Cat. ZC4026. Prices INCLUDES sales tax.
1 – 9 $1.50 each   10 – 99 $1.25 each   100+ ONLY 99 cents each

SEE JAYCARS OTHER ADS FOR ADDRESS DETAILS

JAYCAR

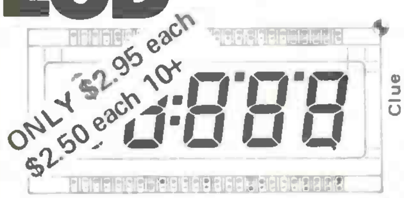
INTRIGUING

DISCO-STROBE LIGHT

A few left from our last shipment.
We have received our FINAL SHIPMENT of lowcost strobes. Unfortunately due to cost increases we have had to increase the price slightly. You must agree that the strobes still represent outstanding value for money. STILL almost HALF our competitors price! Remember these units are guaranteed for 3 months.
Quantities limited to 2 per customer
Cat. XM7005

ONLY $19.95

LCD



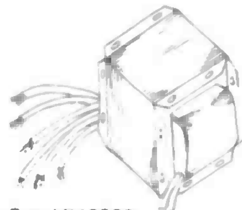
Clue
M-S-T-RM-N-D

We have done it again! Once again Jaycar has secured a quantity of valuable LCD displays. Once again we are passing them on to you at prices that will make our competition green with envy!
Basically we have a 5 digit x 18mm high (that's BIG) LCD display. But there is a snag, and here is where you save. Normally this display would sell for around $20 — if it had the connecting pins bonded to the glass substrate. But this display just has the metallization on the glass substrate. Too hard to connect you say? No, not at all!!!
We have discovered that a humble Molex pin is JUST PERFECT as a connector! You slip the Molex pin on to the edge and superglue it in place. You then have a permament connection, a great LCD display and have saved a fortune to boot! (Instructions for fitting the Molex pins as well as FULL DATA and connection diagrams on the LCD are supplied).
And what do you pay for this LCD display? **ONLY $2.95 each or $2.50 each 10 up.**
Staggering value. Cat. ZM9015
Pack of 50 Molex pins (only 42 required) Cat. PI6540 Only $1.00

We now stock a COMPLETE range of high efficiency Silicon Solar Cells. All cells give 0.45V under rated load and they can be stacked in series or in parallel for higher current.

Cat. No	Description	1-9	10+
ZM9002	Rect. 10x20mm 45mA	$2.45	$1.95
ZM9003	3" diameter 1 amp	$26.50	$22.50
ZM9004	3" diameter x 30° segment 78mA	$3.25	$2.95
ZM9005	4" diameter x ¼ segment 450mA	$12.45	$11.95

COMPUTER TRANSFORMER BARGAIN



Cat. MM2020

$24.50

SAVE $5.00
WAS $29.50

We have secured a quantity of a power transformer at a never-to-be-repeated price. This unit is ideal as the basis of an S-100 power supply, but can be used for many other computer or general power supplies.
SPECS: Primary 240V AC — Secondary 1: 15VAC 2 amp — Secondary 2: 15VAC 2 amp — Secondary 3: 8VAC 8 amp.
A typical DC supply could be ±15V DC @ 1.5A & 5V DC @ 8 A or ±12V DC @ 2A & 5V DC @ 8A. This transformer would normally sell for around $50 — Brand new stock.

JAYCAR

SEE THE OTHER JAYCAR ADS IN THIS MAGAZINE FOR OUR STORE ADDRESSES AND PHONE NUMBERS. . . .

codemaster*

$9.95

WAS $12.50

Many of you know the clever parlour game that uses coloured tokens to stretch the brain to work out a hidden code in a minimum number of moves.
The people that came up with the game used a descriptive name which no-one else can use. It is a popular game and is well known under this name. Our game is similar to this game but - naturally - its electronic!! And, what's more, you can play against the machine - alone. Each XM7015 Codemaster measures 140(l)x85(w)x25(d) looks similar to a pocket calculator and runs off a standard 9V cell. Provision is made for a mains adaptor as well.
The Codemaster once sold for $29.50 but Jaycar has made a huge scoop purchase. You save a fortune!
Grab one now for only $~~12.50~~!! $9.95
* (For a further clue to the origin of this game read this page carefully)

MICRO CHARTS

NOW ONLY $9.95 SAVE $3.00!!

Instant Data on the Most Popular Computer and Microprocessor Parts

- Fully decoded data — no need to unscramble numbers
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- Perfect for programmers and engineers — two sided and totally comprehensive
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Cat. BM8500 Z80 CPU
Cat. BM8501 8080A/8085A
Cat. BM8502 6502(65XX)

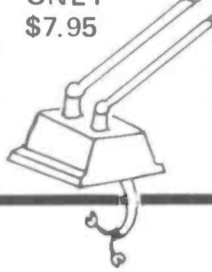
2SC2545

2SC2545. The low noise transistor for pre-amps! (See EA April 1983) Jaycar has them! Only $1.95 Cat. ZT2400

Are the "rabbit ear" antennas on the back of your portable TV broken? You know those ones that are telescopic and have ball-swivel joints.
We have genuine 'HMV' factory spares that will fit other TV's Apparently they are almost industry-standard components.
Each unit comes with a short length of lug-terminated 300 ohm ribbon.
We have a small job lot available at only $7.95 each.
ONLY 220 SETS AVAILABLE.
Cat. AA2005 $7.95

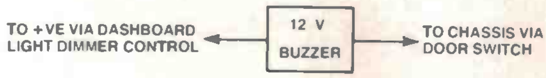
ONLY $7.95

WHAT'S UP DOC?



IDEA OF THE MONTH

☆IDEA OF THE MONTH☆



Parking light reminder

Stephen Mann, Forrestfield WA

There are many different circuits around for devices to remind you to switch your parking lights off. However, this idea must surely be one of the simplest and the cheapest.

The buzzer requires only two connections to the vehicle; one to a door courtesy light switch and the other to the positive battery terminal via the dashboard light dimmer control.

It's very simple to operate. The buzzer will sound when the parking lights are on and you open the car door. This warns you to turn the parking lights off.

An added feature of this circuit is that if you need to have the parking lights on and the door open, you can silence the buzzer by operating the dashboard dimmer control.

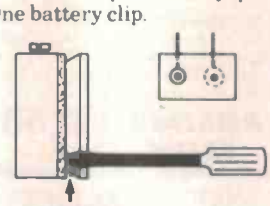
261 transistor battery clip

Darryl Green of Elanora Qld. is another enterprising experimenter.

I was breadboarding a small circuit requiring an op amp and ±9 V rails and found that I only had one 216 9 V battery clip.

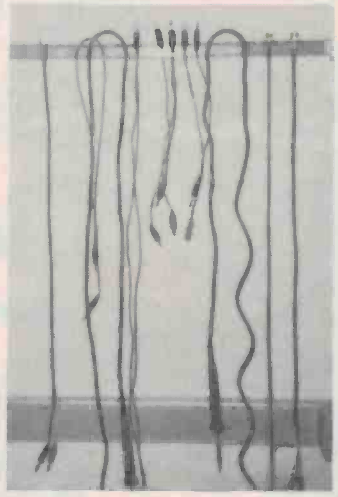
But I did have an old 216 battery and discovered that by prising the metal case open I could remove the top plate with the clips mounted on it.

I then soldered wires on to the back of the plate, taking care not to melt the plastic. Hey presto! One battery clip.



PRISE OPEN

Simple holder for leads, probes etc



If you want to have a tide electronic workshop this low cost lead holder should help.

H.F. Nissink of Launceston Tasmania sent in the idea which makes it easy to store test leads, BNC to BNC connectors and test probes etc.

Slotted cable is readily available through electrical suppliers at a fairly cheap rate. This cable ducting, cut to the required length and bolted to the wall, works well as a lead storage rack.

The slot size is ideal for electronic type leads. As well, the cable ducting may be cut along its length through the centre of the slots with the base of the U-shape bolted onto the wall as shown.

Matchbox cabinet for small components

Chris Nixon of Bentley WA has found a use for empty matchboxes.

A simple but effective method of storage for smaller components e.g: resistors, capacitors, transistors etc. is to glue matchboxes together to form a miniature cabinet. On the opening end of each matchbox write the values and abbreviated names of the components contained in the 'drawers'.

'IDEA OF THE MONTH' CONTEST

PRIZE WORTH $90!

COUPON

Cut out and send to: Scope/ETI 'Idea of the Month' Contest, ETI Magazine, 140 Joynton Ave, Waterloo NSW 2017.

"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 ......

Scope Panavise Multi-purpose Work Centre.

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 Multi-purpose Work Centre, Model 376/300/312, comprising a self-centering head (376), standard base (300) and tray base mount (312), all worth about $90! Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, 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, Federal Publishing Company Proprietry Limited, ESN, The Litho Centre 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.

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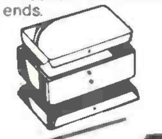

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Application data for the nine to five engineer . . . and the weekend professional.
The book you've always needed, a 'one source' reference for the common devices often used. It contains data on hundreds of semi-conductor devices - descrete, linear, TTL, CMOS, etc the types of components used extensively in Australia, particularly by the Australian Electronics magazines. Cat. B-4200

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EVERY OHM NEEDS ONE!

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Reliable iron for general service or production area and ideal for the hobbyist. High impact plastic handle, complete with Triclad 3mm long life tip. Cat. T-1820
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Styli to suit

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YES!!!

We now stock the incredible new COMMODORE 64 Computer
Call in today for a free test drive . . .

DICK SMITH

NEW 'PHONY PATCH'

Landline Interface

As seen in the May Issue of Electronics Today. Get ready for Phone Patching when it's made legal – this great little kit is ideal for connecting a four wire (eg transmitter/receiver) system to a two wire (eg phone lines or intercoms, etc). You could even set your transmitter up for complete remote operation using VOX.

UNIQUE IN AUSTRALIA!

Cat. K-3054

$59.50

Bargain Grab Bag

Wow! Up to $30 worth – and more. Mainly components from end of runs in our kit department; also includes things like 40 channel CB switches, various pcb's, rubber feet, etc etc. Fantastic bits'n'pieces for the hobbyist's junk box.

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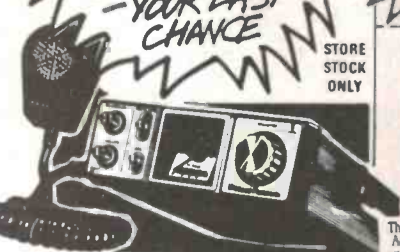
HURRY! ATARI CARTRIDGES AT LOW PRICES – YOUR LAST CHANCE

STORE STOCK ONLY



EXPERIMENTERS TRANSCEIVER

Here's one for all the amateurs, servicemen, technicians etc. Famous National brand 9 channel 27MHz CB, ideal for conversion to 10 meters, use as spare parts, experiment with etc. We over-bought on this model and we MUST reduce stocks – our loss is your gain. Take advantage of our mistake and save a fortune! Cat. D-2500

HURRY! STRICTLY LIMITED STOCK

Now sacrificed at only **$49.95** — WAS ~~$169~~

The last Great Aviation Adventure

A special souvenir edition of Dick Smith's solo round-the-world helicopter flight, with pictures, maps, flight details etc. of this historic & record-breaking flight. Cat. B-9100

ONLY **$1.50**

Dick Smith Flight Cap

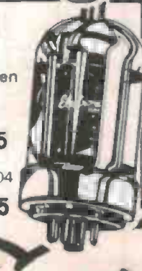
$3.50 Cat. Y-1000

Transmitting Valves

Replacements for when yours stop working.

6146B.... Cat. D-7202 **$19.95**

6SJ6C .... Cat. D-7204 **$14.95**



JOYSTICK INTERFACE KIT

Calling all System 80 owners: isn't it a pain in the neck using the arrow keys to play games? Wouldn't you rather use a Joystick control? Cat. K-3455

Here's your chance! This kit allows you to add a joystick to your System 80 via the printer port – and here's the good news: This month only we're GIVING A FREE 'QUICKSHOT' JOYSTICK with each Interface kit! That's right, save an amazing *$24.95* – this month only!

OVER $62.00 WORTH FOR JUST **$37.50**

QUICK SHOT JOYSTICK

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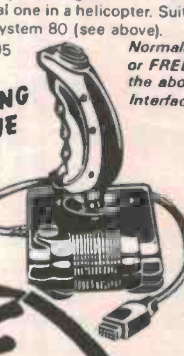
Features:
Contour grip, rubber suction cups to hold it down during those tight movements. It's just like the real one in a helicopter. Suit VIC and Atari, or System 80 (see above).

Cat. Y-1495 — *Normally $24.95 or FREE with the above Interface Kit.*

AMAZING VALUE



NOISE PROBLEM? BEAT IT WITH THESE SUPPRESSORS

Inline Distributor Suppressor
Connect anywhere in lead to eliminate or reduce distributor noise. Cat. A-7904 **55¢**

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Heavy duty 0.5uF-100 volt capacitor. Cat. A-7902 **80¢**

Alternator Noise Suppressor
A capacitor type suppressor with three leads. Reduces or eliminates the whine. Cat. A-7924 **$2.80**

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A coil type filter wound on a high density ferrite core. Cat. A-7926 **$11.95**

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Heavy duty 0.5uF 50 volt coaxial capacitor for extreme cases of alternator whine. Will handle 60 amps. Cat. A-7928 **$5.50**

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Cat K-3520

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All Dick Smith Stores are open for trading during the normal trading hours for their particular area (either 9-5.30 or 8.30-5). Many stores are also open for late night trading. Please ring the store concerned for their particular hours.

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Dear Customers,

Quite often, the products we advertise are so popular they run out within a few days. Or unforseen circumstances might hold up shipments so that advertised lines are not in the stores by the time the advert appears. And very occasionally, an error might slip through our checks and appear in the advert (after all, we're human too!). Please don't blame the store manager of staff; they cannot solve a dock strike on the other side of the world, or fix an error that's appeared in print. If you're about to drive across town to pick up an advertised line, why not play it safe and give the store a call first......just in case.

Thanks,

Dick Smith and Staff

Marconi Radio Society re-launches historic callsign

The callsign used to introduce Britain's first scheduled radio entertainment broadcast, 2MT, will be heard on the amateur bands later this year after a 60-year break in transmission.

British Home Office approval has been granted for the use of the callsign G2MT by the Marconi Radio Society, a group formed recently by amateur radio enthusiasts employed at the Stanmore (UK) headquarters of Marconi Space & Defence Systems Ltd and at other company sites in the locality.

The callsign will be used at Stanmore for the first time at 1200 hours BST on Saturday 2nd July 1983 using equipment owned and operated by members.

The frequencies used will depend on the prevailing propagation conditions but it is hoped to organise contacts with amateur radio clubs affiliated to the BBC and with similar groups within the GEC-Marconi organisation.

The founding of the Marconi Radio Society and its authorisation to use the historic callsign G2MT during 'World Communications Year' has been given wholehearted support by Marconi Space & Defence Systems Limited.

As well as enjoying the use of the company's facilities at Stanmore, the Society's Patron is General Sir Harry Tuzo and its President Dr. W. Bardo, Chairman and Technical Director respectively of MSDS.

Marconi's Wireless Telegraph Company Limited was first granted an experimental licence in the summer of 1920 to use the callsign to introduce news bulletins.

This permission did not apparently extend to music, even in the accompanying role, and the licence was swiftly revoked following the broadcast of 'dramma per musica' by a Danish tenor.

Following representations to the then Postmaster General by the Wireless Society of London (now the Radio Society of Great Britain), the company was later authorised to recommence transmissions.

And so, the first scheduled entertainment broadcast in the UK was transmitted on 700 metres from Writtle, near Chelmsford, on 14th February 1922 under the callsign 2MT ('Two-Emma-Tock'). The 'G' (for England) has now been added to accord with current practice.

The licence restricted broadcasting to half an hour each Tuesday evening and the station was required to cease transmitting for three minutes in every ten. These frequent intervals were spent in checking to hear whether any complaints had been received.

The broadcasts provided amateurs with invaluable checking references and their content set the pattern for later public broadcasting programmes; for example, the first radio play was produced (Cyrano de Bergerac) and a rudimentary 'Children's Hour' was evolved before transmissions ceased in January 1923.

Synthesised HF transceiver from JRC

The compact JST-100 HF transceiver employs an 8-bit microprocessor to control all the complicated functions such as band and mode selection and memory channel access.

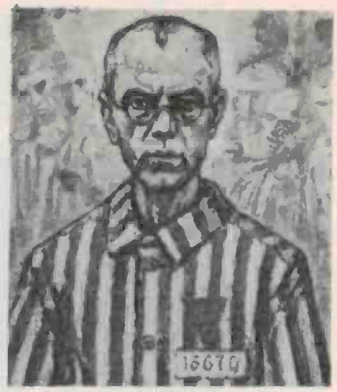
The 11-channel memory can easily store and recall not only VFO frequencies but also working frequency bands and modes.

The JST-100 is fully equipped with capabilities such as three PLL circuits phase-locked with a highly stable 10 MHz standard crystal oscillator; two digital VFOs permitting independent selection of bands and modes, and memory finder capability to recall any stored frequency with the working VFO being held.

Features available include: fully digital 10 Hz-step synthesiser; digital two-VFO system; 11-channel memory; memory finder capability; easy tuning with main dial and up-down buttons; easy-to-operate panel design; receiver input circuit of narrow BPF type; large multi-function display; remote control of frequencies and modes; overmodulation indication; unique ALC input; frequency data output.

Options include a power supply, antenna tuner, speaker, desk microphone, hand microphone and key.

Further details about this exciting rig are available from **Vicom, 57 City Rd, South Melbourne Vic. 3205.** Brances in Sydney, NSW and Lower Hutt, N.Z.



Radio amateur canonised

The first licensed radio amateur to become a saint is Father Maximilian Kolbe, SP3RN, who died at the infamous Auschwitz death camp on 14 August 1941.

Fr Kolbe spent several years as a missionary before starting his amateur radio activities in 1938. He was arrested by the Gestapo in 1939 and sent to Auschwitz, near his home parish of Krakow.

In 1941, when one of his fellow prisoners, who was the head of a large family, was selected for death, Fr Kolbe volunteered to go in his place. He was executed on 14 August that year.

Fr Kolbe was posthumously awarded the highest Polish military medal, the Virtuti Militarta Golden Cross. Pope John Paul canonised Fr Kolbe as a saint on 10 October 1982, thus making him the first licensed radio amateur to become a saint.

(tnx Radio Comm.)

Delsound get A.E.A.

Melbourne-based Antenna Engineering Australia Pty Ltd has announced the appointment of Delsound Pty Ltd as distributor of A.E.A. products in Queensland.

Delsound will hold stocks of A.E.A. antennas and clamps, etc. Contact at **Delsound** is Bud Pouncett. Phone Brisbane **229-6155**, or call at **1 Wickham Terrace, Brisbane.**

Latest Bearcat slashes the price of scanning

The Bearcat 200FB offers a great deal to the fledgling scanning enthusiast for $349. Here's a quick review of this recently released rig.

Available through Dick Smith stores, this latest Bearcat features a 16-channel memory (with battery back-up), auto or manual search over three bands (66-88 MHz, 138-174 MHz, 407-512 MHz), direct channel access, automatic channel lockout and priority functions plus patented selective scan delay so you don't miss the reply on two-way conversations.

The rig can be operated direct from the vehicle battery, or from the mains using a commonly available plugpack. It comes complete with its own telescopic antenna, which suits desk-top operation of the unit, and an external antenna socket so you can really 'pull in' those signals from an outside antenna.

We jumped at the opportunity to review one of these rigs and here's what we found.

The Bearcat 200FB is a compact plastic-cased rig, measuring just 235 mm wide by 220 mm deep by 70 mm high. A 'porch' at the front contains the controls and a sloping panel from the top to the porch contains the 9-digit fluorescent display.

The volume and squelch knobs at the left are well-designed, just right for thumb-and-forefinger operation. The programming keyboard occupies most of the right hand side of the porch. It employs sensor-touch operation and the loudspeaker 'bips' when you press the keys.

Internally, it appears a well-constructed unit, all the electronics being on a single printed circuit board.

On the air, the unit proved to be very sensitive, easily pulling in signals from base stations 50 km away on just its own telescopic whip. Programming it is a breeze.

The handbook that comes with it is clearly written, well set out and easy to use.

The display is a little hard to see with light directly falling on it, but if you locate the unit away from direct light, there's no problem. In any case, the same goes for many other scanners we've seen.

The handbook warns of 'birdies' — spurious signals, generated within the receiver, and conveniently lists them, thus enabling you to avoid them. We had a look at them and looked up our frequency table and think they should not be troublesome.

Basically, the Bearcat 200FB is a delight to use, offers many useful features and is worthy of serious consideration if you're looking for a scanner and don't want to pay 'big bucks'.

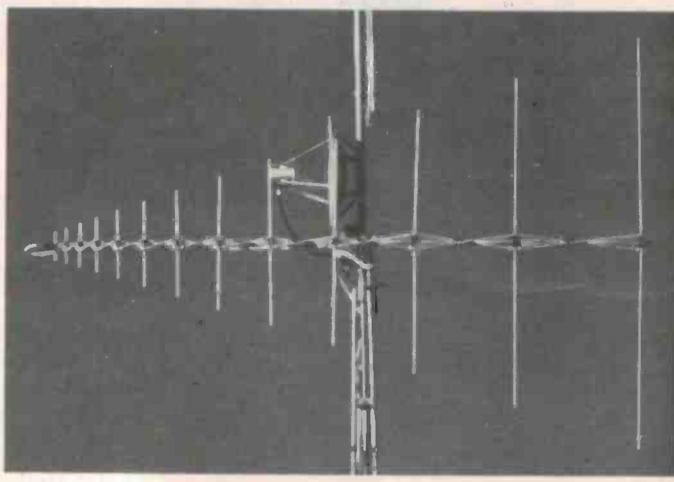
Dream Machine

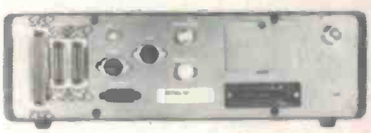
This rig must surely rate as every scanning enthusiast's 'dream machine'. It's just about got everything that opens and shuts.

The J.I.L. SX-400 scanning receiver offers continuous coverage from 26 MHz to 520 MHz in 12 bands. AM and FM detection, two scan rates (4 & 8 ch/sec), 20 memory channels and an IEEE standard interface buss.

An optional-extra converter can extend this coverage to 800 MHz in 480 channels and an extra 12 spot frequencies can be received up to 3.7 GHz! A demodulator for multiplex transmission is also available.

Definitely for the scanner who must hear everything! Further details available from the Australian agents, **GFS Electronic Imports, 15 McKeon Rd, Mitcham Vic. 3132. (03)873-3939.**





New high gain directional antennas

GFS Electronic Imports of Mitcham, Victoria, recently announced the release of two high gain broadband directional antennas designed for use in a wide variety of VHF/UHF applications.

Particularly suited for scanning receiver use, both models provide excellent performance in fringe areas when compared with a standard discone (such as the Scan-X).

Known as the LOG-S and the LOG-SP, the new antennas are of the log periodic type. The Model LOG-S has nine elements with a claimed gain of 9½ (9 dBi) and a bandwidth from 100 to 520 MHz. Boom length is 1.02 metres.

The LOG-SP has a bandwidth from 65 to 520 MHz, comprises 13 elements and features a claimed gain of 10½ (11.5 dBi). Its boom length is just over 3 m.

Both antennas are also quite suited to transmission applications over their designed bandwidth. Maximum input power handling is given as 200 watts.

The LOG-S and LOG-SP are both available exclusively through GFS Electronic Imports or any of their agents. Price of the LOG-S is $89 plus $10 freight, and the LOG-SP is $125 plus $10 freight.

For further information, contact **GFS Electronic Imports, 15 McKeon Rd, Mitcham Vic. 3132. (03)873-3939.**

INTERESTING MARITIME CHANNELS

Here is a short list of interesting maritime channels for scanning enthusiasts in Sydney and Melbourne. The shore stations are located near the harbourside so you need to be in close range to get good reception or at a high location if you're some distance away from the harbour in either city.

Sydney		
156.375 MHz	FM	Navigation warning
156.525	FM	Maritime search & rescue State
156.650	FM	Maritime Services Board
156.800	FM	Weather
454.000	FM	State Maritime Services Board
454.275	FM	State Maritime Services Board
Melbourne		
156.400 MHz	FM	Harbour control
156.550	FM	Harbour control
156.600	FM	Harbour control
156.700	FM	Harbour control
498.650	FM	Sea pilots
493.475	FM	Sea pilots

We would welcome more contributions to this column, particularly from the other states. Send your contributions to: **The Editor, 'Scanners' World', ETI Magazine, PO Box 21, Waterloo NSW 2017.**

The scanner's manual

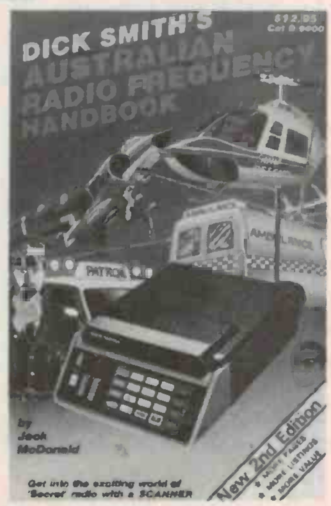
Dick Smith's Australian Radio Frequency Handbook, 2nd Edition, must surely be the 'text' every scanner should have.

Written by scanner 'expert', Jack McDonald, this 170-page-plus book contains a wealth of information on scanning, including a detailed table of frequencies and services you'll find on the VHF and UHF bands.

There are 15 short chapters at the start of the book that explain, in simple language, all the basics you need to know to get into scanning.

The book shows you how to build yourself a simple antenna, how to install a scanner in a car and how to interpret the various codes you hear used on the air.

The book costs $12.95 and is listed as catalogue No. B-9600.



Enquire at any Dick Smith store or **Dick Smith Electronics, P.O. Box 321, North Ryde NSW 2113.**

SHOPAROUND

This page is to assist readers in the continual search for components, kits, printed circuit boards and other parts for ETI projects and circuits. If you are looking for a particular item or project and it is not mentioned here, check with our advertisers.

The mighty monitor! The Micron 300 mm (12") green screen monitor must offer just about the best value for money you can get in a computer monitor. Whilst it does feature 10 Hz to 20 MHz bandwidth and high resolution, like many others you see around, it has the unique feature of 'reverse picture' capability. By simply turning up the brightness and turning back the contrast — presto, instant black-on-white!

The display area will show 24 lines of 80 characters and the resolution is claimed to be 800 lines at the centre. It takes composite video input (neg. sync.), 70 ohms terminated, 10k unterminated. It has a full complement of trace geometry controls and an auxiliary unfiltered rectified output that can deliver 12 Vdc. (That could be handy!).

The review model was delivered by Jaycar and we couldn't wait to fire it up on the lab MicroBee. Needless to say, it performed very well indeed. In fact, we could hardly believe the 'Bee's VDU output was so good!

Enquiries for the Micron green screen monitor should be directed to **Jaycar** in Sydney or **Altronics** in Perth.

ETI-464 general purpose IC audio amplifier

This project will doubtless be widely stocked as a kit. At the time of going to press, the following firms indicated they'd be stocking kits: **Altronics** in Perth, **Dick Smith Electronics** stores everywhere, **Electronic Agencies** in Sydney and **Rod Irving Electronics** in Melbourne. You might also try **All Electronic Components** in Melbourne.

Almost any electronics component supplier will stock the uA380 or LM380 IC and pc boards will be stocked by the suppliers listed at the end of this column.

If you want a negative or positive transparency to make your own pc board, one can be obtained for $1.50 post paid from: ETI-464 Artwork, ETI Magazine, P.O. Box 21, Waterloo NSW 2017. Make cheques payable to 'ETI Artwork Sales' and ensure you ask for a positive or negative, according to what you need.

ETI-465 loudhailer

As this uses the ETI-464 module, the above item applies. If you want to use the sensitive and efficient Benelec 8-224 horn recommended in the article, we know that at least **Electronic Agencies** in Sydney will be stocking it. In Melbourne, ask for it at **Rod Irving Electronics** or **All Electronic Components.**

Kits in one form or another will be stocked by **Dick Smith** stores, **Electronic Agencies** in Sydney, **Rod Irving Electronics** in Melbourne and possibly **Altronics** in Perth and **All Electronic Components** in Melbourne.

Batteries and battery holders to suit this project are widely stocked in electronics stores. The ABS plastic water pipe and caps can be obtained from most hardware stores.

ETI-1520 wideband amp

This useful little project will become the output stage of our upcoming lab. standard function and pulse generator. However, it has many other uses, as suggested in the article.

At this stage, we have no indication of who'll be stocking kits, but **Rod Irving Electronics** is probably a good place to start.

Parts shouldn't be too difficult to obtain. The CA3100 wideband op-amp, which forms the heart of the unit, is distributed by **AWA Microelectronics** in Sydney (02)638-9022. **Radio Despatch** and **Jaycar** in Sydney stock the device and possibly **Rod Irving Electronics** in Melbourne.

The 2N3866 and 2N2905A complementary high speed output devices are widely stocked. The Thermalloy slip-on heatsinks we used on these transistors in the prototype, part no. 2228B, are distributed by Soanar Electronics.

Printed circuit boards will be available from the suppliers listed at the end of this column.

For those of you making your own pc board, a same-size positive or negative transparency can be obtained for $2.85 post paid from: ETI-1520 Artwork, ETI Magazine, P.O. Box 21, Waterloo NSW 2017. Make cheques payable to 'ETI Artwork Sales' and ensure you ask for a positive or negative, as you want.

ETI-265 'power down' timer

There's nothing in the way of 'special' components used in this project, so you should have little difficulty getting the parts together. We understand kits will be stocked by **Jaycar** in Sydney, **Altronics** in Perth and **Rod Irving Electronics** in Melbourne. **All Electronic Components** in Melbourne may also stock kits.

The Unibox case we used for our prototype (P/N 144) is stocked by **Magraths** in Melbourne but a wide variety of cases may be used — even the ubiquitous jiffy box! **Jaycar** stock a new range of smart all-plastic ABS cases, of which the HB6150, 1, 2, 3 series (orange, grey, blue, black) would suit.

Printed circuit boards will be available from the suppliers listed at the end of this column. If you're making your own board and want a positive or negative same-size transparency, one can be obtained for $1.85 post paid from ETI-265 Artwork, ETI Magazine, P.O. Box 21, Waterloo NSW 2017. Make cheques or money orders payable to 'ETI Artwork Sales' and ensure you ask for a positive or negative, as you want.

Printed circuit board and panel suppliers

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

All Electronic Components
118 Lonsdale St
Melbourne Vic. 3000

RCS Radio
651 Forest Rd
Bexley NSW 2207

Panels, meter scales and dial faces for almost every ETI project published may also be obtained from the above two firms.

For pc boards produced over the last three to five years, the following suppliers generally keep stocks on hand:

Electronic Agencies
115-117 Parramatta Rd
Concord NSW 2137
and
117 York St
Sydney NSW 2000

Radio Despatch Service
869 George St
Sydney NSW 2000

Rod Irving Electronics
425 High St
Northcote Vic. 3070

James Phototronics
522 Grange Rd
Fulham Gardens SA 5024

Jemal Products
P.O. Box 168
Victoria Park WA 6100

Jaetronics
58 Appian Drive
St Albans Vic. 3021

Sunbury Printed Circuits
Lot 14, Factory 3
McDougall Rd
Sunbury Vic. 3429

Billco Electronics
Shop 2, 31 Pultney St
Dandenong Vic. 3175

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

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electronics textbooks

ELECTRONICS — IT'S EASY VOL. 1 **$5.95**
Meters, resistance, capacitance and inductance, emitter followers, op amps, power supplies and electronic filters.

ELECTRONICS — IT'S EASY VOL. 1 **$12.95**
Same content in a hard-cover form.

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Digital sub-systems counters and shift registers, A-D and D-A conversion, digital instruments and test equipment, computers, transmission links and oscilloscopes.

ELECTRONICS — IT'S EASY VOL. 2 **$12.95**
Same content in a hard-cover form.

ELEMENTS OF ELECTRONICS
This series is an introduction to modem electronics. All the maths is taught as the reader progresses. The course concentrates on the understanding of concepts central to electronics, rather than digressing over the whole field. The author anticipates where difficulties lie and guides the reader through them.

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All fundamental theory necessary to full understanding of simple electronic circuits and components.

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BOOK 4
BP77 **$9.76**
Microprocessing systems and circuits.

BOOK 5
BP89 **$9.76**
Communications.

BASIC ELECTRICITY/ELECTRONICS VOL 1
21501P **$13.25**
First volume of five volume set provides thorough theoretical and practical background to the overall subject of electricity and electronics.

BASIC ELECTRICITY/ELECTRONICS VOL 2
21502P **$14.95**
Volume 2 in this series builds on the basic information in Volume 1 by giving detailed information on AC and DC circuits — covering series and parallel circuits, electromagnetism, resistance, capacitors and inductance plus associated calculations.

BASIC ELECTRICITY/ELECTRONICS VOL 3
21503P **$14.95**
This, the third volume in this series, introduces valves and transistors — from an introduction to vacuum tube through multi-element tubes, semiconductor devices, power supplies, amplifiers, oscillators, pulse circuits — to special semiconductor devices.

BASIC ELECTRICITY/ELECTRONICS VOL 4
21504P **$14.75**
Volume 4 covers construction, operation and usage of electronic test instruments. Included are analogue and digital multimeters, vacuum-tube voltmeters, oscilloscopes, tube and transistor testers, bridge instruments and signal generators.

BASIC ELECTRICITY/ELECTRONICS VOL 5
21505P **$9.95**
The last volume in this series explains the principles of motors and generators. Devices covered include AC and DC motors and generators, three-phase systems and power converters. The final chapter covers servo control systems.

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
228B **$4.32**
This book supplies the electronics hobbyist with the background knowledge which will exactly suit their specific requirements. Minimum maths.

BEGINNER'S GUIDE TO DIGITAL ELECTRONICS
BP61 **$3.36**
Covers all essential areas including number systems, codes, constructional and sequential logic, analogue/digital/analogue conversion.

A MICROPROCESSOR PRIMER
BP72 **$5.92**
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

reference and data handbooks

AUDIO CYCLOPEDIA
20675P **$66.00**
A complete, in-depth look at the art of audio — from the basic principles of sound to solid-state and integrated circuits. Over 3000 entries and hundreds of illustrations and circuit diagrams cover acoustics, amplifiers, recording, reproduction, test equipment, audio measurements, and much more.

REFERENCE DATA FOR RADIO ENGINEERS
21218P **$54.50**
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TUBE SUBSTITUTION HANDBOOK
21746P **$8.75**
Complete, accurate, up-to-date guide to direct substitutes for receiving and picture tubes. Contains over 6000 receiving tube substitutes, over 4000 monochrome and colour picture tube substitutes, and 600 communications substitutes. Also includes pinouts for quick operational checks.

CONTEMPORARY MATHEMATICS FOR ELECTRONICS
70274P **$29.75**
This book is split into three sections. Direct current maths introduces the student to the calculator, fractions and dimensional analysis. Alternating current maths covers phasors, quadratics and RMS in both sine and digital waveforms. Active device maths introduces number systems and boolean.

HANDBOOK OF RADIO, TV, INDUSTRIAL & TRANSMITTING TUBE & VALVE EQUIVALENTS
BP2 **$2.25**
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.

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
BP7 **$1.60**
This large wall chart covers all colour codes in use throughout the world. For all radio and electronic components made in UK, USA, Europe and Japan.

THE CP/M HANDBOOK WITH MP/M
88048A **$19.95**
Shows you how to use CP/M (control program for microprocessors) and its resources. No prior knowledge of computers is assumed. CP/M is available on nearly all computers using the 8080, 8085 or Z80 microprocessors.

FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
BP1 **$3.36**
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in UK, Japan, USA, Germany, France, Europe, Hong Kong and includes types produced by more than 120 different manufacturers.

SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
BP14 **$5.92**
Interchangeability data covers semiconductors manufactured all over the world. Immediate equivalents are shown and possible substitutes are included.

GIANT CHART — RADIO, ELECTRONICS, SEMI-CONDUCTORS & LOGIC SYMBOLS
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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!

RESISTOR SELECTION HANDBOOK
BP28 **$2.24**
Shows how to combine two preferred values of resistor to obtain virtually any required value of resistance. Includes information about fixed resistors, standard ranges, colour codes and markings, power ratings and resistor calculations.

ELECTRONIC CALCULATOR USERS' HANDBOOK
BP33 **$5.12**
Presents formulae, data, methods of calculation, conversion factors, etc. for use with the simplest or most sophisticated calculators. Includes the way to calculate using only a simple four-function calculator: trigonometric functions, hyperbolic functions, logarithms, square roots and powers.

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PRACTICAL ELECTRONIC CALCULATIONS & FORMULAE
BP53 **$9.76**
For the practical person's workbench. Bridges gap between technical theory and cut-and-dried methods which work but leave the experimenter unfulfilled. There's a strong practical bias. Tedious and higher maths avoided where possible.

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
BP85 **$9.76**
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.

HOW TO IDENTIFY UNMARKED ICS
BP101 **$2.46**
This chart shows the reader how, with just a test-meter, to go about recording the particular 'signature' of an unmarked IC which should enable the IC to be identified with reference to manufacturers or other data.

electronics for beginners

BEGINNERS HANDBOOK OF IC PROJECTS
74286P **$19.25**
The novice is guided in mastering the fundamentals of building, troubleshooting and testing electronic projects. In addition to many elementary projects, more advanced ones are included concerning bipolar integrated circuits and medium and large-scale integrated circuits.

HI-FI LOUDSPEAKER ENCLOSURES
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Data for building corner reflex, bass reflex, exponential horn, folded horn, tuned port, Klipschorn labyrinth, tuned column, loaded port and multi speaker panoramics. Clear dimensioned diagrams included.

SOLID STATE NOVELTY PROJECTS
219B **$3.04**
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.

SOLID STATE SHORTWAVE RECEIVERS FOR BEGINNERS
222B **$4.32**
Design and construction of several solid-state shortwave receivers giving high level of performance yet utilising relatively few inexpensive components.

BEGINNERS' GUIDE TO BUILDING ELECTRONIC PROJECTS
227B **$5.12**
Enables total beginners to tackle electronic projects. Includes component identification, tools, soldering, building methods, cases, legends, etc, etc. Practical basic projects are included.

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
228B **$4.32**
This book supplies the electronics hobbyist with the background knowledge which will exactly suit their specific requirements. Minimum maths.

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
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This large wall chart covers all colour codes in use throughout the world. For all radio and electronic components made in UK, USA, Europe and Japan.

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Shows how to combine two preferred values of resistor to obtain virtually any required value of resistance. Includes information about fixed resistors, standard ranges, colour codes and markings, power ratings and resistor calculations.

HOW TO BUILD YOUR OWN METAL AND TREASURE LOCATORS
BP32 **$5.92**
Electronic and practical details on the simple and inexpensive construction of heterodyne metal locators.

ELECTRONIC PROJECTS FOR BEGINNERS
BP48 **$4.64**
This book gives the newcomer to electronics a wide range of easily built projects. Actual components and wiring layouts aid the beginner. Some of the projects may be built without using soldering techniques.

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A collection of the most popular types of circuits and projects to interest most electronics constructors. The projects cover a wide range and are divided into four basic types: radio, audio, household and test equipment.

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Covers all essential areas including number systems, codes, constructional and sequential logic, analogue/digital/analogue conversion.

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BP69 **$5.92**
How to build many interesting electronic games using modern ICs. Covers both simple and complex circuits for beginner and advanced builder alike.

RADIO CONTROL FOR BEGINNERS
BP79 **$5.92**
How complete systems work with constructional details of solid state transmitters and receivers. Also included — antennas, field strength meter, crystal controlled superhet, electro-mechanical controls. Section dealing with licensing etc. not applicable to Australia.

EASY ELECTRONICS-CRYSTAL SET CONSTRUCTION
BP92 **$6.56**
For those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. The circuits are based on those from earlier publications but have been modified to use modern inexpensive components and home wound coils.

IC PROJECTS FOR BEGINNERS
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Especially written for the less experienced hobbyist, and offers a range of fairly simple projects based around a number of popular and inexpensive linear and digital ICs. Complete layout and point-to-point wiring diagrams included.

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Meters, resistance, capacitance and inductance, emitter followers, op amps, power supplies and electronic filters.

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Fifty projects ranging from very simple ones for complete beginners to more elaborate ones for those with more experience. There's a complete guide to soldering and instructions on how to make your own pc boards.

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Alien invaders, electronic die, sound effects, two slot car controllers, electronic poker machine, the family ferry and lots more.

HOW TO BUILD GOLD AND TREASURE DETECTORS **$3.95**
Tells you how metal detectors work and how to construct the different types of detectors: discriminating, BFO, induction balance and a professional deep-seeking unit. How to build a geiger counter.

constructional projects general

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Essential for keen hi-fi and audio enthusiasts. Projects include stereo decoder, three-channel mixer, FET preamp for ceramic pick-ups, mic preamp with adj. bass, stereo dynamic noise limiter, loudspeaker protector, voice-operated relay, etc.

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Some circuits are new, others are familiar designs. Projects can be split and/or combined for specialised needs.

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Many interesting and useful projects — multivibrators, amplifiers and oscillators; trigger devices; special devices.

MAJOR SOLID STATE AUDIO HI-FI PROJECTS
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Three projects for the more experienced constructor: 12.5 W/ch stereo amplifier, eight input stereo/mono mixer and 4x14 W quadraphonic amplifier. Full constructional details provided.

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BP32 **$5.92**
Electronic and practical details on the simple and inexpensive construction of heterodyne metal locators.

HOW TO MAKE WALKIE-TALKIES
BP43 **$5.12**
This treatise on low power transmitter-receivers (walkie-talkies) covers many aspects from licensing requirements and bands, through practical circuitry and construction to the various types of aerials that may be used.

PROJECTS IN OPTO-ELECTRONICS
BP45 **$5.92**
Included are simple circuits using ordinary LEDs as well as more sophisticated designs such as infra red transmitters and detectors, modulated light transmission and also photographic projects etc.

POPULAR ELECTRONIC PROJECTS
BP49 **$4.96**
Includes a collection of the most popular types of circuits and projects which cover radio, audio, household projects and test equipment.

SINGLE IC PROJECTS
BP65 **$5.12**
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.

ELECTRONIC GAMES
BP69 **$5.92**
A number of interesting electronic games projects using ICs for both the beginner and advanced enthusiast.

ELECTRONIC HOUSEHOLD PROJECTS
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Most useful and popular projects for use around the home. Includes two-tone buzzer, intercom, smoke and gas detectors, baby alarm, freezer alarm etc etc.

REMOTE CONTROL PROJECTS
BP73 **$6.56**
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.

POWER SUPPLY PROJECTS
BP76 **$5.92**
This book gives a number of power supply designs, including simple unstabilised types, fixed voltage regulated types and variable voltage stabilised designs. The designs are all low voltage types for semiconductor circuits.

POPULAR ELECTRONIC CIRCUITS — BOOK 1
BP80 **$6.56**
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.

ELECTRONIC PROJECTS USING SOLAR CELLS
BP82 **$6.56**
Includes 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.

DIGITAL IC PROJECTS
BP84 **$6.56**
Companion to No 225 Practical Introduction to Digital ICs and BP61 Beginner's Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included.

AUDIO PROJECTS
BP90 **$6.56**
Covers a wide range of audio projects including pre-amplifiers and mixers, power amplifiers, tone controls and matching etc. A number of board layouts and wiring diagrams are included.

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ELECTRONIC TIMER PROJECTS
BP93 **$6.56**
These may have a high degree of accuracy with quartz control or they may be quite simple designs, using only a few components. A number of specialist timer projects are car windscreen wiper delay unit, darkroom timer, metronome etc.

ELECTRONIC PROJECTS FOR CARS AND BOATS
BP94 **$6.56**
Fifteen fairly simple projects designed for use with 12 V electrical systems but in some cases can also be employed with 6 V and/or positive earth systems as well.

MODEL RAILWAY PROJECTS
BP95 **$6.56**
Projects include such things as controllers, signals and sound effects units. Construction stripboard layouts are provided for each project.

CB PROJECTS
BP96 **$6.56**
A number of useful designs include a speech processor, interference filters and a simple CB radio receiver. Stripboard layouts, wiring diagrams and notes on construction are provided.

POPULAR ELECTRONICS CIRCUITS — BOOK 2
BP98 **$7.52**
A companion for BP80, this book provides a wide range of designs for electronics enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed constructional information.

MINI-MATRIX BOARD PROJECTS
BP99 **$6.56**
This book provides a selection of 20 useful circuits which can all be built on a mini-matrix board which is just 24 holes by 10 copper strips in size. Simple and easy for those with not much experience in electronics.

MULTI-CIRCUIT BOARD PROJECTS
BP103 **$6.56**
All circuits are based on one specially designed pc board. Recommended to the less experienced hobbyist.

AERIAL PROJECTS
BP105 **$6.56**
Practical aerial designs including active, loop and ferrite which are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

MODERN OP-AMP CIRCUITS
BP106 **$6.56**
A collection of widely varying circuits and projects based on the op-amp ICs.

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 **$6.56**
Helps you to overcome the problems of a circuit that doesn't work by indicating how and where to start looking for many of the common faults that can occur when building up a project.

circuit techniques and design

TTL COOKBOOK
21035P **$17.50**
A complete look at TTL logic circuits — what TTL is, how it works, and how to use it. Many kinds of practical TTL are included, such as digital counters, electronic stopwatches, digital voltmeters, etc.

ACTIVE-FILTER COOKBOOK
21168P **$21.95**
Learn how to construct filters of all kinds — highpass, lowpass, bandpass. The book is easy to understand — no advanced maths or obscure theory is used.

UNDERSTANDING IC OPERATIONAL AMPLIFIERS
21511P **$10.25**
Latest edition of this book covers theoretical and practical aspects of operational amplifiers and associated circuits. This edition includes material on BIFET and BiMOS and CMOS op-amps.

CMOS COOKBOOK
21398P **$19.25**
This book explains CMOS technology and its application to 'real world' circuitry. A mini-catalogue is included, which lists over 100 devices, giving their pinouts and application notes.

IC TIMER COOKBOOK
21416P **$15.95**
Gives you a look at the hundreds of ways IC timers are used in electronic instrumentation.

IC CONVERTER COOKBOOK
21527P **$20.75**
Written for the practising engineer, technician, hobbyist or student, this book will be an invaluable working guide to the understanding and use of IC analogue/digital and digital/analogue converters.

DESIGN OF OP-AMP CIRCUITS, WITH EXPERIMENTS
21537P **$16.50**
The design of the fundamental circuits that are the basic building blocks of more sophisticated systems. A series of 35 experiments illustrates the design and operation of linear amps, differentiators and integrators, voltage and current converters, active filters, and lots more.

555 TIMER APPLICATIONS SOURCE BOOK, WITH EXPERIMENTS
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This book describes the construction of the 555 timer and gives numerous practical examples of its applications in all areas of electrical and computer engineering, including 17 simple experiments.

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GUIDE TO CMOS BASICS, CIRCUITS, AND EXPERIMENTS
21654P **$14.95**
If you are already familiar with TTL devices and are ready to examine the benefits of CMOS, this book is your complete source. It tells you what CMOS devices are, their characteristics and design rules. 22 experiments demonstrate the concepts discussed.

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DESIGN OF VMOS CIRCUITS, WITH EXPERIMENTS
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Basic op-amp theory in detail, with 200 practical, illustrated circuit applications: JFET and MOSFET units are featured, plus manufacturers' data sheets and company addresses.

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Projects include amplifiers and converters, test equipment, tuners, receivers and receiver aids, mixers and tone controls etc etc. The FET used is not critical. This book is of interest and value to SW listeners, radio amateurs, hi-fi enthusiasts and general experimenters.

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PROJECTS IN OPTO-ELECTRONICS
BP45 $5.92
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LM 3900 IC PROJECTS
BP50 $4.64
Unlike conventional op-amps, the LM 3900 can be used for all the usual applications as well as many new ones. It's one of the most versatile, freely obtainable and inexpensive devices around. This book provides the groundwork for simple and advanced uses — it's much more than a collection of projects. Very thoroughly recommended.

50 CIRCUITS USING 7400 SERIES ICS
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50 interesting and useful circuits and applications using these inexpensive and versatile devices.

50 CMOS IC PROJECTS
224B $4.64
Projects include multivibrators, amplifiers and oscillators, trigger devices and other special devices.

SECOND BOOK OF CMOS IC PROJECTS
BP59 $5.12
Leading on from book number 224 '50 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.

COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS
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Well-known author F.G. Rayer features applications and projects using various types of numerical displays, popular counter and driver ICs, etc.

VMOS PROJECTS
BP83 $6.56
Though primarily concerned with VMOS power FETs and their applications, power MOSFETs are dealt with too, in a chapter on audio circuits. Projects include audio circuits, sound generator circuits, dc control circuits and signal circuits.

DIGITAL IC PROJECTS
BP84 $6.56
Helps the reader to develop a knowledge of the workings of digital circuits. Board layouts and wiring diagrams are included.

HOW TO USE OP-AMPS
BP88 $7.52
Design notes and applications on many topics including basic theory, amplifiers, power supplies, audio circuits, oscillators, filters, computers and control engineering. It's written around the 741 IC but includes design notes for most of the common op-amps.

ELECTRONIC TIMER PROJECTS
BP93 $6.56
These may have a high degree of accuracy with quartz control or they may be quite simple designs, using only a few components. A number of specialist timer projects are car windscreen wiper delay unit, darkroom timer, metronome etc.

ETI CIRCUITS BOOKS 1/2/3
$2.95 ea
Many of these circuits have been published in the 'Ideas for Experimenters' section in ETI.

ETI CIRCUIT TECHNIQUES VOLS 1/2
$4.75 ea
The how, what, which, where, why and how much anthology of electronic components, circuits and techniques.

ETI CIRCUIT TECHNIQUES VOL 3
$4.95

test equipment and fault finding

AUTOMOTIVE TUNE-UP AND EMISSION CONTROL SERVICE
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MICROCOMPUTER DESIGN AND TROUBLESHOOTING
21819P $26.75
Tells you how to design microcomputer systems and make them work without an expensive commercial development system or the need for costly test instrumentation. The author also provides a complete description of two popular microprocessors — the 8085 and the 6502.

PRACTICAL REPAIR AND RENOVATION OF COLOUR TVS
BP34 $4.32
This book shows how to obtain a working colour TV for very little outlay by repairing and renovating a set that has been 'written off' by a dealer. Includes practical details of how to construct your own CRT tester/rejuvenator and cross hatch generator.

TRANSISTOR RADIO FAULT-FINDING CHART
BP70 $1.92
Used properly, this chart should enable the reader to trace most common faults quickly. Across the top of the chart are four rectangles containing brief descriptions of the faults. Selecting the appropriate fault, the reader simply follows the arrows and carries out the suggested checks in sequence until the fault is cleared.

ELECTRONIC TEST EQUIPMENT CONSTRUCTION
BP75 $5.92
Describes construction of wide range of test gear including FET amplified voltmeter, resistance bridge, field strength indicator, heterodyne frequency meter etc.

POWER SUPPLY PROJECTS
BP76 $5.92
Includes simple unstabilised types, fixed voltage regulator types and variable voltage stabilised designs. The designs are all low voltage types for semiconductor circuits.

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 $6.56
Helps you to overcome the problems of a circuit that doesn't work by indicating how and where to start looking for many of the common faults that can occur when building up a project.

USE OF THE OSCILLOSCOPE
39389P $27.95
Programmed instruction course for use in a basic electrical engineering laboratory course. Author assumes basic knowledge of DC and AC circuits but none of oscilloscopes. This is an essentially practical course — thoroughly recommended.

TEST GEAR — METERING AND POWER SUPPLY PROJECTS
$3.00
Includes many types of meters, audio noise and signal generators, simple CMOS tester, oscilloscope calibrator etc.

TEST GEAR — VOL. 2
$3.95
Projects include audio oscillator, transistor tester, true RMS voltmeter, RF signal generator, versatile logic test probe, microwave oven leak detector etc.

ELECTRONIC PROJECTS FOR YOUNG SCIENTISTS
$3.95
PH meter, geiger counter, helium-neon laser, sound level meter, solar cells, negative ion generator and much more.

electronic music/audio/video

CHEAP VIDEO COOKBOOK
21524P $11.75
Complete discussion of a new, low-cost way to get words, pictures and opcode out of your computer and onto any ordinary TV screen, using a seven-IC easy-to-build circuit which you can build for less than $20.

AN INTRODUCTION TO VIDEO
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This book is written in layman's language and is for anyone who is thinking about buying or renting or who has just bought or rented a video recorder and wants to get the best out of the machine.

MOBILE DISCO HANDBOOK
BP47 $4.64
Most people who start mobile discos know little about equipment or what to buy. This book assumes no preliminary knowledge and gives enough info to enable you to have a reasonable understanding of disco gear.

AUDIO CYCLOPEDIA
20675P $66.00
A complete in-depth look at the art of audio — from the basic principles of sound to solid-state and integrated circuits. Over 3000 entries and hundreds of illustrations and circuit diagrams cover acoustics, amplifiers, recording, reproduction, test equipment, audio measurements, and much more.

ELECTRONIC MUSIC CIRCUITS
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How to build a custom electronic music synthesiser, outlines numerous other circuit designs and then shows you how to modify them to achieve particular responses. Many of the circuits can be used as special-effects boxes for guitars and other musical instruments.

INTRODUCTION TO ELECTRO-ACOUSTIC MUSIC
81515P $15.95
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MODERN RECORDING TECHNIQUES
21037P $19.25
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SOUND SYSTEM ENGINEERING
21156P $32.50
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TUBE SUBSTITUTION HANDBOOK
21746P $8.75
Complete, accurate, up-to-date guide to direct substitutes for receiving and picture tubes. Contains over 6000 receiving tube substitutes, over 4000 monochrome and colour picture tube substitutes, and 600 communications substitutes. Also includes pinouts for quick operational checks.

HOW TO BUILD SPEAKER ENCLOSURES
20520P $8.75
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ACTIVE-FILTER COOKBOOK
21168P $21.95
Learn how to construct filters of all kinds — highpass, lowpass, bandpass. The book is easy to understand — no advanced maths or obscure theory is used.

DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
21539P $15.95
Introduction to the theory, implementation and design of active filters using the 741 op-amp.

AUDIO IC OP-AMP APPLICATIONS
21558P $13.25
This book discusses IC op-amps and their application in audio systems, and describes the numerous advantages of using op-amps, including small spatial needs, low power consumption, reliable performance and low cost. Assumes a basic understanding of op-amp theory.

VIDEO TAPE RECORDERS
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PRACTICAL CONSTRUCTION OR PREAMPS, TONE CONTROLS, FILTERS, ATTENUATORS
BP60 **$4.96**
This book shows the enthusiast how to construct a variety of magnetic tape recording, microphone and disc preamplifiers, and also a number of tone control circuits, rumble and scratch filters, attenuators and pads.

ELECTRONIC SYNTHESISER PRDJECTS
BP81 **$5.92**
For the electronic music enthusiast, an invaluable reference. This book is full of circuits and information on how to build analogue delay lines, sequencers, VCOs, envelope shapers, etc. etc. The author takes a clear and logical approach to the subject that should enable the average enthusiast to understand and build up what appears to be a quite complex instrument.

AUDIO PROJECTS
BP90 **$6.56**
Covers a wide range of audio projects including preamplifiers and mixers, power amplifiers, tone controls and matching etc. A number of board layouts and wiring diagrams are included.

ELECTRONIC MUSIC PROJECTS
BP74 **$5.92**
Provides constructors with practical circuits for the less complex music equipment including fuzz box, waa-waa pedal, sustain unit, reverb and phaser, tremolo generator etc. Text covers guitar effects, general effects, sound generators, accessories.

SONICS 1982 YEARBOOK **$5.35**
An interview with Kraftwerk, how to cope with recording, lighting, rock acoustics, guitars, equipment reviews and more.

SONICS MAGAZINE **$2.35 ea**
The Australian music magazine dedicated to the art and craft of sound. Published April, July, October, Yearbook in December. $15 for one year subscription. Please indicate starting issue.

computers for beginners

COBOL FOR BEGINNERS
39378P **$21.95**
It is a solid text for introductory programming courses in Cobol, using a format that is easy to understand, yet comprehensive enough to make supplementary readings unnecessary.

THE PET PERSONAL COMPUTER FOR BEGINNERS
61827P **$20.95**
This handy guide is written for use with all varieties of PET computer, from the original 2001 to the new 8032 Super PET. It is suited to novices with no practical experience and provides advice and practical examples.

BIG THINGS FROM LITTLE COMPUTERS
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A layperson's guide to personal computing with all the basic information and lots of examples of how personal computers can be used.

BEGINNER'S GUIDE TO DIGITAL ELECTRONICS
BP61 **$3.36**
Covers all essential areas including number systems, codes, constructional and sequential logic, analogue/digital/analogue conversion.

BEGINNER'S GUIDE TO MICROPROCESSORS & COMPUTING
BP66 **$5.92**
Introduction to basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. Only prior knowledge assumed is very basic arithmetic and an understanding of indices.

A MICROPROCESSOR PRIMER
BP72 **$5.92**
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

AN INTRO TO BASIC PROGRAMMING TECHNIQUES
BP86 **$6.56**
Ideal for beginners seeking to understand and program in BASIC. Book includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.

BEGINNING BASIC
39806A **$19.95**
Intended for beginners with no computing experience, one should be able to intelligently program in BASIC in a short time.

BEGINNING FORTRAN
46011A **$19.95**
Starts with simple elementary examples and proceeds to intermediate level programs. Also includes references, tutorials, flow charts, deck set-ups and matrix algebra.

UNDERSTANDING COMPUTERS
39815A **$17.95**
This book describes how computers work. For people who use small computers, it starts with the most elementary gates and works up to the complete computer. Gives an understanding of languages and how they operate in the computer.

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39842A **$24.95**
This guide to software teaches you about machine language, assembly language programming and BASIC. The emphasis is not on learning to write programs but on learning to use the thousands of available programs that have already been written.

PEANUT BUTTER AND JELLY GUIDE TO COMPUTERS
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A simple, easy-to-digest source of information on personal computing for the potential buyer who is less than an expert in the field.

INTRODUCTION TO WORD PROCESSING
88076A **$17.95**
Written for the non-technical reader, this book tells about the concepts common to all word processing systems, then analyses all features in detail.

YOUR FIRST COMPUTER
88045A **$12.50**
An easy-to-understand beginner's book to small computers. Understanding them, buying them and using them for personal and business applications.

FROM CHIPS TO SYSTEMS: AN INTROOUCTION TO MICROPROCESSORS
88063A **$19.95**
Explains exactly what a microcomputer system is and how it works. Introduces fundamental concepts and covers all aspects of microprocessors and related components: internal operation, memories, interfacing and system development etc.

COMPUTERS FOR EVERYBODY
39849A **$8.95**
In this easy-to-understand book it is explained how a computer can be used at home, in the office or at school. Includes a consumer's guide to computer equipment that will help the reader decide what to buy and who to buy it from.

computers hardware & techniques

IAPX 88 BOOK
93016P **$20.25**
This book from Intel itself describes the unique Intel 8088 microprocessor in total detail. Absolutely invaluable for all involved with the 8088.

USING THE 6800 MICROPROCESSOR
21512P **$13.25**
This will guide the reader through the conception, configuration, writing and running of a variety of programs that demonstrate practical use of a 6800 system.

Z80 MICROCOMPUTER DESIGN PROJECTS
21682P **$20.75**
This book provides a complete look at the internal architecture of the Z80, the heart of many microcomputers, and even shows how to build a microcomputer, the EX80, using this powerful chip.

MICROPROCESSOR CIRCUITS VOL. 1
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Presents basic microprocessor concepts in simple language for beginners and teaches you to construct a useful microcontroller system. Offers 30 demo circuits which take you through assembly, operation and programming of a microcontroller.

INTERFACE PROJECTS FOR THE APPLE II
69387P **$15.95**
A series of interface projects that are easily built and enable the user to realise the computer's potential through project construction. Projects are primarily hardware-orientated, with some software supporting the hardware.

PET INTERFACING
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6809 MICROCOMPUTER PROGRAMMING AND INTERFACING, WITH EXPERIMENTS
21798P **$21.95**
Gives a solid understanding of how to program and interface the high-performance 6809 microprocessor. The author completely explores internal structure, addressing modes, data movement instructions, registers, arithmetic logic and test instructions for the 6809.

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This thorough handbook covers hardware, software and microcomputers built around the Z80.

THE S100 AND OTHER MICRO BUSES
21810P **$13.25**
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MICROCOMPUTER DESIGN AND TROUBLESHOOTING
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Tells you how to design microcomputer systems and make them work without an expensive commercial development system or the need for costly test instrumentation. The author also provides a complete description of two popular microprocessors — the 8085 and the 6502.

OON LANCASTER'S MICRO COOKBOOK, VOLUME 1
21828P **$20.75**
This 'cookbook' starts with the very fundamentals of microprocessors and microcomputers and takes you through number systems, codes, memory, etc. until you can work intelligently with micros.

MICROPROCESSOR CIRCUITS VOL. 1
21877P **$14.75**
Presents basic microprocessor concepts in straightforward language for beginners. Teaches you to construct a useful microcontroller system through progressive demonstration circuits.

8080 MICROCDMPUTER EXPERIMENTS
39808A **$29.50**
This 'hands on' book includes 105 experiments presenting programs and diagrams as required for clarification.

A STEP-BY-STEP INTRODUCTION TO 8080 MICROPROCESSOR SYSTEMS
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Doesn't require any electronics or computer background. This book describes the 8080 architecture and instruction set through simple examples. Some basic software is introduced.

OIGITAL CIRCUITS WITH MICRDPROCESSOR APPLICATIONS
46032A **$39.50**
An introductory text, this book provides readers with the basic ideas and tools needed to analyse and design digital circuits and computer systems. Discusses microprocessor computer organisation, machine language number systems and gate circuits.

MICROPROCESSOR INTERFACING TECHNIQUES
88029A **$24.95**
Teaches you how to interconnect a complete microprocessor system and interface it to the usual peripherals. The hardware and software skills needed to effectively interface peripheral devices are covered along with various buss standards and A/D conversion.

PRACTICAL INTRO TO DIGITAL ICS
225B $4.32
Introduction to digital ICs (mainly TTL 7400). Besides simple projects, includes logic test set to identify and test digital ICs. Also includes digital counter-timer.

BEGINNER'S GUIDE TO MICROPROCESSORS & COMPUTING
BP66 $5.92
Introduction to basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. Only prior knowledge assumed is very basic arithmetic and an understanding of indices.

A MICROPROCESSOR PRIMER
BP72 $5.92
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

PRACTICAL COMPUTER EXPERIMENTS
BP78 $5.92
How to build typical computer circuits using discrete logic. This book is a useful intro to devices such as adders and storers as well as a general source book of logic circuits.

THE 6809 COMPANION
BP102 $6.56
It is not a beginners introduction to microprocessors in general but a discussion of the features of the 6809 and a reference work for the 6809 programmer in particular.

COMPUTERS & COMPUTING YEARBOOK 1982 $4.95
Includes disks, CP/M and your computer, learners microcomputer, programming in CHIP-8, alphasort, fast plotter, PET talk, the System 80 etc.

computing software

HOW TO WRITE AN APPLE PROGRAM
92990P $23.25
Very much a 'how-to' book. Author assumes only a minimal familiarity with computer and BASIC. The book covers every aspect of simple program writing from initial concepts to final debugging — wittily illustrated too!

HOW TO WRITE A TRS-80 PROGRAM
92992P $23.25
This book is virtually identical to 'How to Write an Apple Program' (92990P) described above. Changes have been made to allow for differences in the two machines and variations in BASIC. Also wittily illustrated!

HOW TO WRITE AN IBM PC PROGRAM
92991P $23.25
See above.

USING THE UNIX SYSTEM
98162P $24.95
This book by Richard Gauthier of RGL has been written for people with some knowledge of computers, but with no specific knowledge of Unix. It is however also of value to current Unix users.

APPLE FILES
90191P $23.25
This book is for people who know some BASIC and would like to expand and apply this knowledge by using file capabilities of the Apple. Includes programs for the stock market, mailing lists, inventories, grades and medical records.

CP/M PRIMER
21791P $21.95
A complete one-stop course on CP/M, the very popular operating system for 8080, 8085 and Z80-based microcomputers. Complete terminology, hardware and software concepts, startup of a CP/M system, and a complete list of CP/M-compatible software.

THE CP/M HANDBOOK (WITH MP/M)
88048A $19.95
Contains a step-by-step description of all the CP/M command features. Designed for the beginner, the book progresses to detailed explanations of the file transfer program, the debugging program and CP/M's text editing program.

HOW TO GET STARTED WITH CP/M
39832A $19.95
This practical book eases the reader into the essentials of the system, giving an overview of the operating system, an idea of what it will be like to use and what it can do for the reader.

AUSTRALIAN MICROCOMPUTER HANDBOOK
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Normally $25.00. A detailed buyer's guide to microcomputer systems and application packages in commercial, industrial, scientific, educational and home/hobby areas.

THE 68000: PRINCIPLES AND PROGRAMMING
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An easy-to-read, systematic approach to the 68000 advanced 16-bit microprocessor. The book guides you through the complex architecture, instruction set, pinouts and interfacing techniques. Written for design engineers, programmers and students.

PROGRAMMING IN BASIC FOR PERSONAL COMPUTERS
30739P $14.75
Simple instructions show how to give BASIC commands and statements a wide range of applications, from programming video games to developing business or scientific programs.

PROGRAMMABLE CALCULATORS
46008A $24.95
This book suggests which calculators to buy, their possibilities and limitations, and the how-tos of programming them.

TAKE A CHANCE WITH YOUR CALCULATOR
39807A $14.95
An introduction to modern mathematics, this book deals with programming of programmable calculators and includes probability problems.

AN INTRO TO BASIC PROGRAMMING TECHNIQUES
BP86 $6.56
Ideal for beginners seeking to understand and program in BASIC. Book includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.

BASIC FOR EVERYONE
61481P $19.75
349 pages of BASIC information for all purposes.

BEGINNING BASIC
39806A $19.95
Intended for beginners, this book discusses how a programmer and a basic computer interact with the computer, problems likely to be met by the beginner, the need for and uses of documentation etc.

FIFTY BASIC EXERCISES
88056A $17.95
Designed to teach BASIC through actual practice, this book contains graduated exercises in math, business, operations research, games and statistics. The programs were designed to run directly on a TRS-80 and will run with minor or no changes on any system with Microsoft BASIC.

INSIDE BASIC GAMES
88055A $19.95
The medium of games teaches readers how to design error-free, interactive BASIC programs. Rules, algorithms and coding differences for the PET, APPLE II and TRS-80 are also included.

MICROSOFT BASIC
39823A $19.95
Includes branching and loops, arithmetic in BASIC, strings, editing, arrays and files, the disk and a description of the Radio Shack Level II BASIC.

INTRODUCTION TO FORTH
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computing for business

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SMALL BUSINESS COMPUTER SYSTEMS
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THE VISICALC BOOK — APPLE EDITION
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THE CP/M HANDBOOK (WITH MP/M)
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DON'T (OR HOW TO CARE FOR YOUR COMPUTER)
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INTRODUCTION TO WORD PROCESSING
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INVENTORY MANAGEMENT FOR SMALL COMPUTERS
39848A $24.95
Owners of retail businesses and their employees need this book. The program provides an inventory control system so that you know what stock is on hand, where it is located, what price was paid for it and the selling price.

BASIC FOR BUSINESS FOR THE TRS-80
90352P $22.25
This book covers the application of BASIC language to business uses on the TRS-80 models II and III.

FROM THE COUNTER TO THE BOTTOM LINE
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THE OFFICE AUTOMATION PRIMER
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amateur radio, DX, communications

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RADIO STATIONS GUIDE
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AN INTRODUCTION TO RADIO DXING
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general

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Besides including both simple and more sophisticated burglar alarm circuits using light, infrared and ultra-sonics, this book also gives circuits for gas and smoke detectors, flood alarms, fire alarms, doorphones, baby alarms, etc.

ELECTRONIC CALCULATOR USERS' HANDBOOK
BP33 **$5.12**
Presents formulae, data, methods of calculation, conversion factors, etc. for use with the simplest or most sophisticated calculators. Includes the way to calculate using only a simple four-function calculator: trigonometric functions; hyperbolic functions; logarithms, square roots and powers.

YOUR ELECTRONIC CALCULATOR AND YOUR MONEY
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Starts with a basic revision of percentages and decimals, then deals with mortgages, cars, insurance, fuel, shopping, tax etc. There's a section on investment and the last section deals with the calculator in a small business.

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FOR SALE: DAVID HAFLER DH200 amplifier, 100 WRMS/ch, dc — 150 kHz. Superb sounding power amp. Mint condition, $620. (02)896-2975.

FOR SALE: EQUALISER/REALTIME spectrum analyser. Fast/slow LED grid, pink noise, calibrated microphone, multi-purpose line/level processor. Audio control C-101. New $800, sell $455. (02)620-1203.

WANTED: ELCASSETTES and player in any condition. Also four track tape deck. Lachlan MacDonald, P.O. Box 218E, Ballarat, East Vic. 3350. (053)41-3658.

AUDIORAMA RECORDING CLUB is the club for you. We seek the enthusiast and the beginner. Many services available. For details contact G. Harris, 7 Coleman Ave, Homebush NSW 2140.

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FOR SALE: HANIMEX 4400 SL synchrocorder. Cassette recorder with inbuilt slide projector controller. As new condition, with accessories, instructions, $190. Terry Day (02)73-0433 ext. 440.

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WANTED: SINGLESIDEBAND receiver, 12 V, crystal-locked, loudspeaker, covering channels used on small ships, broadcasts by Brisbane radio. I require a circuit to be designed and a set to be made. Contact H. Fraser, PO Box 158, Bunderim Qld 4556.

FOR SALE: ARC 3-channel/3-servo remote control system, never been used, $100. Amphenol 10-channel AM transceiver, $50. Scott (068)47-2532.

FOR SALE: SX200 scanner, IC290A. All mode 2 metres, Daiwa VHF-UHF SWR. All as new. FM321 80-channel UHF, 16-element LPY. (047)54-2214, leave message.

MISCELLANEOUS

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SELL: ADDO tape punch, reader, spare punch mechanism, 10 rolls tape, $80. Model 15 TTY, $35. Paul Fuller, 24 Penman St, New Lambton NSW 2305. (049)57-2409 weekends.

FOR SALE: UNUSED parts, 74181N, DM74126N, DEC7476, FND500, NM74C175, DM74153N, MC14012B, DM74150N, DM7489N, DM7476N, F7442APC, MC14001B, SN 7483 AJ, DM7474N, LM325N, 7622, HEF4081P, DM7486N, MC14078B, 7705, DM7448N. (08)295-3181.

WANTED: TELONIC sweep generators, 1006-1011-1030, state price. Will consider others with same coverage. Hickman, PO Box 74, Hamilton NSW 2303. (049)48-5553.

COMPUTERS

FOR SALE: ETI-660 3K colour, modulator. Fibreglass case, hex keypad, power supply, loudspeaker, step-repeat function plus many programs on cassette, $165. (02)542-1365

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FOR SALE: HEWLETT-PACKARD HP-85 desktop computer, 32K. Compact, built-in VDU, random-access minicartridge and thermal printer. BASIC, Visicalc, games, tapes, paper. As new, $2500. (03)80-5635 ah.

MODEM CLUB for System-80 and TRS-80 computers. (03)397-6972 for verbal enrolment.

FOR SALE: DBASE II including ZIP and TUTOR. Relational database management system and report generator for Osborne 1. Total value over $900. Will sell $400. Vic (02)747-4218.

FOR SALE: DISK DRIVES for Apple. Two low-profile 250K drives. Brand new, never used, $380 each. (03)339-5604 bh or (03)379-4438.

WANTED TO BUY: Standard mini-floppy drive, Epson printer. B.J. Wight (08)356-0817.

FOR SALE: DIGITAL CASSETTE drives (3), 720K/cassette, 24 Kbaud. Fast fwd/bwd file search, load a 15K file in 5 s. Full documentation including proven interface. $120 each. (03)339-5604 bh or (03)379-4438 ah.

MICROBEE OWNERS: The Sydney MicroBee Users' Group (formerly Northside) is your most concentrated source of information, with monthly meetings and newsletters. Phone Tony Williams (02)909-3951 or Colin Tringham (02)92-6408 ah.

FOR SALE: MICROBEE 'Guess the Number' program. Three levels of play. Tape $5. T. Knowler, 37 Bingley Crescent, Fraser ACT 2615.

ACT VIC-20 BIMONTHLY NEWSLETTER: Many interesting articles and programs. June issue $1.50. Bimonthly $8 per year. Write to Chris Groenhout, 25 Kerferd St, Watson ACT 2602.

SELL: ZX 80/81, 4/8K ROM, 16K RAM. Complete with printer, tape recorder, mags, etc. Perfect running order. Half price $399. (08)384-4208

SELL: TI RS232 interface, $180. Tandy Mk. VII printer, $350. SD Z80 starter kit, $250. B.J. Wight (08)356-0817.

FOR SALE: ZX81, 1K, leads, manual, 1.2 A power supply, numerous programs, constructional articles (add-on memory, etc). $170 ono. F. Los, 13 Kroombit St, Dulwich Hill NSW 2203.

SELL: MICROACE (ZX80 equivalent). 2K adaptor, leads, manual, one tape, three books, $170 ono. G. Clarke, 33 May St, Inverell NSW 2360.

SELL: CENTRONICS 737 printer. 30 cps upper/lower case, three font styles, friction/tractor feed. With manual, carry case and leads, $800. J. Thomas (02)546-4321.

FOR SALE: SYSTEM-80 computer, 16K RAM, joystick interface, over $400 worth of software, manuals, books, etc. Good condition. Software recorded on 50 tapes. $250. Tasmania (002)72-6412.

FOR SALE: ETI-660 microcomputer, ETI-760 modulator, 3K RAM, colour option. Constructional, programming and software articles, also most of published software on tape. $140. Peter (02)708-2014.

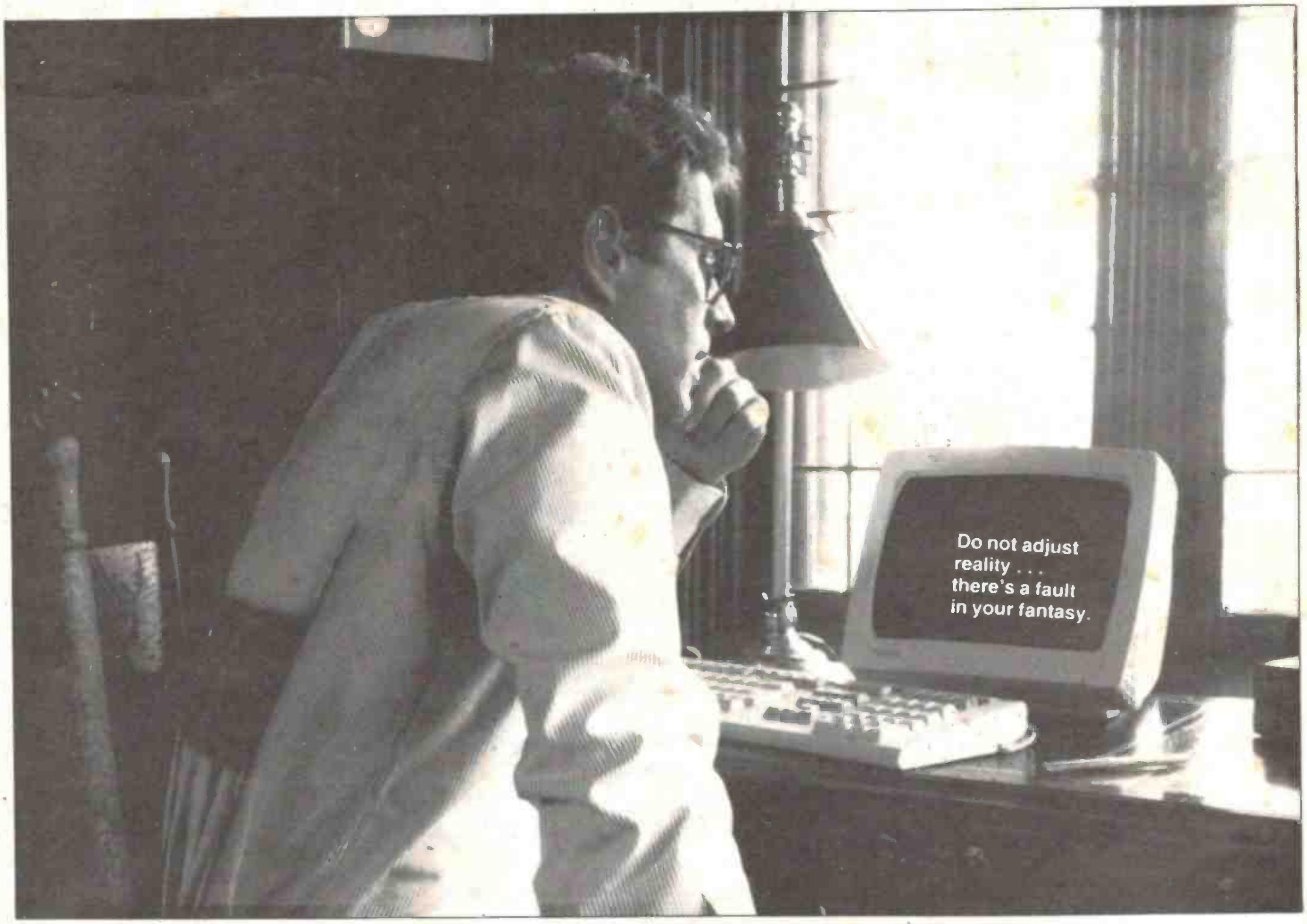
SELL: TARBELL SD/DD floppy disk controller board, $300. Godbout RAM 16 64K, 8/16 bit memory board, $650. A. Cummins, 17 Torrington Rd, Maroubra NSW 2035. (02)349-3684.

SIEMENS 100 TELEPRINTER: A limited number of operational units are available. The models come with or without a keyboard and/or tape punch or reader. They can be picked up or delivered for vehicle running costs, meet you halfway, literally. From $65. Frank Rees, 27 King St, Boort Vic 3537.

SPARE PARTS: Most parts except motors available, to be sold as subassemblies, e.g: any part for type basket (character font) can be obtained by buying whole assembly. I have some arms (badly bent) with characters intact for those capable of changing ends. All parts from $2 to $15. Parts available include tape punch and reader assemblies complete, each $5. Despatch post or rail. Frank Rees, 27 King St, Boort Vic 3537.

SUPPORT AVAILABLE: As a keen hobbyist I'll correspond with anyone needing assistance with their hobby. Frank Rees, 27 King St, Boort Vic 3537.

DREGS



FOR THOSE FANS of the computer and the ubiquitous computer game who have braved the queues and the crowds to see the movie (and I use that term loosely) 'Tron', ponder a moment what went on on 'the inside'. There was the hero, whizzing around inside the circuits, through gates, over flop-flops, down the buss etc. in his own little 'carrier'. Pursuing our micro hero were numerous 'baddies', but along the way were some friendly 'components'. It was all a deadly serious fantasy in the best cops-and-robbers, cowboys-versus-Indians, good-versus-evil traditions.

If you haven't seen Tron, dig it out in some suburban cinema or from a videotape library and *see it*. You'll never view a computer or computer game in the same benign, familiar-with-that fashion *ever* again.

Sidestepping the kill-or-be-killed basis of the Tron fantasy and drifting off in a direction more reminiscent of Woody Allen or Mel Brooks, just let your thoughts wander along a more whimsical or satirical path.

Imagine the sort of conversations you might hear if you could plug in to the circuits inside a computer or computer game and have all those 'instructions' decoded into speech. Your digito-doodling Dregs writer did this exercise recently while doing a dump to the office output port and found these 'conversations' drifting through his memory banks:

"I haven't had a good interruption in microseconds," said the microprocessor to the buss driver.

"Would you like a POKE?" said the data buffer to the screen RAM.

"Seal it with a handshake," said the I/O port to the printer.

"No PEEKing," said the protected RAM to the address buss.

"PEEK before you POKE, or you'll risk corrupting your data," said the OS to the input.

Perhaps some of you Dregs fans might come up with some 'conversations' in the same vein? We'll publish the 'best' of them as they come along — no prizes, just a chance to join in the fun. Write to: "Conversations on the buss", ETI Magazine, P.O. Box 21, Waterloo NSW 2017.